Ershi Qi
Jiang Shen
Runliang Dou *Editors*

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

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

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Chapter 1
A New Estimation Method of the Probability of Informed Trading

Chun-lian Xiong and Hua-gui Duan

Abstract The measure of asymmetric information is an important problem in the market microstructure theories. This paper uses MMPP model to model the number of transactions, then the model is used to estimate the probability of informed trading. Our methodology extends the EKOP framework by allowing the arrival rates of traders to vary over time and the probability of news to vary. It can be used to estimate higher frequency PIN, such as daily PIN. Our estimation of PIN can also be applied to stocks with large number of transactions.

Keywords Informed trading · Markov-modulated poisson process · PIN · Uninformed trading

1.1 Introduction

The measure of asymmetric information is an important problem in the market microstructure theories. It helps us understand the risk of information and the related problem of asset pricing.

In the early period, the literatures measured asymmetric information indirectly by some proxy variables. However, since Easley et al. (1996a, b, 1997, EKOP, hereafter), the theoretical foundations of the probability of informed trading (PIN) were established and we can measure the asymmetric information directly by the transaction data. So far, the model of EKOP has become the classical model of the

C. Xiong
College of Management and Economics, Tianjin University, Tianjin, China

C. Xiong (✉)
School of Science, Tianjin Institute of Urban Construction, Tianjin, China
e-mail: xiongchunlian@163.com

H. Duan
School of Mathematical Sciences, Nankai University, Tianjin, China

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measurement of asymmetric information. Since then, many empirical applications of PIN have appeared in the financial literatures. For example, Easley et al. (1996b) used PIN to explain observed differences in spreads for actively and infrequently traded stocks. Easley et al. (2001) employed PIN to study whether stock split reduce information asymmetries. Easley et al. (2010) examined the relationship between the information risk and asset pricing. Recently, Duarte and Young (2009) demonstrated that PIN can be decomposed into two components, which are related to asymmetric information and illiquidity. They examined the relation between PIN and the cross-section of expected returns. Aslan et al. (2011) used PIN to study the link between microstructure and asset return. Chen and Zhao (2012) investigated the effect of PIN in determining price momentum.

Recently, with the widespread applications of PIN, some researchers have begun to examine its properties. Aktas et al. (2007) documented that the PIN decreases before announcements of M&A and increases after the announcement, however there are considerable evidence of illegal insider trading or information leakage prior to such M&A announcement (Dennis and Mcconnell 1986; Keown and Pinkerton 1981; Meulbroek 1992).

In fact, the EKOP methodology suffers several serious shortcomings. First, the method fails to deliver PIN estimation to all stocks. When the number of buy and sell orders is very large for some actively traded stocks, the estimation of PIN generates overflow error or underflow error.

Second, in the EKOP framework, the trading day and the event day are independent. In fact, the assumption of independence among trading days and among event days is problematic.

Third, the assumption of the arrival rates as constants isn't accord with the financial market. In fact, Easley et al. (2008) proposed a dynamic model to study how the arrival rates of informed and uninformed trading vary over time.

In this paper, to estimate PIN, we design a new methodology that could be viewed as an extension of EKOP, because their definition of the PIN is adopted directly. The new method overcomes the above shortcomings suffered by the EKOP. Our method offers several advantages over the current one. First, the method to estimate PIN can be applied to all the stocks. Second, we can estimate daily PIN and even intraday PIN, in contrast, EKOP can only estimate quarterly PIN at the highest frequency. Third, We not only allow arrival rates to vary over time, but also allow the probability of information to vary.

1.2 EKOP Model and Our Methodology

1.2.1 EKOP Model

In this section, we introduce EKOP model. The model views the trading of a financial asset as a repeating game between a market maker and traders. Nature decides the occurrence of an information event every day. The probability that an information event occurs is denoted by α. If the information event occurs, information is further classified as being either “bad” with the probability δ or “good” with the probability $1 - \delta$. EKOP model the aggregate number of buyer-initiated and seller-initiated orders each day as independent Poisson variables, with different arrival rates for days with good news, no news and bad news. Uninformed traders with no information submit buy orders and sell orders at the arrival rate ε_b and ε_s respectively. On the day when good information event occurs, informed traders submit buy orders at the arrival rate μ and when bad information event occurs, informed traders submit sell orders also at the arrival rate μ. The characterization of each trading day is unknown, and the likelihood of the numbers of buy and sell orders is based on the mixture-of-Poisson distribution. The daily conditional probability of observing buy orders B_i and sell orders S_i on each trading day i equals:

$$\begin{aligned} L(\theta|B_i, S_i) = {} & \alpha(1-\delta)e^{-(\mu+\varepsilon_b)}\frac{(\mu+\varepsilon_b)^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{\varepsilon_s^{S_i}}{S_i!} \\ & + \alpha\delta e^{-\varepsilon_b}\frac{\varepsilon_b^{B_i}}{B_i!}e^{-(\mu+\varepsilon_s)}\frac{(\mu+\varepsilon_s)^{S_i}}{S_i!} \\ & + (1-\alpha)e^{-\varepsilon_b}\frac{\varepsilon_b^{B_i}}{B_i!}e^{-\varepsilon_s}\frac{\varepsilon_s^{S_i}}{S_i!}, \end{aligned} \tag{1.1}$$

where $\theta = (\alpha, \delta, \varepsilon_b, \varepsilon_s, \mu)$ is the set of parameters in the EKOP model. EKOP assume that the trading days are independent, and construct the aggregate log likelihood function on the time series of buys and sells for T days as a sum of the logarithm of the above daily conditional probabilities:

$$L[\theta|M] = \sum_{t=1}^{T} \ln L(\theta|B_i, S_i), \tag{1.2}$$

where $M = ((B_1, S_1), \ldots, (B_T, S_T))$ represents the observing dataset. The probability of informed trading (PIN) is defined as follows:

$$PIN = \frac{\alpha\mu}{\alpha\mu + \varepsilon_b + \varepsilon_s}. \tag{1.3}$$

From the definition, we know PIN measures the ratio of the number of transactions from informed traders divided by the number of transactions from all traders. Maximizing the log probability in Eq. (1.2) over the parameters, we can have the estimation of these structural parameters. However, because no closed-form solution is available to the maximization problem, a numerical maximization technique must be used to obtain a solution. When the trading number is large, it will cause underflow or overflow problems in the maximization process.

1.2.2 Our New Methodology to Estimate PIN

1.2.2.1 Modeling the Number of Trades Based on Markov-Modulated Poisson Process

A Markov-modulated Poisson process (MMPP) is a Poisson process whose instantaneous rate is itself a stationary random process which varies according to an irreducible n-state Markov chain. If n is 1, then the process is just a Poisson process. Points from the MMPP are often referred to as the observed data and the underlying Markov chain as the hidden data. MMPP is widely used in modeling time-varying intensity rate processes such as traffic flows of communication networks, internet traffic flows and queuing systems.

EKOP argues that the arrival rate obeys to Poisson processes throughout the day and the daily arrival rate is constant. However, this is not the case for financial markets. The time series of the number of transactions reflect the underlying hourly, daily, and weekly rhythms of uninformed traders' activity. At the same time, the time series are often corrupted by information events corresponding to burst of unusual informed trading behavior. Trading from informed traders is determined by whether there is new information; however, the information event obeys to one order hidden Markov process.

From the above analysis, we can consider the time series of the number of transactions as from MMPP and model it by Scott and Smyth (2003) nonhomogeneous Markov-modulated Poisson process. The following is the process to model the time series of the number of transactions.

Let us assume that

$$N(t) = N_0(t) + N_E(t), \quad N(t) \geq 0,$$

where $N_0(t)$ is the number of transactions from uninformed traders at time t, $N_E(t)$ is the number of transactions from informed traders at time t.

1. *Modeling the Number of Transactions from Uninformed Traders* $N_0(t)$

According to the EKOP model, we assume the number of transactions from uninformed traders obeys to Poisson process and use a nonhomogeneous Poisson process with a particular parameterization of the rate $\lambda(t)$ to consider the different arrival rates at different intraday time intervals. We decompose $\lambda(t)$as

$$\lambda(t) = \lambda_0 \delta_{d(t)} \eta_{d(t),h(t)},$$

where $d(t)$ takes on values $\{1, 2, 3, 4, 5\}$ and indicates the day on which time t falls (so that Monday = 1, Tuesday = 2, and so on), $h(t)$ indicates the interval (e.g. 5 min for the paper) in which time t falls, $\sum_{j=1}^{5} \delta_j = 5$ and $\sum_{i=1}^{D} \eta_{j,i} = D, \forall j$, D is the number of time intervals in a day (48 for the paper). We can ensure that the value λ_0, δ, η are easily interpretable: λ_0 is the average rate of the Poisson process over a full week, δ_j is the day effect, or the relative change for day j, and $\eta_{j,i}$ is the time of day effect, or the relative change in time period i on given day j. In the paper, we not only consider the change for a week, but also the change for a intraday, this makes it more in accord with the fact of financial markets.

By choosing conjugate prior distribution for these variables, we can ensure that the inference computation in the following section has a closed form:

$$\lambda_0 \sim \Gamma(\lambda; a^L, b^L);$$

$$\frac{1}{5}[\delta_1, \ldots, \delta_5] \sim \mathrm{Dir}(\alpha_1^d, \ldots \alpha_5^d);$$

$$\frac{1}{48}[\eta_{j,1}, \ldots, \eta_{j,48}] \sim \mathrm{Dir}(\alpha_1^h, \ldots \alpha_{48}^h),$$

where Γ is the Gamma distribution, and Dir(•) is a Dirichlet distribution with the specified parameter vector.

2. *Modeling the Number of Transactions from Informed Traders $N_E(t)$*

Information event causes informed trading $N_E(t)$, this makes the number of transactions increase. To model the behavior of informed traders, we use a double process $z(t)$ to indicate the present of an event, i.e.,

$$z(t) = \begin{cases} 0, & \textit{if there is no event at time t} \\ 1, & \textit{if there is event at time t} \end{cases}$$

Define the probability distribution over $z(t)$ to be Markov in time, with transition probability matrix

$$M_z = \begin{pmatrix} z_{00} & z_{01} \\ z_{10} & z_{11} \end{pmatrix}$$

We give the transition probability variables priors specified as

$$[z_{00}, z_{01}] \sim \mathrm{Dir}(z;\ [a_{00}^Z, a_{01}^Z,]),$$

$$[z_{10}, z_{11}] \sim \mathrm{Dir}(z;\ [a_{10}^Z, a_{11}^Z,]),$$

where $Dir(\bullet)$ is the Dirichlet distribution.

Given $z(t)$, we can model the increase in the observation number of trading due to the event, $N_E(t)$, as Poisson process with rate $\gamma(t)$

$$N_E(t) \sim \begin{cases} 0, & z(t) = 0, \\ P(N, \gamma(t)), & z(t) = 1, \end{cases}$$

where P(•) is Poisson distribution, and $\gamma(t)$ as independent at each time t

$$\gamma(t) \sim \Gamma(\gamma, a^E, b^E)$$

In fact, $\gamma(t)$ may be marginalized over analytically, since $\int P(N;\gamma)\Gamma(\gamma;a^E,b^E)\mathrm{d}\gamma = \mathrm{NBin}(N,a^E,b^E/(1+b^E))$ where $\mathrm{NBin}(\cdot)$ is the negative binomial distribution.

Given $z(t)=Z(t)$, we can determine $N_E(t)$ and $N_0(t)$ by sampling. If $z(t)=0$,we take $N_0(t)=N(t)$, if $z(t)=1$ we draw $N_0(t)$ from the negative binomial distribution.

1.2.2.2 Estimating the Parameters and Sampling the Variables

We use Markov chain Monte Carlo (MCMC) method to estimate the parameters and sample the variables. There are four steps:

Step 1: given $N_0(t)$, estimate the three parameters of λ_t, i.e., λ_0, δ, η. For the first estimation, we use the observed number of transaction to replace $N_0(t)$;

Step 2: given $N(t)$, λ_t, M_z, estimate $z(t)$. For the first estimation, the value of $M_z$is priors.

Step 3: according to the value of $z(t)$ from step 2, we can count the frequency of the transition of different values of $z(t)$, so we can obtain the value of M_z, then we use it to replace M_z.

Step 4: given $N(t)$, λ_t, $z(t)$, we use MCMC method to sample $N_0(t)$, $N_E(t)$.

We iterate between drawing samples of the hidden variable $\{z(t),N_0(t),N_E(t)\}$ and parameters until the sampler converges, where convergence is informally assessed by monitoring the parameters values and values of the marginal likelihood.

1.2.2.3 Our New Estimation Method of PIN

From the EKOP model, PIN is defined by

$$PIN=\frac{\text{the expected number of transactions from informed traders}}{\text{the expected total number of transactions from all traders}}$$

According to the definition, and use MMPP model, we have:

$$\hat{PIN}=\frac{\text{the mean of the number of transactions from informed traders}}{\text{the mean of the total number of transactions from all traders}}=\frac{\overline{NE}}{\overline{Nt}}$$

where $\overline{NE}$ can be obtained by MMPP model, while $\overline{Nt}$ is the observed number of transactions. When $\overline{NE}$ and $\overline{Nt}$ is the daily number, we can obtain the daily PINs. Because $\overline{NE}$ and $\overline{Nt}$ is different for different days, the daily PINs is also different. This is contrast to EKOP model, which PIN is the same for the whole sample period. When $\overline{NE}$ and $\overline{Nt}$ is the number for the whole sample period, we have the PIN for the whole sample period. In fact, we can obtain different frequency of

PINs for different frequency of $\overline{NE}$ and $\overline{Nt}$. The following is the specific steps to obtain daily PINs by our new method. We denote our method as MMPP_PIN model.

Step 1: We sum the number of transactions by every 5 min per day during the time of 9:30–11:30 a.m. and 13:00–15:00 p.m. Thus, we have 48.05 min data every day.

Step 2: We use MMPP model to separate $\overline{NE}$ from the observed number of transaction.

Step 3: We count the mean of daily $\overline{NE}$ and $\overline{Nt}$, then the daily PIN equals to $\overline{NE}$ divided by $\overline{Nt}$.

If we expect to have the PIN for the whole sample period, we only need to replace the mean of daily $\overline{NE}$ and $\overline{Nt}$ by the mean of $\overline{NE}$ and $\overline{Nt}$ for the whole sample period.

The PIN estimated by our method is different from EKOP model, because we allow the probability of information is dynamics, i.e., using the transition probability matrix to indicate it. We also allow the arrive rates of informed traders and uninformed traders are time varying. These hypotheses make the model more accurate to the real financial markets.

1.3 Empirical Results

1.3.1 Data

We apply our new estimation method of PIN (PIN_MMPP model) to 10 companies listed in Shanghai Stock Exchange, which are most actively traded. These stocks code are 600010, 600016, 600030, 600050, 600383, 600795, 601668, 601766, 601818, 601899. The tick by tick data are obtained from Shanghai Stock Exchange, we use the data form January 10, 2011 to April 29, 2011. We extract three variables on each stock: time of transaction, transaction price, and direction of transaction. We don’t need to use the Lee and Ready algorithm to determine the daily numbers of buys and sells, because the data directly record the trade directions.

Some summary statistics of the data are given in Tables 1.1 and 1.2. The number of buy and sell is substantially large. The mean and median of the number of buy and sell are both more than 11,000, the maximum of the number of buy and sell are 139,039 and 116,398, the minimum of the number of buy and sell are 1 and 0. For this huge number of trades, EKOP model can’t estimate PIN because of the underflow or overflow problems in the maximization process.

Table 1.1 Summary statistics of the number of buy

Code	Mean	Median	SD	Min	Max
600010	36,606	22,699	36,199	2,565	139,039
600016	16,656	12,519	13,519	4,550	65,139
600030	27,200	21,119	19,980	43	108,544
600050	11,980	10,241	6,852	19	36,011
600383	20,716	17,143	13,389	16	63,502
600795	12,021	8,983	10,117	7	56,370
601668	12,021	11,823	13,821	24	87,173
601766	23,463	21,282	14,091	1	69,205
601818	14,064	12,372	9,077	24	53,690
601899	25,461	20,694	18,561	51	87,173

Table 1.2 Summary statistics of the number of sell

Code	Mean	Median	SD	Min	Max
600010	34,892	23,634	34,369	0	116,398
600016	14,259	12,867	6,814	4,765	36,941
600030	28,848	25,513	15,356	0	93,730
600050	12,531	11,492	5,193	15	32,981
600383	21,253	20,774	10,587	15	59,964
600795	13,847	12,837	7,393	6	37,117
601668	13,722	12,085	7,434	8	49,687
601766	27,881	24,973	15,338	25	64,833
601818	15,904	14,459	6,710	13	35,401
601899	29,137	26,702	13,865	2	83,971

1.3.2 Results and Discussion

The results of the PIN_MMPP model are presented in Table 1.3. Table 1.3 is the result of daily PIN and the PIN for the whole sample period. It can be seen that the daily PIN of the stocks 600010, 601899 and 600030 are lower, while the stocks 600016, 600050 and 601818 are higher. The mean of daily PIN estimation varies from the lowest value of 0.075 for 600010, which is the stock with the most daily trading of buy and sell orders, to the highest value of 0.182 for 600050, which is the stock with the fewest daily trading of buy and sell orders. The result of the PIN is similarly the result of Tay et al. (2009) who estimated the PIN of five NYSE companies by PIN-AACD model. From the result of PIN for the whole sample period in Table 1.3, we can see that the stock 600010 have the lowest PIN, which is 0.089, while the stock 600016 have the highest PIN, which is 0.213.

Table 1.3 Summary statistics of the pins estimated by MMPP_PIN model

Code	Daily_PIN			ALL_PIN
	Mean	Median	SD	
600010	0.075	0.017	0.095	0.089
600016	0.175	0.161	0.137	0.213
600030	0.087	0.049	0.105	0.149
600050	0.182	0.141	0.142	0.206
600383	0.141	0.111	0.127	0.166
600795	0.132	0.106	0.110	0.154
601668	0.173	0.147	0.150	0.195
601766	0.109	0.090	0.109	0.148
601818	0.157	0.126	0.133	0.186
601899	0.091	0.057	0.104	0.119

Table 1.4 Daily correlation of PIN versus return volatility

Code	600795	601668	601766	601818	601899
Corr(RV, PIN)	0.11	−0.12	0.74	0.15	0.83
Code	600010	600016	600030	600050	600383
Corr(RV, PIN)	0.36	0.73	0.68	0.67	0.62

1.3.3 Evaluation of PIN Estimates

In this section, we study the correlation between daily PIN and daily return volatility, which is estimated by realize volatility, to understand the economic implications of our methodology for estimating PIN.

Wang (1993) demonstrated that asymmetric information increases return volatility. If PIN successfully measures the extent of asymmetric information, we would expect the positive correlation between PIN and return volatility. We denote RV as the realized volatility, computed as the sum of squared difference log mid-quotes. As PIN is predicted to be positively correlated with RV, the correlation between daily PIN and daily realized volatility would help us gauge the appropriateness of our methodology. Table 1.4 shows the correlations between PIN and RV range from −0.12 to 0.83. While only the correlation of stock 601668 is negative, other stocks all have positive correlation, some have high correlation. For example, the correlation of stock 601899 is 0.83. Overall, the result shows that our method of PIN estimation is effect.

1.4 Conclusions and Further Research

In this paper, we extend the EKOP model, and overcome several shortcomings suffered by the EKOP model. We relax the assumption of the constant arrival rates in the EHOP framework. Our enhanced methodology yields daily estimation for the probability of informed trading, and allows the probability of information is dynamics. Our methodology also can be applied to all the stocks. We selected a sample of 10 actively traded stocks in Shanghai Stock Exchange to illustrate our method and also verify the improved economic implications of our methodology.

Our daily estimation of the probability of informed trading can be further used to study the impact of various events such as earnings announcements or merger activity on the level of informed trading. It also can be utilized to investigate the asset pricing implications of informed trading by our methodology.

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Chapter 2
A Study on Coordination Relationship of Construction Industry and Economic Growth in Shaanxi Province

Su-xian Zhang and Ling Yao

Abstract In this paper, construction industry, serving as the pillar industry of national economy, has played a great role in promoting the economic growth. Therefore, it is essential to study the coordination between construction industry and economic growth. This paper takes the actual situation of construction industry and economic growth of Shaanxi Province as an example, selects the data from 2001 to 2010, by using coordination formula to analyze correlation and coordination between construction industry and economic growth. Results show that the coordination between construction industry and economic growth is at a high level, but it also slightly fluctuates. In order to enhance the coordination between construction industry and economic growth, sustainable economic growth should be maintained, technological progress and innovation in construction should be strengthened and construction growth mode should be transformed.

Keywords Coordination · Construction industry · Economic growth · Shaanxi

2.1 Introduction

With the rapid development of national economy, construction industry, serving as the pillar industry of national economy, has played a great role in promoting the economic growth. The rapid development of the construction industry has important significance in strengthening the urban and rural infrastructure construction, advancing the process of urbanization, building a harmonious society and improving the whole social production efficiency (Sharma 2010).

S. Zhang (✉) · L. Yao
College of Management, Xi'an University of Architecture and Technology, Xi'an 710055 Shaanxi, China
e-mail: Yao Ling118@126.com

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There are different views about the relationship between construction and economical growth. Some scholars believe that construction and economical growth promote each other; in short time, the economic growth is the cause of construction industry growth causes. In the long-term, the construction industry is caused by economic growth (Tse and Raftery 2001; Chan 2001; Wigren and Wilhelmsson 2007; Lewis; Ozkan et al. 2011; Jiang and Jiang 2007; Lu 2003). However, other scholars point out, in the highly developed areas, the importance of the construction industry is in the weak; but in the less developed areas, construction industry has an important role in promoting the economic growth and dweller income, which provide a theoretical basis for the construction industry of the underdeveloped areas (Pietroforte et al. 2000). Therefore, we should objectively and accurately describe the relationship between construction industry and economic growth.

At present, the domestic and foreign scholars on the interactive relationship of the construction industry and economic growth mostly concentrates in the construction industry on the economical growth influence and contribution, but it is rare for coordinate development of the building industry and economic growth. This article is based on this perspective, taking the actual situation of construction industry and economic growth of Shaanxi Province as an example, selects the data from 2001 to 2010, by using coordination formula to analyze correlation and coordination between construction industry and economic growth. Compared with the existing research, this paper uses synergistic effect to measure the coordination degree, which can avoid judging the coordination degree by using synchrony of the development of the construction industry and economic growth. In addition, using multiple indicators to measure the building industry and economic growth can avoid the possible deviation of single index.

2.2 The Current Situation of Construction Industry and Economic Growth in Shaanxi Province

In recent years, with the rapid development of China's economy, Shaanxi economy development is rapid and construction industry, serving as the pillar industry of national economy develops continuously. As we can see from Fig. 2.1, during 2001–2010, the trends of GDP and the construction industry in Shaanxi are on rise. It can be seen from Fig. 2.2 that there are two obvious peaks in 2003 and 2007 and it has an obvious decline after 2008. With the improvement in the level of openness and market-oriented, construction and economical growth in Shaanxi have a rapid development. In 2001, after China joining in the WTO, the construction industry in Shaanxi province has a rapid development process; in 2003, the construction industry created a peak and promoted the economic development of Shaanxi province. In 2008, the world economy came into the end of the valley because of the American loan crisis, which affected our economy. The construction industry of Shaanxi province started to decline and economy also had an obvious trend of decline.

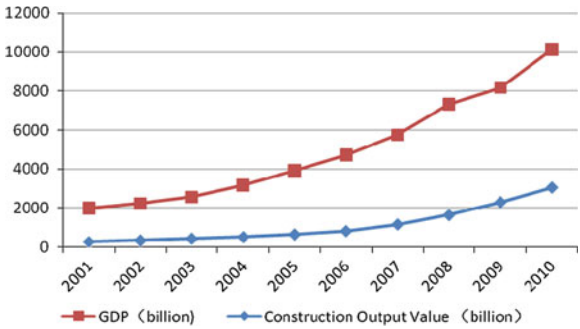

Fig. 2.1 The trends of GDP and construction output value of Shaanxi Province

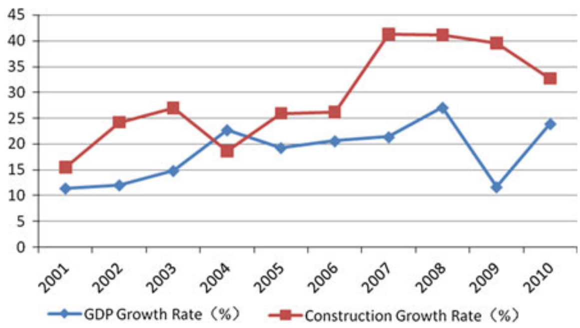

Fig. 2.2 The trends of GDP growth rate and construction growth rate of Shaanxi province

At the same time, we can also see from Fig. 2.2, the construction growth rate was significantly higher than the GDP growth rate, but the construction growth rate is not very consistent with GDP growth rate. Changes in GDP growth slightly lagged behind the growth of the construction industry, especially after the 2003. Therefore, the both have a stronger correlation. So it has a great practical significance in studying coordination between construction and economic growth.

2.3 An Empirical Analysis on Coordination Relationship of Construction Industry and Economic Growth in Shaanxi Province

2.3.1 Calculation Method of Coordination of Construction and Economic Growth of Shaanxi Province

From the perspective of synergetic, coordination generally refers to internal elements of the system or system "harmony" with the proper relationship (Huang et al. 2000). Because the system is in dynamic change, the relationship of the internal elements of the system or the system itself is constantly adjusted. The coordination degree is quantitative indicators, which is to measure the status of good and bad coordination of the internal elements of the system or the system itself (Zheng and Liu 2001). Therefore, we can build the coordination of construction and economic growth indicators to reflect their development coordination degree. The main ideas and the steps are as follows.

1. According to the above main component analysis result, we can establish the systematic evaluation model among them.

$$f(\mathrm{x}) = \sum_{i=1}^{m} ax_i, \quad g(\mathrm{y}) = \sum_{j=1}^{n} by_j \tag{2.1}$$

Among them, f(x) is the comprehensive development level of construction, g(y) is the comprehensive development level of economic growth. x_i, y_j are evaluation index, a_i, b_j are the weight of evaluation index.

2. To investigate the relative development level of construction (X′) compared with economic growth (X) and the relative status of economic growth Y′) compared with the development of construction (Y), X is regressed on Y to get X′, Y is regressed on X to get Y′.
3. The model of static coordination degree (Chen et al. 2007; Li et al. 2003) is as follows.

$$U(i,j) = \frac{\min\{u(i/j),\, u(j/i)\}}{\max\{u(i/j),\, u(j/i)\}} \tag{2.2}$$

where U(i, j) is the static coordination degree between X and Y, u(i/j) is the adaptability of construction to economic growth, u(j/i) is the adaptability of economic growth to construction. The formulation of u(i/j) and u(j/i) are as follows:

$$U(i/j) = \exp\left[-\frac{(X - X')^2}{s_i^2}\right] \tag{2.3}$$

$$U(j/i) = \exp\left[-\frac{(Y - Y')^2}{s_j^2}\right] \tag{2.4}$$

where S_i^2 is the standard deviation of X, S_j^2 is the standard deviation of Y.

In order to directly reflect the coordination degree of development of the construction industry and economic growth of Shaanxi Province, this paper refers to the relevant articles (Liu et al. 2006) and combines with the development characteristics of the construction industry and economic growth, coordination level is divided, as shown in Table 2.1.

Table 2.1 Type classification in the construction industry and economic growth

Coordination degree	Classification	Comparison between f(x) and g(y)	Basic type of development
0.90–1.00	Quality coordinated development	f(x) > g(y)	Economic growth lag of quality coordinated development
		f(x) = g(y)	The synchronous type of quality coordinated development
		f(x) < g(y)	Construction lag of quality coordinated development
0.8–0.89	Good coordinated development	f(x) > g(y)	Economic growth lag of good coordinated development
		f(x) = g(y)	The synchronous type of quality coordinated development
		f(x) < g(y)	Construction lag of quality coordinated development
0.7–0.79	Intermediate coordinated development	f(x) > g(y)	Economic growth lag of intermediate coordinated development
		f(x) = g(y)	The synchronous type of intermediate coordinated development
		f(x) < g(y)	Construction lag of intermediate coordinated development
0.6–0.69	Primary coordinated development	f(x) > g(y)	Economic growth lag of primary coordinated development
		f(x) = g(y)	The synchronous type of primary coordinated development
		f(x) < g(y)	Construction lag of primary coordinated development
0.5–0.59	Reluctant coordinated development	f(x) > g(y)	Economic growth lag of reluctant coordinated development
		f(x) = g(y)	The synchronous type of reluctant coordinated development
		f(x) < g(y)	Construction lag of reluctant coordinated development
0.3–0.49	Mild disorder development	f(x) > g(y)	Economic growth lag of mild disorder development
		f(x) = g(y)	The synchronous type of mild disorder development
		f(x) < g(y)	Construction lag of mild disorder development
0.2–0.29	Moderate offset development	f(x) > g(y)	Economic growth lag of moderate offset development
		f(x) = g(y)	The synchronous type of moderate offset development
		f(x) < g(y)	Construction lag of moderate offset development
0–0.19	Serious imbalance development	f(x) > g(y)	Economic growth lag of serious imbalance development
		f(x) = g(y)	The synchronous type of serious imbalance development
		f(x) < g(y)	Construction lag of serious imbalance development

2.3.2 Data Sources and Indicator System

Drawing lessons from the existing indicator systems of coordinative degree (Niu and Lin 2011) and following the principles of typicality, availability, and systematic analysis, the article develops an indicator system consisting of such subsystem as construction industry and economic growth to measure the coordinative degree of Shaanxi.

Considering the industrial scale, technology level, industrial benefits, social benefits, construction representative indicators consist of the construction output value (million), construction company assets (million), construction annual average personnel (million), the number of construction companies, the rate of technical equipment (yuan/capita), power equipment (yuan/capita), the average wage of construction workers (yuan/capita), construction area (m^2/capita), the contribution rate (%).

Considering economic scale, economic structure and economic benefits, economic growth indicators consist of total GDP (billion), total investment in fixed assets (billion), local revenues (billion), total imports and exports (million), percentage of GDP of the added value of primary industry (%), percentage of GDP of the added value of secondary industry (%), percentage of GDP of the added value of tertiary industry (%), GDP growth rate (%), consumer price index.

The original data sources of construction industry and economic growth from 2001 to 2010 in this article are from the Statistical Yearbooks of China and Statistical Yearbook of Shaanxi Province. Because of different units of measurement indicators, we standardize the data and eliminate the influence of dimension, magnitude, and positive and negative orientation.

2.3.3 Coordination of the Construction Industry and Economic Growth

The index values of the construction industry and economic growth are calculated by regression analysis, and the coordination degrees of the construction industry and economic growth are calculated by the formulas (2.2)–(2.4). The results are given in Table 2.2.

First, it is negative during 2001–2006, which indicates that the construction development level of Shaanxi Province in this period is lower than the average level of development; while it is positive during 2007–2010, which indicates that the construction development level of Shaanxi Province in this period is lower than the average level of development. There are some reasons for accounting for this phenomenon. On the one hand, the government policy support increases the construction investment of Shaanxi Province; on the other hand, the growth way of construction industry improves the development of construction. Economic growth of Shaanxi Province in general is increased year by year, while during 2001–2005

Table 2.2 The evaluation results of coordination of the construction industry and economic growth in Shaanxi province

Years	Construction comprehensive development index f(x)	Economic growth development index g(y)	The adaptability of construction to economic growth	The adaptability of economic growth to construction	Coordination degree	Coordination evaluation of the construction industry and economic growth
2001	−0.8691	−1.0332	0.947	0.805	0.850	Economic growth lag of good coordinated development
2002	−0.6281	−0.7991	0.998	0.987	0.989	Economic growth lag of quality coordinated development
2003	−0.5499	−0.6818	0.992	1.000	0.992	Economic growth lag of quality coordinated development
2004	−0.3195	−0.6541	0.986	0.999	0.987	Economic growth lag of quality coordinated development
2005	−0.5803	−0.2705	0.994	0.974	0.980	Construction lag of quality coordinated development
2006	−0.4547	0.0685	0.986	0.990	0.996	Construction lag of quality coordinated development
2007	0.0482	0.2011	0.998	0.997	0.999	Construction lag of quality coordinated development
2008	0.8551	0.4300	0.891	0.999	0.892	Economic growth lag of good coordinated development
2009	1.2840	1.1997	0.975	0.998	0.977	Economic growth lag of quality coordinated development
2010	1.2143	1.5394	0.999	0.907	0.908	Construction lag of quality coordinated development

it is negative, which indicates that in recent years it is in the low level; during 2006–2010 it is positive, which indicates that it is in the higher levels in this period. Because in recent years, Shaanxi Province, firmly grasp the great western development, the national macro-control and other development opportunities.

Compared integrated development index of the construction industry f(x) with integrated development index of economic growth development index g(y), the coordination degree is obviously divided into four stages. The first phase is from 2001 to 2004, an economic growth retarded, which means economic development has lagged behind the development of the construction industry. This is mainly due to establish the construction industry as one of the pillar industries of Shaanxi Province. As a result, the construction industry developed rapidly. The second phase is from 2005 to 2007, which belongs to a construction lag. This indicates that the construction industry development has lagged behind the trend of economic growth. This is mainly because the construction industry of Shaanxi Province has a long cycle and the growth is slower. The third phase is from 2008 to 2009, which is also economic growth retarded. This is mainly because the financial crisis of 2008 has a greater impact on the economy of Shaanxi Province, which caused the economic growth to decline. The fourth stage is 2010, which belongs to a construction lag. Because the country takes measures on the real estate industry in the early 2010 to limit the demand for the purchase of speculative investment and support user demand. However, the real estate industry is closely related to the construction industry and fluctuations in the real estate industry affect the construction industry, so this development of construction industry in 2010 is relatively slow. At the same time, it can be seen that the level of coordination of the construction industry and economic growth has been in a volatile state, which also shows the construction development of Shaanxi Province is not sound.

2.4 Conclusion and Suggestions

The coordination of construction and economic growth determines the mutual adaptation and the interaction relationship of the construction industry and economic growth in terms of size, structure, and the pace of development. How to coordinate the relationship between the construction industry and economic growth is the foundation of developing construction industry and economic growth. This article uses the coordination in order to analysis construction industry and economic growth of Shaanxi province. We conclude the construction industry and economic growth in Shaanxi province have a stronger correlation, but it has significant fluctuations. The coordination degree of construction and economic growth of Shaanxi province is more than 0.85, which shows that the both have a strong coordination and the development speed is relatively modest. However, we also see that the coordination degrees of the construction industry and economic growth have a large fluctuation, which shows that the improvement space is larger.

From the trend of development, promoting the coordination of construction industry and economic growth is still an urgent task. This demands to maintain a stable economic growth and avoid changes radically. We should closely monitor the operation situation of economy, consider the situation and timely take corresponding measures. What's more, sustainable economic growth should be maintained, technological progress and innovation in construction should be strengthened and construction growth mode should be transformed. We look forward to the construction and economic growth from disorder to order and develop toward the benign direction of sustainable development.

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Chapter 3
A Study on Individual Value Measurement Method for Naval Vessels Equipment Human

Yu Zhang, Bo Wang and Le Gao

Abstract The accurate measurement to the individual value of naval vessels equipment human is an important foundation of evaluating reasonable human resource and reward system, stimulating working enthusiasm. The paper is based on value engineering principles; the costing formula of human capital is established. Analytic hierarchy process (AHP) is employed to calculate the individual's weight in the post, so as to measure the individual value which provide theoretical guidance for the value realization of naval vessels equipment human and then provide reliable human by retaining & developing talent, win the information war.

Keywords Analytic hierarchy process · Naval vessels equipment human · Value engineering · Value measurement

3.1 Introduction

With the rapid development of high-tech and information technology is widely used in the military, which not only have an enormous impact on safeguard ideas, protection mode, and management method of the naval vessels equipment, but also put forward new requirements on naval vessels equipment human. In recent years, the current policy is inadequate compensation for military human capital consumption, decline in efforts to attract high quality talent, it is difficult to play a positive interaction of the human resources in the military with material resources and science and technology (Dong et al. 2011), which mainly due to China's

Y. Zhang (✉) · B. Wang
College of Management and Economics, Tianjin University, Tianjin, China
e-mail: zhangyujjxy@126.com

L. Gao
BoHai Chemical Industry Group Company, Tianjin, China

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military human capital theory is studied later, only few of the literature can be learned, the concept and characteristics of human capital on military, and value of human capital measurement doesn't give enough attention, it is also lack of mature theories and research methods, not to establish a scientific incentive mechanisms and performance evaluation mechanism, so that the value of human capital in the military is also not reasonably reflected, and the working enthusiasm of the naval vessels equipment human is reduced in some extent.

By using the two dimensional model of talent level–category, the naval vessels equipment human is divided into the following class, and the concept, characteristics, impact factors and formation process of the full life cycle of equipment staff value based on of value engineering is put forward. The costing formula of human resource is established which is not only consider the monetary factors but also take non-monetary factors into account, such as level of knowledge and skills, problem-solving ability and somebody's duty. Turn qualitative factors into quantification, and the analytic hierarchy process (AHP) is employed to calculate the individual's weight in the post, so as to measure the individual value which provide a theoretical basis for the rational allocation of the individual value.

3.2 Definition of the Value of Naval Vessels Equipment Human

3.2.1 Division of Naval Vessels Equipment Human

The naval vessels equipment as a physical system, it generates the process of beginning, development and decline, the whole life cycle is divided into five stages (Li and Wu 2009; Ding and Lu 2011; Wang et al. 2010) from project demonstration, equipment development, production, use & indemnification and retired, and each stage is completed by different equipment personnel with the cooperation of each other. The naval vessels equipment human involved from top to bottom, have various departments at all levels, that is to say it is divided into three classes (Li 2007)—naval vessels management cadres, naval vessels technical cadres and naval vessels technical soldiers, and each class based on the professional, responsibilities and objectives of the responsibility, according to the two dimensions of the job nature and the talent level, who is divided into general management cadres, core management cadres, general technical cadres, core technical cadres, general technical soldiers and core technical soldiers, that generally grouped into two broad categories of core staff and general staff.

3.2.2 Content of Naval Vessels Equipment Human

The naval vessels equipment human capital is not only have three common characteristics in general human capital (dependent, private, and variability), but also have the military specificity (Wang 2009; Pan and Jiang 2002; Geng and Fan 2005), such as a military nature, timeliness, utility and potential valuable, so that the measurement of the value is certain difficulty. Learn from the concept of military human capital (Pan 2002), by using full life-cycle management of naval vessels equipment, the paper is defined value of naval vessels equipment human capital as follows: the core staff and general staff who work in project demonstration, equipment development, production, use & indemnification and retired post, gain the knowledge, skills, abilities, dedication, mental quality and health and other quality factors of military and economic value by investment in a variety of education, military training, health and other aspects.

The paper introduces the theory of value engineering, from the point of economy—effectiveness to evaluate the value of naval vessels equipment human capital by the ratio of job function coefficient and the cost coefficients. As shown in Fig. 3.1, from the lateral extension, the human capital value is composed of three aspects of value culture, value measurement and value distribution; from the vertical extension, value culture corresponds to the selection of the personnel, according to the army who have the knowledge and skills, assigned to the different jobs. The value measurement stress on building scientific and standardized value evaluation system, make an objective and fair assessment on input and contribution to the naval vessels equipment human; by value measurement model, we can get the value of the equipment staff, which is based on the development of the pay system, promotion system, reward system, performance improvement and allocation of economic rewards (Zhang and He 2008).

3.3 Post Value Measurement of Naval Vessels Equipment Human

Applying value engineering to value measurement of naval vessels equipment human, by using the basic principle: value coefficient = function coefficient/cost

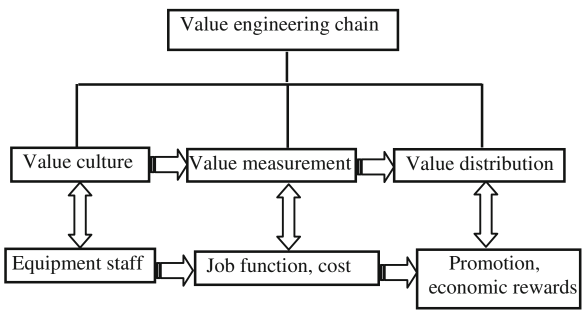

Fig. 3.1 Value engineering chain model of naval vessels equipment human

coefficient (Zhang 2008), the function evaluation of object could be comprehensive capabilities of equipment human, it also can be positions within the organization. The paper put job functions as the valuation, personnel costs or the cost of their investment as a cost.

3.3.1 Concrete Process and Case Analysis of Post Function Measurement

Some naval vessels equipment human is composed of the equipment technical cadres, equipment management cadres and equipment technical soldiers which are summarized as two categories of core staff and general staff who distribute in four different positions (equipment design post, equipment manufacturing post, equipment maintenance post, equipment management post). Identified for the four job functions, showing it by F_i ($i = 1, 2, 3, 4$).

1. *Establishment of evaluation group*: Six reviewers who are familiar with the responsibilities of various positions, according to the core staff and general staff positions, determine the influencing factors for the military quality (equipped with professional knowledge, skills, military management), cultural quality (diploma, basic knowledge, cultural cultivation), the basic qualities (thinking ability, problem-solving skills, interpersonal skills), practical experience (duties, risk, behavior consequences), and three categories of factors is ultimately confirmed that is knowledge and skills, problem-solving skills and job responsibilities.
2. *Scoring on the three factors of job function*: With the Hay job evaluation system (Luo 1997; Zhang and Yang 2011), 6 reviewers' mark three factors on four job functions.
3. *The weight to determine by the AHP-based reliability analysis*: When the fuzzy comprehensive evaluation is made, the weight will have a huge impact on the final evaluation results, sometimes different weights have different conclusions. The author uses AHP-based reliability analysis to determine weight, which make comprehensive evaluation of the results more scientifically and objectively.

By using AHP method to determine the matrix of the weight range in reference (Zhang and Wang 2011). According to the fuzzy set statistics method to deal with interval numbers calculation principle, put the confidence coefficient of evaluation experts and the corresponding indicators weight-interval (u_1, u_2) into the following calculation formula to get index weights (W_i) based on the reliable analysis, and then carry out normalization that can be obtained the factor index weights Vi. By this method, the overall goal of the first level for weight vector is $W = (V_1, V_2, V_3)$ and $V_1 + V_2 + V_3 = 1$; the sub-goal of the second level for weight vector are W_1, W_2, W_3, $W_1 = (V_{11}, V_{12}, V_{13}, V_{14}, V_{15})$ and $V_{11} + V_{12} + V_{13} + V_{14} + V_{15} = 1$;

$W_2 = (V_{21}, \quad V_{22})$ and $V_{21} + V_{22} = 1$; $W_3 = (V_{31}, \quad V_{32}, \quad V_{33})$ and $V_{31} + V_{32} + V_{33} = 1$.

4. *The calculation of the job function coefficient*: $f_{ij}(i = 1–4;\ j = 1–6)$ is on behalf of every job function of total scores which is got from each post score based on the Hay table multiple with respective weights and then plus together. The function coefficient is equal to average score of a job function divided by the average of all the scores. The function coefficient $F_{I1} = \Sigma f_{1i}/\Sigma f_{1i} + \Sigma f_{2i} + \Sigma f_{3i} + \Sigma f_{4i}$; $F_{I2} = \Sigma f_{2i}/\Sigma f_{1i} + \Sigma f_{2i} + \Sigma f_{3i} + \Sigma f_{4i}$; $F_{I3} = \Sigma f_{3i}/\Sigma f_{1i} + \Sigma f_{2i} + \Sigma f_{3i} + \Sigma f_{4i}$; $F_{I4} = \Sigma f_{4i}/\Sigma f_{1i} + \Sigma f_{2i} + \Sigma f_{3i} + \Sigma f_{4i}$.

3.3.2 The Calculation of Naval Vessels Equipment Human Cost

The formation and increasing in the value of naval vessels equipment human comes from investment in human capital. The input method is the measurement of human capital investment, which is the full cost in order to acquire, use and develop of human capital. According to the investment formal, it is mainly divided into education (military workers in accordance with the form of education investment costs = family investment cost + personal investment cost + state investment cost + social investment cost), military technical training, investment in health care, human resources flowing. This article in accordance with input measurement method (Wang 2009). The naval vessels equipment human capital is divided into (a) staff acquisition costs (C_1); (b) the development cost (C_2); (c) use costs (C_3); (d) insurance costs (C_4); (e) leave-office costs (C_5).

The naval vessels equipment human cost C, the formula (3.1) as follows:

$$C = C_1 + C_2 + C_3 + C_4 + C_5 \tag{3.1}$$

3.3.3 A Value Measurement for Naval Vessels Equipment Human Based on the Value Engineering

Applying value engineering to measure human capital, not only consider monetary factors such as division and calculation of human capital investment cost; but also take non-monetary factors into account, such as the level of knowledge and skill, problem-solving ability and job duties and then evaluate the job function capacity, so the value coefficient is more reasonable and reliable for assessing the value of human capital.

The position function coefficient $F_{Ii} = F_i/\Sigma f_i$; cost coefficient $C_{Ii} = C_i/\Sigma C_i$, so the value coefficient $V_{Ii} = F_{Ii}/C_{Ii}$.

3.3.4 Individual Value Measurements for Naval Vessels Equipment Human

By using the concrete process of post function measurement and the calculation model of naval vessels equipment human cost, the group value is determined, but it can't acquire the value of each person in the job, and thus it also can't provide a theoretical basis for the rational allocation of the individual value. So the paper take core management positions for example, using the analytic hierarchy process to calculate the weight of each employee in the core management positions, and then multiply the value coefficient of core management positions which the individual value can be calculated that the staff create in this position.

1. *Determine the position value of the core management*: Assuming that the core management positions of a naval vessels equipment troops consists of three people, the job function coefficient F_{Im} determine by Eq. (3.1) concrete process and case analysis of post function measurement; cost coefficient C_{Im} is obtained by researching the Force Finance Office, the calculation model of naval vessels equipment human cost is gained by Eq. (3.2), so the value of the core management positions $V_{Im} = F_{Im}/C_{Im}$.
2. *By using the analytic hierarchy process method to calculate the weights of core management positions of three persons*: As shown in Fig. 3.2, the weight of hierarchical structure of core management human is built.

Followed by the introduction of 1–9 scaling method, construct comparison judgment matrix of A–B and B–C, latent vector of each judgment matrix T, maximum characteristic root and related consistency test is calculated by use of the square root method (Du and Pang 2008). Finally by AHP program, it gets all levels of the total row weight $T = (t_1, t_2, t_3)$ t_1, t_2, t_3 is respectively on behalf of the weight of three core management staff C_1, C_2, C_3, and $t_1 + t_2 + t_3 = 1$.

3. *The individual value measurement for naval vessels equipment human*: The value of the core management staff VI_{mi}, the formula (3.2) as follows:

$$VI_{mi} = VI_m \times t_i (i = 1 - 3) \tag{3.2}$$

3.4 Conclusion

1. According to the two dimensions of job nature and talent level, the naval vessels equipment human is divided by analyzing the necessity of individual value measurement. And then defines the connotation of the value of naval vessels equipment human capital and combine the three links of the value chain with human resource management innovatively.

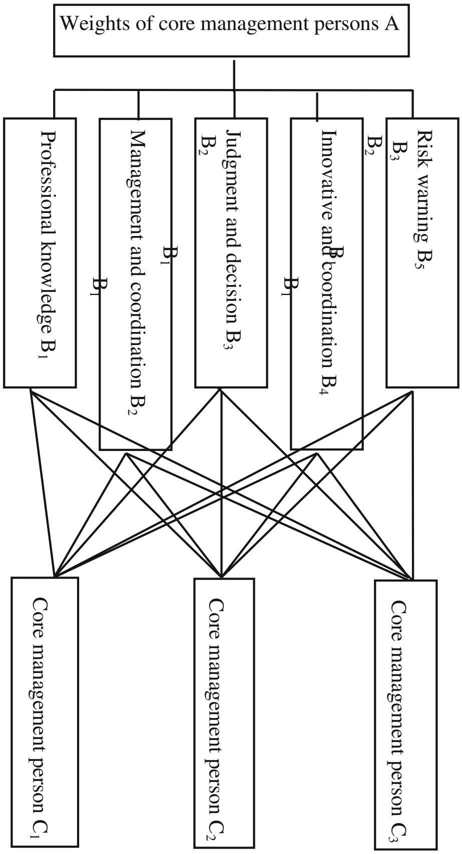

Fig. 3.2 The weight of hierarchical structure of core management human

2. Take job functions as the valuation functions capacity and summarize three evaluation indicators which impact on job function. By using Hay Figure, make a selection and scoring for indicators affected the job functions, and put forward improved-AHP index weighting method by learning from reliability theory to calculate the function coefficient in the positions.
3. Applying value engineering to value measurement for human capital, not only consider monetary factors but also taken non-monetary factors into account, transform the qualitative factors into quantitative, evaluate the job function of naval vessels equipment human, so the value coefficient is more reasonable and reliable for assessing the value of human capital.
4. Take the core management positions for example, by using analytic hierarchy process to determine the weight of each human in the post, give the method and steps to calculate the individual value measurement for naval vessels equipment human, which provide theoretical guidance for each staff's performance appraisal and the value allocation.

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Chapter 4
Analysis About Relationship Between Infrastructures Invests in Three Industry Departments and Economic Growth in Hubei Province

Wen-jun Fu

Abstract There are internal links between infrastructure and economic growth. This paper has built the infrastructure invest and economic growth Granger causality model and the contribution of infrastructure invest on economic growth model by using econometric methods, getting the interaction between the infrastructure invest and economic growth in Hubei province, which shows the infrastructure is the cause of economic growth, on the contrary, it is not. The unit output of the primary infrastructure invest and secondary infrastructure invest contributes largely to economic growth; therefore, to expand the proportion of gross production of the first and secondary infrastructure invest in areas helps to guide the economy of Hubei province to a healthy development. And on this basis, the paper raises appropriate policy recommendations.

Keywords Co-integration · Economic growth · Granger causality test · Infrastructure

4.1 Introduction

In the 17th century, according to the actual situation of Britain in his representative Political Arithmetic published in 1691, W. Petty pointed that manufacturing could bring more income than agriculture, while could not be more than business section. Petty's description about different of income infrastructure investment revealed that the relative differences regularity of income between infrastructure investments (Yang and Gan 2009). After Petty, C. Clark's further studies have shown employees had transferred from the primary infrastructure investment into second with the

W. Fu (✉)
Department of Management, Wuhan University of Technology,
Wuhan, People's Republic of China
e-mail: jing.weixiao@163.com

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improvement of the nations' income, which had transferred into the tertiary infrastructure invest as the nations' income further improvements(Li and Pan 2005). This conclusion was called Petty–Clark Theorem. Chenery reputed that a series of interrelated changes of economy structure was a necessity to sustainable growth (Chenery 2005). Rostow considered the growth of modern economy was a process of infrastructure investments section changes in nature, which rooted in cumulative production function spreading provided by modern technology, and the changes between technology and organization could be only analyzed in the way of infrastructure investment of economic section. The practice has shown that economic growth always realized the result of restructuring increasingly in the process of infrastructure investment (Liu et al. 2011), and the evolution of infrastructure investment adjustment was an eternal topic. The restructuring and improvement of infrastructure investment can lead to the total economic growth (Li and Zhao 2011); However, the growth of economic aggregate will also lead to adjustment of infrastructure investment. Modern history reveals that economic growth is to a large extent influenced by the increase-decline and changes in growth momentum of different infrastructure investment and sections (Tong et al. 2010).

For recent years, Hubei has faced a series challenges like the state's western development strategy in depth, establishing China—ASEAN Free Trade. Therefore, how to faster economic growth of Hubei by adjusting the infrastructure investments and transformation of economic growth is an urgent problem at present. As a result, research on relationship between infrastructure and economic growth in Hubei province shows its far-reaching and realistic significance. In this paper, relative data of three-infrastructure investment in Hubei Province from 1978 to 2010 will be cited to help empirical research and analysis by using Co-integration and Granger Causality Test.

4.2 Infrastructure Investment and Economic Growth of Hubei

4.2.1 Model

In order to determine the cause of economic growth in infrastructure investment adjustment, or economic growth to changes in infrastructure investment, the paper used in the econometric theory of the Granger causality test model of infrastructure investment and economic growth in Yunan Province, the relationship between the two, on the one hand it can avoid "spurious correlation" phenomenon, it can also specify whether there is a one-way influence between the two causal relationship.

Granger causality test is measured by the famous British economist Granger (Granger) in 1969 and the definition of causality test developed on the basis of the system of vector autoregressive (VAR) (Alleman et al. 2004). The forecast assumes that all information of each variable included in these variables among the time series. Testing requirements for the two regression equations are estimated as follows:

$$X_t = \sum_{i=1}^{m} \alpha_t X_{t-1} + \sum_{j=1}^{m} \beta_t Y_{t-1} + u_{1t} \tag{4.1}$$

$$X_t = \sum_{i=1}^{m} \lambda_t X_{t-1} + \sum_{j=1}^{m} \delta_t Y_{t-1} + u_{2t} \tag{4.2}$$

If we accept the original hypothesis: $H_{01} : \beta_1 = \beta_2 = \ldots = \beta_m = 0,$ on the instructions not to Granger cause $\mathrm{X_t}$, Y_t is the Granger otherwise known reasons: If we accept the original hypothesis: $H_{02} : \lambda_1 = \lambda_2 = \ldots = \lambda_m = 0,$ $\mathrm{X_t}$ of the Granger speaks not cause. Otherwise, the Granger cause claimed is Y_t. The partial regression coefficient of the joint test of zero can be achieved by F test, F statistic constructed as follows:

$$F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)} \tag{4.3}$$

where RSS_R and RSS_{uR} are said in the original hypothesis under the H_{01} or H_{02} the residual sum of squares regression with and without the residual sum of squares, m said the order delay, n said the number of samples, k said unconstrained regression in the number of regression factors. If the calculated *F value* is greater than a given threshold, we reject the null hypothesis that the causal relationship, otherwise the null hypothesis is accepted, indicating there is no causal relationship.

4.2.2 The Choice of Indicators and Sample

Changes in infrastructure investment variables are usually the first, second and third industry output value of employment structure, asset structure and technical structure (Angelopoulos et al. 2007). From their view, each variable shows the industrial situation, with differences, but also has similarities. This choice scholars commonly used indicators of infrastructure investment and employment structure as a representative of the infrastructure investment variables in the calculation of the value of specific indicators used the proportion of primary infrastructure investment output and employment share, the two were called S1, S2, S1 said that the output value of primary infrastructure investment share of GDP, S2 indicated that the primary infrastructure investment employment share of total employment. Economic aggregates used in Hubei's GDP index GDPI, with 1978 as the base. The three variables are natural logarithm, to eliminate possible heteroscedasticity. GDP expressed as logarithmic $\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{m} \theta_t \Delta y_{t-1} + u_t$, the proportion of primary infrastructure invest output value is expressed as logarithmic $\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{m} \theta_t \Delta y_{t-1} + u_t$, the proportion of primary infrastructure invest employment, expressed as a logarithmic $\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{m} \theta_t \Delta y_{t-1} + u_t$. Sample interval is for 1978–2010. This sample data are from "Statistical Yearbook of Hubei".

4.2.3 Unit Root Test

In the specific application of analysis of dynamic econometric models, firstly it must be analyzed separately whether the variable time series unit root (Unit Root), to determine whether the stationary time series or not. Because Granger and others say that when using non-stationary time series regression will result in spurious regression, and Watson has proved that when there is unit root variables, that is non-stationary. The conventional statistics, Such as the *t* value, *F* value, *DW* values, and will be correct (Chandra and Thompson 2000). In order to test statistic effectively, firstly the paper will use Augmented Dickey–Fuller method (ADF) to test the stationary time series. ADF tests will be on the next major type (including constant and trend) for T test.

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{m} \theta_t \Delta y_{t-1} + u_t \tag{4.4}$$

Where it is the time trend term, *m* is the optimal lag orders, *m* value of the amount of information by the Akaike AIC and SC Schwartz minimum amount of information the decision. The original hypothesis for the test $\gamma = 0$, that there is unit root. Calculated by the Eviews3.1 completed and the results shown in Table 4.1.

Table 4.1 Test for the regression equation

Sequence	ADF test value	1 % critical value	5 % critical value	10 % critical value	Notes
$\ln gdpi$	−2.210818	−4.3082	−3.5731	−3.2203	Unstable
$\ln s1$	−2.572810	−4.3082	−3.5731	−3.2203	Unstable
$\ln s2$	0.946981	−3.6752	−2.9665	−2.6220	Unstable
$\Delta \ln gdp$	−5.495779	−4.3226	−3.5796	−3.2239	Steady
$\Delta \ln s1$	−5.040210	−4.3226	−3.5796	−3.2239	Steady
$\Delta \ln s2$	−4.537999	−4.3226	−3.5796	−3.2239	Steady

Note ΔLNGDPI, ΔLNS1, ΔLNS2 are LNGDPI, LNS1, LNS2 first-order differential form

The results of Table 4.1 show that $\ln gdpi$, $\ln s_1$, $\ln s_2$ of the ADF test values are greater than their critical values, which are non-stationary. But the three variables of the first difference all through the ADF test, and test variables can determine the entire sequence to a single order.

4.2.4 Co-integration Test

In order to determine whether the three variables of LGDPI, *LS*1 and LS_2 have the relationship of long-term stable equilibrium or not, we use the test method of co-integration which Engle and Granger proposed. There is the co-integration between the independent variable and the dependent variable through the coordination theory. The dependent variable can be explained by a linear combination of the independent variables. There is the stable equilibrium relationship between them, and the rest parts of the dependent variable which cannot be explained by the independent variable make up a residual sequence which should be stable (Cronin et al. 2001). Therefore, testing whether there is co-integration among a set of variables or not is equivalent to testing whether the residual sequence of the regression equation is a stationary series or not. The unit root test results of the equation residual are in Table 4.2.

Test results show that the residuals of the equation reject the null hypothesis at the 5 % significance level, and accept the conclusion which there is no unit root, thus determine u. The stationary sequence—u $\sim$ (0). The test results of the co-integration show that: There is co-integration among LGDPI, LS_1 and LS_2, and the co-integration among the three variables can be expressed as:

$$\mathrm{LGDPI} = -1.851793 - 1.631\,LS_1 - 4.443\,LS_2 \tag{4.5}$$

This model shows that for every 1 % change of LS_1 will lead to 1.631 % changes of LGDPI in the opposite direction; and every change 1 % of LS_2 will lead to 4.443 % changes of LGDPI in the opposite direction.

4.2.5 Granger Causality Test

The method of Granger causality test is: estimating whether the value of sequence y can be explained by the level of its own lag value, and then introducing the

Table 4.2 The unit root test of residuals ADF

Test statistic of ADF (%)	T Statistics −3.0678
Significance level 1	−3.6852
5	−2.9705
10	−2.6242

Table 4.3 Granger causality test results

Original hypothesis	F statistic	P value	Conclusion
LS_1 Granger not cause $\ln gdpi$	4.6791	0.0332	Reject the original assumption
$\ln gdpi$ not LS_1 Granger cause	2.1546	0.2882	Accept the original hypothesis
LS_2 Granger not cause$\ln gdpi$	5.4574	0.0052	Reject the original assumption
$\ln gdpi$ not LS_2 Granger cause	1.3425	0.5809	Accept the original hypothesis

lagged sequence of verify whether x can improve the level of y to be explained (Dymond 2002). If so, then the sequence x is a Granger cause of y, and then the lag coefficient of x is statistically significant. As well as considering whether the sequence y is Granger causes of x or not. Usually the two-variable regression of two equations is following:

$$\mathrm{Y}_t = \sum_{i=1}^{m} \alpha_i \mathrm{X}_{t-i} + \sum_{i=1}^{m} \beta_i \mathrm{Y}_{t-i} + u_{1t} \tag{4.6}$$

$$\mathrm{X}_t = \sum_{i=1}^{m} \lambda_i \Upsilon_{t-i} + \sum_{i=1}^{m} \delta i \mathrm{X}_{t-i} + u_{2t} \tag{4.7}$$

where, m is the maximum lag orders, inspection of the original assumption is that sequence X(Y) is not a sequence of Y(X) of Granger cause. Use Eviews3.1 software for LGDPI in Granger causality test, the test results as shown in Table 4.3.

By the Granger causality test, we can see that In determining the 5 % significance level, the adjustment of infrastructure investment is the reason of the economic growth of Hubei Provinc, but economic growth is not the reason of adjustment of infrastructure investment in Hubei Province. Hubei's infrastructure investment has an economic growth effect. Changes in infrastructure investment to adapt to the requirements of economic growth. From long-term trend, to accelerate Hubei's infrastructure and promote economic growth in theory and practice is feasible.

4.3 Industrial Measurement of its Contribution to Economic Growth in Hubei

4.3.1 Model Building

Through the calculation of economic growth Romer suggested that long-term economic growth is due to the technological progress(including changes in the economic system)contributions, while the short-term economic growth is driven by factors such as capital and labor inputs to increase contributions (Joskow and

Tirole 2005). However, technology, capital and labor are grouped together to produce based on a certain structure. For technology, capital and labor which given, different infrastructure investment will lead to different production, and thus bring different contributions to economic growth (Morimoto and Hope 2004).

Supposing that the function of impact by different infrastructure investment to production is y—F($X_1, X_2, \ldots X_K, A$), among which y represents total output, Xi represents the invest output, i = 1,2,3, A represents the economy system and technical level. For the function Y = F($X_1, X_2, \ldots X_K, A$), it can be drawn by differential calculus:

$$d\mathrm{Y} = \frac{\partial \mathrm{Y}}{\partial \mathrm{X}_1} dX_1 + \frac{\partial \mathrm{Y}}{\partial \mathrm{X}_2} dX_2 + \cdots + \frac{\partial \mathrm{Y}}{\partial \mathrm{X}_k} dX_k + \frac{\partial \mathrm{Y}}{\partial \mathrm{A}} d\mathrm{A} \tag{4.8}$$

Then division with y both sides of the equation, will have the following equation:

$$\frac{d\mathrm{Y}}{\mathrm{Y}} = \frac{\mathrm{X}_1}{\mathrm{Y}} \frac{\partial \mathrm{Y}}{\partial \mathrm{X}_1} \frac{d\mathrm{X}_1}{\mathrm{X}_1} + \frac{\mathrm{X}_2}{\mathrm{Y}} \frac{\partial \mathrm{Y}}{\partial \mathrm{X}_2} \frac{d\mathrm{X}_2}{\mathrm{X}_2} + \cdots + \frac{\mathrm{X}_k}{\mathrm{Y}} \frac{\partial \mathrm{Y}}{\partial \mathrm{X}_k} \frac{d\mathrm{X}_k}{\mathrm{X}_k} + \frac{\mathrm{A}}{\mathrm{Y}} \frac{\partial \mathrm{Y}}{\partial \mathrm{A}} \frac{d\mathrm{A}}{\mathrm{A}} \tag{4.9}$$

$\frac{\mathrm{X}_i}{\mathrm{Y}} \frac{\partial \mathrm{Y}}{\partial \mathrm{X}_i}$ represents the third industry infrastructure investment total output elasticity, denoted as β_i, $\beta = \frac{\mathrm{A}}{\mathrm{Y}} \frac{\partial \mathrm{Y}}{\partial \mathrm{A}} \frac{d\mathrm{A}}{\mathrm{A}}$ represents contributions of the economic system's changes to total output, it can got the following model: $\frac{d\mathrm{Y}}{\mathrm{Y}} = \beta + \beta_1 \frac{d\mathrm{X}_1}{\mathrm{X}_1} + \beta 2 \frac{d\mathrm{X}_2}{\mathrm{X}_2} + \cdots + \beta k \frac{d\mathrm{X}_k}{\mathrm{X}_k}$.

Transform the above model, using the following model to calculate the contribution of infrastructure invest on economic growth,

$$\log(\mathrm{GDP}) = \mathrm{c} + \mathrm{a} * \log(X_1) + \mathrm{b} * \log(X2) + \mathrm{c} * \log(X3) + \varepsilon \tag{4.10}$$

4.3.2 *The Contribution of Hubei Province's Infrastructure Investments on Economic Growth*

According to Gross National Product and the three biggest industrial output statistics in 1978–2010, which are calculated using Eviews3.1 regression results are as follows:

$$\begin{aligned} \log(\mathrm{GDP}) = & 1.0773 + 0.2812 * \log(X_1) + 0.4833 * \log(X_2) \\ & + (14.583)(6.695)(19.497)0.2376 * \log(X_3)(8.6577) \end{aligned} \tag{4.11}$$

R^2 = 0.9999 Adjust R^2 = 0.9999 F = 79,824.23 D.W = 1.21

From the regression results, $R^2 = 0.9999$ Shows that the model fit well in the whole, from the t-value of the intercept and the slope, are greater than the 10 % level significance of t-critical value. From fitting the slope of the infrastructures investments: the first, second and third industry infrastructure invests increased flexibility are: 0.2812, 0.4833, and 0.2376. Namely: primary infrastructure invest output growth of 1 % will lead regional GDP growth of approximately 0.2812 %; secondary infrastructure invest output grew by 1 % would result in GDP growth of approximately 0.4833 %; the output of tertiary infrastructure invest volume growth of 1 % will result in GDP growth in 0.2376 % similar. It can be seen, the economic pull of the Hubei Province is the second largest infrastructure invest.

4.3.3 The Contribution of the National Infrastructure Investment on Economic Growth

Using the model above, through the country's GNP and industrial output value statistics, we can measure the contribution of a country's infrastructure investment on economic growth (1978–2010), that is:

$$\begin{aligned}\log(\mathrm{GDP}) =& 1.1219 + 0.1437 * \log(X_1)(15.8824)(5.8409)\\ &+ 0.5677 * \log(X_2) + 0.2758 * (X_3)(22.5466)(11.6469)\end{aligned} \tag{4.12}$$

$R^2 = 0.9999$ Adjust $R^2 = 0.9999$ F = 107,802.9 D.W = 0.67.

From the above calculated results, we can see that China's output of primary infrastructure investment grew by 1 % would lead to the national GDP growth of approximately 0.1437 %; secondary infrastructure investment output grew by 1 % would lead to similar growth in the country's GDP 0.5677 %; tertiary infrastructure investment output growth of 1 % will lead to the national GDP growth of approximately 0.2758 %. Thus, according to the national average, Hubei Province, the economic contribution of primary infrastructure investment are relatively large proportion, but the contribution of secondary infrastructure investment and the relatively low average level, the contribution of the tertiary infrastructure investment is relatively low, has not yet reached the national average. Therefore, adjustment of infrastructure invest in Hubei Province from the lateral view, with the national average there is a gap, the next stage also need to deepen the restructuring.

4.4 Discussion

4.4.1 Interaction Between Infrastructure Invest and Economic Growth

Granger causality test in infrastructure invest and economic growth shows that exists a one-way causality between infrastructure invest restructuring and economic growth, that's to say, adjustment of infrastructure invest promote economic growth, not by the contrast. In Hubei province, different industrial sectors of resources have different marginal productivity, leading the labor force and capital transfer from the low productivity sectors to high productivity sectors, which can bring significant resources tremendous benefits. Empirical results in the paper show that the relationship between the proportion of primary infrastructure invest and real economic growth changes in the opposite direction, which explains the productivity of primary infrastructure invest is lower than the other infrastructure invest. Thence, in the long term, the reallocation of the recourses of primary infrastructure invest is significant to overall economic growth in Hubei. Optimizing the infrastructure invest, improving the structure changes will have very great potential in contributing to real economic growth of Hubei province.

4.4.2 The Analysis of the Contribution of Infrastructure Invest to Economic Growth

From the contribution of infrastructure invest to economic growth regression model, at present, the unit output of the primary infrastructure invest and secondary infrastructure invest contributes largely to economic growth, between which the later is the main impetus of driving economic growth. As for Hubei province, the emphasis of infrastructure depends on promoting agricultural industrialization and the industrialization and urbanization vigorously. As far as infrastructure is concerned, it is right to do a progressively development. Only under the guidance of thought of "Strengthen the primary infrastructure invest, enhance the secondary infrastructure invest, and develop tertiary infrastructure invest" can realize the virtuous circle of economy and development in Hubei province.

4.5 Policy Recommendations

4.5.1 Speed Up the Development of Animal Husbandry and Sideline and Fisheries Adjust and Optimize the Internal Infrastructure Structure of Agricultural in Hubei

As the agricultural occupied the biggest proportion of the primary infrastructure invest, to increase infrastructure construction, and to further improve the efficiency of agricultural production is important, especially for the development of cash crops, should adhere to the principle of concentration of the most suitable areas, relying on the advanced technology, stressing on the product quality (Newbery

2007). For example, focus on the development of plant size of tobacco, sugar cane and tea, building distinctive growing base of biological resources.

4.5.2 Promote the Optimization and Upgrading Infrastructure Invest is the Most Important

As the economic pull of Hubei's largest secondary infrastructure invest, so Hubei Province will focus on infrastructure: Consolidating and improving the industry infrastructure invest; Transforming and improving the infrastructure invest like metallurgical, chemical, mechanical and electrical, building materials, and other traditional infrastructure invest with application of high-tech; Relying on technological innovation, speeding up the development of new biological resources such as infrastructure invest and information infrastructure invest. Accelerating the establishing of Industrial County, and industrial parks, optimize space layout and promote balanced regional development (Norton 2002). Fully play a part of being a platform and carrier in developing SMEs and private economy, absorbing investment, realizing enterprise and industrial clustering, leading infrastructure, transforming economic growth. Accelerate the pace of building industrial park in order to establish an industrial park which is a block economy with distinctive features of leading infrastructure invests.

4.5.3 Vigorously Develop the Tertiary Infrastructure Incest's Potential

As the tertiary infrastructure invest in Hubei Province lag, so the potential mining development of tertiary infrastructure invest is conducive to economic development. Vigorously develop base systems, to achieve a synchronous development with the national economy. The base system includes traffic, transportation, telecommunication and urban public utilities and other departments, which plays an important role of delivery, economic network connection, and communication, the intrinsic link between primary and secondary infrastructure invest, strengthening horizontal linkages between regions in the tertiary infrastructure invest and even in the whole national economy. Exploit the tourism recourses in Hubei province reasonably, and make tourism to be one of the highlights of the province's economic growth. Besides, long-term building of the western region has formed favorable conditions for concentrating defense infrastructure invest enterprises and institutions, research institutes, and concentrates group of professionals, providing the basic conditions for the development of high-tech infrastructure invest, advanced in developing biological engineering, aerospace, modernization of Chinese medicine, new energy, new materials, electronic information, advanced manufacturing and so on. Hubei province should make full use of these advantages, develop high-tech infrastructure invest, to realize Hubei province's rapid infrastructure invest adjustment and economic development by leaps and bounds.

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Chapter 5
Application Analysis of Activity-Based Costing in Logistics Cost Management: In Comparison with Traditional Costing

Xiang-xia Meng and Shu-guo Tian

Abstract In the reason of the deficiencies in their own areas, traditional costing methods cannot accurately measure the cost of logistics. It urgently asks us to find new methods to measure logistics cost accurately and effectively. The application of activity-based costing to logistics management is keeping with this request. The principles of activity-based costing are expounded firstly, then this text intends to identify that activity-based costing have also its applicability in the logistics cost management in comparison with traditional costing. Finally two methods are compared and result of testing is analyzed. This text is focused on the application of activity-based costing to calculate logistics cost, which solves the problem of how to combine activity-based cost with practice.

Keywords Activity-based costing · Cost accounting · Logistics cost · Traditional costing

5.1 Basic Principle of Activity-Based Costing

Activity-based costing is a method of collecting and distributing costs in the process of producing by collecting "activity" as costing objective, which base on the theory of the cost drivers and analysis cost drivers based on the relationships between products and activity, activity chain, value chain. The basic principles are as follow: activities consuming resources, products consuming activities, activities

X. Meng (✉)
School of Economics and Management, Mudanjiang Teachers College, Mudanjiang, China
e-mail: goldxx2009@163.com

S. Tian
Finance Department, Mudanjiang Medical University, Mudanjiang, China
e-mail: tsgmxx@163.com

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resulted from production, and indirect expenses or indirect costs resulted from activities.

Activity-based costing was presented based on the fact that indirect expenses or indirect costs were not distributed factually under the traditional cost accounting system (Bao 2006). The distribution criterion for indirect cost always uses direct man-hours under the traditional cost accounting system, and this distribution method makes a positive effect previously, but it is difficult to distribute with reasons because of more product variety and high cost. The distribution for indirect cost is not in products, but in activities under the activity-based costing system, the distribution method presents causality of expense allocation which leads to cost accounting correctly. The essence of activity-based costing is to separate conclude and composes the activities that serve as a link between recourse expense and product expense, and then product cost form (Qu 2004).

5.2 Comparison Analysis Between Activity-Based Costing and Traditional Costing

Activity-based cost accounting is a whole new method compared to traditional costing, and the characteristics are as follows:

5.2.1 Allocation for Logistics Indirect Cost More Reasonable

The allocation base (cost drivers) of activity-based cost accounting has been made qualitative change compare to traditional cost accounting, which no longer adopt singular allocation base, but diversified allocation base, and combine financial variables with non-financial variables, and specially on non-financial variables (such as order handling times, transportation distance, quality inspection times etc.). So activity-based costing provides more accurate information than traditional cost accounting (Smith 2000).

5.2.2 Activity-Based Costing Based on Activities

Traditional costing is one way of cost account based on physical objects or logistic processes and function mainly, yet activity-based costing adopts activities as basic cost objective, and the costs of other costing objective are distributed through activities. So cost information providing makes it possible to carry out activity-based management and improve activity chain.

5.2.3 Application of Activity-based Costing to Logistics More Broadly

Traditional full costing regards many items of cost as period charge that uses one-time deduction rather than distribution in the current period occurred. In case of activity-based costing, cost occurred in the field of marketing, storage and retrieve etc. which can be distributed to related products or other cost objective by activities, as long as there is the related product, can be distributed to the products or the other cost object, so cost information provided in this way will be easier to make price decisions (Jiang 2003). Activity-based costing can illuminate assign reasonably the cost responsibilities which was obscured in the old costing system, and make the uncontrollable indirect cost controllable.

5.2.4 All of the Cost Being Variable

In case of variable costing, substantial proportion of cost will be divided into fixed cost due to invariableness with the variations of business volumes. But from activity-based costing point of view, this part of cost varies with the variations of other factors, although it stops down with increasing of business volumes, these factors include sales batch, the adjustment of machine equipment, operation capacity and so on (Li and Liu 2005). Activity-based costing regards all cost as variable, which will be of great benefit to analyze the reason for logistic cost, and then adopt approach and measure which can control and lower cost.

5.3 Applicability Analysis of Activity-Based Costing in the Logistics Cost Calculation and Management

We can know that the logistics cost management has all sorts of flaws comparing activity-based costing to traditional costing, so we introduce activity-based cost management, and discuss the applicability in our logistic cost management.

The analysis about activity-based costing applying to logistic cost management are as follows: (1) the feature of activity-based costing has got to meet the requirements of logistic cost management just right; (2) activity-based costing is applied not only to abroad, but to inland increasingly, and has made well results which will explore a road for applying activity-based costing to logistic cost management successfully; (3) with the maturity of the activity-based costing theory system, more and more companies pay attention to it; (4) the development of computer technique; (5) the raising of employee quality. All these can provide the theories and facts for activity-based costing applying to logistic cost management.

5.4 Comparison and Analysis Based on Cases

5.4.1 Enterprise Information

A product and B product are made and sold in a certain enterprise. The productive process of two products is almost the same, the difference between A and B is logistic service provided: A product carries out logistic service which is large-scale and less frequent, the number of products is 4,000 each batch; B product carries out logistic service which is small-scale and high frequent, the number of products is 10 each batch (Wang and Chang 2003). The enterprise adopts activity-based costing to accounting logistic cost, activities involved mainly as follows: order processing, pick and packaging, adjustment of packaging equipment, transport and handling, quality inspection, summons management, general management (Feng 2005).

Other related materials are as follows:

1. It sold 5 batches A products and 140 batches B products this month, and total 20,000 pieces A and 1,400 pieces B.
2. Orders can be processed 1,008 the whole month, and this month orders have been processed 800 which include 500 A orders and 300 B orders.
3. 4 packaging machines which can be used 640 machine hours the whole month, packaging A product needs 1.5 min each, and packaging B product needs 2 min.
4. Unloading transporting can provide 840 working hours the whole month, and A product will spend 120 h each batch and B product will spend 0.4 h each batch.
5. Quality inspection: checkout procedure is identical both A product and B product.
6. Summons management is accomplished by computer aided design system which can provide 840 machine hours. A product spent 168 h and B product spent 420 h this month.
7. General management: the use degree of the staff, and facilities and etc. is 75 %.
8. Resources provided this month mainly include: labor costs, electric charge, equipment depreciation and office allowance (Wang 2011). The value of these resources is: labor costs: 23,400, electric charge: 4,800, depreciation: 24,400, office allowance: 8,500.

5.4.2 Accounting Logistics Cost of the Product in Traditional Method

Because the productive process of A product and B product is almost the same, and expense components for these two products are as Table 5.1 show:

As a result: unit cost of A 60,550 ÷ 20,000 = 3.03
unit cost of B 33,070 ÷ 1,400 = 23.62

Table 5.1 Logistics cost's calculation list of product A, B (Unit: ¥)

	Material	Electric charge	Wages	Factory overhead	Total
A	$1.5 \times 20{,}000 = 30{,}000$	$4{,}800 \div 2 = 2{,}400$	$2{,}340 \div 2 = 11{,}700$	$(24{,}400 + 8{,}500) \div 2 = 16{,}450$	60,550
B	$1.8 \times 1{,}400 = 2{,}520$	$4{,}800 \div 2 = 2{,}400$	$23{,}400 \div 2 = 11{,}700$	$(24{,}400 + 8{,}500) \div 2 = 16{,}450$	33,070

5.4.3 Accounting Logistics Cost of the Product in Activity-Based Costing

1. The first step is to confirm activities and establish the cost database. Each activity will be established cost database which can be used gathering resources consumed (Li et al. 2011). Result is as Table 5.1.
2. The second step is to confirm resource diver and distribute resources value to each cost database (Roudaki and Doroodchi 2009). Distribution as Table 5.2 show.
3. The third step is to confirm cost drive of activities. Result is as Table 5.3.
4. The fourth step is to calculate the distribution ratio of the activity driver. Result is as Table 5.4.

The distribution ratio of the activity driver calculated is as follow: order processing: 5.46, adjustment of packaging: 8.38, packaging: 20.94, transport and handling: 12.92, quality inspection: 20.00, and summons management: 9.74.

5. The fifth step is to calculate resources value consumed of A and B product.

Transport and handling have consumed 656 working hours this month, A product: $5 \times 120 = 600$ (working hours), B product: $140 \times 0.4 = 56$ (working hours).

Packaging has consumed 546.67 machine hours this month which include 500 machine hours for A and 46.67 machine hours for B. the total number of produces inspected are 470, A product: $5 \times 10 = 50$ (pieces), B product: $140 \times 3 = 420$ (pieces). We can calculate resources value of products according to the results.

6. The sixth step is to calculate total cost and unit cost.

Direct material of A = $20{,}000 \times 1.5 = 30{,}000$ (yuan)
Direct material of B = $1{,}400 \times 1.8 = 2{,}520$ (yuan)
Total logistics costs of A = $30{,}000 + 26{,}844 = 56{,}844$ (yuan)
Total logistics costs of B = $2{,}520 + 19{,}220 = 21{,}740$ (yuan)

7. The seventh step is to gather results above, and Logistic cost sheet can be made according to gathering results (see Table 5.5).

Comparative statements of product costs are given between activity-based costing and traditional costing according to results (see Table 5.6).

Table 5.2 Distribution of resource (Unit: ¥)

	Order processing	Adjustment of packaging	Packaging	Transporting and handling	Quality inspection	Summons management	General management
Wages	1,600	480	4,320	5,000	5,000	4,000	3,000
Electric charge	200	160	1,440	1,250	1,400	180	170
Depreciation	2,500	560	5,040	4,000	7,700	2,400	2,200
Office allowance	1,200	140	1,260	600	1,900	1,600	1,800

Table 5.3 Each activity-based cost driver

Activity	Activity-based cost driver
Order processing	Order processing copies
Adjustment of packaging	Adjustment times of packaging
Packaging	Machine hours
Transport and handling	Working hours
Quality inspection	Number of cases
Summons management	Computer hours

Table 5.4 Practically consumed resources value of product A, B

Activity	Distribution ratio	Cost driver of activity consumed			Resource consumed (Unit: ¥)	
		A	B	Total	A	B
Order processing	5.46	500	300	800	2,730	1,638
Adjustment of packaging	8.38	20	140	160	168	1,173
Packaging	20.94	500	47	547	10,470	984
Transport and handling	12.92	600	56	656	7,752	724
Quality inspection	20.00	50	420	470	1,000	8,400
Summons management	9.74	168	420	588	1,636	4,090
General management	0.13	23,756	17,009	40,756	3,088	2,211
Total					26,844	19,220

Note the figures in the table are rounded to two decimal places

Table 5.5 Logistics cost's calculation list of product A, B (Unit: ¥)

	Resources value	A		B	
		Unit cost	Total cost	Unit cost	Total cost
Direct material	32,520	1.50	30,000	1.80	2,520
Order processing	5,500	0.14	2730	1.17	1,638
Adjustment of packaging	1,340	0.01	168	0.84	1,173
Packaging	12,060	0.52	10,470	0.70	984
Transport and handling	10,850	0.39	7,752	0.52	724
Quality inspection	16,000	0.05	1,000	6.00	8,400
Summons management	8,180	0.08	1,636	2.92	4,090
General management	7,170	0.15	3,088	1.58	2,211
Total	93,620	2.84	56,844	15.53	21,740

Note the figures in the table are rounded to two decimal places

Table 5.6 Result comparison of two different methods in calculating logistic cost (Unit: ¥)

	A	B
Activity-based costing	56,844	21,740
Traditional costing	60,550	33,070
Absolute difference	−3,706	−11330
Relative difference	−6.52 %	−52.12 %

5.5 Conclusion

It is clear that the two product cost is overvalued under traditional costing against activity-based costing, and the calculation of traditional costing leads to cost information twisted. Comparative results show that traditional cost information lost the decision relevance to a large extent. This case indicates that the difference of simulation results between traditional costing and activity-based costing lies in the difference of method and basis of distribution. That is to say, traditional costing allocate cost based on quantity, but activity-based costing allocate cost based on activities, that is we choose relevant cost drivers to allocating factory overhead to products, therefore accuracy of costing has improved greatly.

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Chapter 6
Building Energy Consumption in the Universities of China: Situation and Countermeasures

Zi-Li Liu, Shu-Quan Li, Min-Qiang Li and Ling-Xiang Feng

Abstract Choosing the buildings in the universities as study objects, this paper investigates the basic characters and the related energy consumption indexes of the teaching building, the office building and students' dormitories respectively. Based on the data of the investigation and the appraisal conclusion of the energy consumption, this paper puts forward a target system of building energy saving in the universities. By making a comparison between the situation of the building energy consumption and the target system of energy saving, this paper finds that reconstruction rate of the existing campus architecture is low and water saving devices are few. Thus according to these problem countermeasures are put forward.

Keywords Universities · Building energy consumption · Energy saving · Countermeasures

University is a place for educating talents, therefore the promotional work of building energy efficiency in universities can help students to establish the concepts of energy saving and develop the habits of cherishing the energy and the environment. By investigating and analyzing the constructional age, the structure, the form, the energy systems, the energy consumption indicators and the life cycle of the existing buildings in the universities, a building energy saving plan is developed. The plan gives a clear energy-saving objectives, scope and requirements. It further refers that the countermeasures of the building energy saving are important.

Z.-L. Liu (✉) · M.-Q. Li
University of Tianjin, Tianjin, People's Republic of China
e-mail: liuzilitj@126.com

S.-Q. Li · L.-X. Feng
University of Tianjin Finance and Economics, Tianjin, People's Republic of China

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6.1 The Investigation of Building Energy Consumption

6.1.1 The Design and the Distribution of the Questionnaire

The questionnaire is designed according to the basic characters and the related energy consumption indexes of the students' dormitories and the office buildings. Hundreds of questionnaires are distributed to the students in about a hundred Universities in China.

1. *The brief introduction of the questionnaire*

The questions in the questionnaire can be mainly divided into two aspects, the basic characters and the building energy consumption indexes. The basic characters include the constructional age, the structure, the energy systems and the life cycle of the existing buildings. The building energy consumption indexes include heating, water and electricity.

2. *The number and scope of the distribution*

The questionnaires are distributed to about a hundred universities in China. 600 questionnaires are distributed to the students' dormitories and among them 562 are valid. The covering area includes 20 regions, Beijing, Tianjin, the three provinces in northeast China, Inner Mongolia, Shanxi, Ningxia, Hebei, Shandong, Henan, Anhui, Jiangsu, Zhejiang, Chongqing Sichuan, Hunan, Hubei, Guangxi Guizhou Yunnan, Fujian, Shanghai and Guangdong. 100 questionnaires concerned with the office building are distributed into 9 districts of China, Beijing, Tianjin, Inner Mongolia, Heibei, Shandong, Jiangsu, Shanxi, Chongqing, Sichuan and Hunan. 89 of them are valid.

6.1.2 The Results of the Investigation

1. *The basic information of the objects*

According to the data, most of the office buildings are multi-layers, and they were built between 2005 and 2010. In addition, most of the office buildings are facing the South or North and they seldom face the West or East. To be specific, office buildings in Beijing, Tianjin, Hebei and Shandong not only face to the South or the North, but also face to the West or East. While office buildings in Jiangsu, Shanxi, Inner Mongolia and Hunan face to the South or The North, especially the office buildings in Shanxi, Inner Mongolia and Hunan only face to the South.

Speaking of the data about the students' dormitories, most of the buildings are multi-layers and they are mainly built in two periods which are from 1997 to 2004 and 2005 to 2010. Besides most of the buildings face to the South or the North and they seldom face to the West or the East. From the district, we can see that only the dormitories in Guizhou, Guangxi and Yunan face to the East. The rest of the dormitories face the South or the North.

2. *The analysis of the consumption* (Yang et al. 2007; Ni 2007)
(a) Restriction on power supply

The office buildings which have restriction on power supply only accounts 18 %. The average electricity consumption is 326.64. The students' dormitories which have restriction on power supply accounts 70 %. The free electricity consumption is 149.69.

(b) Power supply

The investigation shows the different power supplies in the office building. Most of the office buildings have illumination, drinking water dispensers, air-conditioning, computer and printer while, only a few office buildings have the power supplies such as small digital apparatus, electric fan and duplicator. Speaking of the power conservation supplies, the illuminations, air-conditionings and computers used in most of the office buildings have the function of power conservation.

(c) Restriction on water supply

80.9 % of the office buildings use automatic system to control the running water. When the taps are broken-down, 38.2 % of the investigators would report immediately, 34.8 % of the investigators choose to report in a day, 20.2 % of the investigators mention to report in a week and 6.7 % of the investigators would report after a week. Among all the investigated office buildings, only 24.7 % of them use the taps which have conservation function.

71.5 % of the dormitories do not have restriction on water supply. Free water supply covers from 0 to 5, 15.1 to 20, 5.1 to 10 and 10.1 to 15 tons. From these statistics, we can see that the water consumption of most dormitories is not over standard.

3. *Satisfaction of the buildings*
(a) Satisfaction about the temperature in summer time

In the survey about the satisfaction on the temperature in the office buildings during summer times, people in Beijing, Tianjin, Inner Mongolia, Shanxi, Hebei, Chongqing and Sichuan are satisfied with the temperature in the office buildings, while people in Hunan are not satisfied with the temperature in the office buildings. The ratios of satisfaction in Shandong and Jiangsu are 67.7 and 75 % respectively.

In the survey about the satisfaction on the temperature in the dormitories during summer times, the ratio of dissatisfaction is higher than the ratio of the satisfaction.

(b) Satisfaction about the temperature in winter time

People in Beijing, Tianjin, Hebei, Inner Mongolia, Shanxi, Jiangsu, Chongqing and Sichuan are satisfied with the temperature in the office building during winter times, while people in Hunan not satisfied with the temperature in the office buildings especially in winter. The ratio of satisfaction in Shandong is 54.5 %, while the ratio of dissatisfaction in Hunan is 100 %.

In the survey about the satisfaction on the temperature in the dormitories during winter times, the ratio of satisfaction is higher in Beijing, Tianjin, Northeast China, Hebei, Shandong, Inner Mongolia, Henan, Shanxi, Ningxia and Guangdong, while the ratio of dissatisfaction is higher in Jiangsu, Hunna, Hubei, and the southwest of China, Chongqing, Sichuan, Fujian, Shanghai and Zhejiang.

(c) Satisfaction about the lighting

People are satisfied with the lighting in both office buildings and the dormitories.

4. *The situation of energy saving reconstruction* (Wang et al. 2007; Fang et al. 2006)

(a) The buildings which have finished energy-saving renovation

10.1 % of the office buildings have already finished energy-saving renovation, while most of the dormitories have never done energy-saving renovation.

(b) The reasons for energy saving reconstruction

The reasons for the office building to do energy saving reconstruction can be concluded as following. 51.2 % of the office buildings have low heat comfort. 18.6 % of the office buildings mildew. 27.9 % of the office buildings are too noise. Speaking of the office buildings which have already finished energy saving reconstruction, the purpose for them to do so are concluded as following. 57 % of the buildings want to improve the environment and 40 % of the buildings want to lower the source consumption.

(c) The statistics about wishing to reconstruct the structure

29 % of the investigation objects want to reconstruct the structure of the dormitories. 58 % of the study objects want to reconstruct the control of temperature. 38 % of the objects want to reconstruct the heat source. 41.6 % of them want to use the electric saving apparatus. 38.9 % of them want to reconstruct the water saving devices. 28.9 % of them want to reconstruct the supply of heating system.

Among all the reasons, the main reasons for reform can be summarized as three aspects. First, want to improve the environment. Second, the low heat comfort. Third, lower the source consumption.

6.2 The Target Index for Energy Saving

According to the "evaluation standards for green building" and "civil architecture saving energy design standard" issued by our country, the "green building assessment system" issued by the United States green building council, and combined with the reality of energy-saving assessment standards, this paper puts forward the building energy conservation target index for university and the corresponding evaluation standards(Construction Ministry 1986, Construction Ministry 2006; Zhang 2007) (Table 6.1).

6.3 The Technical Problems Exit in Building Energy Consumption and Saving

Compare the technological data of the building energy consumption and energy saving with the evaluation standard for university building energy saving, following conclusions can be got.

6.3.1 The Low Rate of Building Renovation

The questionnaire shows that only 10.1 % of the office building and 11 of the dormitories have already done the renovation. Compare to the evaluation standard (35 %), the rate is much lower.

6.3.2 The Degree of the Users' Satisfaction to the Indoor Temperature is Ordinary

66 % of users are satisfied with indoor temperature in summer times, while 79.7 % of the users are satisfied with the indoor temperature in winter times. Generally speaking, the satisfaction rate is lower than the satisfied standard of indoor temperature which is above 80 %.

Table 6.1 The target index for energy saving

Evaluation index		Evaluation standard
Energy-saving renovation measures	Reform the structure of the buildings in the universities, try to reduce the noise	The reconstruction rate of the university architecture is above 35 %
	Take effective measures to shade the building	Over a half of the university buildings use sunshade measures
	The structure of the building can effectively guarantee the building insulation	The satisfaction rate about the indoor temperature is over 80 %
	Make full use of the natural ventilation and lighting	The users' satisfaction rate is over 75 %
	Effectively avoid the leakage of the water supply pipe network	The rate of the leakage is under 12 %
	Glass to floor area ratios meets the requirement of energy saving	Over 80 % of the glass to floor area ratios meets the standard (1/8 ~ 1/4)
	Use high reflective materials as the cover of the building to reduce the absorption of the heat	The rate of the building which use high reflective materials is over 60 %
The mode of energy conservation	Strengthen the usage of the non-traditional water resources such as reclaimed water, rain etc	The utilization rate of the non-traditional water resources is not less than 30 %
	Make full use of the renewable resources such as solar energy, geothermal resource etc	The usage rate of the renewable resources is above 5 % of the total consumption
	Choose the equipment with high energy efficiency	The usage rate of the equipment with high energy efficiency is above 50 %
	Use the temperature adjustment and heat measurement units	Above 75 % of the buildings use such measure
	Form a good habit of using water and electricity	Above 80 % of the users have such good habits
	Use intelligent water saving, and controlling devices	Above 50 % of the buildings use such devices
	Do not use the electrical equipment which contains fluorine chlorine hydrocarbon refrigerant	Above 80 % of the universities use it
	Propaganda and guiding garbage recycling methods, set the recycling product center and classify the waste	The garbage recycling rate in the universities is above 90 %

6.3.3 The Users' Satisfaction to the Lighting and Ventilation of the Building is Much High

86.9 % of the users are satisfied with the ventilation of the building. 87.8 % of the users are satisfied with the lighting of the building. These two ratios are above the standard of the energy saving evaluation.

6.3.4 There is a Huge Distance Between Glass to Floor Area Ratios and the Requirement of the Standard

The data shows that the buildings which meet the standard(1/8 ~ 1/4)only account 43.2 %, while the standard requires above 80 % of the building to meet (1/8 ~ 1/4).

6.3.5 The Utilization Ratio of the Non-traditional Water Resource can Meet the Basic Requirement

The rate of the non-traditional water resource used for greening is 36.7 %, which is slightly above the standard of energy saving (30 %).

6.3.6 Energy Saving Appliances Accounted for 45 % Among all the Electrical Apparatus

There is no big difference with the energy saving standard (50 %).

6.3.7 The Users in Universities have Good Habits of Using Water and Electricity

To be specific, 86.4 % of the users have good habits of using electricity and 75.6 % of them have good habits of using water.

6.3.8 There is Less Intelligent Water Saving and Controlling Devices in the Universities

The rate of using these kinds of devices is less than 20 % which can hardly meet the energy saving standard.

In conclusion, according to the energy saving target index for universalities, a lot of problem existed in the energy saving renovation for university buildings, which need further improvement.

6.4 Countermeasure Analysis

From the above analysis, this paper puts forward countermeasures from two aspects, energy saving technology and energy saving management.

6.4.1 Strategies for Energy Consumption and Energy Saving Technology

1. On the perspective of power saving, rationally adjust the pattern of power supply, update and enlarge the substation equipment, reform the old network in time. Use the light resources with the following characters, luminous, good color rendering, long service life, suitable for color temperature and accord with environmental protection requirements. Reasonably choose the illumination lamps with high photosynthetic. Widely introduce new economical technology, promote the use of energy saving equipments, use the indirect lighting, and make full use of natural light, etc (Zhan 2009; Ren 2009; Liu 2009).
2. On the perspective of water consumption, the main way is to collect rain water and reuse it. Use the sea water rationally and avoid the leakage of network. Use the water saving implements, change the habit of using water, and reduce the water consumption. Use the reclaimed water system. Speaking of the indoor environment, set the indoor parameter reasonably, raise the temperature a bit higher during summer time.
3. On the perspective of energy saving renovation, reform the building external envelope, such as the reformation of the window, the exterior wall and the roof.

6.4.2 Strategies for Energy Consumption and Energy Saving Management

1. Establish and improve the system for energy saving management. This kind of system should be guaranteed from the organization and management mechanism. Establish and improve the assessment system for energy saving. Based on the effectiveness of energy saving, establish the rewards and punishments system. According to the specific situation of each university design the energy saving scheme and plan respectively.
2. Help student to form the beliefs about energy saving. Using students' environmental protection association to propaganda the knowledge about energy saving and environmental protection.
3. Cultivate and introduce some people who have the experience of energy saving and management. Professional people are the key to the energy saving management (Wang 2009; Liu 2008; Chen 2009).

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Chapter 7
Empirical Analysis of Correlation Between Coal Enterprises and Electric Power Enterprises Based on Logistic Regression

Li Ping, Dan-jun Wu and Huo-gen Wang

Abstract This paper, from the mathematical statistic angle, adopts the method of principal components analysis and logistic regression to study and evaluate the financial performance of the existing listed coal and electric power enterprises and then comes to a conclusion that the performance of coal enterprises and electric power enterprises is correlated.

Keywords Coal · Electric power · Logistic regression · Principal component analysis

7.1 Introduction

In order to truly reflect the correlation between coal enterprises and electric power enterprises, this paper, from the mathematical statistic angle, selects the existing listed coal enterprises and electric power enterprises, adopts the method of principal components analysis to convert and integrate all financial indicators reflecting a company's operating status and obtain the comprehensive indicator, then compares and ranks the enterprises selected and gives comprehensive evaluation based on the comprehensive indicator. Besides, this paper will exploit logistic regression to evaluate the performance of these enterprises based on the

L. Ping (✉) · D. Wu
JiangXi Vocational and Technical College of Electricity, Nanchang, Jiangxi, People's Republic of China
e-mail: 302518514@qq.com

D. Wu
e-mail: wdj600818@163.com

H. Wang
Jiangxi Agricultural University, Nanchang, Jiangxi, People's Republic of China
e-mail: whuogeng@163.com

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factors derived from the principal components analysis. Given that the number of shareholders of listed enterprises is generally much higher than that of non-listed enterprises and the organizational structure and scale of the former is more complex than the latter, this paper therefore will mainly focus on evaluating the operational performance of listed coal and electric power enterprises. The evaluation method is also applicable to non-listed enterprises, as long as they meet the standards of the indicator system (Jihong 2001).

7.2 Methodology

1. Logistic Regression Analysis: If we set the probability of operational performance of listed coal and electric power enterprises as P, P ∈ (0,1), and logit (p) as the dependable variable, we will get $p = 1/(1 + e^{\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_k x_k+\mu})$ by fitting the linear equation $\mathrm{Logit(p)} = \ln\frac{p}{1-p} = \beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\ \beta_k x_k+\mu$ which is called the logistic regression model. Here, β_0 is a constant term unrelated to the indicator variables x_i, and $\beta_1, \beta_2, \ldots, \beta_k$ are regression coefficients which represent the contribution each indictor variable has made to P. With the regression model generated from this method, we can directly calculate the probability of good and bad operational performance of listed coal and electric power enterprises and then compare their values with the break-point, so that we can clearly distinguish and predict the operational performance of coal and electric power enterprises, which is of high practicability (He 2003).
2. *Indicator Selection and Data Source*: The design of the evaluation indicator system is the key and pain point in designing the overall performance evaluation system. Here, by evaluating the comprehensive performance of natural monopoly industries such as coal and electric power industries, we try to assess their market competitiveness in a relatively long term, including their status quo of survival and future prospects of development. Given the availability of data, the performance evaluation system in this paper mainly includes financial indicators. Input and output are core principles in developing these indicators. As the evaluation method of financial performance of natural monopoly industries is generally in accord with that of general competitive industries, in this paper we will adhere to the evaluation principle stated in the Detailed Operating Rules and Regulations on Enterprise Performance Evaluation (Revised Edition) which was promulgated by the Ministry of Finance of P.R.C. and we will not give repetitious details of the indicator designing at all levels. But we will give prominence on the cash flow indicators and dynamic indicators, as the users of the financial information, such as the government, investors, creditors, staff, customers and other shareholders, are more concerned about the

industry's capability of creating favorable cash flow and its future development potential. The indicators we use in this paper are as follows: current ratio (X1), quick ratio (X2), cash/current debt ratio (X3), shareholders' equity ratio (X4), current debt ratio (X5), debt/equity ratio (X6), earnings per share (X7), weighted EPS (X8), EPS growth rate (X9), distributed earnings per share (X10), retained earnings per share (X11), net assets per share (X12), net assets per share—adjusted (X13), cash per share (X14), capital reserve per share (X15), surplus reserve per share (X16), debt ratio per share (X17), growth rate of net assets per share (X18), inventory turnover ratio (X19), total asset turnover ratio (X20), accounts receivable turnover ratio (X21), prime operating financial expense ratio (X24), gross operating margin (X25), rate of return on assets (X26), net return on assets ratio (X27), net profit margin (X28), return on equity (X29), pre-tax profit growth rate (X30), growth rate of return on equity (X31), growth rate of main business income (X32), net profit growth rate (X33), total asset growth rate (X34), growth rate of main business profit (X35), asset/liability ratio (X36), cash flow/main business income ratio (X37) and cash flow/net profit ratio (X38). All these indicators can basically reflect the economic and financial features of the profitability, growth, cash flow, debt-paying ability, asset management ability and administration structure of the listed coal and electric power enterprises (Zhou 2002; www.stockstar.com; www.jrj.com; www.gw.com.cn; www.3jjj.com; http://www.cec.org.cn/).

7.3 Results

1. Calculate the value of the principal components (Wendai 2000)

The specific formula is as follows: $f_j = a_{1i}X_{1j} + a_{2i}X_{2j} + \cdots + a_{mi}X_{mj}$, $j = 1, 2, \ldots, n$, $i = 1, 2, \ldots, m$.

Substituting the number, we get f_1 = 0.861 * X29 + 0.851 * X10 + 0.839 * X7 + 0.817 * X28 + 0.815 * X8 + 0.806 * X11 + 0.73 * X23 + 0.724 * X26 + 0.691 * X14 + 0.67 * X24 + 0.561 * X20 + 0.451 * X16, and so on, we can get the value of $f_2, f_3, \ldots, f_n$.

2. Meanings of the Performance of Principal components

As shown in Table 7.1, meanings of the performance of principal components are determined by the indicator whose coefficient's absolute value is the largest in the formula. The absolute value of the coefficient shows the contribution that an indicator has made to the corresponding principal component.

The meaning of the performance of the first principal component is interpreted by indicators whose contribution ratio is higher than 0.5. These indicators are as follows: return on equity (X29), distributed earnings per share (X10), earnings per share (X7), net profit margin (X28), weighted EPS (X8), retained earnings per

Table 7.1 Logistic regression variables

			Score	df	Sig.
Step 0	Variables	f1	7.499	1	0.006
		f2	2.015	1	0.156
		f3	11.448	1	0.001
		f4	0.425	1	0.514
		f5	0.957	1	0.328
		f6	7.487	1	0.006
		f7	0.178	1	0.673
		f8	3.300	1	0.069
	Overall Statistics		33.315	8	0.000

share (X11), management expense ratio (X23), rate of return on assets (X26), cash per share (X14), financial expense ratio (X24), total asset turnover ratio (X20), surplus reserve per share (X16). The first principal components contains 21.961 % of the original information, so that it can reflect an enterprise's ability of making profit through low consumption and high yields and can determine the performance of an enterprise. We regard it as Profitability Factor.

The meaning of the performance of the second principal component is interpreted by indicators whose contribution ratio is higher than 0.5. These indicators are as follows: asset/liability ratio (X36), current ratio (X1), quick ratio (X2), shareholders' equity ratio (X4), debt/equity ratio (X6), debt ratio per share (X17), cash/current debt ratio (X3). The second principal component shows a company's debt-paying ability in short and long term. We name it Debt-paying Ability Factor.

The meaning of the performance of the third principal component is interpreted by indicators whose contribution ratio is higher than 0.5. These indicators are as follows: growth rate of return on equity (X31), pre-tax profit growth rate (X30), net profit growth rate (X33), EPS growth rate (X9), growth rate of main business profit (X35), accounts receivable turnover ratio (X21). The third principal component shows the long-term development ability of an enterprise, so that we call it Enterprise Growth Factor.

The meaning of the performance of the fourth principal component is interpreted by indicators whose contribution ratio is higher than 0.5. These indicators are as follows: net assets per share (X12), net assets per share—adjusted (X13), capital reserve per share (X15), inventory turnover ratio (X19). The fourth principal component shows a company's capacity of equity expansion, so that we call it Scale Effect Factor.

3. Comprehensive Performance Evaluation and Rank

According to formula in Sect. 1, the model for enterprise comprehensive performance evaluation, we can get a comprehensive performance evaluation model for the listed coal and electric power enterprises to calculate the value of first eight principal components which contain over 80 % of the information of the original indicators. The model is as follows:

$$f = 0.2196 * f_1 + 0.1613 * f_2 + 0.1489 * f_3 + 0.1011 * f_4 + 0.0616 * f_5 + 0.048 * f_6 + 0.044 * f_7 + 0.0438 * f_8,$$

With this model, we will figure out the comprehensive evaluation values, rank them in a descending order, and then we get the rank of enterprises' performance in a descending order. The factor analysis helps us rank the operational performance of the coal and electric power enterprises, structuralize the messy and complex indicator system, simplify the observation dimension and retain most information of the raw data, which lays foundation for the logistic regression (Zeng 2002; Wu 2001; Beaver 1996).

Usually 0.5 is regarded as the breakpoint to classify samples in logistic regression analysis. If the probability (P) is larger than 0.5, the sample is classified as blue-chip company, otherwise it is regarded as poor performance company. We select 49 listed coal and electric power enterprises as samples and set the performance value of coal enterprises as good, that is p = 1, and the performance value of electric power enterprises as bad, that is p = 0. The eight principal factors we have obtained from the above-mentioned factor analysis are analysis variables, which are used to fit the logistic regression model. With the Logistic Regression of SPSS 13.0, we conduct binary logistic regression analysis of samples to be evaluated, and the results are shown in Table 7.1.

It can be noted that under 10 %, variable coefficients f2, f4, f5, f7 are not significant enough, while f1, f3, f6, f8 are very significant. Therefore, we can conclude that indicators reflecting the profitability and growth of an enterprise exert great influence on the enterprise's performance. Next we will analyze the significant variables in regression step by step, as shown in Table 7.2.

According to Table 7.2, we incorporate f1, f3, f6 and f8 as variables into the regression equation and get the logistic regression model:

Table 7.2 Logistic regression variables

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	f3	1.709	0.561	9.290	1	0.002	5.525
	Constant	−0.865	0.368	5.532	1	0.019	0.421
Step 2(b)	f1	2.155	0.792	7.407	1	0.006	8.632
	f3	2.324	0.780	8.877	1	0.003	10.216
	Constant	−1.230	0.489	6.336	1	0.012	0.292
Step 3(c)	f1	1.945	0.839	5.373	1	0.020	6.994
	f3	3.015	0.961	9.851	1	0.002	20.392
	f6	1.781	0.709	6.317	1	0.012	5.939
	Constant	−1.342	0.572	5.507	1	0.019	0.261
Step 4(d)	f1	1.999	0.922	4.704	1	0.030	7.381
	f3	3.157	1.095	8.316	1	0.004	23.500
	f6	2.142	0.878	5.952	1	0.015	8.519
	f8	0.979	0.541	3.268	1	0.071	2.661
	Constant	−1.492	0.669	4.971	1	0.026	0.225

Note B is the value of independent variable coefficient and constant

Table 7.3 Performance evaluation table of listed coal and electric power enterprises

Stock Code	Stock Name	f1	f2	f3	f4	f5	f6	f7	f8	Factor evaluation value	Logistic regression value
600971	Hengyuan coal industry and electricity power	1.1	0.51	0.04	2.2	1.1	0.7	1.33	3.22	0.88	0.9899716
600188	Yanzhou coal mining	0.57	2.36	1.49	0.3	1.4	−1	0.96	−0.18	0.85	0.9949624
000933	Shenhuo coal and power	1.09	0.8	1.03	1	1.2	0.4	1.45	−0.49	0.77	0.9984426
000937	Hebei Jinniu energy resources	1.08	0.09	1.37	0.6	0.2	0	−2.2	0.54	0.46	0.9654901
600508	Shanghai Datun energy resources	1.26	0.01	1	0.6	−0.7	1.2	−2.1	−0.36	0.4	0.9970001
600997	Kailuan energy chemical	0.02	1.54	0.15	0.4	1	−1	−1.5	2.46	0.39	0.9795866
600123	Shanxi Lanhua sci-tech venture	0.78	0.02	0.71	−0	1.2	0.8	1	−0.32	0.39	0.9610684
000983	Shanxi Xishan coal and electricity power	0.41	0.3	0.79	0.8	0.3	−1	0.62	0.35	0.36	0.9967478
600348	Shanxi Guoyang new energy	0.57	0.01	0.39	0.6	−1.3	1.6	0.79	1.42	0.35	0.9958837
600098	Guangzhou development industry (Holdings)	0.94	1.11	−0.91	1.5	0.6	−0	−1.7	−1	0.32	0.9605132
600740	ShanXi coking	1.41	−0.99	0.18	1	−0.7	0.6	0.04	−0.44	0.26	0.9927823
600333	Changchun gas	0.31	0.85	0.24	−1	0.8	0.9	1.22	−0.18	0.26	0.4058134
000027	Shenzhen energy group	1.03	0.62	−0.39	−0	−0.1	−1	0.4	−1.1	0.16	0.9959906
600408	Shanxi Antai group	0.69	−1.46	2.05	−2	−0.3	1.8	0.72	0.01	0.16	0.5844771
000037	Shenzhen Nanshan power	1.25	−0.57	−0.91	−0	0.1	1.3	0.9	−0.19	0.12	0.1900185
600395	Guizhou Panjiang refined coal	−0.09	0.88	0.04	−0	−1.9	1.2	0.58	0.72	0.1	0.606869
000875	Jilin power share	−0.87	2.25	−0.12	0.2	−1.5	−0	0.55	−0.11	0.1	0.0951771
000539	Guangdong electric power development	0.55	1.2	−0.46	−0	0.3	−0	−1.3	−1.52	0.09	0.1186308
000968	Taiyuan coal gasification	0.18	−0.14	1.37	−1	−0.6	0.9	−1.8	−0.19	0.08	0.0450064
600578	Beijing Jingneng thermal power	−0.18	1.07	0.14	−1	−0.4	0.9	0.8	−0.77	0.07	0.6249495
600101	Sichuan Mingxing electric power	0.36	−0.88	−1	2.1	0.8	0.2	0.19	−1.3	0.03	0.0605776
000531	Guangzhou Hengyun enterprises holding	0.69	−0.54	−0.24	−0	0.2	−0	0.41	0.21	0.02	0.0482981
600121	Zhengzhou Coal Industry and electric power	−0.41	0.61	0.72	−1	0.8	0.6	−0.9	−0.13	0	0.2550989
600744	DaTang HuaYin electric power	−1.09	−0.06	2.49	0.6	−2.6	−2	0.83	0.15	0	0.0004656
000543	Anwei Wenergy company	−0.17	1.46	−0.62	−0	−0.9	−1	0.45	−0.59	0	0.3143414

(continued)

Table 7.3 (continued)

Stock Code	Stock Name	f1	f2	f3	f4	f5	f6	f7	f8	Factor evaluation value	Logistic regression value
000899	Jianngxi Ganneng	−0.74	2.51	−0.65	−1	−1	−2	0.39	0.04	−0.1	0.3657299
600642	Shenergy	0.56	−0.31	−0.66	−0	0.4	0.4	0.58	−1.37	−0.1	0.0605099
600011	Huaneng power international	0.93	−0.39	−0.54	−1	0	0.5	−1.2	−0.87	−0.1	0.4104053
600397	Anyuan industrial	−0.64	−0.17	−0.18	0.2	0.7	0.8	0.69	−0.65	−0.1	0.0424651
600396	Shenyang Jinshan energy	−0.22	−0.37	−0.06	−1	0.6	0.6	1.18	−0.39	−0.1	0.0172453
600310	Guangxi Guidong electric power	−0.3	−0.74	−0.44	0.9	−0.1	−1	0.67	−0.06	−0.2	0.257866
000601	Guangdong Shaoneng group	−0.25	−0.56	−1.12	1.8	−0.2	−1	0.36	−0.17	−0.2	0.0218304
600236	Guangxi Guiguan electric power	0.13	−1.11	−0.73	1	1.4	−2	0.29	−0.4	−0.2	0.0845719
600726	Huadian energy	0.19	−1.16	−0.23	−0	−0.7	−0	−1.3	2.67	−0.2	0.0241916
600864	Harbin Hatou investment	−0.32	−0.23	0.23	0.1	−0.9	0.2	−1.4	−0.95	−0.2	0.0034331
000767	Shanxi Zhangze electric power	0.2	−0.13	0.11	−1	−0.4	−1	−1	−1.06	−0.3	0.0552214
600719	Dalian thermal power	−0.65	−0.55	−0.41	0.4	0.5	0.5	−0.8	−0.55	−0.3	0.0007931
600795	GD power development	0.2	−1.67	0.1	−0	−0.2	−1	0.84	0.34	−0.3	0.0281583
600131	Sichuan MinJiang hydropower	−1.04	0.19	0.54	−2	2.1	−1	−1.2	1.84	−0.3	0.0002371
000692	Shenyang Huitian thermal power	−0.58	−0.33	−0.29	0.8	−1.6	−0	−0.8	−0.69	−0.3	0.0156151
600505	Sichuan Xichang electric power	−1.01	−0.9	0.37	−1	2.5	−1	0.24	−0.59	−0.3	4.306E − 05
600509	Xinjiang Tianfu thermoelectric	−0.25	−1.26	0.08	−0	0.2	−1	−1.1	0.27	−0.3	0.0041054
600863	Inner Mongolia MengDian HuaNeng thermal power	−0.22	−0.72	−0.24	−1	−0.8	−1	0.59	0.5	−0.3	1.971E − 06
000958	Shijiazhuang Dongfang thermoelectric	−0.54	−0.48	−1.48	0.5	0.1	0	−0.7	0.55	−0.4	0.0023297
000966	Hubei Changyuan electric power development	−0.15	−1.21	−0.38	−1	−0.8	−1	0.8	0.12	−0.4	0.046394
600292	Chongqing Jiulong electric power	−0.44	−1.4	−0.23	−1	−0.5	−1	0.55	0.88	−0.4	1.262E − 08
000720	Shandong Xinneng Taishan power generation	−0.39	−0.69	−0.69	−1	−0.9	0.5	0.77	−0.24	−0.5	0.0046535
000993	Fujian Mindong electric power	−5.01	−0.21	1.28	2.1	0.9	1.9	−0.2	−0.65	−0.6	1.006E − 05
001896	Henan Yuneng holdings	−0.98	0.84	−3.95	−1	−0.2	1.8	−0.2	1.22	−0.7	0.0307385

$$p = \frac{\exp(-1.492 + 1.999 * f1 + 3.157 * f3 + 2.142 * f6 + 0.979 * f8)}{1 + \exp(-1.492 + 1.999 * f1 + 3.157 * f3 + 2.142 * f6 + 0.979 * f8)}$$

Based on the principal component analysis and logistic regression, we obtain the performance evaluation table of 49 listed enterprises in 2004, as shown in Table 7.3.

7.4 Conclusion

This paper firstly proposes the idea of evaluating a company's performance by combining principal component analysis and logistic regression and then builds a logical model combining principal components and logistic regression after having empirically analyzed data from the annual reports of listed coal and electric power enterprises. A comparison between principal component analysis model and the principal components logistic regression model is made in this paper, which shows that the latter is much better than the former in evaluating the fitting effects of the sample group and in predicting. Therefore, this paper concludes that the principal components logistic regression model has certain applicability.

1. Employ the principal component analysis of mathematic statistics to comprehensively evaluate the operational performance of listed enterprises, solve the problems of indicator overlapping and subjective weight and improve the rationality of performance evaluation results. Besides, complex matrix computation can be easily solved with the computer, which enhances the performance evaluation efficiency and reduces the subjective interference, thus offering a feasible way to determine the weight of performance indicators.
2. The original classification of four indicators has certain imitations, because different enterprises have different indicator classification methods. In practical applications, we should consolidate all indicators at the very outset and then use principal component analysis to categorize them.
3. As can be seen from the ranking of the operational performance of 49 coal and electric power enterprises, 13 of the 16 coal enterprises rank top 16 and their f_1 value is relatively higher. As f_1 represents the profitability of an enterprise, we come to a conclusion that the profitability of coal enterprises is higher than that of electric power enterprises.
4. The performance of the electric power industry is generally lower than that of the coal industry, but not without exceptions. For example, Shenzhen Energy Group, Shenzhen Nanshan Power and Guangzhou Development Industry (Holdings) rank top 16, which shows that the rising coal prices is not the only factor, the internal management also counts. The reasons why Shenzhen Energy Group, Shenzhen Nanshan Power and Guangzhou Development Industry (Holdings) rank top 16 boil down to their low operational cost, management and financial expense compared with their counterparts, thus enhancing their profitability. Therefore, we

hold that implementing "coal-electricity price linkage" is not a fundamental approach to improving the operational performance of the electric power industry. The best way is to reinforce management, lower the operational cost, management and financial expense (http://www.cec.org.cn/; http://www.epri.sgcc.com.cn/rcpy/yjszs/; http://dts.gw.com.cn/; http://www.sxcoal.com/).

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Chapter 8
Empirical Analysis of Economic Value Influence Factors of Spectrum

Xian-feng Wu, Xu Yuan and Jing Zhou

Abstract With the increasing demand of spectrum, many of scholars have begun to concern about the economic value of spectrum. To study factors that influence the economic value of spectrum from the enterprises, this paper researched extent that some enterprises factors effected economic value of spectrum by quantitative analysis through establishing the Log–Log Model. Based on the mobile communications market of the United States in the empirical analysis found that telecom enterprise fixed asset, market share, churn of users significantly influenced the economic value of spectrum. Namely spectrum economic value depends not only on the spectrum natural factors and administrative factors, but also spectrum users' enterprise factors. And the higher telecom enterprise on the utilization rate of the spectrum, the bigger spectrum economic value.

KeyWords Economic value of spectrum · Enterprises factors · Input–output ratio · Log–log model

8.1 Introduction

Spectrum as an indispensable input factors of radio operations industry production and management are widely used in broadcast television, satellite communications, mobile communications and other fields. According to the mobile

X. Wu (✉) · X. Yuan · J. Zhou
School of Economics and Management, Chongqing University of Posts and Telecommunications, Chongqing, China
e-mail: wuxf1963@qq.com

X. Yuan
e-mail: shmilyxz@qq.com

J. Zhou
e-mail: zhou-jing2010@126.com

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communications market statistics, the number of global mobile subscribers reached 5.787 billion, a penetration rate of 87 % in 2011. The numbers are expected to reach 6.263 billion in 2012 and will be more than 7 billion in 2014. With the increase of mobile subscribers, the demand of the spectrum resources is expanding, but spectrum supply is limited. How to make limited frequency resource fully realize its economic value? This requires us to study the factors influencing the economic value of spectrum.

Domestic and overseas scholars from a macroeconomic perspective, estimate the spectrum resources' contribution to GDP growth (UK Radio Communications Agency 1996; Europe Economics Chancery House 2006. Nozdrin (2003), Bruwaene (2004), Doyle (2006) had studied the model of spectrum pricing (Nozdrin 2003; Bruwaene 2004; Doyle 2006, 2007). Through reading the economic value of spectrum related literature, we found that the influence factors of spectrum economic value that scholars studied with focused on the physical features of spectrum resources and administrative features, such as bandwidth, coverage, government policy, etc., and they ignored the impact to cause by the telecom competitiveness (Harald 2001; Thomas 2004; Wang et al. 2010; Sun 2009). If you only consider the physical features and administrative features in the process of measuring the economic value of spectrum resources, the economic value of one spectrum license is the same for any enterprise. But the bidding process and results of spectrum auction indicated that different enterprises have different expected price for the licensing of homogeneous spectrum. Traditional influence factors can only reflect the common value of spectrum, but can't reflect the personality value of spectrum.

This paper bases on the former research and a case study of mobile communication market in the United States, focuses on analyzing the relationship between spectrum economic value and enterprise factors, so as to make full use of the spectrum resources provide important basis for decision-making.

8.2 Enterprise Influence Factors of Economic Value of Spectrum

This article explores the factors that influence the economic value of spectrum from the internal and market competitiveness of telecom enterprises, in order to improve telecom enterprises utilization rate of spectrum.

(a) *Interior Factors*

Telecom enterprise's internal competence is composed of internal, dominant enterprise resources and capabilities, such as assets, human capital, technological innovation capability (Chao-qun and Gao-qiang 2011; Lu 2007; Yun-fei and Chao-qun 2006). Usefulness of spectrum to human is originated from inputting a certain amount of capital, labor, knowledge and technology on it (Sun et al. 2011).

Spectrum creates economic value that is inseparable from the process of interaction between capital, labour and other factors.

As a typical capital concentrated industry, telecom enterprises fixed assets account for a large proportion of the total assets, the proportion is usually above 60 %. Fixed asset is mainly manifested in the telecom enterprise of radio access equipment investment. So with increasing fixed assets, spectrum efficiency is ascending. However, to update technology usually requires a longer period, it is called scientific and technological input hysteresis, so this paper dose not research technology development input on the influence of the spectrum economic value.

With the increase of the network infrastructure and the expansion of the scale of mobile users, telecom enterprise need to put more human capital to maintain all kinds of network equipment and customer relationships. Labor input improves the utilization of the spectrum with capital, technology in joint collaboration, thus improving the economic value of spectrum.

(b) *Market Factors*

With the competition of the mobile communications industry intensified and low-end of new users, ARPU (Average Revenue Per User) of the global mobile industry is a declining trend. Large data showed that income increment by the increasing users was greater than income reduction by the decline in ARPU because low-end users' demand elasticity is bigger. The lower ARPU attracted a lot of users, so as to enhance spectrum efficiency.

Market share measured the economic value of spectrum in terms of the number of users. Under the limited network capacity, the greater market share, the higher spectrum efficiency. That is the more subscribers make spectrum resources is fully used, so the spectrum economic value is bigger.

User churn measured the economic value of spectrum in terms of the users' loyalty. Through calculation, existing users' ARPU is higher than new users, and acquiring the new users cost is five time than retaining the existing users cost (Xinlong and Xiao-bing 2011). Thus low user churn would lead to the higher economic value of the spectrum resource.

8.3 Research Variables and Model

(a) *Variables Description*

This article regards the spectrum input–output ratio as an indicator measuring the economic value of spectrum. That is used for spectrum devoted funds divided by service income of mobile business. Formula for: $k = C/R = 1/N$, $N = R/C$. C represents spectrum cost input per year and R represents service income of mobile business per year. The N count is bigger; the economic value of spectrum is higher. All the variables identified in Table 8.1.

Table 8.1 Variables used in model

Variables	Description
Spectrum input–output ratio (SIOR)	Input one unit currency spectrum outputs how many units business income
Fixed assets (FA)	Telecom enterprise for production of fixed assets, including wireless access equipment, cable, etc
Labour input (LI)	The total workforce for maintaining sustainable business operation
Average revenue per user (ARPU)	Operation revenue from per user in a period
Market share (MS)	The proportion that enterprise mobile business users accounted for the industry total mobile business users
User churn (UC)	The number of users who give up current network number a proportion of the total number of users

Because our country assigns spectrum license by administrative allocation way, which does not fully reflect the true economic value of the spectrum resource. Therefore this paper chose historical data of spectrum trading market and mobile communications market in America to do empirical research.

The enterprises include AT&T, Sprint and Nextel.[1] Spectrum license cost derived from official website of FCC. According to relevant "Enterprise accounting system", using "Linear Amortization" share the total spectrum license cost to the usage period and added each year's inflation rate to evaluate the monetary value of spectrum license cost of telecom enterprise. Mobile business services revenue comes from telecom enterprises annual reports, and according to the equation obtains spectrum input–output ratio. Fixed assets, labour input, ARPU, market share and user churn obtains by calculation of annual reports directly or indirectly.

(b) *Model Setting*

The Log–Log Model is mainly used to estimating production function and demand function. It is widely used because of reducing the volatility of the data and improving the accuracy of the model through variables taking the logarithm. The basic model for:

$$\ln \mathrm{Y} = \boldsymbol{\alpha} + \boldsymbol{\beta} \ln \mathrm{X} + \boldsymbol{\mu} \tag{8.1}$$

In this paper, the model based on double logarithm model, and on the basis of the model expression for:

$$\ln \mathrm{SIOR} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \ln \mathrm{FA} + \boldsymbol{\beta}_2 \boldsymbol{lnLI} + \boldsymbol{\beta}_3 \ln \mathrm{ARPU} + \boldsymbol{\beta}_4 \mathrm{MS} + \boldsymbol{\beta}_5 \mathrm{UC} + \boldsymbol{\mu} \tag{8.2}$$

In Table 8.1, Ms and Churn is percentage data, so the two variables do not take logarithm in the model.

[1] Sprint acquired Nextel, and the combined company takes on the Sprint Nextel name. Three companies' mobile business market share ranks top five in US.

8.4 Regression Analysis

Base on the above data and model; take use of the SPSS software to do the model parameter estimation. The regression results as shown in Table 8.2.

From the Table 8.2 of goodness of fit of the model 1, we know that the enterprise internal competitiveness factors can explain 58.7 % of the dependent variable changes. After adding the enterprise market competitiveness factors, two kinds of factors commonly explain 80.6 % of the dependent variable changes. The adjusted goodness of fit of the model 2 arrived 75.8 %, F value of 16.635 is significantly better, so we think this group of data fitting degree is better. In the model 2, judging from the explanatory variable parameter estimation, fixed capital, market share and user churn passed the *t* test and the significant is respective 0.01, 0.1 and 0.05. ARPU estimated result refused the test of significance. In the model 1 and 2 model, the labor input parameter estimation are significant negative, this idea is not consistent with our assumption.

So we believe it is necessary to examine the model whether there are serious multiple collinearity. Making use of the SPSS software can get all of the variables of linear diagnosis report, such as Table 8.3 shows:

From Table 8.3 we see that all the variables' VIF were less than 10, therefore we think the model 2 does not exist serious problem of multiple linear; each variable can be used to explain the dependent variable changes.

This paper took the way of data classification tested the robustness of regression results, and with telecom enterprise as classification standard. Extracting the data

Table 8.2 Empirical regression estimation results

Explanatory Variables	Dependent Variable = Ln(SIOR)		
	(1)	(2)	(3)
LnFA	3.123***	1.875***	1.928***
	(5.693)	(3.724)	(4.118)
LnLI	−1.967***	−1.202***	−1.234**
	(−5.196)	(−3.201)	(−3.469)
LnARPU		−0.638	
		(−0.337)	
MS		0.078*	0.081**
		(2.059)	(2.244)
UC		−1.018**	−0.942**
		(−2.452)	(−2.758)
R^2	0.587	0.806	0.806
$R^2 - A$	0.551	0.758	0.758
F	16.333***	16.635***	21.680***
N	26	26	26

Notes:***, **, * respectively represents significant on the level of 1, 5 and 10 %, the number is the t—test value In brackets. R^2 − A indicates adjusted goodness of fit, "F" is on the significance of the regression coefficients in the regression statistics for homogeneity of variance tests; "N" is sample number

Table 8.3 Variables multiple collinearity diagnosis

Explanatory Variables	Variance Inflation Factor (VIF)	
	(1)	(2)
LnFA	4.068	6.352
LnLI	4.068	7.421
LnARPU		2.020
MS		2.778
UC		3.190

of AT&T and Sprint made the robustness inspection of parameter estimation. Use the SPSS software doing the model parameter estimation. The regression results as shown in Table 8.4.

Table 8.4 shows there is no significant change about parameter estimation results for fixed assets, market share and user churn, we think the three explanatory variables can pass the robustness inspection. Labor input parameter estimation result is greatly significant changes. At last, we can find weather the model 2, model 4 or model 5, ARPU influences on the spectrum input–output ratio is not a significant. So we ruled out the ARPU from the model and the new regression results as shown in the model 3 at the Table 8.2. Comparing the regression results between model 2 and model 3 we found after excluding the explanatory variables of ARPU, ability of the rest of the explanatory variables to explain changes in the dependent variable was not weakened, and *t* test value, F-test value were improved.

Table 8.4 Robustness inspection result

Explanatory variables	Dependent variable = Ln(SIOR)	
	(4)	(5)
LnFA	0.536**	1.760**
	(2.419)	(3.189)
LnLI	0.905*	3.330*
	(1.897)	(2.441)
LnARPU	1.108*	−6.667
	(1.755)	(−1.166)
MS	0.142***	0.175*
	(11.882)	(2.725)
UC	−0.770**	−0.317
	(−2.389)	(−0.620)
R^2	0.989	0.996
$R^2 - A$	0.980	0.990
F	111.544***	167.216**
N	12	9

Notes:***,**,* respectively represents significant on the level of 1, 5 and 15 %, in the model 1 and model 2, the regression model data respectively comes from AT&T and sprint

8.5 Conclusion

By the regression results indicate that the spectrum input–output ratio is significantly influenced by telecom enterprise competitiveness, the evidence indicates the value economic of spectrum is not only effected by the physical features and administrative features of spectrum, but also enterprise features of spectrum user. Proposed enterprise influence factors of spectrum economic value can explain the reason why there is different estimated price of spectrum license among the telecom enterprises. And it provides the decision-making basis that promotes the effective management of spectrum resources from the two sides. On the one hand, for the telecom enterprises, it can promote enterprises to improve spectrum efficiency and thus to be full realization of the economic value of spectrum. On the other hand, for the spectrum resources management department, enterprise influence factors of spectrum economic value adds the study content about economic value influence factors of spectrum. In some areas where the market transaction mechanisms of spectrum is developing, management department can assign the spectrum to telecom enterprises that is efficient use of spectrum through studying enterprise factors of spectrum economic value, so as to promote efficient distribution of resources.

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Chapter 9
An Empirical Study on Irrational Bubbles of Ordinary Residential Market in China

Ying Wang and Bo Wang

Abstract This paper analyzes present situation of real estate market in China and studies the method to determine the basic price of ordinary housing and measure the degree of irrational bubbles based on the partial equilibrium framework. This paper also analyzes the irrational bubbles of ordinary residential market with real estate-related data in Beijing and Xi'an. In addition, this paper presents some recommendation on formulating real estate regulatory policy for Chinese government.

Keywords Basic price · Economic bubbles · Irrational bubbles · Ordinary residential market

9.1 Introduction

Since the second half of 1998, China has implemented the system of monetization of housing distribution. Then real estate industry in China began to develop quickly, which became main driving force of the national economy. According to preliminary estimates, 100 yuan of housing fund can bring 170–220 yuan needs for related industries in China. However, with the fast pace of urbanization, the scarcity of urban land has become increasingly prominent and real estate prices in Chinese major cities rose sharply, which attracted many non-rational speculators

Supported by the key discipline of Shanxi Province and supported by the featured discipline of philosophy and general social sciences of Shanxi higher education institutions.

Y. Wang (✉) · B. Wang
School of Management, Xi'an University of Architecture & Technology, Xi'an, China
e-mail: wangbojay@126.com

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for short-term interest in the real estate market. Domestic and international experience has shown that a large number of speculators in the market will lead to economic bubbles and rupture of economic bubbles will cause serious economic crisis. Therefore, the study of bubbles in Chinese real estate market has an important significance for the development of Chinese real estate industry and economy.

Economic bubble is the part in asset price deviated from its basic price caused by local speculative demand. According to different views on market efficiency, the economic bubble theory is divided into rational bubble theory and irrational bubble theory. The former holds the view that there are rational bubbles in asset prices caused by rational investment, which explains the formation mechanism of market bubble to some extent. However, due to asymmetric information, there is irrational investment which may cause economic bubbles and rational bubble theory can hardly explain it.

Behavioral finance provides theoretical basis for the research of irrational bubbles. De Long established the DSSW model to explain the reason that the price of stock deviated from the basic value from the perspective of microscopic behavior (De Long et al. 1990). At the base of De Long's study, follow-up researchers compromised traditional supply and demand theory, utility theory and behavioral finance to study irrational bubble. Shen and Niu analyze the inherent mechanism to cause the irrational increase of housing price and suggest that the key to stabilizing housing price is to cut off the positive feedback trading behavior and the self-reinforced inherent mechanism (Shen and Niu 2008). Shi studies the process of generation, development and burst of speculative bubbles (Shi 2005).

On the base of existing study on irrational bubbles, this paper establishes the evaluation model of irrational bubbles and studies the method to measure the degree of irrational bubbles in the real estate market based on the partial equilibrium framework. Besides, this paper analyzes the irrational bubbles of ordinary residential market in Beijing and Xi'an.

9.2 The Construction of Theoretical Model

The real estate market is full of uncertainty and information asymmetry. In this market investors' behavior jointly decides the price of real estate. The investors who master all the information in the market are called rational investors (Binswanger 1999). The price they determine by rational expectations is the basic price of real estate.

However, due to the effectiveness of the market is not established, there is some deviation in the investors' awareness of information. The deviation makes investors make decisions based on experience and intuition resulting in inadequate response or overreacting to information (Qiu 2009). The price they determine contains irrational bubbles.

In order to measure the degree of irrational bubbles in the real estate market, it's necessary to estimate the basic price and irrational price of real estate. Liang Gao suggests two methods to determine the basic price of real estate (Liang 2011). This paper estimates the basic price from the perspective of supply and demand in the market.

9.2.1 House Price Model Under Rational Expectations

Under rational expectations, consumers and developers are rational, who can master all the information, have comprehensive understanding of the market and achieve the maximization of utility under the condition of partial equilibrium. This paper estimates the basic price of real estate by establishing the demand function of consumers and supply function of developers.

1. Demand function of real estate under rational expectations

For investors, there are some assumptions as follows.

(1) The consumer's utility is made up of the consumption of general goods and buying housing (Lianhua and Chunpeng 2005).
(2) Consumers can accurately expect the price of real estate in current period (P_0) and next period (p_1).
(3) No matter the investor of real estate is in rigid demand or to rent, its utility is annual rental and the rate of return (R) is equal every year.
(4) Ying Wang thinks that purchase cost includes: cost of capital (i), cost of conservation (d), the benefit of depreciation or appreciation (m), tax benefit or expense (t_i) (Wang and Tang 2010). Rongrong Ren thinks that ownership cost includes opportunity cost (r) of first payment as well (Ren 2008).

$$C = P_0 Q_0 \cdot [1 + i + t_i + d + r - \pi] \tag{9.1}$$

(C refers to ownership cost; Q_0 refers to area of real estate; π refers to inflation rate.)

(5) The life of real estate is long enough and all the products in the market are homogeneous.
(6) The utility function of investors obeys the Cobb-Douglas function and the utility is separable (Donald and Winkler 2002).

$$U = G_t^{\alpha} \cdot P_0 Q_0 (1 + R)t \tag{9.2}$$

(G refers to total value of general merchandise)

Under the constraint of disposable income, consumers buy real estate of proper quantity to achieve utility maximization.

$$\max : U = \sum_{t=1}^{\infty} G_t^{\alpha} \cdot P_0 Q_0 (1 + R)t \tag{9.3}$$

$$s.t. : Y = G_t + P_0 Q_0 \cdot [1 + i + t_i + d + r - \pi] \tag{9.4}$$

Compromise the constraint condition (9.4) into utility function (9.3) and calculate the logarithm on both sides. Then calculate one order partial derivatives to Q0 in order to obtain the condition of utility maximization, which is demand function of consumers under rational condition.

$$P_0 = \frac{Y}{(\alpha + 1)[1 + i + t_i + d + r - \pi] Q_0} \tag{9.5}$$

2. Supply function of real estate under rational expectations

The developer's profit is the result that sale subtracts cost. For developers, utility maximization means profit maximization (Zhao and Tu 2008). There are some assumptions as follows.

(1) The developer's utility is separable.
(2) The developer's housing cost is a quadratic function of quantity to conform to the reality of increasing marginal cost.

Developers develop real estate of proper quantity to achieve utility maximization.

$$\max : U = P_0 \cdot Q_0 - C \cdot Q_0^2 - B_0(i + r) \tag{9.6}$$

$$s.t. : B_0 = C Q_0^2 \tag{9.7}$$

(C refers to unit cost; B_0 refers to investment in current period)

Compromise the constraint condition (9.7) into utility function (9.6) and calculate the logarithm on both sides. Then calculate one order partial derivatives to Q0 in order to obtain the condition of utility maximization, which is supply function of developers under rational condition.

$$P_0 = 2 C Q_0 (1 + i + r) \tag{9.8}$$

3. Basic price of real estate under the condition of partial equilibrium

Under the condition of partial equilibrium, the quantities of demand and supply are equal (Yang and Wu 2007). Therefore, by demand function of consumers (9.5) and supply function of developers (9.8), we can obtain the basic price of real estate.

$$P_t^l = \sqrt{\frac{2YC(1+i+r)}{(\alpha+1)[1+i+t_i+d+r-\pi]}} \quad (\alpha = 1) \tag{9.9}$$

9.2.2 *Measure Model of Irrational Bubbles Under Irrational Expectations*

The price of real estate which includes irrational elements and rational elements is determined by both irrational investors and rational investors. Therefore, the price of real estate in the market can be expressed as follows.

$$\begin{aligned} P_t &= (1-\varphi)P_t^l + \varphi P_t^f = (1-\varphi)P_t^l + \varphi(P_t^l + b) \\ &= P_t^l + \varphi b \end{aligned} \tag{9.10}$$

(φ refers to the proportion of rational investors; $\mathrm{P}_\mathrm{t}^\mathrm{l}$ refers to the basic price of real estate determined by rational investors; $\mathrm{P}_\mathrm{t}^\mathrm{f}$ refers to the price of real estate determined by irrational investors; b refers to the bubbles caused by irrational investors.)

$$\varphi b = P_t - P_t^l \tag{9.11}$$

$$\lambda = \frac{\varphi b}{P_t^l} \tag{9.12}$$

(λ refers to the degree of irrational bubbles)

If $\lambda > 0$, it means there are irrational bubbles in the market; If $\lambda < 0$, it means irrational bubbles don't exist in the market.

9.3 Analysis of the Irrational Bubbles of Ordinary Residential Market in China

This paper selects Beijing as the representative of first-tier cities and Xi'an as the representative of second-tier cities when analyzing the irrational bubbles of ordinary residential market in China.

9.3.1 *Calculation of the Irrational Bubbles*

Through the analysis above, the data used to calculate irrational bubbles is shown as follows.

Table 9.1 The calculation table of indicators of irrational bubbles in Beijing and Xi'an

Years	P_t		P_t^l		φb		λ	
	Beijing	Xi'an	Beijing	Xi'an	Beijing	Xi'an	Beijing	Xi'an
2001	4,437.1	2,306.5	3,495.25	2,021.94	941.85	284.56	0.302313	0.177302
2002	4,277.34	2,328.73	3,589.55	2,459.17	687.79	−130.44	0.220558	−0.02344
2003	4,550.3	2,409.13	3,674.17	2,581.39	876.13	−172.26	0.268991	−0.03712
2004	5,505.15	3,010.08	4,652.87	2,921.69	852.28	88.39	0.212584	0.063497
2005	7,321.68	3,122.05	4,443.66	3,028.73	2,878.02	93.32	0.689907	0.064066
2006	7,055.41	3,452	5,219.74	3,706.87	1,835.67	−254.87	0.386751	−0.04641
2007	10,018.7	3,657.39	6,234.33	4,235.34	3,784.37	−577.95	0.650149	−0.11462
2008	11,055.39	4,272.78	6,884.84	4,730.17	4,170.55	−457.39	0.65037	−0.07684
2009	12,064.01	4,950.4	6,651.76	4,655.89	5,412.25	294.51	0.858909	0.083233
2010	15,731.07	6,027.01	8,581.9	5,176.47	5,064.68	850.54	0.880464	0.186956
2011	16,812.98	6,472.95	9,344.45	5,694.18	4,984.46	778.77	0.847994	0.159285

(1) Disposable income of urban residents (Y);
(2) Social average profit margin (R);
(3) Taxes generated by purchase of real estate (t_i);
(4) Interest rate of loan for purchase of real estate (i);
(5) Inflation rate (π);
(6) The development costs of developers (C);
(7) The transaction price of ordinary housing in real estate market (P_t).

The related data can be found in statistical yearbook and relying on the types above, the indicators of irrational bubbles in ordinary residential market of Beijing and Xi'an can be calculated, which can be seen in Table 9.1.

9.3.2 Analysis of the Irrational Bubbles

From the Table 9.1, it can be seen that the degree of irrational bubbles has been above zero in Beijing since 2001, which indicates the ordinary residential market in Beijing has bubbles all the time; The fact that the number of λ is bigger and bigger indicates that the irrational bubbles of ordinary residential market in Beijing increase year by year. And the lowest point and highest point appeared in 2004 and 2010.

From the Table 9.1, it also can be seen that in 2001, 2004, 2005, 2009, 2010 and 2011, the degree of irrational bubbles has been above zero in ordinary residential market of Xi'an, which indicates there are irrational bubbles. It wasn't high in 2001, 2004, 2005. From the whole, the actual transaction price of ordinary housing in Xi'an fluctuated around the theoretical price before 2008. After 2008, the irrational bubbles appeared in large number. The lowest point and highest point appeared in 2003 and 2010.

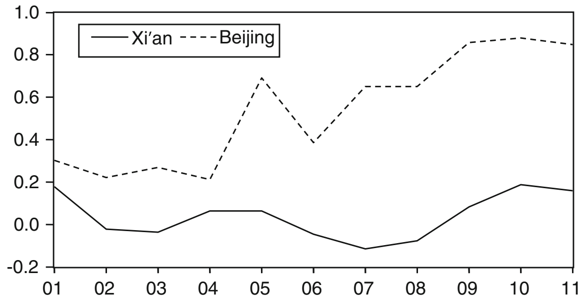

Fig. 9.1 The wave diagram of irrational bubbles in ordinary residential market in 2001–2011

In order to show the change trend of irrational bubbles in ordinary residential market of Beijing and Xi'an from 2001 to 2011 better, using Eviews software with the results above, the wave diagram of irrational bubbles can be drawn in Fig. 9.1.

From the Fig. 9.1, it can be seen that the change trend of irrational bubbles in Beijing and Xi'an is similar. And the degree of irrational bubbles in Beijing (a first-tier city) exceeds Xi'an (a second-tier city) significantly.

In 2005 and 2010, peaks appeared both in Beijing and Xi'an. The reason that they appeared in 2005 is the price of the real estate began to increase fast in our country in 2003 and speculators invested ordinary housing based on the expectation of increasing housing price. Due to the "eight national regulations" and the rise of loan interest rate they began to decrease in 2005. The reason that they appeared in 2010 is after the financial crisis in 2008 the government adopted active policies to promote the development of ordinary residential market and a large number of speculators began to appear. After 2010, because the government adopted a series of severe administrative and financial policies to control the real estate market and kinds of investors started to quit, the degree of irrational bubbles decreased gradually. Besides, it reflects that current policy on real estate in our country has a positive effect on eliminating real estate bubbles.

According to the current situation of ordinary residential market in China, this paper puts forward the following suggestions on regulation policies. Firstly, adopt different control policies in different areas according to actual situation and strengthen control power in first-tier cities; Secondly, adopt different purchase quota policies for different kinds of consumers to avoid reducing the enthusiasm of people who really need the house when hitting the speculators; In addition, when controlling the price, improve per capita income in order to improve housing purchase ability of rigid demanders and reduce the bubbles caused by irrational investment.

9.4 Conclusion

Based on the partial equilibrium framework, this paper studies the method to determine the basic price of ordinary housing and measure the degree of irrational bubbles in ordinary residential market. According to that, it analyzes the irrational bubbles of ordinary residential market in Beijing and Xi'an with real estate-related data. The empirical research reflects that irrational bubbles exist in Chinese ordinary residential market and the situation of first-tier cities is more serious. Therefore, the government should formulate and implement effective regulation policies to restrain the irrational bubbles in ordinary residential market and make sure the real estate industry develop better.

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Chapter 10
Estimating the Hidden Costs of Operating Room with Time-Driven Activity-Based Costing

Ni-ni Gao, Zi-xian Liu and Ya-fang Li

Abstract Operating room costs control is an important part in the hospital cost management, in order to control the operating room costs comprehensively, the paper analyzes the hidden costs of operating room, and estimates the hidden costs with the theory of time-driven activity-based costing (TDABC). A case of a third-class hospital in China was studied to estimate the hidden costs of operating room with TDABC, the result showed that the value of the hidden costs of the operating room is large, and its rate can reach to 30 % of the total costs. So the hospital must pay more attention to the hidden costs of operating room and control them.

Keywords Estimating · Hidden costs · Operating room · Time-driven activity-based costing (TDABC)

10.1 Introduction

Operating room is regarded as one of the most important sectors in a hospital. It is the largest cost center in a hospital because it involves expensive surgical facilities, special equipment, and the high salary labors, the cost of operating room can account for 40 % of a hospital's resource costs (Macario et al. 1995). While the operating room is also the highest revenues sector, it can generate approximately two-thirds of hospital total revenues (Jackson 2002). So it is very important to manage the operating room costs, whether to control the cost of operating or to

N. Gao (✉) · Z. Liu
College of Management and Economics, Tianjin University,
Tianjin, China
e-mail: gaoxueni126@163.com

Y. Li
People's Liberation Army No.254 Hospital, Tianjin, China

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increase the revenues of hospital. But people always pay more attention to the explicit costs of operating room that are easy to find, such as the depreciation of equipment, cost of labor, materials cost and so on. In fact, there are a lot of hidden costs exit in the operating room, they do not appear in the financial accounting and always are hidden in the total costs, so they are ignored by the manager, but they influence the total costs to a large degree. To control it, measure it first. In order to control the cost of operating room more fully and systematically, and also to make the hospital managers to pay more attention to the hidden costs of operating room and have cognition to the hidden costs in quantity, the paper tries to measure the hidden costs of operating room with the time-driven activity-based costing.

The remainder of this paper is organized as follows: Sect. 10.2 the hidden costs of operating room will be analyzed. Section 10.3 introduces the time-driven activity-based costing and the model of hidden cost of operating room will be proposed. In Sect. 10.4 there will be a case study to estimate the hidden costs of operating room. Section 10.5 there is a discussion. Finally Sect. 10.6 provides brief conclusions.

10.2 Hidden Cost of Operating Room Analysis

Hidden costs is relative to the explicit costs, it is a kind of cost that is hidden in the total costs of economic organization but outside of the financial audit and supervision, it is a kind of future costs or switching costs that is somehow un-seeable and made by the economic agents intentionally or accidentally, it is the sum of future cost and switching costs (Wang 2007).

From the definition we know that there are a lot of factors can lead to hidden costs. We can get the support form some literatures. Strategic cost was considered as a kind of hidden costs (Porter 1985; Shields and Young 1992). Callioni et al. (Gianpaolo et al. 2005) analyzed the hidden costs of inventory in their work; lots of researchers did research about the hidden costs caused by quality, analyzing the content and try to measure it with different methods (Kim and Liao 1994; Georgios et al. 2001; Soo-Jin et al. 2011). Other factors such as the wrong decision, unscientific planning and the idle resources also can produce hidden cost. Because the hidden cost is unseen, it is difficult to measure, different hidden cost need different methods to measure. In traditional accounting, only the cost of material costs, labor costs and the overhead costs are included, in this paper we only discuss the hidden cost which caused by idle resources, without considering the costs which because of strategy, quality and so on. When we calculate the cost of operating room, all the costs including the direct labor (salaries of analgesics, nurses et cl.), the fixed cost of surgical equipment, the medicine and the materials for surgery, and the expense of water, electricity that support the operating room work smoothly. In fact, not all these costs belong to the surgical costs, the labor and the operating room is idle in a long time, when they are unused they don't make any value to the operating room, but the costs they spent are shared by the

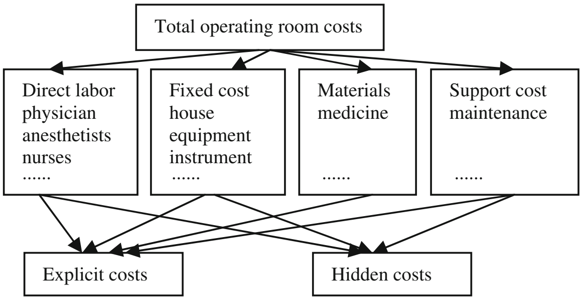

Fig. 10.1 Operating room costs analysis

revenues of operating room, in fact, it is a kind of switching cost. The idle labor will produce idle labor costs, the idle operating room will produce idle equipment costs and the relative costs, such as the maintenance and other indirect costs. All these costs were made intentionally or accidentally, hidden in the total operating room, they do not do contribution to the operating room, increase the total operating room costs to a large extent. Figure 10.1 shows the operating room costs analysis.

10.3 Mathematical Model

10.3.1 Time-Driven Activity-Based Costing Method

In order to estimate the hidden costs of operating room which were made by the idle resources, we adopted the time-driven activity-based costing approach.

To overcome the difficulties in conventional activity based costing, time-driven activity-based costing as a new approach was developed by Kaplan and Anderson based on the activity based costing, time-driven activity-based has been proven can calculate the cost more correctly than the conventional activity based costing approach. There are two parameters to estimate, one is the unit cost of the supplying resources and the time required to perform an activity by this resource guoup(Kaplan and Anderson 2004).Then unit cost of the resources multiplied by the time required for an activity can get the cost of the activity. The same theory, we regard the idle state of labor and operating room as idle activity, so if we estimate the time of the idle activity, or called hidden cost time, and we can estimate the cost of hidden cost of operating room which caused by the resources in idle. There are six steps to follow according to the literature (Patricia 2008).

1. Identify the resources which perform the activities.
2. Collect the total costs data of each resource.
3. Estimate the available time capacity of each resource.
4. Calculate the unit time cost of each resource according to the total costs of each resource and the available time capacity.

5. Determine the required time for each activity.
6. Calculate the total costs for a cost object through multiplying the unit time cost by the time required for each activity.

10.3.2 TDABC Model for Operating Room Hidden Costs Estimating

In fact, a lot of non value-added activities exist in the surgical procedures because of the operational motion is non-standard, forming hidden costs. But because there are a lot of surgeries and different physicians, one hand it is very difficult to define the standard motion, on the other hand it is impossible to analyze everyone's operational motion, which needs costing a lot of work. So in this work, we assume that all the workers perform the surgeries with the standard activity, without redundant motion.

For operating room, according to the six steps we do following hypothesis.

First we suppose that the number of the resources in the operating room is n.

Second, let C_i represents the total costs of resource i in period d day.

Thirdly, let T_i represents the theoretical time capacity of resource i everyday. Because not all the theoretical time capacity of resources are used for working, some time is used for resting, repairing and so on, the available time capacity must be smaller than the theoretical time capacity. We assume there is a utilization rate for each resource, and let V_i represents the theoretical utilization rate of each resource. We can calculated the available time capacity of each resource is $T_i * V_i$ every day.

Fourthly, according to the former hypothesis we calculate the unit time cost of each resource.

Unit time cost of each resource $= \frac{C_i}{dT_i * \mathrm{V_i}}$.

Fifthly, in order to estimating the time for idle activity of each resource, let t_{ij} be the practical time capacity of resource i in day j. so the idle time for each resource $= dT_i * \mathrm{V_i} - \sum_{j=1}^{d} t_{ij}$.

Finally, the two parameters we have got, so we can calculate the total hidden cost of operating room.

The total hidden cost $= \sum_{i=1}^{n} \frac{C_i}{dT_i * \mathrm{V_i}} \left(dT_i * \mathrm{V_i} - \sum_{j=1}^{d} t_{ij} \right)$.

10.4 Case Study

In this study, we take a comprehensive surgical department in a third-class hospital as an example. There are 8 operating rooms in the hospital's comprehensive surgical department, all of them can be used for all kinds of surgeries. All the operating rooms are open everyday, and they stay open for 8 h. There are 13 analgesics and 21surgical nurses for the operating rooms. They work 8 h everyday and 22 days in each month according to the national legal workday. In general, one analgesic and two nurses are needed for a operation. We select the operating room data in January 2012 to calculate the hidden costs of operating room. The total surgery quantity in this month is 365, and the total operating time is 720 h. The operating time refers to the time from the patient entering into the operating room to the patient leaving the operating room. There is a block during the two surgeries, and the nurses need to clean the operating room and prepare for the next surgery. In common, different clean class operating room need different cleaning time, we take average value of 40 min. Before the operation, the analgesist and nurses need do a lot of preparation for the operation, and after the operation the analgesist and nurses also need to look after the patient to make sure their state is good. The average working time of one nurse outside the operating room is about 1 h for a patient, and for one analgesist is approximate 1.25 h.

According to the above data we have collected and follow the six steps to calculate the hidden costs of operating room in January 2012.

Step one, we make sure that all the equipment, instrument, operating personnel and the operating room overheads are the resource group. The surgeon salary isn't included in the operating room costs, so the surgeon cost isn't considered here.

Step two, we collect the total cost pools of operating room resources. It is shown in the table 10.1.

Step three, calculate the available time capacity according to the theoretical time capacity and the utilization rate. Different type of resources have different utilization rate, because the operating room need maintenance and cleaning, 100 % utilization of operating room is unrealistic, and the literature show that it is reasonable for operating room when its utilization rate is in 70 %∼80 %, and it is irrational when the utilization rate surpasses 80 %, it will influence the efficiency and decrease the satisfaction of patients and physicians (Mcquarrie 1981). Here we take the rational utilization is 70 %. Same to the operating room, the personnel need some time to have a rest during their work, in general, people assume the utilization rate of work is 80 %. The available time capacity is shown in table 10.2.

Table 10.1 The cost pools of resources of the resources (*Unit* ¥)

Cost pools	Items	Cost
Depreciation of fixed assets	Depreciation expense of house, equipment and instrument	75,497
Labor costs	Basic wage and performance pay of analgesists	58,656
	Basic wage and performance pay of nurses	52,500
Operating room overheads	Expense of water, electricity and so on	15,300

Table 10.2 The available time of operating room in a month (*Unit* Hour)

Type of resources	Theoretical time capacity	Utilization rate (%)	Number of resources	Available time capacity
Fixed assets	240	70	8	1,344
Analgesists	176	80	13	1,830.4
Nurses	176	80	21	2,956.8
Overheads	240	70	8	1,344

Table 10.3 The Unit Time Cost Of Operating Room Resources (*Unit* ¥)

Type of resources	Total costs	Available time capacity	Unit time cost
Fixed assets	75,497	1,344	56.17
Analgesists	58,656	1,830.4	32.05
Nurses	52,500	2,956.8	17.76
Overheads	15,300	1,344	11.38

Step four, according to the result of Tables 10.1 and 10.2 we can get the unit time cost of each resource. See Table 10.3.

Step five, estimating the practical time capacity of each resources. For the operating room, the result of the available time capacity minus the working time and the block during the two operations is the operating room idle activity time(hidden activity time). The idle activity time of operating room = 1,344 − 720 − 365 × 40/60 = 381 h. But for the analgesists and nurses are different, the practical working time of analgesists and nurses is the operating time and the working time outside the operating room. The idle activity time of analgesists = 1,830.4 − 720 − 1.25 × 365 = 654.15 h. The idle activity time of nurses = 2,956.8 − 720 × 2 − 365 × 2×1 = 786.8 h. The result is shown in Table 10.4.

Finally, multiply the unit time cost (the result of step four) by the idle activity time of each resources to get the total hidden costs of operating room. See Table 10.5.

From the table we can see that the hidden fixed costs made by operating room idle is 2,1400.77 RMB, made by the analgesists is 20,965.51 RMB, and for the nurses is 1,3973.57 RMB, the overheads share 4,335.78 RMB. And the total hidden cost of operating room owning to the idle activity is 60,675.63 RMB.

Table 10.4 The idle activity time of each resource (*Unit* Hour)

Type of resources	Available time capacity	Practical working time	Hidden activity time
Fixed assets	1,344	963	381
Analgesists	1,830.4	1,176.25	654.15
Nurses	2,956.8	2,170	786.8
Overheads	1,344	963	381

Table 10.5 The total hidden costs of operating room (*Unit* ¥)

Type of resources	Unit time cost	Idle activity time	Total costs
Fixed assets	56.17	381	21,400.77
Analgesists	32.05	654.15	20,965.51
Nurses	17.76	786.8	13,973.57
Overheads	11.38	381	4,335.78
Total			60,675.63

10.5 Discussion

Based the time-driven activity-based costing approach we have got the value of hidden costs of operating room in January 2012, The total costs of operating room in this month is 201953RMB(without including the cost of material). so the rate of hidden cost $= 60{,}675.63/201{,}953 \times 100\ \% = 30.04\ \%$. We can see that the hidden costs that were made by the idle activity accounted for a large proportion in the total operating room costs, so the hidden costs should get attention by the hospital managers and all these costs should be controlled in the operating room management. There are so much hidden idle resources exits, stemming from the scale of the operating room and the staff number more than the demand, the hospital should do reasonable decision when the operating room was established, and should reduce the number of operating room and the staff. There are a lot of techniques can be learned to satisfy the demand with the high efficiency and the least cost. More information can refer to the literature (Randy 2008; Friedman et al. 2006; Hanss et al. 2005).

In fact, these costs are only part of the hidden costs, there a lot of hidden costs contents aren't included, which we have discussed in Sect. 10.2. We will try to estimate them according to their character with other methods in future research.

10.6 Conclusion

Operating room costs influence the total hospital costs and revenue in a large extent, in order to provide the overall cost control for the operating room, this paper analyze the hidden costs exist in the total operating room costs, and try to estimate the value of the hidden cost which caused by the idle resources. The result show that the hidden cost occupied a large part in the total operating room cost, the hospital managers should pay much attention and adopt technique to control them.

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Chapter 11
Identification of the Important Influence Factors of the Low Carbon Building Based on Rough Set

Zi-Li Liu, Min-Qiang Li, Shu-Quan Li and Xue Sun

Abstract From life cycle perspective, this paper analyzes the influential factors of low carbon building. After processing the data with the rough set theory, it identifies the most important influential factors of low carbon building, and puts forward the countermeasures of using low carbon buildings.

Keywords Identification · Influential factors · Low carbon building · Rough set

11.1 Introduction

The development of social economy provides people with rich material and cultural life, at the same time, it also brings a lot of environmental problems. Especially the high consumption of the energy and high emissions bring adverse effects to the climate change. People gradually realize that in order to protect the environment, it is necessary to reduce carbon emissions while developing the economy. According to the statistic, there are altogether 43 billion square meters of buildings in our country and the buildings which have the high energy consumption account for 95 %. If the ratio can be lower to 50 %, then 300 billion kwh of electricity can be saved and 300 million tons of carbon dioxide emissions can be reduced. The statistic shows that there is a huge potential of energy conservation and environmental protection in the area of construction (Zou and Qu 2009; Zhou 2005; Tang 2011).

Z.-L. Liu (✉) · M.-Q. Li
University of Tianjin, Tianjin, People's Republic of China
e-mail: liuzilitj@126.com

S.-Q. Li · X. Sun
University of Tianjin Finance and Economics, Tianjin,
People's Republic of China

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Low carbon building has become an inevitable trend for the economic development and it is also an inevitable choice of sustainable development. The implementation of the low carbon buildings can reduce carbon emissions to a great extent, but the popularization of the low carbon building promotion has not reached people's expectations. What concerned the promotion of the low carbon building most are its key influencing factors which will be discussed in this paper (China Architecture and Building Press 2007; Huang 2010; Jiang and Keith Tovey 2009).

11.2 The Analysis of the Influencing Factors of the Low Carbon Building

Low carbon building refers to reduce the consumption of the fossil energy, improve energy efficiency and reduce carbon dioxide emissions during the construction and the usage of the building. The influential factors of the low carbon building include the emission of carbon dioxide during the process of construction. Only when we know the influential factors and make detailed analysis and evaluation, can we finally control the emission of the carbon dioxide.

There are numerous factors influencing the emission of the carbon dioxide, thus we need a specific way to make systematic review. The streamlined Life Cycle Analysis tool (sLCA) is a life cycle theory, which reduced the complexity of the theory and attained the objective by specializing the theme of a research. With the help of sLCA, the main activities that influence the emission of the carbon dioxide can be analyzed. In this paper, we analyze the influential factors of low carbon building from the planning stage, the construction stage, the operation stage and the maintained and updating stage respectively.

11.2.1 The Planning Stage of Low Carbon Building

Planning is the initial stage of a project. Many decisions made during this stage may influence the design of the building, construction and the operation management of the building. The work in the designing stage includes the different parts of construction and all the activities in operation management (Day et al. 2009; Li 2008). One thing to mention, this stage do not includes carbon emission and its influence is follow-up.

Based on the existed evaluation index of the planning stage and the suggestions of the experts, the main influential factors of the carbon emission can be classified as following,

1. The selection of architecture placement and the qualification of the place

The selection of the architecture placement influence the service life of a building, while the qualification of the place which includes the sunshine, lighting, ventilation, heat island effect and greening influence the indoor environment.

2. The characters of the building itself

These characters include building orientation, the sunshine, lighting, ventilation, window-wall ratio, the wide and depth of the surface and the shape coefficient.

3. The selection of the building materials and resources

The selection of the building materials is the foundation of the low carbon building. It includes the durability of the building, the recycling of the old material, the usage of the new type of the material, the treatment of the solid waste and the utilization of renewable energy.

4. The selection of structural system

The selection of the structural system includes the wall system, the system of the door and the window, surface system, shading system, flooring system, the design of the energy saving system which includes, building envelope, lighting, air-conditioning, the measurement of the energy equipment and the system for monitoring and control.

11.2.2 The Construction Stage of the Low Carbon Building

Construction stage is the key step of the low carbon building, during this stage electricity, oil and fossil fuel are highly consumed. If we can control the consumption of the energy and improve the structure of energy use, it will help to improve efficiency, protect the environment, and reduce carbon dioxide emissions.

But the construction process is too complicated. This paper uses process analysis to study the activities of carbon emissions in the construction stage. Based on the division and design of the sub-project in *unified standard for construction quality acceptance of building engineering* (GB50300-2001), this phase mainly considers the carbon emission in ground and foundation, main structure and decoration and fitment (Li and Colombier 2009; Shuai and Li 2009).

1. The factors of the constructional personnel

In this phase, the carbon emission mainly from temper ary office field, the consumption of water and electricity in the place where constructional personnel live.

2. The project of ground and foundation

This section mainly involves four processes, earth excavation, brick foundation, concrete foundation and pile foundation. Among them the activities involved with carbon emissions are the transportation of earthwork, sand, rock and concrete, the operation of large and middle machine, such as the equipment of pile driving, concrete mixer and vibrating machine, the consumption of power used for machinery and lighting, exhaust emission by constructional vehicle and equipment.

3. The construction of the main structure

The main structure can be classified as three parts during the construction process, formwork engineering, reinforcement engineering and concrete engineering. Among them the activities involved with carbon emission are the operation of reinforcing steels, template hoisting machine and concrete mixer, the transportation and handling of sand, rock and concrete, the consumption of power used for machinery and lighting, the emission of the carbon dioxide during the process of welded steel and the emission of carbon during the process of mixing the concrete.

4. Decoration and fitment

This division mainly involves waterproof insulation, curtain wall and detailed construction. The activities involve carbon emission are the consumption of power during the operation of power saw and electric drill, the transportation and handling of sand, rock and materials for decoration and the emission of carbon from different decoration materials.

11.2.3 The Operation Stage of the Low Carbon Building

After the completion of a building, the emissions of carbon dioxide are still involved in the usage of the building, which is always a focus in the study of energy-saving buildings. The studies consists the energy consumption of heating, cooling, ventilation and lighting.

11.2.4 The Maintenance and Updating Stage of the Low Carbon Building

The carbon emission in this stage refers to the emission during the process of the decoration, maintenance and overhaul. To be specific, three aspects are involved in

Table 11.1 The influential factors of the carbon emission in different phases of low carbon building

Stage	Influential factors
Planning stage	The selection of architecture placement and the qualification of the place
	The characters of the building itself
	The selection of the building materials and resources
	The selection of structural system
Construction stage	Personnel factors
	The project of ground and foundation
	The construction of the main structure
	Decoration and fitment
Operation stage	The energy consumption by the equipments
Maintenance and update stage	Energy saving transformation
	Equipment updating
	Environmental transformation

carbon emission, which are energy saving transformation, equipment updating and environmental transformation.

All in all, the influential factors of the carbon emission in different phases of low carbon building are summarized in the following Table 11.1.

11.3 The Brief Introduction About the Rough Set Theory

11.3.1 The Introduction about the Rough Set Theory

Rough set theory first proposed by Prof. Dr. Zdzisaw Pawlak in 1982 is a kind of data deduction method use to analyze the imprecise, incomplete information and knowledge. Rough set theory is based on the classification on the basis of the mechanism, it will be interpreted in a particular space classification of equivalence relation, and equivalent relation of the space constitutes the division. Rough set theory is the key idea using the known knowledge base to depict the unknown and inaccurate knowledge or not accurate knowledge. The characteristic of the theory is that it does not need to provide the problem solving process data outside of any priori information, so the description of uncertain question is relatively objective. Based on data observation the redundant information can be deleted and some hidden mode and relations can be found. Under the premise of keeping the key information, simplifying the data and the minimum knowledge expression, the relations of the dependence of data and the formation of classification or decision rules can be got (Zhang 2003).

11.3.2 The Tools for the Application of the Rough Set

In the past few years, a lot of KDD systems of the rough set had been established. Among all the systems, the ROSE2, ROSETTA are the representatives.

ROSE (Rough Set data Explorer) is developed by Poznan Technology University of Poland. Based on the rough set theory, this system used to make decision analysis and it is the update version of Rough Das and Rough class system. Rough Das system is used for data analysis and Rough class system is used to classify the data. Both systems have been applied to many practical fields.

Rosetta (A Rough Set Toolkit for analysis of data) is developed by the Department of Computer and Information Science, Norwegian University of Science and Technology (NTNU) and mathematics research institute of Warsaw university Poland. It is a toolkit for analyzing tabular data within the framework of rough set theory. It includes calculation nucleus and graph boundary. It can be operated in the Windows environment and also has a version used in UNIX environment. The main characters of this system are that it gathered different methods for data preprocessing and at the same time, it provides the commonly used algorithm in the rough set, such as Genetic Algorithm, Manual Reduce and so on. Therefore it supports the whole process of data preprocessing and analysis. The main functions provided by this system are as following, ① acquire the data and output the result, and it supports ODBC and some of the DBMS. The formats of the output include table, graph and MATLAB document. ② preprocessing of the data, it can complete and discretize the data in the decision table. ③ Based on discernibility-based modeling, ROSETTA finally obtains general simplified rules.

This paper uses Rosetta to analyze the influential factors of the low carbon building when reduction is made. It tries to find the most important factors or the most potential factors to the low carbon building and it further puts forwards the related solutions.

11.4 The Identification of the Important Factors

The influence of the factors in the already built index system is different. Thus how to find the most important factor and take pertinence measures are significant. This paper will use the reduction character of the rough set theory to analyze the above factors and try to find the most important factors or the most potential factors to the low carbon building. Finally it will put forwards some useful suggestions and solutions to solve the problems.

11.4.1 Acquire of the Index

The questionnaire is designed based on the aspects of the index and the actual investigation of engineering projects. To make sure the effectiveness and accuracy of the survey, objects are scientific arranged and questionnaires are sent by a particular person. With the help of the related unit, 40 effective questionnaires are got, which are the samples of this research.

11.4.2 Data Preparing and Processing

1. Data preparing

The column in the decision table represent attribute. Attribute are divided as condition attribute and decision attribute. Data with condition attribute can be classified as quantitative data and qualitative data. The rough set can only deal with the quantitative data and some of the qualitative data, such as the orientation of the building, the condition of the equipments and the selection of the materials, the criteria to these indexes are good, not bad and bad. We normal preprocessing these qualitative data first and then change them into quantitative data. According to the 31s index, different questions are made. Some questions may represent the same index, so when processing the data, we weight the data and finally get 25 conditions attribute.

Decision attribute is used to identify whether the project is energy saving or not. Thus decision attributes belongs to qualitative index. According to the status of the building, four criteria are made, not bad, good, very well, and excellent. For decision attribute D, assign its value 0, 1, 2, 3, respectively, to be specific 0 represents general, 1 representative good, two representative is very good, three representative outstanding. Thus the initial decision table is established.

2. Data supplement and discretization

Use Rosetta tools to preprocess the initial evaluation data. In a survey, the intensity of the heat island and energy measurement are omitted by some projects. Therefore, before the reduction, it is necessary to filling the gap. Normally, we use the higher reliable filling method and Mean Completer to fill the omissions.

This paper use Equal Frequency to discretize the data. Each value of the attribute can be well discretized. The number of value between each breakpoint is the same. The final decision table is built. Because the amount of the data is too much, some of the data is shown in Table 11.2.

Table 11.2 Part of the decision table

a1	a2	a3	a4	a5	a6	a7	a8
[*,2)	[2,3)	[2,3)	[3,*)	[*,2)	[2,3)	[2,3)	[*,2)
[*,2)	[*,2)	[*,2)	[3,*)	[2,3)	[3,*)	[2,3)	[*,2)
[2,3)	[2,3)	[*,2)	[3,*)	[*,2)	[*,2)	[*,2)	[*,2)
[*,2)	[2,3)	[*,2)	[2,3)	[2,3)	[2,3)	[*,2)	[2,3)
[*,2)	[2,3)	[*,2)	[2,3)	[2,3)	[2,3)	[*,2)	[2,3)
[3,*)	[3,*)	[2,3)	[2,3)	[*,2)	[*,2)	[2,3)	[3,*)
[*,2)	[2,3)	[2,3)	[2,3)	[3,*)	[3,*)	[3,*)	[*,2)
[2,3)	[2,3)	[2,3)	[*,2)	[3,*)	[*,2)	[*,2)	[*,2)
[2,3)	[2,3)	[2,3)	[*,2)	[3,*)	[*,2)	[*,2)	[*,2)
[2,3)	[3,*)	[3,*)	[*,2)	[2,3)	[*,2)	[*,2)	[3,*)

11.4.3 The Reduction of the Decision Table and the Analysis of the Result

1. The reduction of the decision table

Use Genetic method and Johnson's method to make reduction of the decision data. By using genetic method, 6 groups of data are got. By using Johnson's method, one group of data is got. The accuracy of the reduction equals to genetic method. Take the intersection of both methods the following nine attributes are got, a1, a4, a6, a7, a14, a16, a17, a18, a22. After reduction, the result is shown in Table 11.3.

According to the reduction, the following 35 rules are extracted. Because of the length of the paper, part of the rules is shown in Table 11.4.

2. The analysis of the results

This paper uses rough set theory to analyze the important factors of low carbon building. After the analysis of the actual project, some useful decision rules are got. From the result, we can see that the following nine factors are important to the low carbon building, a1 (the selection of the place), a4 (the greening), a6 (the indoor environment of the building), a7 (maintenance structure), a14 (equipment system), a16 (construction energy saving), a17 (the use of energy saving), a18 (transportation system), a22 (the production of the construction materials). Thus in the future, in order to achieve better affects, these nine factors should be pay attention to.

Among these nine factors, a14(equipment system), a16 (construction energy saving), a17 (energy saving for maintenance), a18 (transportation system) belong

Table 11.3 The result after reduction

Reduction	Support	Length
{a1, a4, a6, a7, a18, a22}	100	9

Table 11.4 Specific rules after the reduction

Condition result			
a1([*,2))	AND a4([3,*))	…	AND a22([*,2)) => D(0)
a1([*,2))	AND a4([3,*))	…	AND a22([3,*)) => D(1)
a1([2,2))	AND a4([3,*))	…	AND a22([2,3)) => D(1)
a1([*,2))	AND a4([2,3))	…	AND a22([2,3)) => D(1)
a1([*,2))	AND a4([2,3))	…	AND a22([3,*)) => D(3)
a1([3,*))	AND a4([2,3))	…	AND a22([*,2)) => D(2)
a1([*,2))	AND a4([2,3))	…	AND a22([2,3)) => D(1)

to energy management which account 50 % of all the influential factors. This phenomenon is accordance with people's common knowledge thus it future testify the accuracy of the result. Therefore in the process of carbon reducing, energy management and control is the most important thing, while other factors cannot be ignored. In the development of the low carbon building, we should reduce the emission of the carbon as well as save the energy.

11.5 Conclusions

This paper analyzes the influential factors of the low carbon building. Using the rough set theory to process the data and then identify the important factors to the low carbon building. According to the result, the evaluation index system can be built, which is the further work.

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Chapter 12
Pareto-Optimal Proportion Structure Criterion of Income Distribution

Zhen He

Abstract The two keys to whether the income distribution is reasonable are the distribution of active practice and the scientific judgment criterion. The current estimate criterion is almost based on their 'own' practices, which has no big guiding significance to the others. Based on Pareto optimality theory, this article gives the Pareto-optimal criterion for the proportion structure of income distribution: the Pareto-optimal theoretical criterion under fiver equal parts of the income strata with decreasing order is 60, 20, 11.7, 6.3, 2 %; the Pareto-optimal theoretical criterion of Gini Ratio or the concentration ratio is 0.57; the theoretical criterion of how the resource would be allocated and combined between the personal department and the public department should be 86.6:13.4 %. That criterion can judge whether the income distribution is reasonable and has the general guiding significance to the income distribution practice in the different countries and different regions.

Keywords Engel's coefficient · Income distribution · Pareto optimality · Proportion structure · Theoretical criterion

12.1 Introduction

Currently, the ways to judge whether the income distribution is reasonable are Pareto Analysis, Equivalence analysis, Lorenz curve, and Gini Coefficient. But they are just the statistical models, and have been usually criticized for lacking the support of the relative economic theories (Eatwell et al. 1987).

Z. He (✉)
School of Accounting, Zhengzhou Institute of Aeronautical Industry Management, Zhengzhou, China
e-mail: zhenhe598@yahoo.com

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The author has offered a strong support of Pareto Optimality theory to judge whether the income distribution is reasonable (He 2011a), which includes: Pareto Optimality is a Criterion uniting Efficiency and Justice for the income distribution; the theoretical Pareto Optimal curve looks like a perfect circle, and because of that, the author has presented the circular "curve criterion" to judge whether the income distribution is reasonable (He 2011b). On above basis, this article presents a quantification proportion structure criterion to judge whether the income distribution is reasonable.

12.2 Pareto-Optimal Proportion Structure Criterion of the Income Distribution

The income distribution is about the given income distribution among the different individuals or different income groups. The distribution aiming at the individuals is complicated. When things are complex, we will think of classification management while we are dealing with them. Through the actual observation, Nakata Isamu thought: in every classification, the closer every individual's the value, the effect, the result, and the affect is, which is equivalence, the higher the efficiency of the management is; the closer the values, the effects, the results, and the affects between the classifications are, the higher the efficiency of the management is. Make every part equivalent, which means divided equal the accumulation of output (wealth) or the total utility (happiness), so that the efficiency is high (Isamu 1987).

How many classifications things that need to be managed should be sorted into not only depends on the complexity but also depends on the point that we focus when we deal with them. For example, if we assume it's two social, or if things aren't complex or we only care about one certain thing or crowd, we can simply classify them into two parts, meaning the other thing or crowd that we care about and others; if things are more complex, we can deal with them more efficiently by adding the number of the classification properly, such as three classifications, five classifications, etc. If the special situation of every person in the society needs to be cared of, that is to say, every social member needs to be considered as a classification, so there will be the same number of the classification as that of the social members. Thus, this looks like inefficient. Therefore, theoretically speaking, the state points of Pareto Optimality have infinite numbers; in fact it's decided by the complexity of things and the person's cognitive competence, so the number of the classification is limited.

People's "Happiness and Harmony" (Bruni 2006) depends on not only the entire satisfaction of the "Five needs" (Maslow 1999) for the Happiness (Skousen 2001), but also the proportion coordination of the "Five needs" satisfaction for the Harmony (He 2010). Therefore, even though the importance of the "Five needs" differs from man to man, the ideal condition is its proportion structure that fits the

Pareto Optimality Criterion that units Efficiency and Justice. Hence, all social goods and service can be divided into entire five productions corresponding to the entire “Five needs” based on the Maslow’s Theory. Similarly, all social labor (population) can be divided into five stratums. Correspondingly, we can divide the total output (wealth) accumulation or the total utility (happiness) accumulation into five equal parts.

Pareto Analysis is also called a method of “a small number of key” and “a big number of subordinate”. In accordance with this, P. F. Drucker pointed out “In a social situation a very small number of events at one extreme—the first 10 per cent to 20 per cent at most—account for 90 % of all results; whereas the great majority of events accounts for 10 per cent or so of the results” (Drucker 1963, 1964). Although Pareto’s analysis and Drucker’s proportions are still empirical, what we care about is the symmetry of two sides’ affect of the same thing that Pareto and Drucker implied. In fact, when Amartya Sen was doing insightful discourses to the welfare and poverty, he indicated: not only should the economy care about the minority situation of the rich, but also the majority situation of the poor (Sen 1981).

Theoretical Pareto optimality curve presents circular, as shown in Fig. 12.1.

Assume W represents the Wealth output, L represents the Labor, so the mathematical model of the theoretical Pareto optimality curve is the curvilinear equation of the circular, as the following:

$$(L-1)^2 + W^2 = 1 \tag{12.1}$$

Therefore, considering the symmetry of the labor affect and the population affect, by the strictly circular Pareto Optimality curve, based on the Function (12.1), and under the analysis of income or population into five, three or two equal

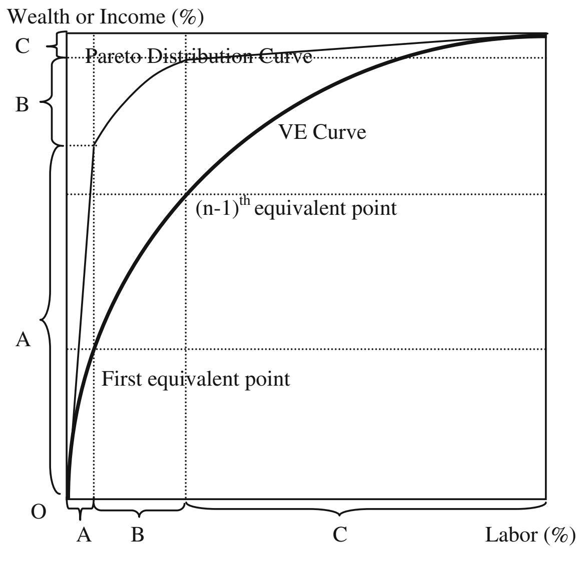

Fig. 12.1 Theoretical Pareto optimality curve

parts, the result and the computing course of the Pareto-optimal proportion structure of income distribution are shown in Tables 12.1, 12.2, 12.3.

In terms of some single index like the wealth or the population, etc., the theoretical criterion of their symmetrical Pareto optimality proportion structure is as follows:

12.2.1 The Pareto-Optimal Theoretical Criterion of Equal Part Analysis

Five equal parts analysis, that is to divide the income strata into five. As shown in Table 12.1, the Pareto-optimal theoretical criterion under fiver equal parts of the income strata with decreasing order is 60, 20, 11.7, 6.3, 2 %. If we take the level of the lowest income group account for 1, the multiple of the income strata with increasing order is 1:3.1:5.8:10:30. It should be noted that, in view of the management efficiency, based on the thoughts to make them equitable the amount of each individual's value, effect, result, affect of each class, and to make them equitable the total amount of each class's value, effect, result, affect, we get yet that there are income gaps about the efficient and just income distribution among the different income stratum.

Ditto, the theoretical criterion of Pareto optimality "three equal parts analysis" and "two equal parts analysis" can be calculated, shown in sheet 2 and 3.

Of course, if someone thinks that the stratums of the classification are not enough, there are still ways to add more corresponding classifications by the measures above. That is to say, the multi level classification can be done in the management objects. For example, in the college, teachers can be divided into

Table 12.1 Pareto-optimal proportion structure under five equal parts of the income distribution (%)

C1	C2	C3	C4	C5
0	0	2	60	1
20	2	2	60	1
40	8.3	6.3	20	2
60	20	11.7	11.7	3
80	40	20	6.3	4
100	100	60	2	5

Note

C1: W's cumulative value on Pareto-optimal curve (that is five, three or two equal parts of ordinate)

C2: L's cumulative value on Pareto-optimal curve $L = 1 - \sqrt{1 - W^2}$

C3: The proportion of each Lon Pareto-optimal curve (the result is that the number in this line minus that in the up line)

C4: The proportion of each Won Pareto-optimal curve (symmetrical to L's)

C5: Group No. (Decreasing order of their income)

Table 12.2 Pareto-optimal proportion structure under three equal parts of the income distribution (%)

C1	C2	C3	C4	C5
0	0			
33.3	5.7	5.7	74.6	A
66.6	25.4	19.7	19.7	B
100	100	74.6	5.7	C

Note
C1: W's cumulative value on Pareto-optimal curve (that is five, three or two equal parts of ordinate)
C2: L's cumulative value on Pareto-optimal curve $L = 1 - \sqrt{1 - W^2}$
C3: The proportion of each Lon Pareto-optimal curve (the result is that the number in this line minus that in the up line)
C4: The proportion of each Won Pareto-optimal curve (symmetrical to L's)
C5: Group No. (Decreasing order of their income)

Table 12.3 Pareto-optimal proportion structure under two equal parts of the income distribution (%)

C1	C2	C3	C4	C5
0	0			
50	13.4	13.4	86.6	A
100	100	86.6	13.4	B

Note
C1: W's cumulative value on Pareto-optimal curve (that is five, three or two equal parts of ordinate)
C2: L's cumulative value on Pareto-optimal curve $L = 1 - \sqrt{1 - W^2}$
C3: The proportion of each Lon Pareto-optimal curve (the result is that the number in this line minus that in the up line)
C4: The proportion of each Won Pareto-optimal curve (symmetrical to L's)
C5: Group No. (Decreasing order of their income)

Professor, Vice Professor, lecturer, TA (Teaching assistant), trainee teacher, etc. In the position of the Professor, there can be four different levels. And there should further be the corresponding "Income difference" and the corresponding job responsibility. What needed to be paid attention is that the proportion structure of the "income difference" still corresponds to the criterions above if one "income stratum" is done by "Equal parts analysis" as a whole, which is being further divided out.

12.2.2 The Pareto-Optimal Theoretical Criterion of Gini Ratio

Considering the strictly circular Pareto-optimal curve, referring to Fig. 12.1, and based on Function (12.1), the Pareto-optimal theoretical criterion of Gini Ratio or the concentration ratio is 0.57.

12.2.3 The Theoretical Criterion of the Government Economic Activity Boundary

The government economic activity boundary is about the problem how the resource would be allocated and combined between the personal department and the public department, which actually means the problem about the two classifications of the government and the market effect. Apparently, on the basis of the above analysis, the theoretical criterion of how the resource would be allocated and combined between the personal department and the public department should be 86.6:13.4 %. The similar reference indicates that the allocated resource in personal department generally takes 85 %, and the public department generally takes 15 % resource (Jin-she 2010).

12.3 Conclusion

Under the Pareto optimality analysis, the effect of two aspects in one object has symmetry. Therefore, partially analyzing one aspect, the allocation of the wealth and the resource represents the form of the pyramid. However, entirely analyzing two aspects, the allocation of the wealth and the resource represents rectangle. The result of the allocation shows that it's neither "diamond", not "dumbbell" form, more is not "pyramid" form (Jin-she 2011).

The theoretical Pareto optimal curve and based on it the optimal proportion structure provide the ideal criterion of the wealth. The allocation bias of the actual wealth and the stratum that causes the bias can be found, after describing the curve of income distribution (like the Pareto distribution curve in Fig. 12.1) on the foundation of the actual data, contrasting the theoretical criterion of Pareto optimality. By establishing the policies that fit the different stratums, which will make the wealth allocation be continuously close as far as possible to the ideal condition, the efficiency and the justice of the social wealth allocation will be finally achieved.

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Chapter 13
Research on Cost Management in Foundry Enterprises Based on ERP

Jin-long Wu, Jia-ying Jiang, Jian-xin Zhou, Xiao-yuan Ji, Hong-tao Tang and Hai Jiang

Abstract In order to improve the market competitiveness, foundry enterprises should strengthen the cost control and refine cost management. This paper analyzed the situation of cost management in foundry enterprises and proposed the standard activity-based costing management model on the basis of comparing standard cost with activity-based costing. It contained three aspects including standard cost estimating, activity-based cost accounting and later cost analysis. It deepened cost management into process level. Then, this paper designed the cost management system. It provided the effective control and analysis capability for cost management. Finally, it offered a reasonable cost management scheme for foundry enterprises.

Keywords BOM · Cost management · ERP · Foundry enterprise · Process

J. Wu (✉) · J. Zhou (✉) · X. Ji
State Key Laboratory of Materials Processing and Die & Mould Technology, Huazhong University of Science and Technology, Wuhan 430074, China
e-mail: wjl2086@163.com

J. Zhou
e-mail: zhoujianxin@mail.hust.edu.cn

J. Jiang
Colloge of Mechanical Science and Engineering, Huazhong University of Science and Technology, Wuhan 430074, China
e-mail: 199234301@qq.com

H. Tang · H. Jiang
Colloge of Material Science and Engineering, Huazhong University of Science and Technology, Wuhan 430074, China

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13.1 Introduction

Facing the fierce market competition and personalized customer need, foundry enterprises should control production cost timely and accurately. Cost management is directly related to the survival and development of enterprises. However, because of the enormous production process data, complex process and onerous production task, it becomes more and more difficult for foundry enterprises to manage the production cost (Hansen et al. 2007). At present, traditional cost management method is out of date and traditional cost control is lagging behind because of lacking modern methods (Jin and Han 2010; Gao et al. 2009). So it could no longer meet the need of cost management for foundry enterprises.

Cost management based on ERP realizes comprehensive and effective control of the entire supply chain, which provides the effective control and analysis capability for foundry enterprises (Scapens and Jazayeri 2003). For the finance, this management could reduce the stock investment, save the cost for inventory management and reduce inventory loss; for manufacture operation, it could reduce the cost, improve the production and increase the capital flow; for enterprise management, it could raise level of management (Spathis and Constantinides 2003).

13.2 Methodology

13.2.1 Problems of Cost Management in Foundry Enterprise

Cost of the foundry enterprise could be divided into three categories: the production cost, operating cost and management cost. The production cost includes direct materials, labor cost and manufacturing cost. Operating cost is comprised of marketing cost, distribution cost and customer service cost. The management cost consists of process design cost and administration cost.

At present, problems of production cost management in foundry enterprise are as followed:

1. Information Island still exists, accurate information couldn't be provided for production cost management.
2. Cost accounting cycle is long, cost information couldn't be offered timely for enterprise's business decision.
3. Casting cost method could not reflect the actual production expense.
4. Standard cost management is not complete because of lacking dynamic data.

Traditional cost management could not satisfy the need for foundry enterprise. So, more effective cost management method should be put forward to solving problems.

13.2.2 Comparison of Cost Management

Standard cost management which combines plan, control, calculation and analysis of cost is a kind of cost management method (Chai et al. 2011; Patterson et al. 2003). Before the cost occurred, it makes the standard cost by analyzing the historical data. In the process of the cost, it records the difference and makes proper control and adjustment by comparing the actual cost and standard cost. After the cost occurred, it makes new standard cost by analyzing and studying the difference between the actual cost and standard cost completely. However, standard cost variance analysis couldn't get causes and effects of cost occurred, which just stayed in surface layer (Zhang et al. 2004). Standard cost management could not deepen cost management into process levels. Standard cost management that ignores the entire value chain of cost control couldn't reduce cost authentically.

Activity-based costing that all the activity consumption of resource cost is recorded in the homework accurately is a kind of cost calculation method (Gunasekaran and Sarhadi 1998; Wu 2009). But, activity-based costing still provides the historical cost information, so Activity-based costing couldn't plan production cost ahead.

The core thought of ERP is to achieve the effective management of the entire supply chain (Ning 2006; Wang 2004). However, whether standard cost management or activity-based costing management could not reflect production cost accurately and timely. According to the characteristic of the foundry enterprise, this paper proposed standard activity-based costing management model based on ERP including standard cost estimating, activity-based cost accounting and later cost analysis. First, this model improved the accuracy of the indirect cost allocation and enhanced the indirect cost control ability. Secondly, this model optimized the whole chain of activity and reduced the cost of the whole chain by identifying and eliminating the value-added activity (Li and Zhang 2004; He and Jin 2004; Xu et al. 2003). Finally, this model defined the responsibility of cost control to the benefit of performance for main cost control. This model established complete standard activity cost library and achieved effective cost control to reach the purpose of improving the cost. Figure 13.1 lists the ERP cost management processing logic.

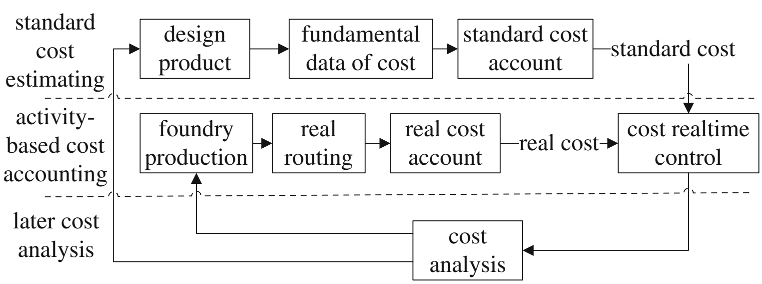


Fig. 13.1 ERP cost management processing logic

13.2.3 Research and Design of Cost Management

Procedure of cost management in foundry Enterprise: First, after the enterprise signed reasonable order, enterprise design the process sheet by analyzing and researching castings, which include BOM information and routing process of castings. BOM lists the raw materials and components of product. BOM is the core file for material requirements planning and production materials and direct material cost (Zhang 2009; Wu 2008; Xu 2006). Routing lists all the production process including resources and working hours. Routing which controls the direct artificial, manufacturing cost is the basic document for capability requirements plan and workshop flow process. After designing the process sheets, we could do cost simulation for calculating materials, artificial and manufacturing cost. This makes it easy to make the production decision for enterprise management stratum. If feasible, generating standard cost by using convolution cost method to give order price for customer and ordering production plan for workshop. Then, we could timely record BOM information and routing for the actual production process of the castings. After the order finished, we analyze and adjust the standard cost scheme aiming at improving economic performance for enterprise. Thus, BOM and process is the fundamental basis for realizing standard activity-based costing management that includes standard cost estimating, activity-based cost accounting and later cost analysis. As the Fig. 13.2 shows:

Standard activity-based costing management is to achieve the entire control of cost for enterprise which includes planning, production and account. This model structure consists of standard cost estimating, activity-based cost accounting and later cost analysis. The system module structure shows in Fig. 13.3:

Standard cost estimating is to formulate the cost control standards and indicate the cost control goal and direction through the forecast method, according to the market information before the production. The cost of foundry enterprise is built on the fundamental data. These fundamental data include BOM, work center, process routing, material master record and cost center. Specifically, technical department design and confirm the process sheet according to specifications and

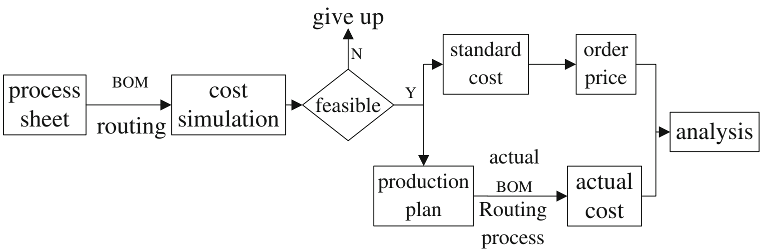


Fig. 13.2 Procedure of cost management in foundry enterprise

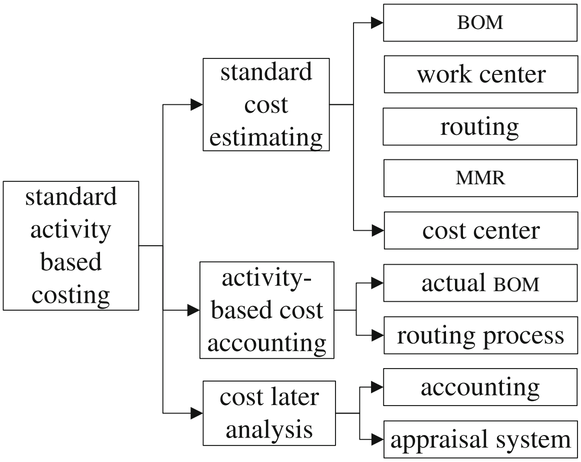
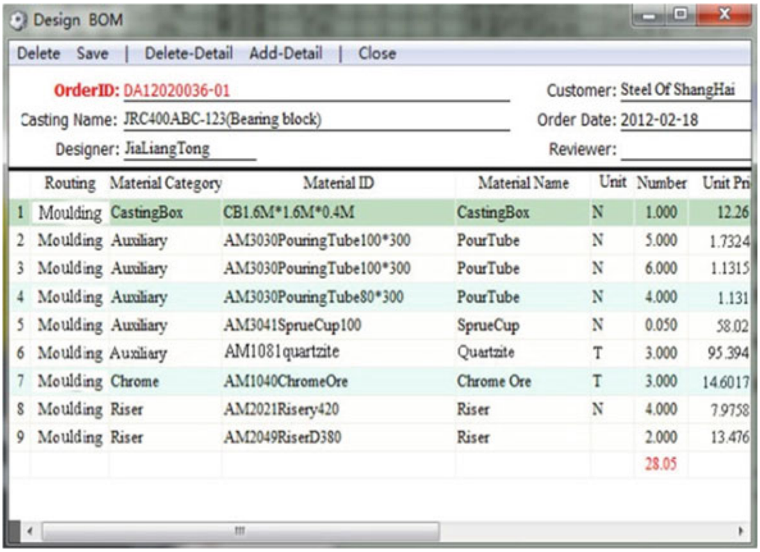


Fig. 13.3 System module structure

drawings. After completed, the system could generate the BOM and routing process. BOM describes the component lists of product completely and structurally which includes materials numbers, quantities and unit. Work center is an abstract concept. We could call each process as a work center. Work center is the foundation for calculating the artificial and manufacturing cost which defined by the formula. The formula is related to product manufacturing cost. Process routing defined each process and the sequence of process which based on work center. System could calculate standard activity consumption amount by using the formula in work center and standard values in the process routing and activity price. Then, the system could calculate the standard of manufacturing cost. Cost center is the organization that collects and controls the cost. By this way, Work center could calculate the material and artificial cost for each process.

Activity-based cost accounting subsystem consists of actual BOM and routing process. In order to ensure standard activity-based costing management carrying out smoothly, we need to confirm the responsibility of each department and save resources for global activity, which could improve the economic benefits finally. We record the actual consumption materials and each routing process such as Moulding, Smelt, Fettling and Weld up timely. So it could reflect the actual cost for each routing process. Eventually the system could calculate the routing process cost according to the bottom–up sequence.

Cost later analysis subsystem includes accounting and appraisal system. After the production completed, the system could compare the difference between actual cost and standard cost, analyze the reason of difference, find out responsibility and evaluate performance in order to formulating effective measures, which could avoid unreasonable expenses and losses. Finally, the system points out the direction of the future cost management and the way to reduce cost.


Design BOM

Delete Save | Delete-Detail Add-Detail | Close

OrderID: DA12020036-01 Customer: Steel Of ShangHai

Casting Name: JRC400ABC-123(Bearing block) Order Date: 2012-02-18

Designer: JiaLiangTong Reviewer:

	Routing	Material Category	Material ID	Material Name	Unit	Number	Unit Pri
1	Moulding	CastingBox	CB1.6M*1.6M*0.4M	CastingBox	N	1.000	12.26
2	Moulding	Auxiliary	AM3030PouringTube100*300	PourTube	N	5.000	1.7324
3	Moulding	Auxiliary	AM3030PouringTube100*300	PourTube	N	6.000	1.1315
4	Moulding	Auxiliary	AM3030PouringTube80*300	PourTube	N	4.000	1.131
5	Moulding	Auxiliary	AM3041SprueCup100	SprueCup	N	0.050	58.02
6	Moulding	Auxiliary	AM1081quartzite	Quartzite	T	3.000	95.394
7	Moulding	Chrome	AM1040ChromeOre	Chrome Ore	T	3.000	14.6017
8	Moulding	Riser	AM2021Risery420	Riser	N	4.000	7.9758
9	Moulding	Riser	AM2049RiserD380	Riser		2.000	13.476
						28.05	

Fig. 13.4 BOM information

13.3 Results

According to the standard activity cost management model, the cost management system based on ERP is designed and developed. It adapt with the characteristics of cost management in foundry enterprise.

In standard cost estimating subsystem, after designed the process sheet, system could generate the BOM and routing process. Figure 13.4 shows the BOM information of casting which order ID is DA12020036-01. It could get basic information from process sheet including order ID, customer, order date and casting name. It records materials of the casting including process routing, numbers and quantities. Work center records cost calculation formula for every process.

Figure 13.5 is routing information which includes two parts information. Part one is casting basic information including order ID, order date, customer, casting name, material and category. Another part lists all routings process of the casting including the sequence and time-consuming. Then, combined with BOM information the system could calculate each process standard of manufacturing cost.

Figure 13.6 is the cost of casting for routing process which the work center worked out. It lists detailed cost information for each process which order ID is DA12020036-01. It deepens cost management into process levels. From Fig. 13.6 we could get cost item information. It divides cost into some categories including labor cost and material cost by different process routing. We could see cost breakdown clearly by stretching cost levels. In activity-based cost accounting subsystem, system could record the actual consumption materials and time of each

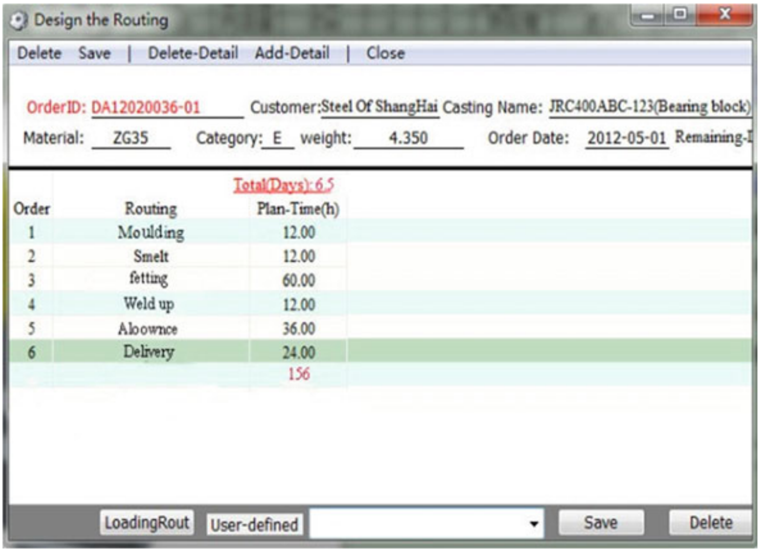


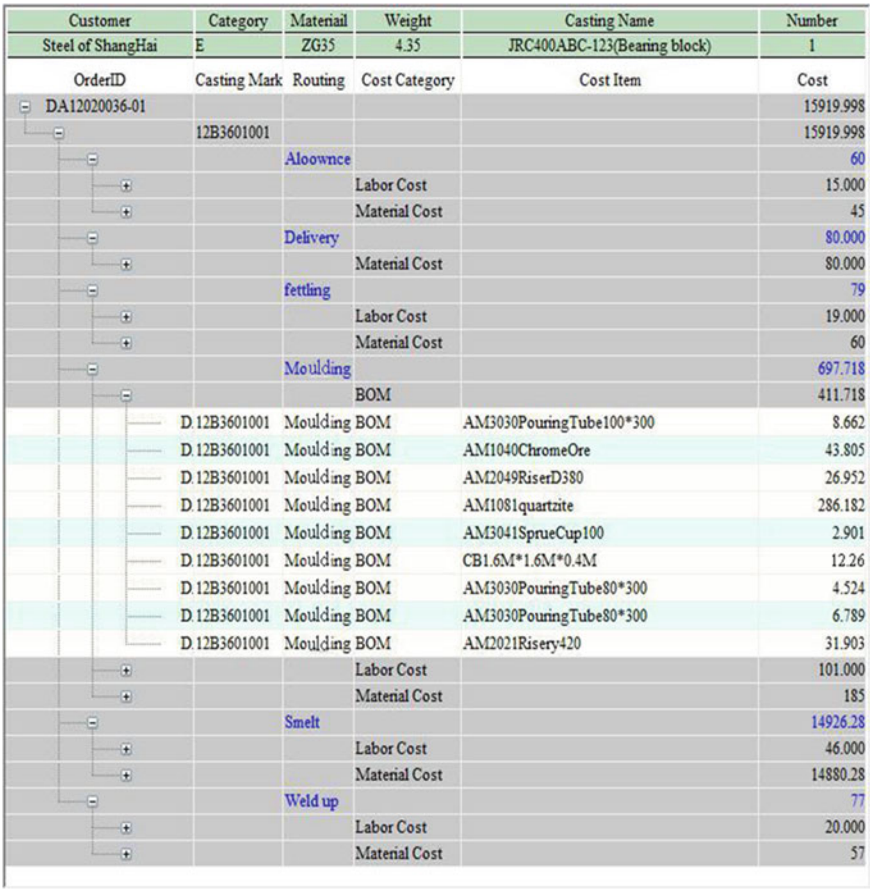
Fig. 13.5 Design routing

routing process accurately. So, it could also calculate the actual cost of casting. After completed, the system could compare the difference between actual and standard cost in each routing process. Then, we could find which process emerged issue. Finally, we could avoid losses.

13.4 Discussion

According to the cost solution proposed by this paper, the standard activity-based costing management system could control production cost timely and accurately, which could also improve the level of enterprise's management. Summarized as follows:

1. This paper discussed problems of cost management in foundry enterprise and proposed the standard activity-based costing management model.
2. The system contained three aspects including standard cost estimating, activity-based cost accounting and later cost analysis.
3. The system could generate the BOM and routing process information after designing the process sheets. So, it would allow designers to evaluate the cost of product earlier.
4. It could calculate detailed cost item information of each process for actual and standard cost.



Customer	Category	Materiail	Weight	Casting Name	Number
Steel of ShangHai	E	ZG35	4.35	JRC400ABC-123(Bearing block)	1

OrderID	Casting Mark	Routing	Cost Category	Cost Item	Cost
DA12020036-01					15919.998
	12B3601001				15919.998
		Aloownce			60
			Labor Cost		15.000
			Material Cost		45
		Delivery			80.000
			Material Cost		80.000
		fettling			79
			Labor Cost		19.000
			Material Cost		60
		Moulding			697.718
			BOM		411.718
	D.12B3601001	Moulding	BOM	AM3030PouringTube100*300	8.662
	D.12B3601001	Moulding	BOM	AM1040ChromeOre	43.805
	D.12B3601001	Moulding	BOM	AM2049RiserD380	26.952
	D.12B3601001	Moulding	BOM	AM1081quartzite	286.182
	D.12B3601001	Moulding	BOM	AM3041SprueCup100	2.901
	D.12B3601001	Moulding	BOM	CB1.6M*1.6M*0.4M	12.26
	D.12B3601001	Moulding	BOM	AM3030PouringTube80*300	4.524
	D.12B3601001	Moulding	BOM	AM3030PouringTube80*300	6.789
	D.12B3601001	Moulding	BOM	AM2021Risery420	31.903
			Labor Cost		101.000
			Material Cost		185
		Smelt			14926.28
			Labor Cost		46.000
			Material Cost		14880.28
		Weld up			77
			Labor Cost		20.000
			Material Cost		57

Fig. 13.6 Cost center

However, the successful implementation of the system depends upon the organizational and behavioral characteristics of the foundry enterprise. The issues such as training of employees and incentives to motivate employees play a major role in the successful implementation in practice.

13.5 Conclusion

Reducing cost and improving profit is the enterprise eternal theme. This paper analyzed the situation of cost management in foundry enterprises and proposed standard activity-based costing management model on the basis of comparing standard cost and activity-based costing. It deepened cost management into process levels. This would allow designers to evaluate the cost of product earlier during the design stage. Actual application indicated that this model could achieve the effective control of all the routing process and improve cost management level of foundry enterprise. Finally, the system could help enterprise expand market share in the fierce competition.

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Chapter 14
Research on Sales Channels Costs of Iron and Steel Enterprises

A Comparison Based on Distribution and Direct Sales

Jian-zhong Cao and Hu-sheng Lu

Abstract There is overcapacity in China's iron and steel industry. The average profit level of the whole industry was only 2.42 % in 2011. Structure of sales channels and sales costs of iron and steel enterprises influence the profit level to a large extent. Through analysis of characteristics of sales channels and channel cost structure in iron and steel enterprises, this paper questioned the generally accepted view that increasing the proportion of direct sales could boost profits. Moreover, this paper further made a comparison between direct sales cost and distribution cost. For comparison, the actual settlement data in an iron and steel enterprise were used. And this paper concludes that setting up sales channels in accordance with product category is a reasonable way to boost corporate profits in the sales link.

Keywords Direct sales · Distribution · Iron and steel enterprises · Marketing channel · Sales channels costs

14.1 Introduction

In 2011, China's crude steel output was 695.5 million tons, which accounted for 45.5 % of the world's total crude steel output. And China continued to maintain the status of the world's largest steel-producing country. In contrast, the average

J. Cao
School of Economy and Management, Inner Mongolia University of Science and Technology, Baotou, China

J. Cao (✉) · H. Lu
Key Laboratory of Integrated Exploitation of Bayan Obo Multi-Metal Resources, Inner Mongolia University of Science and Technology, Baotou, China
e-mail: ok_caojianzhong@163.com

H. Lu
e-mail: hushenglu1964@yahoo.com

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profit level of China's iron and steel industry was only 2.42 % in 2011. And the three large iron and steel projects which has been newly approved to construct by July 2012 will bring about 48 million tons of new capacity. This makes the overcapacity problem in iron and steel industry become more prominent. Reducing the cost of sales channels and improving the efficiency of sales channels to raise revenues are important means to increase the level of corporate profits for iron and steel enterprises in a competitive market environment (Zhu et al. 2011).

As one kind of means of production, iron and steel products are very different from general consumer goods in sales. The sales of iron and steel products have five main features: users make large purchases; both buyers and sellers have strong professional backgrounds; the purchase process has the characteristics of multi-step and complexity; many iron and steel enterprises make a long term cooperation with buyers and establish close supply and demand relationship; due to poor substitutability of steel, the demand is quite rigid (Wang 2005). According to the features of iron and steel sales, how to enhance the level of corporate profits through improvement of sales channels construction is the problem which many iron and steel enterprises are facing.

14.2 Overseas and Domestic Literature Review

Dai et al. (2009) discussed the establishment of product sales channel structure from the perspective of transaction costs and put forward seven principles of designing iron and steel sales channels: effectiveness, overall efficiency maximization; value-added nature; division and coordination; targeted competition; dynamic equilibrium; sustainable development. Li (2010) analyzed the sales channels of key member companies of China Iron and Steel Association in 2010, and then proposed that iron and steel enterprises should increase the construction of sales branches, raise direct supply ratio, and make more profits of iron and steel products stay inside themselves during the construction of sales channels. Lou (2007) analyzed the distribution of iron and steel enterprises and proposed that China's iron and steel enterprises should increase the proportion of high-end products, stabilize the proportion of direct sales, and focus on investment in processing and distribution. Zhao (2004) conducted a research on the sales channels of the iron and steel enterprises from the perspective of transaction costs and thought that the sales channels were divided into self-built channels and outsourcing channels. Sales channels of iron and steel enterprises in China were mainly characterized by five features: the long-term product self-built channels had disappeared; self-built channels in the form of branches were decreasing or made some form of change; consignment model had been replaced by distribution model basically; distribution agencies were gradually transformed into independent subsidiaries or offices for enterprises with high technological content of products; large iron and steel enterprises generally made a long-term agreement with channel partners, and small iron and steel enterprises often made no long-term agreement.

In addition to study on sales channels as a whole, some scholars also made special research on different types of sales channels. For example, Hou (2009) conducted a study on distribution model and proposed that middlemen played an important role in iron and steel market, which included reservoir function; elastic connection function; product distribution function; establishment of strategic cooperative relations with customers; information transmission function; decentralized financial risk; user services.

14.3 Sales Channels and their Cost Structure of Iron and Steel Enterprises

Sales channels used by the domestic iron and steel enterprises are divided into four kinds: direct sales, distribution, retail and branch sales (Li 2010). Each kind of sales channel has different characteristics, and then its composition and performance of sales costs are also different (Fan et al. 2005).

14.3.1 Direct Sale

Graphics should be in TIFF, 600 dpi (1 bit/sample) for line art (graphics, charts, drawings or tables) and 220 dpi for photos and gray scale images. Please use the drawing tools in Word or Visio to finish your figures and tables. The channel of direct sales is divided into two models: ordinary direct sales and tripartite direct sales. Ordinary direct sales mean that iron and steel enterprises sell directly to end users instead of through middlemen. In general, direct sales process is that the iron and steel enterprise signs a sales agreement with customers and then begins to organize production. According to the characteristics of production cycle in iron and steel enterprises, the delivery date is at least about 3 months after the signing of agreement. And it will take the users 3–9 months to effect payment after delivery.

In general, iron and steel enterprises require the users to pay before delivery, and the users require obtaining goods before payment. In order to meet the settlement requirement of both sides, they invite a distributor to provide loans for completing the transaction under the circumstance that both sides reach consensus in other contents of the agreement. This is the channel of tripartite direct sales. Iron and steel enterprises offer a discount to the distributor.

The steel variety which uses direct sales as the main sales channel is often high value-added product dedicated to a particular area. The production of these products aims for the user's specific needs or for the construction of large-scale projects, and these products are not readily available in the secondary market because of their special requirements. Typical products include hot rolled sheet (such as automobile steel sheet), high-grade rail (such as one hundred-meter heavy rail), high-grade tubing (such as oil casing) and so on.

The channel costs of direct sales mainly include the following three areas: customer relationship maintenance cost, the additional cost of special product production and capital cost (Jin 2012).

14.3.2 Distribution

Distribution means that the distributor signs a sales agreement with the iron and steel enterprise, underwriting a certain quantity of steel. This approach is equivalent to the approach that the distributor purchases the ownership of a certain quantity of steel, and then sells them on the market.

The sales process of distribution is as follows. Firstly, the distributor signs a sales agreement with the iron and steel enterprise. The term of the agreement is usually one year. Secondly, the distributor pays a certain amount of cash deposit to the iron and steel enterprise after signing the agreement. Finally, within the term of the agreement, the distributor orders at least the required quantity of steel from the iron and steel enterprise every month. If the quantity ordered is less than the required quantity, the distributor will be penalized by the iron and steel enterprise, deposit deducted. And if the quantity ordered is more than a certain quantity, the distributor will be offered a further price discount. When the distributor signs the agreement with the iron and steel enterprise, full purchase price must be paid. And then iron and steel enterprise begins to organize production. The delivery date is generally about 3 months.

The steel variety which uses distribution as the main sales channel is often the ordinary steel variety with low technical content and strong universality. The number of manufacturers producing these steel is large, and the market is perfectly competitive, in which full information is shared. Typical products include rebar, ordinary seamless tube, welded tube, wire rod and so on.

The main sales process of distribution is completed by the distributor, so the channel cost of distribution is mainly from the price discount that is given to distributor by the iron and steel enterprise.

14.3.3 Retail

Retail refers to the sales pattern in which the iron and steel enterprise sells to the customer whose quantity ordered is less than the minimum quantity ordered in the self-built retail sites (such as steel supermarket). The quantity ordered is often less than the minimum transport unit is. This kind of sales channel tends to take the form of cash on delivery. The sales quantity of this channel only occupies a smaller proportion of the total sales quantity of the iron and steel enterprise, so the impact of this channel on iron and steel enterprise is not evident.

Retail customers are mostly minor customers that use small quantity of steel. Such customers mainly use ordinary steel, so the gap between the steel variety in the retail channel and the steel variety in distribution is not large. The steel variety in the retail channel mainly includes wire rod, rebar, seamless tube and ordinary ribbon steel.

The channel cost of retail comes from the maintenance cost of the self-supporting retail agencies of the iron and steel enterprise, Such as rent and decoration of the retail stores, office expenses, staff salaries and so on.

14.3.4 Branch Sales

Branch sales refer to the sales pattern in which the iron and steel enterprise sells to users through the branches established away from its own location. Branch sales target both end users and middlemen. The branches place orders with the corporate sales department after obtaining orders, and the ordering process is basically the same as the ordering process of distributors. Sales branches can sell to local customers face to face, not through the middlemen, which can help the iron and steel enterprise narrow the gap between the enterprise and customers, and enhance the information exchange between the enterprise and users.

Branches are the assignment institutions of sales department in the iron and steel enterprise, so the varieties of products sold are mainly relevant to the needs and circumstances of local customers and have small correlations with sales pattern.

The cost of branch sales is mainly from the cost of maintaining the branches to normal operation, cost of encouraging and supervising branch staff and cost generated by branch staff's concealing information (Zhong 2008).

14.4 A Cost Comparison Between Different Sales Channels

Since the 2008 financial crisis, the profit level of China's iron and steel enterprises has been declining all the time. Particularly, in 2010 and 2011, the profit margin was the minimum among those of domestic industries. In this circumstance, many insider and scholars proposed to increase the proportion of direct sales to reduce intermediate links, and make more profits stay inside the iron and steel enterprises (Chen 2011).

Can increasing the proportion of direct sales in all the sales channels really improve the profit level of the iron and steel enterprises? According to the above analysis, we can see that direct sales and distribution have the greatest impact on sales of iron and steel enterprises. So this part will emphasize on the cost comparison between these two channels.

14.4.1 A Comparison of Capital Cost

The sales process of the two sales channels is different, so the two sales channels have a very obvious difference in capital cost.

Direct sales model requires the iron and steel enterprises organizing production by themselves after signing sales contracts. The full costs needed for production are normally paid in advance by the iron and steel enterprises, so the iron and steel enterprises have to bear the cost of the capital needed for production for 8–12 months.

Distribution model requires the distributor paying the full amount in advance after signing a contract, and then the iron and steel enterprises organize production using the received payment. In this case, the iron and steel enterprises do not bear any capital cost.

The capital cost of the two sales channels can be compared based on the interest rate. At present, RMB one-year lending rate published by the People's Bank of China is 6.0 %. If the period from the signing of the contract to final payment is 9 months on average, this means that the capital cost of direct sales is 4.5 % higher than that of distribution. This is a heavy burden for the iron and steel enterprises. Because the average profit of the whole industry was only 2.42 % in 2011.

14.4.2 A Comparison of Ex-factory Price

In general, the ex-factory price of direct sales is determined by bidding and bid. According to the actual situation of the bids from the iron and steel enterprises, the quotation is generally 90–105 % of the listing price for the same period in iron and steel enterprises, which is lower than the listing price in most instances (Chen and Cheng 2012). From the perspective of distribution, the iron and steel enterprises usually give the distributors a certain degree of price discount, which depends on the varieties of steel. Which ex-factory price is higher still needs explaining by the actual settlement price data.

14.4.3 A Comparison of Distribution Cost

Both sales channels use the method of self-delivery and self-distribution by the iron and steel enterprises. However, the direct sales channel also uses the method of processing and distribution, which is a new direct sales model used increasingly by many iron and steel enterprises in recent years (Li 2011). The advantage of processing and distribution is that the steel products can be processed into the shape easy to use for customers, through which the iron and steel enterprises strive to establish long-term cooperative relations with customers. Even the processing and distribution centers of some iron and steel enterprises are jointly invested with customers. Based on the practical research of iron and steel enterprises, the author found that processing and distribution increased value-added of their products and the ex-factory price, but it did not necessarily improve profit level. According to the introduction of heads of the sales departments in several iron and steel enterprises with which the author are familiar, an increase in the processing and distribution price can not compensate for the increase in cost at least at the early stage of the processing and distribution implementation (Cao and Lu 2012).

14.5 A Comparison of the Selltement Data from Iron and Steel Enterprise

After the theory analysis, we use the settlement price data to do a statistical analysis. The data in Table 14.1 is the statistical result of 50,162 settlement data of a large iron and steel enterprise in southern China from Jan. 2011 to Jun. 2012. The table shows us the comparison of different channel's average settlement price. Because both direct sales and branch sales are in one column in the enterprise, so the column in Table 14.1 is "Direct sales/Branch sales".

There are 5 broad categories 8 varieties of data in Table 14.1. The statistical result show that mutual there are high and low in the settlement price of both direct sales and distribution. After carefully analysis, we find that the settlement price of high valued-added products is relative higher in direct channel than in distribution.

Table 14.1 Comparison of different channel's average settlement price of an iron and steel enterprise. From Jan. 2011 to Jun. 2012 unit: ¥

Broad categories	*Tube*		*Plate*	
Variety	High-pressure fertilizer tube	Ordinary seamless steel tube	Galvanized steel sheet	Hot rolled heavy plate
Direct sales/ branch sales	5,253	4,175	4,789	4,154
Distribution	4,966	4,133	5,175	4,491
Spread	287	42	−386	−337
Broad categories	*Wire and Rebar*	*Rail and Beam*		*Strip*
Variety	Hot rolled plain bar	Switch rail	Ordinary I Beam	Hot rolled Strip
Direct sales/ branch sales	3,843	5,658	3,466	3,884
Distribution	4,801	5,645	3,630	3,840
Spread	−959	13	−165	44

By contract, the settlement price of ordinary products is relative lower in direct channel than in distribution. Of course, it is not absolutely.

Through the comparative analysis in the Table 14.1, the conclusion is that settlement price of direct sales is not always more expensive than distribution's. It means direct sales can't bring more profits for the enterprise. In some varieties, distribution can bring more profits. Then, increase the proportion of a certain marketing channel is an unreasonable way to gain more profits. The better way should be adjusting the structure of marketing channel based on steel products varieties.

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Chapter 15
Research on the Management Fee Claims in Accordance with the Bill of Quantities Valuation Mode in China

Hua Gao and Tong Sun

Abstract China engineering project costs claims have large similarity with international claims, and therefore China engineering claims always directly reference to the international research project claims compensation. But the existing researches ignore the difference between China engineering cost constitution and international engineering cost in form. This paper got the structure of the management fee of China through the deductive reasoning method and analyzed the common and difference based on China engineering and international engineering management fee. Finally this paper obtained the management fee claims calculation method under the bill of quantities valuation mode in China, referencing to the international project management selectively, and amending with the actual.

Keywords Bill of quantities · Cost claims · Management fee claims · Valuation mode

15.1 Introduction

The management fee is an important part of the tender offer, how to claim for management fee is the important issue concerned by the contractor. People's Republic of China Standard construction bidding documents (2007 version) defined the cost as "In order to fulfill the contract all reasonable expenses occurred or will occur, including management fee and other costs should be assessed, but does not include profit". China Project cost components vary with the international

H. Gao (✉) · T. Sun
School of Management, Tianjin University of Technology,
Tianjin, China
e-mail: lotusgh@126.com

T. Sun
e-mail: suntong0378@163.com

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project, to determine the management fee claims value is the need to solve a problem in the operation of the actual claims work. Resolve identify the problem of management fee claims or profit claims, will facilitate the identification the claim value for the costs of claims. Therefore, this paper explores the composition of the management fees claims and the claims value.

15.2 Research of the Management Fee Claim

At present, domestic scholars on the management fee claims is mostly concentrated in the claims of the international project management fee (Yongqiang and huibo2008; Wenjie 2006; Shen 2005; Shuibo and Yongqiang 2011). In the international engineering, management fee is divided into the site management fee and Headquarters management fee. Fu-gang He (2006) pointed out that the Headquarters management fee claims, including the headquarters of the wages of workers, office buildings, office supplies, financial management, communication facilities and other cost-sharing, headquarters leadership went to the construction site to inspect and guide the work and other expenses, the site management fee claims, including on-site management staff salaries, office fees, communications fees, transportation fees. Xiao-Yu Si (2005) considered that when occurred complete the additional works, extension of time such events, can claim site management fee, and proposed when occurred project direct costs claim, can place on-site management fee, but the loss of personnel or work slowdown direct costs increase except. Jian Liang (2002) also consider that headquarters management fee mainly expression on project delays caused the increase of management fee. For headquarters management fee, adopted share equally method. Yao-huang Guo, Ya-ping Wang (1999) pointed out that the Headquarters management fee influenced by time, less affected by the project direct costs. Xing-yu Zhu, Xiu-qin Wang (2009) system analyze calculation methods of site management fee and headquarters management fee, and illustrates the applicability of various calculation methods. Xiao-yong Yuan (2008), respectively contrapose for the international project contracting, the employer default to the contractor throughout the contract was delayed, the employer breach of contract cause contract early termination, the employer make the change under the contract, all three cases can cause the contractor to claim for Headquarters management fee.

In summary, domestic scholars research on management fee claims are around the composition of the international project management and site management fee and headquarters management fee calculation methods, few scholars have research the composition of the management fee in the bill of quantities valuation mode and claim value, while management fee is difficult to determine the part of the cost of claims, and therefore research on the determination of the bill of quantities valuation mode management fee claim value is necessary.

15.3 The Composition and Development of the China Management Fee

This article adopted the deductive method to judge the derivation management fee constitute under the mode of China's bill of quantities. Deductive method is deduced from the general premise of the individual premise, this article deductive reasoning based on the 2008 code of valuation with bill quantity of construction works (Ministry of housing and urban-rural development of the people's republic of China 2008; Ministry of construction of the people's republic of China 2003), the interpretation of the core idea is to install based on the composition of the international project management fee and the composition of Chinese construction and installation cost of the project, derived composition of the management fee through the deductive method under the bill of quantities mode.

On the composition of costs, to adapt the needs of the engineering bill valuation reform, the Ministry of Construction and the Ministry of Finance jointly issued The composition of construction and installation cost items (Building Standards (2003) 206 text), it has a wide range of adjustment on the composition of construction and installation costs, to split, merge based on A number of provisions on the adjustment of construction and installation costs of project components (Building Standards (1993) 894 text) ,the main change is separate the project entities consumption and non-entities consumption. Building Standards (2003) 206 text restructure construction and installation costs, and laid a good foundation for the introduction of the bill of quantities valuation model. As Fig. 15.1 shows.

It can be seen from Fig. 15.1 of the composition of construction and installation cost items merged original site management fee, enterprise management fee, financial costs and other costs for indirect-cost. According to the requirements of the national social security system, listed social security costs in the fees. But in A number of provisions on the adjustment of construction and installation costs of project components (Building Standards (1993) 894 text) the other charges refers to provide for payment the project cost (quota) fixed the preparation of the

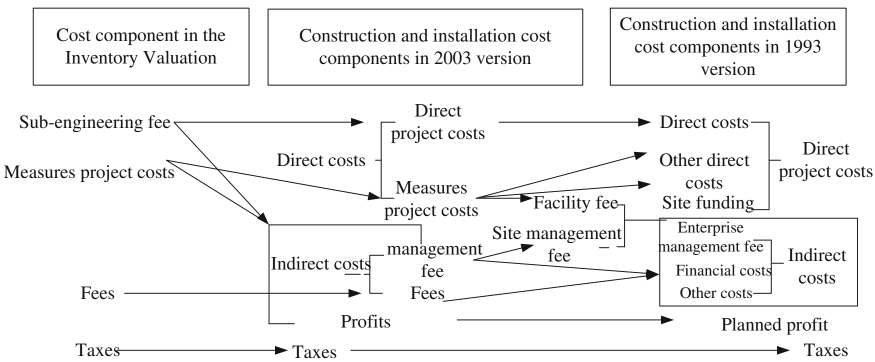

Fig. 15.1 Kinds of provisions in the fabrication cost constitutes

management fee of the administrative department of labor quota management department the fixed determination of fees. And higher management fee has been paid according to relevant departments, but this cost in the 2011 list of amendments has been canceled. Thus, according to the nature of the management fee, division component project management fee can be divided into three categories: site management fee, enterprise management fee and financial costs.

In summary, the changes of division component project management fee can be divided into three categories: site management fee, enterprise management fee and financial costs. Changes of the financial costs can be divided into financial costs change caused by repayment time change, new loans or advances.

15.4 Impact Factors of the Management Fee

15.4.1 Site Management Fee

Site management fee increase is more complicated, because some of management fee related to the duration, some of it related to the quantities, and some is fixed, and for certain costs are both time type and also quantities type [such as on-site management staff salaries, office fee (and wage strong correlation)] (2009). Specific classification as is shown in Table 15.1. Therefore, including the extension of time under the insurance guarantee fee increase, completion of the increase in management fee caused by the additional works.

15.4.2 Enterprise Management Fee

Enterprise management fee (or headquarters management fee) as indirect costs, through the sharing principle, enterprise management fee was assigned to the project costs itself is strongly correlated with the duration. Therefore, increase in enterprise management fee, including the extension of time under the enterprise management fee increase.

15.4.3 Financial Costs

Financial costs are the various fees and charges to raise funds, changes of the financial costs can be divided into financial charges change caused by repayment time change, new loans or advances.

Table 15.1 The classification of site management fee

Classification	The name of cost	The specific content
Fixated type	Tools appliances, acquisition costs in the fee	Refers to that does not belong to the production of fixed assets management and use of tools, appliances, furniture, transport and inspection, testing, mapping, fire, utensils and other maintenance and amortization charges.
	Labor insurance premiums	Refers to enterprise paid for retired workers resettle elsewhere subsidies, workers retirement pay, sick leave for more than six months of wages, workers funeral subsidy required to pay the expenses of the retired cadres.
	Taxes	Enterprises required to pay property tax, travel tax, land tax, stamp duty etc.
	Other fees	Including technology transfer fees, technology development costs, entertainment expenses, green fees, advertising fees, notary fees, legal consultancy fees, audit fees, consulting fees.
Type related to time	On-site management staff salaries	Refers to the basic wage of on-site management staff, wage subsidies, employee benefits, labor protection, etc.
	Office expenses	Refers to the on-site management office stationery, paper, accounts table, print, post and telecommunications, books, newspapers, meetings, hydropower, water heating and collective heating (including the site temporary quarters for heating) of coal and other costs.
	Fixed assets fee	Refers to on-site management and testing departments and subsidiary production establishment used housing, equipment which belonging to the fixed assets, instruments such as depreciation, overhaul and maintenance or rental fee.
	Depreciation and amortization charges in tools appliances fees	Refers to that does not belong to the production of fixed assets management and use of tools, appliances, furniture, transport and inspection, testing, mapping, fire, utensils and other maintenance and amortization charges.
	Property insurance	Refers to the construction management, property and vehicle insurance.
	Labor union dues	Refers to the provision of trade unions by the total wages billing.
	Funding for staff education	Refers to the provision for the cost of the total wages, the enterprise for employees to learn advanced technology and raising the cultural level.

(continued)

Table 15.1 (continued)

Classification	The name of cost	The specific content
Type related to quantities	On-site management staff salaries	Refers to the basic wage of on-site management staff, wage subsidies, employee benefits, labor protection, etc.
	Office expenses	Refers to the on-site management office stationery, paper, accounts table, print, post and telecommunications, books, newspapers, meetings, hydropower, water heating and collective heating (including the site temporary quarters for heating) of coal and other costs.
	Property insurance	Refers to the construction management, property and vehicle insurance.
	Labor union dues	Refers to the provision of trade unions by the total wages billing.
	Funding for staff education	Refers to the provision for the cost of the total wages, the enterprise for employees to learn advanced technology and raising the cultural level.

15.5 The Determination of the Management Fee Claim Value

Under the bill of quantities valuation mode, the management fee consists of three parts, site management fee, enterprise management fee and financial costs. These three types of costs have different methods to determine, and therefore introduce the methods to determine three types of management fee claims.

15.5.1 The Determination of the Financial Costs Claim Value

According to the method of calculating financial costs, it can be drawn two factors affect the financial cost: the loan amount and interest rates.

The financial costs claim is calculated as: Eq. (15.1)

$$CV = DP \times (1 + IC \times R)^{INT\left(\frac{DC}{IC}\right)} \times \left\{1 + \left[DC - INT\left(\frac{DC}{IC}\right) \times IC\right] \times R\right\} \quad (15.1)$$

CV *Claim Value*
DP *Delay In Payments*
IC *Intreset Bearing Cycle*
R *Monthly Interest Rate*
DC *Delay Cycle*

Which the function INT ( ) denotes take integer number, delay payments according to the actual payment records and payment application, the contract price for the amount of works has been delayed. Monthly interest on loans must comply with the contract, refer to bank lending rates. Delay cycle is calculated according to the date of actual payment records, payment application date, the number of day's duration of the delay both sides recognized.

15.5.2 The Determination of the Site Management Fee Claim Value

Estimates in the preparation of engineering design, engineering bidding (Bidding price control), tender offer, the site management fee, generally using the percentage method, including the construction, municipal works, the garden project is generally based on direct cost multiplied by a certain percentage obtain site management fee, decoration engineering and the installation engineering are general based on labor costs multiplied by a certain percentage obtain site management fee. To calculate complete the additional work (claims events) caused the site management fee claim, if can't itemize site management fee loss value, can use a similar approach, as mode 1 shown in Table 15.2. Column names to

Table 15.2 The determination of the site management fee claim value

The factors of cost claims	Calculation method	Determination of parameters	Proof
Completion of additional work (claims events) resulting in increased site management fee	Mode 1: Project direct costs which can claimed multiplied by type related to quantities site management rate	Type related to quantities site management rate: type related to quantities management fee in the project's site management fee schedule compare to labor, materials, mechanical over the same period	Site management fee schedule, Previous payment details
	Mode 2: Column the additional expenditure details	Expenditure under the normal state: obtain refer to the other similar projects and industry	Site management fee schedule, Expenditure certificate
Extension of time under the site management fee increased	Type related to time management fee rate multiplied by the delay period of the product	Type related to time management fee rate: type related to time management fee in the project's annual or quarterly or monthly site management fee schedule compare to the same period in time	Site management fee schedule

Table 15.3 The determination of the enterprise management fee claim value

The factors of cost claims	Calculation method	Determination of parameters	Proof
Extension of time under the enterprise management fee increased	Unit time enterprise management fee rate multiplied by the product of the delay period	Unit time enterprise management fee rate: The project enterprise management fee/ contract duration	Site management fee schedule

complete the additional work (claims events) significantly increased spending site management fee, should be adopted in the calculation method. As mode 2 shown in Table 15.2.

15.5.3 The Determination of the Enterprise Management Fee Claim Value

Enterprise management fee adopted sharing method, so the calculation the value of the claims of headquarters management fee under the schedule delays should be considered the apportionment of headquarters management fee in the engineering units of time, and then come to a specific value of the claim. The specific content reference to Table 15.3.

Mutual overlapping relationship between the above three types of management fee does not exist, so the duration of the delay when the financial costs, site management fee, enterprise management fee in the same time claim event (such as the duration of the delay under the non-change), three claims for the cost can be calculated value and were superimposed, in turn can obtain claim management fee.

15.6 Conclusion

Management fee claim is an integral part of the construction claims, to solve the problem of determination management fee claim value in favor of cost claims and profit claims. Through the mechanism of the influence factors of the management fee claim areas corresponding costs, obtained the management fee claim value formula, and then determine the management fee claim value. The management fee is difficult to determine in the part of the cost claims, research to the management fee claim value will play an important role in the problem of determine costs claims.

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Chapter 16
Research on the Optimal Supervision Level of Government in Highway Under PPP Model

Ying-hui Jian and Dan Xu

Abstract By game analysis of the public and private in PPP projects without the government supervision, the private enterprise will reduce the effort degree without the government supervision, then the public welfare in PPP projects must be reduced, which demonstrated the necessity of government supervision. And it is analyzed that the government supervision has effect on promoting the private enterprise to invest the PPP project according to the agreement, and solved the optimal investment level of government supervision. Finally, it built the supervision mechanism of the whole process of project to improve the efficiency of government supervision.

Keywords Highway · Government supervision · Optimal PPP · Supervision level

16.1 Introduction

PPP, namely public–private partnership, refers that government department and the private enterprises sign the concession agreement so that the both parties form an effective cooperation based on the project to realize the win–win result by the investment of the project from private enterprises. In recent years, the PPP Mode has been widely used in domestic infrastructure construction, where highway is an important application of PPP Mode (Hang and Wang 2008; Lu and Gou 2011).

In the view of the infrastructure construction under PPP Mode has the nature of quasi-public goods, government department and the private enterprise have different interests target. The literatures (He and Fu 2008; Xu et al. 2009;

Y. Jian (✉) · D. Xu
Business School, Hohai University, Nanjing, China
e-mail: revilya@163.com

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Ye et al. 2010; Ahmed 2004; Tang et al. 2007) hold that the government supervision plays an important role on ensuring the benefit of PPP projects, and investigate the measure system of government supervision. This paper proves the necessity of government supervision based on the game theory and the characteristics of expressway PPP projects, and solved the optimal investment level of government supervision; also put forward the relevant supervision mechanism to ensure the successful application of PPP Mode in highway.

16.2 Public–Private Game Analysis Without Government Supervision

16.2.1 Basic Assumption

The game analysis model of government departments and private enterprises based on the following assumptions:

(1) The public and the private are economic rational. The government takes the maximum of public welfare as the goal, but the private enterprise takes the maximum of its own profit as the goal.
(2) During the process of construction and operation of the highway PPP project, the cooperation of the both parties is stable with no significant changes in the internal and external environment.

16.2.2 Game Model Between the Public and the Private

The total investment of the highway PPP project is c, including the construction funds and effort degree, which is made up of the investment of private enterprise c_1 and the investment of government c_2, i.e. $c = c_1 + c_2$. Among them, the investment of private enterprise is $c_1 = (x_1, y_1)^T$, x_1 is the construction funds, y_1 is the effort degree; the investment of government is $c_2 = (x_2, y_2)^T$, x_2 also is the construction funds and y_2 is the effort degree. In the operating process of highway, the maintenance cost of the average per units of transportation usage is $g(c) = kc^{\alpha}$, k and α are the constants which is more than 0, and $\partial g/\partial c > 0$, which means the more the total input of highway, the longer the highway mileage, and the more perfect the service, also the higher the maintenance cost. If the whole highway transportation usage is $f(p, y_1, y_2) = a(y_1, y_2)e^{-\frac{p}{b}}$ in concessionary time, where p is the identified price of highway usage per units in concession agreement (which do not change in short term), a (y_1, y_2) is the parameter converting p into transportation usage of highway ($a > 0$), which is mainly under the influence of effort degree of the public and private; b represents the average income of highway user ($b > 0$).

Assume that the profit of private enterprise is $E = d + \theta f(p, y_1, y_2)[p - g(c) + \eta]$ in the concession agreement of PPP project, d is the fixed income of private enterprise, θ represents the incentive degree of government for private enterprise, η is the random disturbance term whose value is 0. Social benefits in the process of highway is $S = \phi f(p, y_1, y_2)$, including consumption surplus of users, the economic increasing effect and social culture development and so on, ϕ is the parameter converting transportation usage into social benefits.

Government as a player, whose profit is the public welfare of the project, i.e. the direct profit of the project and social benefits, then deducting the total investment of the project, so the profit of the government is:

$$H_G = \phi f(p, y_1, y_2) + f(p, y_1, y_2)[p - g(c) + \eta] - c \tag{16.1}$$

The expected profit of the government is:

$$EH_G = \phi f(p, y_1, y_2) + f(p, y_1, y_2)[p - g(c)] - c \tag{16.2}$$

Private enterprise as another player, whose profit is the benefit of project, so the profit of private enterprise is:

$$H_P = d + \theta f(p, y_1, y_2)[p - g(c) + \eta] - c_1 \tag{16.3}$$

The expected profit of private enterprise is:

$$EH_P = d + \theta f(p, y_1, y_2)[p - g(c)] - c_1 \tag{16.4}$$

Government occupies the leading position in highway PPP project, so it will take the maximum of EH_G as the optimal investment level in the formulation of project concession agreement. The decision model of the government is:

$$\max EH_G = \phi f(p, y_1, y_2) + f(p, y_1, y_2)[p - g(c)] - c \tag{16.5}$$

$$\text{s.t.}\, EH_P = d + \theta f(p, y_1, y_2)[p - g(c)] - c_1 \geq \varepsilon \tag{16.6}$$

Formulae (16.6) is the participation constraint condition of the private enterprise, ε is the minimum income when private enterprise converts the investment in PPP project into other projects.

The government signs the concession agreement with private enterprise landing the optimal investment level based on the formulae (16.5) and (16.6). After that, private enterprise invests the appointed construction funds x_1 in accordance with agreements, but the effort degree y_1, including the investment of maintenance management, service quality and so on, is difficult to supervision, and then the private enterprise will choose the effort degree y_1 again to maximize its own profits. In this case, the decision model of private enterprise is:

$$\max EH_P = d + \theta f(p, y_1, y_2)[p - g(c)] - c_1 \tag{16.7}$$

Formulae (16.7) means that private enterprise will choose the effort degree y_1 again to maximize its own profit under the concession agreement x_1, x_2 and y_2, when it is out of the government supervision.

16.2.3 Game Analysis on the Behavior of the Public and Private

According to the decision model of government, the optimal investment level with the goal of $EH_{公}$ maximum is $c_1^* = (x_1^*, y_1^*)^{\mathrm{T}}$ and $c_2^* = (x_2^*,\ y_2^*)^{\mathrm{T}}$. Suppose the total investment of the PPP project is $c^* = c_1^* + c_2^*$, then the expected profit of the government is:

$$EH_G^* = \phi f(p, y_1^*, y_2^*) + f(p, y_1^*, y_2^*)[p - g(c^*)] - c^* \tag{16.8}$$

The expected profit of private enterprise is:

$$EH_P^* = d + \theta f(p, y_1^*, y_2^*)[p - g(c^*)] - c_1^* \tag{16.9}$$

In the operation process of PPP project, the private enterprise gets the optimal effort degree y_{11}^* based on the economic rationality and the solution of formulae (16.7). By discussing the size relationship between y_{11}^* and y_1^*, the shirking motive of private enterprise can be analyzed Medda (2007).

Under the optimal investment level $c_1^* = (x_1^*,\ y_1^*)^{\mathrm{T}}$ and $c_2^* = (x_2^*,\ y_2^*)^{\mathrm{T}}$, then:

$$\frac{\partial EH_G}{\partial y_1^*} = \phi e^{-\frac{p}{b}} \frac{\partial a}{\partial y_1^*} + e^{-\frac{p}{b}} \frac{\partial a}{\partial y_1^*} [p - g(c)] - f(p, y_1^*, y_2^*) \frac{\partial g(c)}{\partial y_1^*} - 1 = 0 \tag{16.10}$$

The value in $c_1^* = (x_1^*,\ y_1^*)^{\mathrm{T}}$ and $c_2^* = (x_2^*,\ y_2^*)^{\mathrm{T}}$ of partial derivative on y_1 based on the private enterprise objective function EHP is:

$$\frac{\partial EH_P}{\partial y_1^*} = \theta e^{-\frac{p}{b}} \frac{\partial a}{\partial y_1^*} [p - g(c)] - \theta f(p, y_1^*, y_2^*) \frac{\partial g(c)}{\partial y_1^*} - 1 \tag{16.11}$$

By substitution formulae (16.10) into formulae (16.11), we have:

$$\frac{\partial EH_P}{\partial y_1^*} = \theta[1 - \phi e^{-\frac{p}{b}} \frac{\partial a}{\partial y_1^*}] - 1 = (\theta - 1) - \theta \phi e^{-\frac{p}{b}} \frac{\partial a}{\partial y_1^*} < 0 \tag{16.12}$$

Based on the formulae (16.12) partial derivative on y_1^* of private enterprise revenue function is $\partial EH_P / \partial y_1^* < 0$, i.e. when the private enterprise reduces the effort degree on the basis of y_1^*, its profits can be increased. As the private enterprise is economic rational, when its own profit is maximum, the optimal effort degree would be $y_{11}^* < y_1^*$. Therefore, private enterprise will take the lazy behavior and reduce the effort degree, its actual total investment is $c_{11}^* = (x_1^*,\ y_{11}^*)^{\mathrm{T}}$. Then, the total investment of highway PPP project is $c^{**} = c_{11}^* + c_2^*$, $c^{**} < c^*$.

When the private enterprise reduces the effort degree, its profit is:

$$EH_{P2}^{*} = d + \theta f(p, y_{11}^{*}, y_{2}^{*})[p - g(c^{**})] - c_{11}^{*} > EH_{私}^{*} \tag{16.13}$$

The profit of the government is:

$$EH_{G2}^{*} = \phi f(p, y_{11}^{*}, y_{2}^{*}) + f(p, y_{11}^{*}, y_{2}^{*})[p - g(c^{**})] - c^{**} \tag{16.14}$$

As the private enterprise reduces the effort degree, the actual investment of the public and private is $c_{11}^{*} = (x_{1}^{*},\ y_{11}^{*})^{\mathrm{T}}$ and $c_{2}^{*} = (x_{2}^{*},\ y_{2}^{*})^{\mathrm{T}}$, the actual investment level deviates from the optimal level under the maximum of public welfare, there must be:

$$EH_{G2}^{*} < EH_{G}^{*} \tag{16.15}$$

Based on the above analysis, the private enterprise increases its income by reducing the effort degree when the government does not take effective supervision and punishment measures, but the public welfare also decreases, which is clearly inconsistent with the original intention of the government to carry out the highway construction. Therefore, the government must take effective supervision and punishment measures to realize the maximization of public welfare.

16.3 Pubilc–Private Game Analysis with Government Supervision

16.3.1 Validity Analysis of Government Supervision

The government takes charge of the private enterprise on the effort degree y_1 in highway PPP project, and the government will give a fine of F once the private enterprise is found be lazy at work. Assumption that the cost of government supervision is k, the probability of that the private enterprise is found be lazy at work is $\lambda = \mathrm{h(k)}$, $\partial h / \partial k > 0$.

As fine F is transfer payment, the expected profit when the government takes supervision is:

$$EH_{GS} = \phi f(p, y_1, y_2) + f(p, y_1, y_2)[p - g(c)] - c - k \tag{16.16}$$

There is no relationship between the supervision cost and the investment level of the public and private, when EH_{GS} is maximum, the optimal investment level of the government still is $c_{1}^{*} = (x_{1}^{*},\ y_{1}^{*})^{\mathrm{T}}$ and $c_{2}^{*} = (x_{2}^{*},\ y_{2}^{*})^{\mathrm{T}}$. Then, if the both sides invest in accordance with the contract, the expected profit of the government is $EH_{G}^{*} - k$, the private enterprise is EH_{P}^{*}.

Assume that EH_{PS-F} is the investment when the private enterprise takes the lazy behavior and is found by the government, and EH_{PS-NF} is the investment when the private enterprise takes the lazy behavior and is not be found. If the private enterprise takes the lazy behavior to reduce the effort level, then the expected profit of it is:

$$\begin{aligned} EH_{PS} &= \lambda EH_{PS-F} + (1-\lambda)EH_{PS-NF} \\ &= d + \theta f(p, y_1, y_2)[p - g(c)] - c_1 - \lambda F \end{aligned} \tag{16.17}$$

Obviously, when EH_{PS} is maximum, the optimal effort level of the private enterprise is y_{11}^*, the expected profit of the private enterprise is $EH_{P2}^* - \lambda\text{F}$, and the expected profit of the government is $EH_{G2}^* - \text{k}$.

As the government should consider the maximization of the public welfare, the supervision behavior of government must make the maximum profit of the private enterprise, so that the investment of the private is $c_1^* = (x_1^*,\ y_1^*)^{\mathrm{T}}$, i.e. the private enterprise takes no lazy behavior. Then it must satisfy:

$$EH_{P2}^* - \lambda\text{F} = EH_{P2}^* - h(k)\text{F} < EH_P^* \tag{16.18}$$

$EH_{P2}^* - \lambda\text{F}$ is the maximum expected profit, when the private enterprise does not take the effort level y_1^*. So when the formula (16.18) is tenable, by considering the maximum of its own profit, the effort degree of the private enterprise is y_1^*, and the public welfare also gets the maximum. At the same time, by choosing the fine F and the investment of supervision k, formula (16.18) is tenable, so the government can promote the effort degree of the private enterprise as the agreement to ensure the maximum public welfare of the PPP project.

16.3.2 The Determination of the Optimal Supervision Level of the Government

The supervision of the government can promote the private enterprise to choose the effort degree initiatively in favor of the maximum of the public welfare in the highway PPP project, at the same time, the investment of supervision and the punishment dynamics must meet:

$$\lambda\text{F} = \text{h(k)F} > EH_{P2}^* - EH_P^* \tag{16.19}$$

$$EH_G^* - k > EH_{G2}^* \tag{16.20}$$

Formula (16.19) ensures that the private enterprise will choose the effort degree as the expectation of the government based on the economic rationality under the supervision of the government. And the formula (16.20) indicates that the government need pay the costs of supervision k after taking the supervision behavior, but its target profit is improved.

According to the formulae (16.19) and (16.20), for the economic rationality, the optimal supervision investment of government k^* is the solution of following formulae.

$$\mathrm{h}(k^*)F = EH^*_{P2} - \mathrm{EH}^*_P \text{ and } \mathrm{k}^* < EH^*_G - EH^*_{G2} \tag{16.21}$$

Fine F is determined in the concession agreement, then according to the formula (16.21), the government can obtain the optimal supervision investment k^*. If the optimal supervision investment based on the formula (16.21) can't be obtained, it just needs to increase the fine F. In general case, in order to maximize the public welfare, the government can be appropriate to increase the fine F to reduce the investment k^* and with the result of more profits Sun et al. (2011) .

16.4 The Government Supervision Mechanism in PPP Project

16.4.1 Supervising Subject

By drawing on the supervision mechanism of the public projects in developed countries and the actual application of the PPP model in Chinese highway construction and "the comprehensive independent regulatory" is established which acts as the supervision subject of the highway PPP project to participate in the whole process. During the construction process of supervision institution, the vertical and horizontal authority should be restructured scientifically, the regulatory authority should be divided scientifically, and on the basis, the coordination mechanisms should be established to ensure the effective implementation of government supervision authority Alonso-Conde et al. (2007).

16.4.2 Supervision Basis

During the supervision process of highway PPP project, in order to ensure the supervision work as jurisprudence and efficiency, supervision institution supplies the legal constraints on the basis of the laws and a series of related policies, the contract restriction with the concession agreement and a series of other contracts, meets the signal system and property exchange, and reflects the incentive mechanism. Therefore, the basis of the government supervision should include laws and regulations system, other relevant policies, the concession agreement and a series of other contracts, the signal system, incentive mechanism and property restriction and so on.

16.4.3 Supervision Contents

During the construction and operation process of highway PPP project, the government independent supervision department should participate in the whole process supervision of project on the access of private enterprise, cost, price, service contents and quality, safety and environment and so on; the supervision contents in different project stages are as follows:

(1) Early in the project, based on the review of other appropriate body, the government carries out the supervision of the choice of the private enterprise, the conclusion of contracts and the approval of feasibility report and preliminary design.
(2) In the project construction period, the government supervision department should focus on the supervision of the implementation of the concession agreement, the choice of design unit and construction unit, construction safety, the engineering fund plan and using condition and completion acceptance. At the same time, the supervision department also needs concern about the index test of economy and technology in the project trial operation period.
(3) In the period of project operation, supervision department should pay attention to the supervision work in the process of highway operation, which is the stage project gives play to utility and the weak stage of supervision. In this period, supervision department should focus on the emergent events, and check the fields which the government mainly concern, the main duties include the supervision of the costs and prices, the operation maintenance of public infrastructure, the quality or service of the product and the performance evaluation of project operation and so on.
(4) In the period of project transfer, the main contents of supervision are monitoring of property rights and implement situation of the contracts, at the same time, the supervision department need make accurate assessment on the project to ensure the efficiency of government department.

16.5 Conclusion

The efficient operation of highway PPP projects, as infrastructure projects, is directly related to the public benefit of projects. In highway PPP projects, scientific government supervision in the whole process is necessary, which can ensure the successful implementation of PPP mode and improve the project public benefit. In this paper, the optimal solutions of supervision investment based on the game theory and the government supervision mechanism in the whole process can improve support and references in the application of PPP mode in highway projects.

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Chapter 17
Research on the Risk Allocation Efficiency of Agent Construction of Government Investment Projects

Jiao-jiao Deng and Ling Yan

Abstract Risk allocation is one of the key factors for the success of government investment projects, its research has been concerned widespread in the academic community, and has achieved fruitful research results. However, there is need for further consideration of risk allocation efficiency, so the reliability of the conclusions of various studies still need further survey. This paper build a model of risk allocation efficiency by learning from the efficiency of inter-enterprise transactions, and the results of the model show that the enforcing costs has a direct impact on risk allocation efficiency and even the contract efficiency.

Keywords Agent construction management · Efficiency · Enforcing costs · Government investment project · Risk allocation

17.1 Introduction

Research on allocation of risks widely exists in the fields of sociology, finance, investment, management and economics. In the field of engineering project, risks allocation for the construction project shall form a symmetrical state for the benefit of win–win results at the end; from cost perspective, it means to pay the minimum of the total cost for the risks taken. Therefore, project owner and consignor should not divert risks to the agent (namely the contractor) blindly, but to seek allocation of risks for the optimal share (Wang and Ke 2008). However, the risks allocation of construction project is the process of political games between contracting

J. Deng (✉)
Faculty of Management and Economies, Tianjin University, Tianjin, China
e-mail: dengjiaojiao6@163.com

L. Yan
School of Management, Tianjin University of Technology, Tianjin, China

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parties, it's hard to achieve its optimum state, so most of literature review are on the research of reasonable allocation of risks.

Reasonable risks allocation is a relative stable state to be achieved through political games by contracting parties. It can also be regarded as the balance result achieved by contractor through bargaining with the project employer on the price and risks to be undertaken (Flanagan and Norman 1993), it can lower the transaction cost of the project significantly (Zaghloul and Hartman 2003). Abednego and Ogunlana (2006) and some other people think that the goal of risks allocation is to increase the operational excellence, so to promote the success of the project. Reasonable risks allocation is to distribute risks (WHAT) to the most competent recipient (WHO) at the right time (WHEN) based on the provided options (HOW).

The risks of project construction can be lowered via management, but cannot be eliminated completely, for this reason, reasonable risks allocation becomes the key problem to solve so to ensure the smooth implementation of the project. Government projects usually involve huge amounts of investment, with long construction period, and with many participants. The implementation of government projects face more potential risks, the importance of risks allocation is more significant. Many research support reasonable risks allocation is one of the key factors (Zhang 2005; Li et al. 2005; Jefferies 2006) to ensure the success of governmental invested projects and received wide concern in research field.

17.2 Literature Review

Research on the risks allocation of governmental invested projects usually associates with specific implementation mode such as public private partnership system (PPP) and agent construction institution etc. Common research method includes questionnaire survey, case study and mathematical model. Questionnaire survey is to form one's own judgment on risks allocation through organizing experts' ideas on risks allocation. Such as Ke et al. (2009) analyzed the risks allocation preference of our country's PPP project by Delphi method. Through the analysis of risks allocation situation on different projects, summarizes the suggestions on risks allocation in general, this is the research framework of case study. Such as Wang and Tiong (2000) summary and analysis on the risks allocation of Laibin B power plant project in Guangxi Province. Questionnaire survey and case study both belong to qualitative research, cannot give exact quantitative results on risks allocation. So many scholars investigate the best and most reasonable risks allocation ratio through mathematical model method, lots of risks allocation models spring up. For example, Jin (2010) constructed the evaluation system of PPP project risks allocation strategy, and use obscure neural network to evaluate and predict reasonable risks allocation strategy; Fan et al. (2007) researched respectively on the risks allocation ratio model on influencing costs and earnings of projects.

Theoretically, research the risks allocation of government invested projects increased richly, but the reliability of all kinds of research results is to be further validated, this come to the consideration of efficiency and effect of projects' risks allocation. Risks allocation is to achieve win–win, as projects are different, and models different, Vega (1997) proposes the actual results on analysis of risks allocation should aim at specific items. Frederick (2002) thinks the best program is the corresponding risks allocation program that achieves the smallest total economic cost to undertake risks. Zheng (2011) bases the standard of whether or not it is to the benefit of risks allocation target, the ultimate effect of risks allocation expresses itself in encouraging effect and weakening effect. Ke (2010) chose six classic risks allocation models, compare the mechanism of efficiency of these risks allocation models through eight standards in theory and application, so to discriminate the merits. Thus it can be seen that, the academic circle conducted limited research on the efficiency of risks allocation at the moment.

17.3 The Efficiency Model of Risk Allocation in Agent Construction Projects

17.3.1 Design Model

From the perspective of the contract theory, risk allocation efficiency including resource allocative efficiency and implementation efficiency. Resource allocative efficiency is the division efficiency of risk responsibility, including the corresponding rights, resources and benefits. More importantly, the efficiency of risk allocation is reflected not only for the rights of arrangements, but also embodied in the effective implementation of these responsibilities. Based on this, this article learn from the research of the efficiency of inter-enterprise transactions (Chen 2000), design and analysis the model of risk allocation efficiency focusing on the implementation of the program of risk allocation.

At the assumption of a government sector and an agent participate in one agent construction project together, in accordance with the classical assumption of the incomplete contract theory, the period of interaction between the both sides is set to three stages: initial risk allocation, both sides inputs, renegotiation and yielding profit. At the same time, risk allocation efficiency model was improved in the following aspects: ① The risk allocation coefficient is introduced into the model as a continuous variable to change the traditional 0/1 configuration in the model, more close to the reality situation of income distribution and improve the tradition of the 0/1 configuration in the original model, so that the model of income distribution is closer to the reality; ② The introduction of risk allocation satisfaction to analyze the impacts on participants in implementing the program.

17.3.2 Analysis Model

1. The implement costs of risk allocation program

In the model of the efficiency of inter-enterprise transactions, the costs of execution the contract include: ① the future benefit of repeated game (X_1), repeated game make cooperation extending to the future. ② reputation spill-over effect (X_2). In order to expand the selection range of profitable trading, traders will establish reputation that makes others enable trust. ③ inducement affects (X_3). In other words, people have the tendency to keep his promise and choose to be fair and honest in the trade, when the incentive of the benefits of less than inducement affect.

For the agent construction projects, the public nature of the project to make repeated transactions possible between the government and the agent, accordingly reputation spill-over effect is also possible. Therefore, and are suitable for risk allocation program in agent construction projects. Inducement affects challenge to the external institutional environment, as long as the speculative behavior that point to institution may bring greater benefits, the agent will likely to breach of contract, thereby weakening the self-enforcing mechanisms of contract. In addition to the above three contract enforcement costs, risk allocation satisfaction also will directly affect the execution of the contract, its mechanism of action similar to inducement affects. So add risk allocation satisfaction (X_4) as a fourth category of cost in the implementation of risk allocation program.

If the benefits of the government and the agent's specific investment are simplified as a linear function, then these four implement costs can be translate into four incomes. These four incomes combined together to form self-execution costs which can be expressed as $SEC = \sum_{i=1}^{4} X_i = \sum_{i=1}^{4} \lambda_i a_i$, among them, a_i indicates the specific investment of i. SEC impact on the behavior of the participants.

2. Solving model

Period 0, the government and the agent established risk allocation program and sign contracts. Assuming that the two sides distribute risk factors in accordance with the risk allocation coefficient, including the corresponding ownership of projects, benefits from risk, and so on. Period 1, the two sides with the maximum utility for the target to select the level of specific investment and put into cost. Finally, the investment expression for the value of this agent construction project. Period 2, the government and the agent according to the agreed risk allocation program or renegotiations to form a new program for trading and realized profit.

It is mathematical expressions to explain the relevant process.

$$V = V(a_{1,}a_2) \tag{17.1}$$

$$C = C(a_{1,}a_2) = C(a_1) + C(a_2) \tag{17.2}$$

$$a^* = \arg\max\left[V(a_{1,}a_2) - C(a_{1,}a_2)\right] \tag{17.3}$$

The meaning of symbols in the above expressions: V means the value of the agent construction projects; a_1 means the specific investment of the agent; a_2 means the specific investment of the government; C means the costs of the specific investment; a^* means specific investment efficiency under Pareto optimality.

P means that the government pays to the agent currency, depending on the negotiations results of period 2, and the ultimate value of the agent construction project, that is to say:

$$P = (1-\theta)[V(a_1, a_2) - C(a_1, a_2)] \tag{17.4}$$

Risk allocation between the government and the agent in accordance with the coefficients θ and $1-\theta$. A simplified model, assumes that the risk allocation coefficient is the income distribution coefficient that due to the risks and risk-benefit to a certain extent proportional.

Then, the agent's profits expressed as:

$$\pi_1 = P - C(a_1) \quad \text{(Does not consider the indirect benefits)} \tag{17.5}$$

$$\pi_1 = P - C(a_1) + \lambda(a_1) \quad \text{(Consider the indirect benefits)} \tag{17.6}$$

The agent's optimal amount of specific investment expressed as:

$$\begin{gathered} a_1 = \underset{0 \le a_1 \le a_1^*}{\arg\max}\, \theta[V(a_1, a_2) - C(a_1, a_2)] - C(a_1) \\ \text{(Does not consider the indirect benefits)} \end{gathered} \tag{17.7}$$

$$\begin{gathered} a_1' = \underset{0 \le a_1 \le a_1^*}{\arg\max}\, \theta[V(a_1, a_2) - C(a_1, a_2)] - C(a_1) + \lambda(a_1) \\ \text{(Consider the indirect benefits)} \end{gathered} \tag{17.8}$$

If the value of the agent construction project is regarded as the direct benefits obtained by the government, then, by the same token can get the government's optimal amount of special investment:

$$a_2 = \underset{0 \le a_2 \le a_2^*}{\arg\max}\ \theta[V(a_1, a_2) - C(a_1, a_2)] - C(a_2) \tag{17.9}$$

$$a_2' = \underset{0 \le a_2 \le a_2^*}{\arg\max}\ \theta[V(a_1, a_2) - C(a_1, a_2)] - C(a_2) + \lambda(a_2) \tag{17.10}$$

The government and the agent's specific investment can be seen as the response that one trader to another trader. Then using the Cournot model to get both sides of the response function and the response curve, as shown in Fig. 17.1.

3. Analysis results

Not consider SEC ($SEC = 0$), the government and the agent's response curves intersect at point F, forming of investment efficiency in general circumstances. On the contrary, consider SEC ($SEC \neq 0$), because the continued accumulation of SEC, both the government and the agent will be to improve the specific investment,

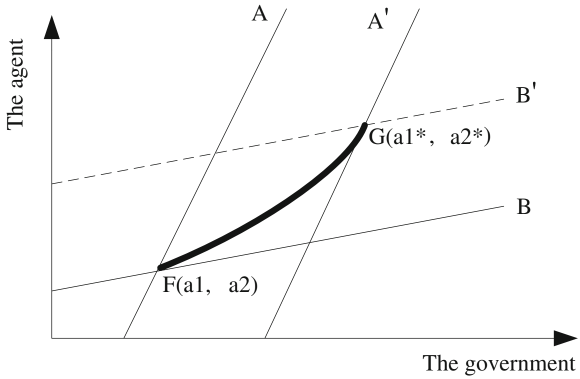

Fig. 17.1 The response curve of both the government and the agent

thereby causing the movement of specific investment response curve, and making the improvements of investment efficiency, even to the point G of the Pareto optimal investment.

Based on the above analysis, the evaluation of the project risk allocation program can be converted for comparison of the specific investment response function. If present program 1 and program 2, as long as compared with the intersection of investment response curve that obtained from the different, the pros and cons of these two risk allocation programs can be determined.

17.4 Discussion

17.4.1 The Significance of the Model

SEC is the core of the model of risk allocation efficiency, and results from model analysis show that, the SEC has a direct impact on risk allocation efficiency and even on the contract efficiency.

1. The future benefit of repeated game (X_1). Repeated game means that the possibility of long-term cooperation between the government and the agent, and the long-term cooperation depends on the agent market development as well as the temporary sacrifice of the agent. The agent can expect future profits due to the development of the agent construction market. And on this basis, the agent will consider the immediate benefits in exchange for long-term interests.
2. Reputation spill-over effect (X_2). Repeated game is the premise of reputation. Reputation is essentially a kind of implicit contract. To some extent, the value of reputation cannot simply be calculated in the scope of trade, and the real utility of the reputation is to have an impact beyond the trading range, that is reputation spill-over effect which can reduce the uncertainty of government policy, avoiding unnecessary risks, thus influence the government in the market an in a project to allocate resources.

3. Inducement affects (X_3). Inducement to a large extent reflects the pros and cons of the institutional environment on behalf of the agent construction market. In powerful security environment, the possibilities that the agent challenges institution bottom line or the loopholes in the system for speculative will be greatly reduced.
4. Risk allocation satisfaction (X_4). Risk allocation satisfaction mainly refers to the satisfaction of the parties to the risk allocation program that by mutual agreement after the negotiation. If the agent is satisfaction with the rationality of the program, its speculation will be reduced or even eliminated; conversely, if the agent is dissatisfaction with the program, as long as the speculative behavior can gains greater than losses that due to unreasonable allocation, they may take all kinds of speculative behavior.

17.4.2 The Shortcomings of the Model

The factors that influence efficiency of risk allocation are not only the efficiency of resource allocation, but also the efficiency of implementation for the risk allocation. Firstly, the level of resource allocative efficiency is decided by the principle of risk allocation under specific institutional environment and the negotiating skills of government and agent. Secondly, the implementation effect of risk allocation program is not only decided by the program itself, but also the implementation of it, which places emphasis on the institutional environment. Thirdly, in order to simplify the construction and calculation of the model, the construction of risk allocation model put emphasis on the discussion of implementation efficiency, but reduce analysis the resource allocative efficiency. Actually, resource allocative efficiency is the premise of implementation efficiency; the implementation efficiency finally decided the achievement of the resource allocative efficiency. Therefore, the research of the resource allocative efficiency needs to be further.

17.5 Conclusion

The existing research of the government investment projects on risk allocation more emphasis on the risk allocation program, model and countermeasures through the qualitative or quantitative methods. But the research of the risk allocation efficiency in government investment projects is particularly weak. Risk allocation efficiency can be used to judge the validity and reliability of the specific program, model and countermeasures, so it is the deepening of existing research. Therefore, this paper builds a model of risk allocation efficiency that learning from the efficiency of inter-enterprise transactions. Based on this model, the preliminary research results show that the enforcing costs have an important influence to risk allocation efficiency.

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Chapter 18
An Improved NSGA-II Algorithm for Resource-Constrained Discrete Time–Cost Tradeoff Problem

Hong Zha and Lian-ying Zhang

Abstract In this paper, a resource-constrained discrete time and cost tradeoff problem (RCDTCTP) is considered in knowledge intensive project, where the resources are mainly renewable resource, especially manpower. A multi-objective model for this problem is proposed. In order to illustrate the model, an improved non-dominated sorting genetic algorithm is introduced to solve the model with a numerical example. The results showed that a set of Pareto optimal scheduling alternatives can be obtained in given resource constraints, from which the project stakeholder can choose the preferred alternative.

Keywords Improved NSGA-II · Multi-objective · Project scheduling · Time–cost tradeoff

18.1 Introduction

Resource-constrained project scheduling problem (RCPSP) has attracted a lot of attention for a long time both from science and practice. There are many research papers with respect to optimization models and algorithms in RCPSP, which have been reviewed by Herroelen and De Reyck (1998), Brucker et al. (1999) and Hartmann and Briskorn (2010). Brucker et al. (1998) researched on a branch and bound algorithm to determine a schedule with minimal project time in RCPSP problem, in which the precedence relationship are given in the form of finish-start relationship. Damak et al. (2009) introduced a differential evolution (DE) algorithm to minimize the project time of a multi-mode RCPSP. Coelho and Vanhoucke (2011) solved the multi-mode RCPSP to minimize the project time with a new two-stage

H. Zha (✉) · L. Zhang
College of Management and Economics, Tianjin University,
Tianjin, China
e-mail: zhahong@tju.edu.cn

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algorithm, which was able to execute two stages in one run relied on a single priority list. Ahn and Erenguc (1998) focused on a multi-mode resource-constrained project problem with minimal project cost, which was the sum of all activity costs and the penalty cost for delay. Wuliang and Chengen (2009) researched on the multi-mode RCPSP with a given deadline and minimization of the efficient cost, which was composed of direct and indirect cost. Rodrigues and Yamashita (2010) focused on the minimization of resource availability cost in RCPSP before deadline.

However, the optimization objective of above-mentioned research is about either project time or project cost. None of them can provide project planners all the feasible tradeoff schemes between project times and costs, which satisfies the specific requirements with respect to time and cost of the project being considered. Besides, in the current circumstances, the resource constrained in projects mostly are renewable resources, such as manpower resources and machines. And the projects time and cost change in pace with different occupation of renewable resources.

In this paper, we present a multi-objective model for the resource-constrained discrete time/cost tradeoff problem (RCDTCTP) based on recent researches. Several important characteristics of this model are described as follows: (18.1) the schedule set of feasible tradeoff between project time and project cost can be generated, from which the project planners are able to choose the appropriate scheduling scheme; (18.2) the renewable resources are focused and the resource capacities are limited. An improved NSGA-II is developed to solve above model. Ultimately, a numerical example is introduced to testify the effectiveness of the proposed model and algorithm.

18.2 Problem Description

18.2.1 RCDTCTP

We consider a project consisting of J activities labeled from 1 to J. Due to technical requirement, there are precedence relations between all activities in the project. Activity j may not start before all its predecessors P_j are finished. The precedence relations can be depicted by an acyclic activity-on-node network $G = (V, E)$ where the nodes and arcs represent the activities V and precedence relationE, respectively. Renewable resources are focused in RCDTCP; there are K renewable resource types where the resource type $k \in K$ has the top bound R_k. For each activity j, there are M_j executed modes. Performing activity j in mode m takes d_{jm} periods and occupies a set of renewable resources, of which a resource type k has resource requirement r_{jmk}. By means of determining the executed sequence of activities in project and allocating executed mode for each activity, the tradeoff between project time and cost can be realized.

18.2.2 A Multi-objective Model for RCDTCTP

The multi-objective model for the resource-constrained discrete time–cost tradeoff problem is stated as follow:

$$\min F_t = \max\{f_J\} \tag{18.1}$$

$$\min F_c = \sum_{k=1}^{K} \sum_{j=1}^{J} \sum_{m \in M_j} \left(c_k r_{jmk} d_{jm} x_{jm}\right) + c_{in} F_t \tag{18.2}$$

s.t:

$$\sum_{m \in M_j} x_{jm} = 1, \tag{18.3}$$

$$f_j - \sum_{m \in M_j} d_{jm} x_{jm} \geq f_i, \quad i \in \mathrm{pred}(j), \tag{18.4}$$

$$\sum_{j \in A_t} r_{jmk} x_{jm} \leq R_k, \quad k = 1, \ldots, K, \tag{18.5}$$

$$A_t = \left\{ j \middle| f_j - \sum_{m \in M_j} d_{jm} x_{jm} < t \leq f_i \right\},$$

$$j = 1, \ldots, J, \tag{18.6}$$

$$k = 1, \ldots, K. \tag{18.7}$$

In the formulation, the objective function (18.1) minimizes the project time. The objective function (18.2) minimizes the project cost, including the direct cost when renewable resource are occupied in activities and indirect s cost when the project in progress, where $c_k^p$is the price for renewable k. Constraint set (18.3) ensures that all the activity can be performed only in one mode, where X_{jm} is a decision variable. If the activity j is performed in mode m, $X_{jm} = 1$, otherwise, $X_{jm} = 0$. Constraint set (18.4) is about precedence relationship among activities. Constraint set (18.5) indicates that for each time periods A_t and for each resource type k, the renewable resource amounts required by activities in progress cannot exceed the resource capacity R_k. Formula (18.6) and (18.7) represents the activity number and renewable resource type in project.

18.3 Improved Nsga-II Algorithm

NSGA-II is a kind of non-dominated sorting based multi-objective evolutionary algorithm with elite strategy, proposed by Deb et al. (2002) in 2002. Because of its excellent performance, the algorithm has been applied widely and become a benchmark multi-objective algorithm gradually. In this paper, we improved the algorithm in framework of NSGA-II for RCPSP, and apply the improved NSGA-II to solve the multi-objective model for RCDTCTP with a project numerical example.

The improved algorithm has six steps, including initial population, fitness evaluation, tournament selection, crossover operator, mutation operator, and termination criterion.

1. Initial population. Generate a population randomly, which include m individuals. Each individual is encoded in the form of doubly linked list. The first list $\lambda = (j_1, \ldots, j_J)$ represents a precedence feasible activity list (AL). The AL is decoded with serial SGS method (Rainer 1996) where the activities are selected according to their order in the list and scheduled at their earliest start periods. And the second list $\pi = (m_1, \ldots m_J)$ is mode list, which represents the executed mode allocated to each activity.
2. Fitness evaluation. The fitness value for each individual should be calculated. For each individual i, the project time can be obtained by serial SGS decoding (Rainer 1996), and then the efficient project cost can be computed to formula (18.2). After sorting the non-dominant rank R(i) and calculating the crowding distance CD(i) according to the individuals' objective values, the fitness for individual i can be given by fitness(i) = CD(i)/R(i).
3. Tournament selection. Two individuals from the parent population P are selected randomly, and the individual with higher fitness value will be preserved in the child population Q. This procedure will continue till the population size of Q is as large as P.
4. Crossover operation (Elloumi and Fortemps 2010). As shown in Fig 18.1, two parent individuals $I^F = (\lambda^F, \pi^F)$ and $I^M = (\lambda^M, \pi^M)$ are selected randomly to cross both activity and mode list with each other, then child individuals $I^S = (\lambda^S, \pi^S)$ and $I^D = (\lambda^D, \pi^D)$ are produced. When λ^F and λ^M cross, an integer

Fig. 18.1 Schematic diagram for crossover operation

I^F

1	3	4	8	7	6	10	2	5	9	11
2	1	2	2	1	1	3	2	1	3	3

I^M

1	2	3	5	4	6	9	7	8	10	11
1	2	1	2	1	1	2	2	1	3	1

I^S

1	3	4	8	2	5	6	9	7	10	11
2	1	2	2	2	1	1	2	2	3	1

I^D

1	2	3	5	4	8	7	6	10	9	11
1	2	1	2	1	1	2	1	3	3	3

$q_{cos1}=4$, $q_{cos2}=7$.

$q_{cos1}(1 \leq q_{cos1} < J)$ is generated λ^D inherits λ^F's gene segment from 1 to q_{cos1} and the remaining genes are arranged following the order of λ^M. Similarly, from 1 to q_{cos1}, λ^S inherit λ^M's gene segment, and from q_{cos1} to J its remaining genes are arranged following the order of λ^M. When π^F and π^M cross, an integer $q_{cos2}(1 \leq q_{cos2} < J)$ is generated randomly. From position 1 toq_{cos2}, modes are allocated to activities in π^S and π^D according to π^F and π^M respectively. But for the remaining positions, modes allocated to π^S and π^D according to π^M and π^F in order.

5. Mutation operation (Elloumi and Fortemps 2010). An individual $I = (\lambda, \pi)$ is selected randomly and two integers $q_{mut1}(1 \leq q_{mut1} < J)$ and $q_{mut2}(1 \leq q_{mut2} \leq J)$ are randomly generated for it. This operator is applied, first, on activity list string and, second, on the mode assignment one. If the activity in position q_{mut} is not a predecessor of activity located in $q_{mut} + 1$, the two activities can be swapped. Otherwise, another integer q'_{mut} is generated. This procedure will repeat till two activities can be swapped. Afterwards, for the mode list, allocated a different mode to activity located in.q_{mut2}
6. Termination criterion. When the iterative number reach the given generation, the evolution is terminated and the result is output, otherwise the iteration continues.

18.4 Computational Experiment

18.4.1 Numerical Example

A project example is analyzed in order to illustrate the effectiveness of the proposed model and algorithm. The project in example consists of 11 activities, and the data of executed modes for all activities is shown as Table 18.1.

The two types of renewable resource required in this project are limited, where$R_1^\rho = 1,000$, $R_{12}^\rho = 600$. And c_1^ρ and c_2^ρ are 200 and 500 dollars per unit for each work day.

18.4.2 Results and Discussion

In this paper, we have used the improved NSGA-II algorithm to solve aforementioned multi-objective model for RCDTCTP (18.1–18.7). In the parameters for the algorithm, the population size and the evolutionary generation are set as 50 and 1,000.

The time–cost tradeoff curve is drawn as Fig 18.2, which includes 31 Pareto optimal scheduling alternatives. The project time of these alternatives varies from

Table 18.1 Data for the project example

Activity	Predecessor	Modes	Duration	R1	R2
1	–	1	20	100	20
		2	15	200	40
		3	10	400	80
2	1	1	60	80	50
		2	45	160	100
		3	30	320	200
3	1	1	40	60	30
		2	30	120	60
		3	20	240	120
4	1	1	50	140	70
		2	37	280	140
		3	25	560	280
5	2	1	30	50	40
		2	22	100	80
		3	15	200	160
6	3	1	20	80	30
		2	15	160	60
		3	10	320	120
7	4	1	50	40	10
		2	35	80	20
		3	25	160	40
8	4	1	80	170	90
		2	60	340	180
		3	40	680	360
9	5,6	1	100	200	130
		2	75	400	260
		3	50	800	520
10	7,8	1	70	150	80
		2	52	300	160
		3	35	600	320
11	9,10	1	20	50	15
		2	15	100	30
		3	10	200	60

130 to 240 days, the corresponding project cost changes from 59.823 to 31.554 millions of dollars. The feasible schedule with minimal project time subjects to the resource constraint, in such environment the activities cannot always be started and operated in the quickest possible way. The project cost is composed of direct cost related to renewable resource occupied in activities and indirect cost depended on project time. The minimal project cost is the outcome of tradeoff between direct and indirect cost. From the time–cost tradeoff curve obtained, it is easy for project managers to balance the project time and cost, from which the project stakeholders can choose the preferred scheduling alternative according to the given resources.

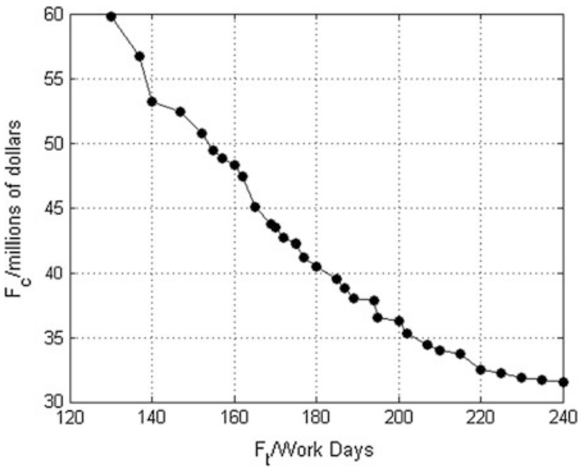

Fig. 18.2 Time-cost tradeoff curve

18.5 Conclusion

The resource constrained discrete time and cost tradeoff problem (RCDTCTP) is a research hotspot in project scheduling problem. In this paper, renewable resource in knowledge intensive projects is considered and the multi-objective model for RCDTCTP is proposed. In order to illustrate the model, an improved non-dominated sorting genetic algorithm is introduced to solve the model with a numerical example. The results showed that a set of Pareto optimal scheduling alternatives can be obtained in given resource constraints, from which the project stakeholder can choose the preferred alternative.

In nowadays, most projects in practice subject to uncertainty Future study are going to focus on time–cost tradeoff problem subjected to both resource constraints and uncertainty.

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Chapter 19
Application Research on the Artificial Neural Network in the Building Materials Price Prediction

Hongxiang OuYang, Xinjuan Zhang and Cencen Hu

Abstract The bidder's accurate Prediction of the materials' up and downs during the construction process will undoubtedly improve the reliability of the bidding price and the possibility of winning a bid. This article proposes the material price forecasting model with the BP Neural Network, which uses the materials' historical price as samples based on analyzing the influence of the materials' future ups and downs to the construction profit. The case shows that the model has strong nonlinear mapping ability and fault tolerance capability, and can be a reliable method for construction enterprises to predict the materials price trend when bidding.

Keywords Artificial neural network · Bidding price · Material price · Prediction

19.1 Introduction

The material cost level plays a decisive role to the construction cost in the engineering project sometimes. Facing the fierce competition situation of the construction market, the bidders' material price research and forecasting is the important presupposition for reasonable bidding and accepting the bid, and also the key part for ensuring the enterprises' profit. Generally, the construction period is long, at least a few months, at most years or even decades. In this long construction process, the materials price will change certainly. The contract

H. OuYang (✉) · C. Hu
Business School of Hohai University, Nanjing, China
e-mail: oyanghx@163.com

X. Zhang
JINQIAO Real Estate Co. Ltd, Nanjing, China
e-mail: zhxj326@163.com

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between the employer and the contractor has mainly two ways to handle the materials price rising, one is the material price dose not adjust completely, the other is the material price adjusts finitely. The so-called material price does not adjust, by definition, refers to all materials price do not adjust because of the market price increasing during the entire construction period, and the contractor bears the risk of material price rising. The material price adjusting finitely means that when the material price fluctuation reaches certain amplitude during the construction period, such as the increasing part is over the bidding price 10 or 15 %, the over part is not adjust anymore. So the risk within the material price rising limit is borne by the contractor, and the risk outside the material price rising limit is borne by the owner. This price adjustment method fully reflects the principle of risk-sharing, which is widely used in the project. No matter what method, the contractor should bear certain material price rising risk. If the contractor can fully understand the market situation and can accurately predict future price trend when bidding, undoubtedly it is a great help to improve the possibility of accepting a bid and the profitability after inning a bid. By searching the "Chinese Journal Full-text Database", we find that research results on the application of the Neural Network in the building material price prediction are seldom. Most of the articles focus on the structural parameters, like the foundation type, base elevation, engineering category, storey number, storey height, construction area and so on, as the main characteristic indexes. These articles select some samples, train the BP Neural Network, map the main characteristic indexes to the cost index, then realize the rapid prediction of construction cost (Zhang et al. 2010; Hu et al. 2008; Wang 2011; Li 2011; Wang and Xing 2011; Peng and Zhang 2005; Xin and Yang 2008; Xi 2007). Their deficiency is that the selection of characteristic index is not uniform, and the quantitative of characteristic index has large randomness. This article finds another way to focus on the influence of the future building material price ups and downs to the current bid and offer help to the decision makers. The reason to select the BP Neural Network to predict the building material price trend is that the BP Neural Network has the advantages of self-learning, self-organization, self-adaptive and strong nonlinear mapping and generalization ability, which is especially suitable to solve the problem of the market prediction.

19.2 The Bp Neural Network Model

The multi-layer perception by using BP algorithm, called BP neural network, is one of the most widely used neural networks by far, and particularly the application of the three-layer perception is the most common one. The three-layer BP neural network structure shows in Fig. 19.1.

In the three-layer perception, the input layer input vector is $X = (x_1, x_2, \ldots, x_i, \ldots, x_N)^T$, the hidden layer output vector is $Y = (y_1, y_2, \ldots, y_j, \ldots, y_M)^T$, the output layer output vector is $O = (o_1, o_2, \ldots, o_k, \ldots, o_l)^T$. The weight matrix of the input layer to the hidden layer is shown as V, $V = (v_1, v_2, \ldots, v_j, \ldots, v_M)^T$, and v_j

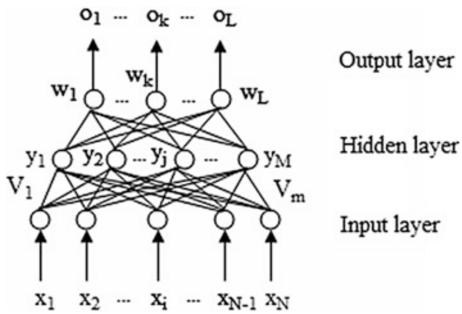

Fig. 19.1 Three-layer BP neural network

shows the weight vector of the j-th neuron in the input layer to the hidden layer. The weight matrix of the hidden layer to the output layer is shown as W, W = (w_1, w_2, …, w_k,…, w_L), and w_k shows the weight vector of the k-th neuron in the hidden layer to the output layer. The desired output vector of the output layer is shown as D, D = $(d_1, d_2, \ldots, d_k, \ldots, d_L)^T$ (Han 2006; Zhang et al. 2008).

The function characteristics of the BP neural network are determined by the weight values of the input layer to the hidden layer and the hidden layer to the output layer, which is determined by the weight matrix V and W. The BP Neural Network can change the connection weight value of the neural network by learning and training the sample, then make the actual output O of the neural network keeps close to the desired output D of the neural network (the difference between the two is called the network output error E). The process of the weight value adjusting continuously, that is the learning and training process of the neutral network, this process will continue until that the network output error is reduced to an acceptable level or reach the pre-set time of learning .

19.2.1 The Mathematical Relationship of the Network' S Each Layer

For the output layer, there is

$$o_k = f\left(\sum_{j=1}^{M} w_{jk} \cdot y_j\right), \quad k = 1, 2, \ldots, L \tag{19.1}$$

In the formula (19.1), w_{jk} is said to the connection weight value of the hidden layer's neuron j to the output layer's neuron k.

For the hidden layer, there is

$$y_j = f\left(\sum_{i=1}^{N} v_{ij} \cdot x_i\right), \quad j = 1, 2, \ldots, M \tag{19.2}$$

In the formula (19.2), v_{ij} is said to the connection weight value of the input layer's neuron i to the hidden layer's neuron j.

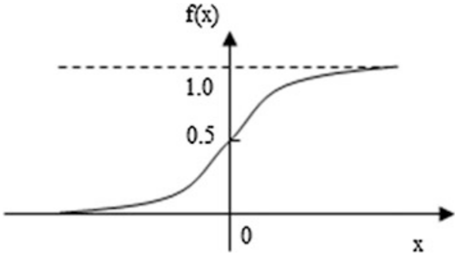

Fig. 19.2 The monopole S type transform function

In the above two formulas, the transformation functions $f(\bullet)$ are all monopole Sigmoid functions, that is $f(x) = \frac{1}{1+e^{-x}}$, $f(x)$ has the continuous conductive characteristics, and $f^{'}(x) = f(x) \cdot [1 - f(x)]$. The monopole Sigmoid function graph is shown in Fig. 19.2. Sometimes it also uses the bipolar Sigmoid function, that is, $f(x) = \frac{1-e^{-x}}{1+e^{-x}}$. The bipolar Sigmoid function graph is shown in Fig. 19.3.

19.2.2 The Network Output Error and the Weight Value Adjustment

When the actual output of the neural network is not equal to the expected output, it implies the existence of the network output error E, which is defined as follows:

$$E = \frac{1}{2}(D - O)^2 = \frac{1}{2}\sum\nolimits_{k=1}^{L} (d_k - o_k)^2 \tag{19.3}$$

Spreading out the above formula gradually to the input layer, there is:

$$E = \frac{1}{2}\sum\nolimits_{k=1}^{L} \{d_k - f[\sum\nolimits_{j=1}^{M} w_{jk} \cdot f(\sum\nolimits_{i=1}^{N} v_{ij} \cdot x_i)]\}^2 \tag{19.4}$$

By the formula (19.4) we can see that the network output error E is the function of each layer weight value w_{jk} and v_{ij}, therefore adjusting the weight value can change the size of the network output error E. Clearly, the principle of adjusting the weight value is to reduce the error continuously. The calculation formula of the three layer BP neural network weight value adjustment is as follows:

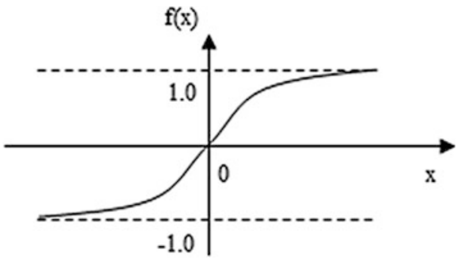

Fig. 19.3 The bipolar S type transform function

$$\Delta w_{jk} = \eta(d_k - o_k)o_k(1 - o_k)y_j \tag{19.5}$$

$$\Delta v_{ij} = \eta(\sum_{k=1}^{L} [(d_k - o_k)o_k(1 - o_k)w_{jk}])y_j(1 - y_j)x_i \tag{19.6}$$

19.2.3 The Neural Network Price Forecasting Process

Forecasting the building materials by using the BP Neural Network, it should collect the historical price information firstly, and then design the BP Neural Network parameter values, use the historical price information samples training the initial neural network continuously, until the training accuracy meets the requirements. Lastly, input the testing price data to the mature BP neural network, and obtain the forecasting value by calculation. The process is shown in Fig. 19.4.

19.3 The Major Building Materails Price Forecasting

As a part of the project entity, the building materials have larger proportion in the whole construction cost, some even as high as 60–70 %, and the building materials prices rising will certainly cause the increase of the construction cost. Therefore, the bidders should have clear knowledge to the future building materials prices trend when bidding. In the general construction projects, the main building materials include steel, cement, gravel, concrete, and so on. This paper uses the steel (Ⲫ12–25) as an example, introduces in detail how to use the BP Neural Network model for forecasting the steel price. For example, the project cost department issued the steel (Ⲫ12–25) price information of an area in 2011, which is shown in Table 19.1.

Each month's price in Table 19.1 can be shown as a vector $X = (x_1, x_2, \ldots, x_{10})$, and normalize the vector X according to the formula (19.7), we can obtain the vector Y.

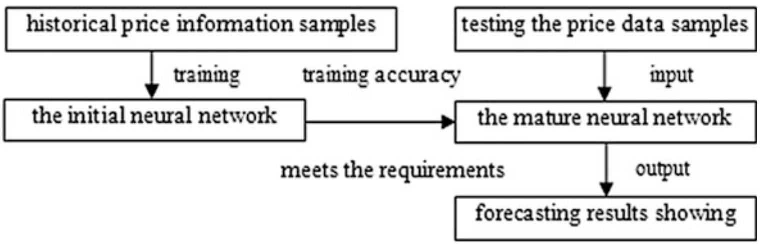

Fig. 19.4 The neural network price forecasting

Table 19.1 The steel market price of an area in 2011

Date	January	February	March	April	May	June	July	August	September	October
Price (yuan/t)	4,710	4,800	4,810	4,880	4,900	4,880	4,860	4,850	4,900	4,950

$$y_i = \frac{x_i - \min\{x_i\}}{\max\{x_i\} - \min\{x_i\}} \tag{19.7}$$

$$Y = \{y_i\} = (0, 0.375, 0.417, 0.708, 0.792, 0.708, 0.625, 0.583, 0.792, 1)$$

19.3.1 Standardizing the Data

It uses rolling forecast method to forecast the steel price that is to use the first four months' market price to forecast the fifth month's price. For example, use the market price of January, February, March and April to forecast the fifth month's market price, and use the market price of February, March, April and May to forecast the sixth month's market price and so on. Finally use the market price of June, July, August and September to forecast the tenth month's market price. If each data is shown as a column of a matrix, we will get the input matrix P:

$$P = \begin{pmatrix} 0 & 0.375 & 0.417 & 0.708 & 0.792 & 0.708 \\ 0.375 & 0.417 & 0.708 & 0.792 & 0.708 & 0.625 \\ 0.417 & 0.708 & 0.792 & 0.708 & 0.625 & 0.583 \\ 0.708 & 0.792 & 0.708 & 0.625 & 0.583 & 0.792 \end{pmatrix}$$

Make the normalized data of May, June, July, August, September and October as the desired output, that is $T = (0.792, 0.708, 0.625, 0.583, 0.792, 1)$. The difference between the desired output and the actual output is the output error E.

19.3.2 The Neural Network Parameters

Use the three-layer BP Neural Network structure. (1) the input layer: four neurons represent the price of four months. (2) the hidden layer: according to the input layer and output layer neuron number, refer to the experiential formula, and test repeatedly, determine to select eight neurons. The activation function of the hidden layer uses the bipolar Sigmoid function. (3) the output layer: one neuron is used to output the forecasting price. The activation function of the output layer also use the bipolar Sigmoid function. (4) the training function uses the gradient descent function traingd(). (5) the learning accuracy is set to $\varepsilon = 0.005$.

19.3.3 Training the Test Results

Using the newff(), tansig() and other functions which are provided by the Matlab software, make the calculation procedure. After learning 3,779 times, the learning accuracy is reached to 0.004995, meets the designed accuracy requirements, and the training error curve is shown in Fig. 19.4, the learning results is shown in Table 19.2. The relative error means (the training value—the expected value)/the expected value.

From the Table 19.2 we can know, except for the data of August's output value and expected value has larger error, the relative of the rest of the learning samples has smaller error, and the average error is 2.49 %. Therefore the learning result of the three-layer BP Neural Network is ideal.

19.3.4 Forecasting the Future Price

According to the trained mature BP Neural Network, we can forecast the steel price of the future six months. For example, we use the data of July, August, September and October to forecast the data of November, and then use the data of August, September, October and November to forecast the data of December, and so on, we can forecast the data of the future six months or even more months. The forecasting results are shown in Table 19.3 and Figs. 19.5, 19.6.

19.3.5 Analyzing the Data and Making Countermeasures

If the bid document submission deadline is October 31st, the contract type is unit price contract, and the contract price is allowed to adjust only when the price change is reached to 10 %. According to the data in Table 19.1, the steel price in October is 4,950 yuan/ton. The data in Table 19.3 shows that the steel average price in the future six months is 4,890 yuan/ton, and the material price decline was only 1.2 %. Therefore, the contractor does not need to worry about the problem of the contract price adjustment. Considering that the steel price in the future six months has the trend to fall, the contractor may offer in normal circumstances, and adjusts certain amplitude down appropriately, reduces their

Table 19.2 The learning results of the neural network

Month	May	Jun	Jul	Aug	Sep	Oct
The training value	0.732	0.702	0.653	0.695	0.725	0.907
The expected value	0.792	0.708	0.625	0.583	0.792	1
The relative error (%)	−7.59	−0.82	4.45	19.18	−8.42	−9.29

Table 19.3 The forecasting result of the neural network

Month	Nov	Dec	Jan	Feb	Mar	Apr
The output value	0.932	0.804	0.772	0.706	0.746	0.568
The forecasting rice (yuan)	4,933	4,903	4,895	4,879	4,889	4,846

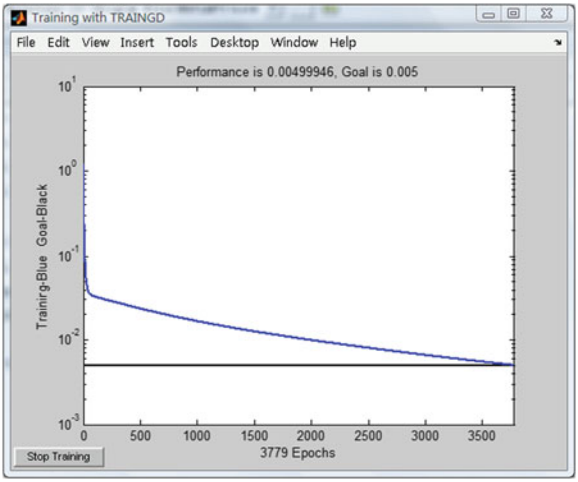

Fig. 19.5 The training error curve

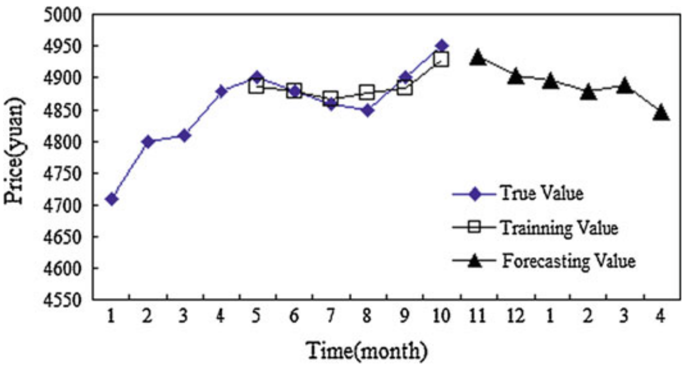

Fig. 19.6 The neural network price forecasting

price to increase the probability of accepting the bid. In the construction process, if the actual material price trend is the same with the forecast results, the contractor has no loss at all.

19.4 Conclusion

In the construction bidding activity, whether can compute the construction cost rapidly and reliably affects the possibility of winning the bid directly. As a part of the architectural entity, the building materials have larger proportion in the whole construction cost. The building materials prices rising will certainly cause the increase of the construction cost. Therefore, how to correctly forecast the material price trend is a difficult and hot issue. Compared with other forecast methods, the Neural Network has the outstanding advantages of strong adaptability, good fault tolerance, strong non-linear mapping ability and others, and can deal with the multivariate nonlinear problems effectively. This article proposes the material price forecasting model with the BP Neural Network, which uses the materials' historical price as samples and offer help for the contractor to bid. The case shows that this method is feasible and effective.

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Chapter 20
Study on the Application of Activity Based Costing in Packaging and Printing Enterprise

Yujie Zhu and Mian Yang

Abstract With the development of economy and environment change, the automation degree of enterprise to rise increasingly, the transformation of the mode of production lead to enterprise production cost produced tremendous change. The products of packaging and printing enterprises became more complex; the traditional cost method cannot have satisfied product cost precision requirements. The Activity-Based Costing (ABC) as a kind of advanced methods to cost management, is to work for the center of a cost allocation, according to product agent distribution cost, which can provide more accurate cost information, so the introduction of Activity-Based Costing method is the requirement of packaging and printing enterprise on cost management.

Keywords Activity-based costing · Cost accounting · Packaging and printing enterprises

20.1 Introduction

Under the center of economic construction, the packaging and printing enterprise in our country faced an unprecedented opportunity and developed rapidly. At the same time, packaging of management in enterprise is increasingly important, cost management as an important part of economic management in it and also puts forward new management requirements. At present, cost management of packaging and printing enterprise there are many problems, mainly reflected in the following three aspects.

Y. Zhu (✉) · M. Yang
College of Engineering Technology, Northeast Forestry University, Harbin, People's Republic of China
e-mail: yangmian12345@163.com

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1. Cost management of production is not scientific enough. Now many packaging and printing enterprises are only concerned about the cost of production and cannot pay enough attention to product design and combination of factors of production on the pre-production. They don't have analysis of the cost of the formation of motivation from the perspective of the entire enterprise, which only with the cost control itself is given priority to, superior to an inferior assessment focuses on the production of evaluation and only focus on the management of labor. While ignoring the cost of consumption of resources and object management, product management, there is a heavy results that an ineffective cost.
2. The cost information of production is not accurate. At present, some packaging and printing enterprises have this problem that some products in the market well, sales are good, but the profit is very low, the reasons for it is that enterprise always follow the traditional accounting methods, the wrong distribution of the cost affecting the sale of the product and pricing.
3. Pay attention to income instead of profits. It focuses on income rather than profit in the performance evaluation of packaging and printing enterprises, the assessment of the leader mainly based on income and staff bonuses also related to income, so it may accept the order of inefficient production projects to retain revenue.

20.2 The Applicability of ABC in Packaging and Printing Enterprise

20.2.1 Applicability of ABC

Along with the globalization of economy, the packing industry has already formed the size of the industry chain; packaging and printing companies also have formed a certain scale with rapid development and provides certain conditions to introduce the method of Activity-Based Costing.

1. Requirements of packaging and printing industry trends in our country. First of all, the production capacity increased significantly, whether the number of enterprise, equipment or level of the quality of the managers have been improved significantly; Second, the scale of whole industry growing rapidly; finally, the distribution of regional and diversified competition, in the Yangtze river delta and pearl river delta area more concentrated, rapid development of the industry requirements enterprise uses the advanced management method.
2. The influence of national policy on the industry. For economy development in the circular, policy on packaging materials are strictly limit to some of the products for survival in the competition, the advanced processing cost management is necessary as the cost management become the focus of enterprise.

3. Requirements on the cost of internal operating decisions. In the new environment, the enterprise management, business management and decision-making put forward higher requirements on cost management system. Enterprise gets similar cost information with traditional method while the method of ABC can find loopholes in the production process and the lack of dynamic costs through job management tracking and management.
4. The proportion of indirect costs are on the rise. With the packaging and printing enterprises growing and developing, indirect costs of enterprise continue to increase, so the accuracy of traditional cost of the production is low.
5. The products of packaging and printing enterprise are continuously enriched. The enterprise have the implementation of the basic conditions of Activity-Based Costing with production, organization and process characteristics of it, at the same time, the process of product can be divided to activities for job analysis.
6. The implementation of computerization management in packaging and printing enterprise. Currently, packaging printing enterprises have already implemented a computerized management, some software are used for complex calculations of ABC, such as UFSOFT and Kingdee.
7. The introduction of highly qualified personnel. With the rapid development of packaging and printing enterprise, the large scale introduction of relevant personnel, including packaging professionals, expertise in the production of production line management, accounting professionals and provide condition for the implementation of ABC.

20.2.2 SWOT to Analysis the Method of ABC

SWOT is a method of analysis, it determine the strength, weakness, opportunity and threat from the conditions of enterprise itself and then to evaluate and the analysis, thus will achieve business goals by uniting strategy, resources and external environment of the expertise. What's more, expertise understands the opportunities and challenges have faced, which has an important significance for making the strategy of the development of company for future. This paper packaging and printing enterprise as an example for analysis shown in Table 20.1.

20.3 An Overview of the Activity Based Costing

20.3.1 Accounting Principle of Activity-Based Costing

Activity-Based Costing, which is a cost calculation method, it is a kind of to work as the foundation of the indirect costs and ancillary expenses will be more accurately assigned to products and services (Hansen 2005). In the operation cost

Table 20.1 Method of SWOT to have analysis of packaging and printing expertise

Strength	*Weakness*
1. The tool of Private packaging and printing enterprise for marketing is flexible while the state-run ones has the support of national special funds	1. Low threshold of the packaging industry, low barriers to entry
2. Accumulated a certain amount of customer resources and provided a basis for further development of enterprises	2. Lack of relevant national policy support, and special fund compared with state-run ones
	3. No forming brand advantage for establishing in a relatively short time
	4. Cost information is not accurate for the product cost allocation still only by hours
Opportunity	*Threat*
1. Industry has great demands under rapid development of national economic	1. Personnel training system is imperfect, a serious brain drain
2. National advocacy intensive society, such as green packaging, environmentally and friendly packaging market, development of packaging industry has a potential advantage	2. Not to establish a scientific decision-making mechanism
	3. Cost accounting system is still not mature and perfect

method, the direct costs are recorded in the relevant products in the same way, different is the range of direct costs (Kaplan and Anderson 2004), while the direct costs including the broader in the method of ABC, to reduce the inaccurate allocation to materials, labor and other costs be directly traced to a specific product while the other can not be traced directly to the cost of the product, which must first be assigned to tasks, the calculation of operating costs and then allocated to the relevant product, the operating cost method of accounting principle is shown in Fig. 20.1.

20.3.2 Elements of Activity-Based Costing

The basic elements of Activity-Based Costing are resource, activity, activity centre, cost objects, activity chain and value chain, resources driver, activity driver, activity cost and cost element (Hilton 2005).

1. Resource. Resource is the expense of the enterprise to carry on the business activities of the consumption of labor, material and financial resources to produce, or in the process of the implementation of work of the total price.
2. Activity and Activity Centre. Activity is a specific mission or repeated execution in the enterprise. Activity Centre will put the same or similar activities together to form the shared functions of the center.
3. Cost Objects. The object of Activity-Based Costing including product the service, customers and something others, which is the final object for measurement and allocation.

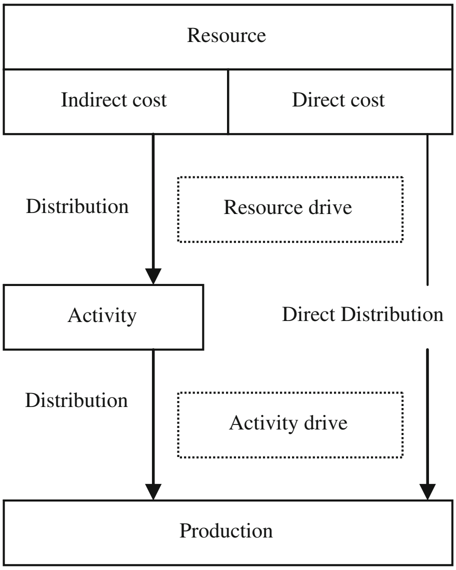

Fig. 20.1 Schematic diagram of activity-based costing

4. Activity Chain and Value Chain. Product of Enterprise is made by a series of inside and outside activities which on orderly operation, so called Activity Chain. From the perspective of monetary and value to reflect the operating chain is formed Value chain.
5. Resources Driver and Activity Driver. Cost driver is the cause factors of the operating cost or product cost changes.
6. Cost Element and Activity Cost. Cost Element is the resource assigned to each job. Activity Cost is the currency forms that corresponding to the operation centers, including the sum of all cost elements related to each job.

20.4 Application of Activity Based Costing

20.4.1 Division of Activities

Implementation of Activity-Based Costing in the packaging and printing enterprise must obey some rules. Firstly, it should determine every activity of the production through talking to the relative personnel to have a preliminary understanding of the production. Then to the workshop of production to learn about the production process and have a detail understanding of every link of the nature of the production, such as working process, employees and other information. Familiar with the production processes of packaging printing enterprises have a vital role in the e implementation of ABC, which is closely related with the division of activity, process of activity and choice of activity drive. As the Fig. 20.2 shows, the production process of corrugated box according to the packaging and printing enterprise can be divided into thirteen activities, including activity of cutting, activity of stitching, activity of fluting, activity of adhesive, activity of drying, activity of score, activity of slotting, activity of mould, activity of printing, activity of joint stuck, activity of quality management, activity of managing, activity of counting.

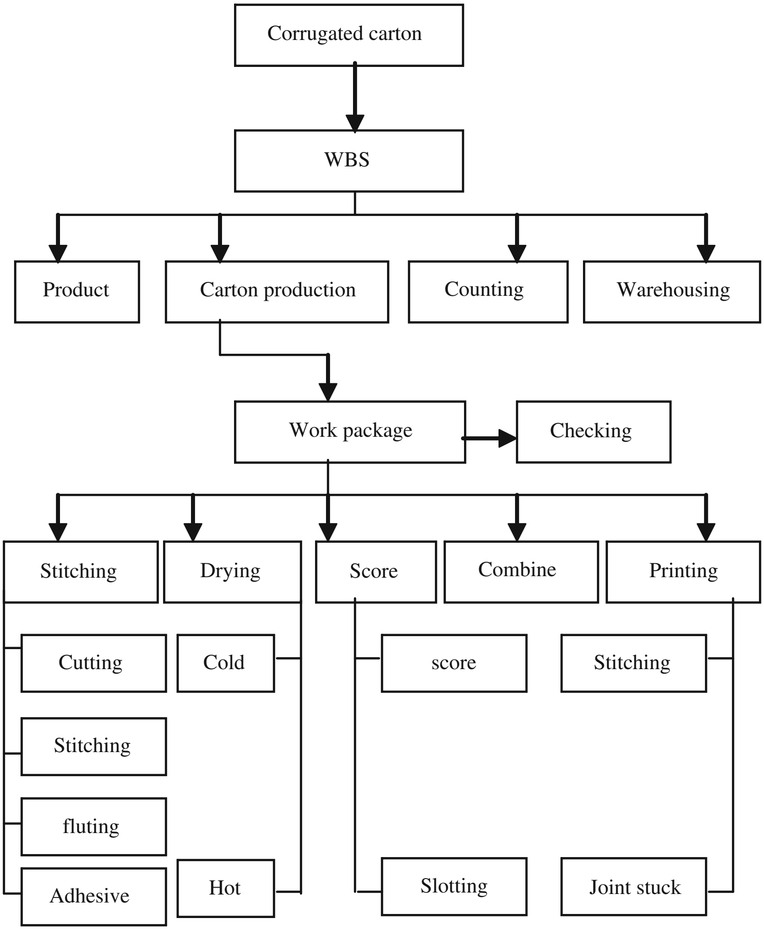

Fig. 20.2 Process diagram of the corrugated carton

20.4.2 Recognition and Measurement on Consumption of Resources

When the activity is confirmed, the resources consumed by all of it need to be collected. Packaging and printing enterprise should pay attention to high value resources which easy to cause significant cost error during the imputation the cost of resource, and put focus on difference between resources meanwhile. To make full use of existing information systems when carrying out data imputation, such as manufacturing costs, workshop schedules, asset schedule, and some dates needed officer reasonably estimated due to lack of raw ones. The data collection of enterprise should make full use of ERP if it has got it. The cost that directly attributable to the product of artificial expenses for sure to specific product or service t, and included in this particular product or service while office cost, depreciation cost is listed as cost of activity.

20.4.3 Division of Activity Center

It's inconsistent with the principle of cost and benefit in the packaging and printing enterprise while all listed the amount of activities, which can be quite tedious. Therefore, activities need to put together according to a certain principle of merger to establish activity center. Division of activity center need to follow certain principles. First, the principle of homogeneous, activity is to point to have the same or homogeneous nature. Second, the center should have the appropriate size.

According to the importance and cost consumption of the determined activities, activity center is established by the key ones. So we have eight centers in Packaging and printing enterprise, including center of combining, center of drying, center of score, center of mould, center of printing, center of checking, center of accounting, center of managing.

1. Center of combining. The center all is for the synthesis of corrugated cardboard including activities of cutting, stitching, fluting, and adhesive. The amount of work related with the needs of the volume of corrugated cardboard, so these activities classified as a center to simplify the allocation of costs.
2. Center of drying. The center contains main activity of the production and direct impact on the various performance of corrugated carton. Therefore, it can be a separate center.
3. Center of score. The center contains activities of score and slotting, they usually classified as activity center because the two process are completed in one machine.
4. Center of mould. Some activities can be finished in one machine, so they are in the same center. Therefore, score and mould is finished n one machine, we still divide them to two centers for the importance of in the production.

5. Center of printing. The center contains activities of printing, stitching and joint stuck. They usually classified as activity center because the activities are completed in one machine.
6. Center of checking. It is important to the products to make sure the quality, so it can be a separate center.
7. Center of accounting. It is an essential part of production with the cost forecast analysis by financial department, and financial aspects of accounting involve a lot of content. Therefore, some related activities also belong to the center for easy calculation in this paper.
8. Center of managing. It is necessary for enterprise to adapt to the constantly changing market environment and the development of new products instead old ones and overall development strategy which a link can not be ignored in the production cost imputation. In this paper, similar activities are designated as a cost center.

20.4.4 Choice of Cost Drive

It has considerable significance to choose the cost drivers for calculation. One activity cost may have multiple cost drivers and the most relevant one will be best, what's more, it's relatively easy to be quantified. Through the analysis of the workers, technicians, the activity drive of center as shown in Table 20.2.

20.4.5 Cost Collection and Cost Allocation of Activity Center

Together the related activity which has same activity drive to the homogeneous activity center. According to the analysis of the division of the packaging and printing enterprise above, establish relevant activity cost center and collect the cost that associated imputation.

1. United the center of combining and center of drying as both of them are related to the volume.

Table 20.2 Table of activity drive

Name of activity center	Activity drive	Unit
Center of combining	Volume	m^3
Center of drying	Volume	m^3
Center of score	Area	m^2
Center of mould	Area	m^2
Center of printing	Area	m^2
Center of checking	Direct labor hours	h
Center of accounting	Direct labor hours	h
Center of managing	Direct labor hours	h

2. United the center of score and center of mould as it's difficult to define the cost between them, and activity drive are the same.
3. United the center of checking and center of managing as both of them are the job for product management, and activity drive are the same.

Above all, packaging and printing enterprise can set up five cost center including the drying, mould, printing, accounting and managing cost center. The ultimate purpose of the activity-based costing is to calculate the total cost of the product, to determine the number of activities and calculate the cost according to the formula.

20.4.6 Causes of Differences in the Two Methods

The calculated costs of products of packaging and printing enterprise have great difference under traditional method and the ABC method, the reason is the basis for distribution is abhorrent. Due to the production has different consumption of the number of activities and labor hours, and method of ABC distributed indirect expenses by activity drive, so the product can obtain more accurate cost.

20.5 Conclusion

Most of the packaging and printing enterprise still using traditional cost accounting method in our country, but the methods already cannot adapt to the new market environment and satisfied accuracy requirements of cost. In addition, the development of enterprise will be restricted by unsuited cost accounting methods, core competitive power also can be affected. Through the analysis above all, enterprise has the condition to implement the Activity-Based Costing method, it is necessary to form competitive advantage through the overall allocation of resources to achieve business objectives in the new environment, so it has practical significance to introduce the method of Activity-Based Costing to the enterprise.

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Chapter 21
The Dynamic Progress of the Project Cost Optimization

Nan-nan Liu, Jian-ping Yang and Qi Chen

Abstract In the view of the defects of the traditional model to optimize the exchange of time and cost, this article introduces the dynamic optimization by considering the time value to receive the schedule scheme, of which the present value is lowest. This essay establishes the model of dynamic time optimization based on the progress of the project payment, aims to realize the maximization of the net present value from the prospects of the contractor. The objective function including the cash inflow and outflow of the project implementation: owner pay, activity direct costs, project indirect expenses and so on.

Keywords Fonts · Formatting · Margins · Cost

The traditional activity network time expenses exchange problems (TCTP), is the study of the assumption that through the increase the cost can be in a certain range of compressed activities period, with minimal cost increased to meet the requirements of the progress schedule of the project period. Traditional time-cost trade-off did not consider the time value of money, with relatively high interest rates and expensive financing costs, especially for the capital-intensive industries project, project maximum net present value shall be is a more reasonable goal, and reasonable fund management strategy will help the net present value enhancement. But, to get the maximum net present value of technology research has been greatly behind the allocation of resources and resources optimization analysis. So, project implementation scheme optimization of the urgent need to consider the time value of money (Xiong and Kuang 2007).

N. Liu (✉) · J. Yang
Management College, Xi'an University of Architecture and Technology, Xi'an, China
e-mail: lnn5577@163.com

Q. Chen
Sinosteel Luoyang Institute of Refractories Research Co. Ltd, Henan, China

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21.1 Projects the Progress of the Construction of a Static Cost Optimization

The period of project construction project cost optimization is to point to the static progress in does not consider the time value of money condition, to the project construction stage of progress and cost optimization, to get with a minimum total cost of static plan.

21.1.1 Optimization Steps

(1) By activity normal operation time determined key activities and key circuits. (2) Crashing cost rate calculation of the activities of the network diagram. (3) According to the crush rate minimum principle choose optimized object. (4) The consideration not change in the nature of key activities and can reduce within the range of such principle as optimized object can determine the time shorten the time and the optimized. (5) Calculate the corresponding cost value-added. (6) Consider the time change indirect expenses and other profit and loss, based on this project total cost calculation. (7) Repeat step 3–6 steps, until the lowest cost so far (Sijun 2007a; Su et al. 2009).

21.1.2 The Construction of Mathematical Models

1. Project total cost TC is the direct and indirect cost for combined: $\mathrm{TC} = \mathrm{DI} + \mathrm{IC} = \sum C^D i + \Delta C^{ID} T$

Among them, $C^D i$ is A project I direct costs of any work; ΔC^{ID} is project of indirect cost rate, that works for one day every consumption in the indirect cost, project of indirect fee for a fixed value generally, that is every day for engineering consumed by indirect expenses are fixed; T is the project construction period (Hongxian 2006).

Any work i the direct cost rate ΔC_i^D: $\Delta C_i^D = (C_i^C - C_i^N)/(d_i^N - d_i^C)$

Among them, c_i^c, c_i^N is the limit costs and the normal cost of the work I; d_i^c, d_i^N is limit the duration and the normal duration of the work i.

The total cost rate of key work j is Δc_j : $\Delta c_j = \Delta c_j^D - \Delta c^{ID}$

So, when $\Delta c_j < 0$, with the duration T of shortening, reduce total cost of; when $\Delta c_j > 0$, with the duration T of shortening, the total cost increase.

The progress of the static cost optimization is the through the time limit for the lowest total have to compression of the cost advantages. The same as that through the compression of the total cost rate $\Delta c_j < 0$ the key to reducing the total cost of the project construction (Tareghian and Taheri 2006; Peng et al. 2008).

2. Quadratic function of the direct costs and duration of the work (activities) as follows: $c_j = a_i d_i^2 + b_i$ where c_i, d_i expressed the direct costs and duration of activity i. Coefficients a_i, b_i according to the normal duration of the activities and costs, limit the duration and cost of strike, Calculating formula is (Dayanand and Padman 1997):

$$a_i = [c_i^n - c_i^C]/[(d_i^N)^2 - (d_i^C)^2]$$
$$b_i = [c_i^C(d_i^N)^2 - c_i^N(d_i^C)^2]/[(d_i^N)^2 - (d_i^C)^2]$$

Thus, it is known that in this mode period optimization model is (contractors maximize the return):

$$maxV_{cont} = \Pi - \sum_{i \in H} c_i - \sum_{i \in \overline{H}} c_i^N - \Delta c^{ID}(T - \Delta T)$$

H for the compression behavior of the activities of collection, $\overline{H}$ is the compression behavior of the activities set. The traditional static period optimization method is the optimal period T_1, then $T_1 = T - \Delta T.\Pi$ is engineering contract value (Erenguc et al. 1993; Prabuddha et al. 1997).

21.2 Consider the Payment of the Progress of the Dynamic Time Optimization Model

The traditional time limit cost optimization problem just consider speed up progress will increase the crush cost activities, maintain or extend the time limit may need to be more original plan of engineering indirect cost spending, so this kind of optimization is essentially period compression fee and engineering indirect cost tradeoff. It is the biggest disadvantage costs does not consider these expenses weighing happened time and neglect the time value of money. And to large construction projects, must consider the bond payment time, the relevant expenses spending time, so, dynamically considering time limit optimization problem, and more in line with the real project construction period of the real decision (Wang et al. 2000).

With relatively high interest rates and expensive financing costs, the net present value of the maximization of the project may be a more reasonable goals. Especially for the capital-intensive industries project, reasonable fund management strategy will help the net present value of the acquisition (Yang 2005).

21.2.1 The Basic Assumptions

Π is engineering contract value. Payment is based on engineering milestone events, projects a landmark event, in every milestone after completion of the payment to pay part of events. For the first time in advance before the start of the project payment engineering $\lambda_1\Pi$, λ_1 for advance payment rate. The second pay happened in total duration of 1/(n − 1) place, engineering payments for $\lambda_2\Pi$; The third engineering pay happened in total duration of 2/(n − 1) place, payments for $\lambda_3\Pi$; The first h time pay happened in the project total duration (h − 1)/(n − 1) place, payments for $\lambda_h\Pi$; The n time engineering pay at the end of our project, project all the balance payment, this time the engineering payments is $(1-\lambda_1-\lambda_2-\lambda_3-\cdots\lambda_h-\cdots-\lambda_{n-1})\Pi$ (Sijun 2007b).

R for project is finished the owner of the gains. For the project, however, the cash flow can through to the project after the production operation period of the cash flow of the discount to project completion and sometimes get.

Consider the time value of money, that the earnings after t period discount to project start gain is $e^{(-\alpha t)} \approx (1+\alpha)^{-t}$, including α is the discount rate (Jingwen et al. 2005).

21.2.2 Mathematical Model Construction

The period of project construction engineering dynamic schedule cost optimization, according to its main body is different, can be divided into the project owners to the party dynamic schedule cost optimization, and the contractor of dynamic schedule cost optimization. The contractor's schedule is construction contract signed later, its resources into the arrangement, the interest for a short period, even for the unit is day (such as large-scale construction equipment rental and leasing), can approximate continuous compounding or simplified according to the way plan breath. When the approximate according to continuous compound interest plan breath, the mathematical model can be used to eat the bottom of the exponential model. The goal is to fixed contract during the period, the present value revenue maximization (Chen and Ma 2007; Guorong et al. 2005).

$$
\begin{aligned}
\max NPV_{\underset{T_2}{cont}} = {} & \lambda_1\Pi + \lambda_2\Pi e^{[-\alpha T_2/(n-1)]} \\
& + \cdots + \lambda_h \Pi e^{[-\alpha(h-1)T_2/(N-1)]} + \cdots \\
& + (1-\lambda_1-\lambda_2-\cdots\lambda_h-\cdots-\lambda_{h-1})\Pi e^{(-\alpha T_2)} \\
& - \left[\sum_{i=1}^{n} \begin{array}{c} C_i^D(P/F,\alpha,i-1/n-1) \\ +\Delta C^{TD}(P/A,\alpha,T_2) \end{array} \right]
\end{aligned}
$$

The objective function of the first n for income fold present value, a discount for expenses after present value.

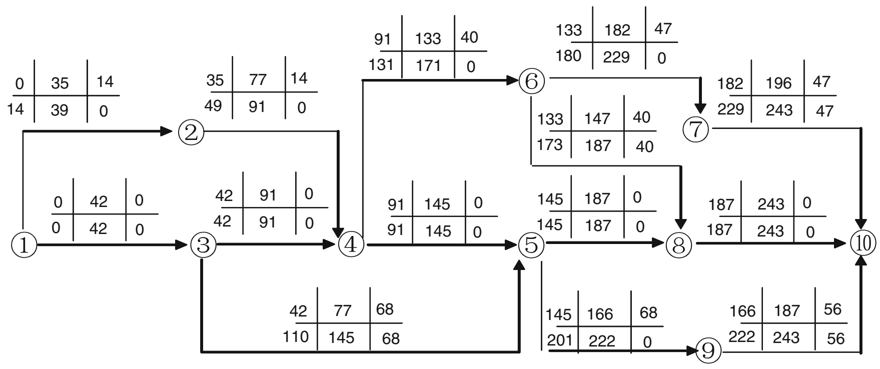

Fig. 21.1 Project activities network diagram

21.3 Example Analysis

Project contract amounting to 16.5 million yuan, the owner of the expected earnings for 30 million yuan, indirect cost rate b = 25 (one thousand yuan/day), the average interest rate ($\alpha = 0.19$ ‰). The owner of the contractor's pay are divided into four times, the first time before the start of the project for advance payment, advance ratio $\lambda_1 = 0.1$; The back of the three times respectively in the project happened pay 1/3 of the total duration, 2/3 place and project is finished, pay the percentage for $\lambda_2 = 0.2$, $\lambda_3 = 0.2$, $\lambda_4 = 0.5$ (Fig. 21.1, Table 21.1).

The calculation, the project's total duration for 243 days, project total cost is 16.961 million yuan, the contractor's income for-461000 yuan. Consider the time

Table 21.1 Project network diagram activities parameters

Activity code i–j	Activities operation time (day)		Activity costs (thousand yuan)		The crush rate (thousand yuan/day)
	d_{i-j}^N	d_{i-j}^c	c_{i-j}^N	c_{i-j}^c	
1–2	35	28	1050	1120	10
1–3	42	32	840	960	12
2–4	42	38	840	912	18
3–4	49	38	1176	1330	14
3–5	35	30	990	1100	22
4–5	54	42	810	840	2.5
4–6	42	21	630	735	5
6–7	49	35	980	1155	12.5
6–8	14	10	280	350	17.5
5–8	42	35	1050	1190	20
5–9	21	18	525	576	17
7–10	14	9	280	297	3.4
8–10	56	42	1120	1218	7
9–10	21	14	315	420	15

Table 21.2 Consider the time value of money period cost optimization table

Optimization process	Compression activities	Period compression (days)	The total period (days)	Project total cost (ten thousand yuan)	Contractor income (ten thousand yuan)
Initial state	–	–	243	1637.95	−40.21
First	4–5	12	231	1615.00	−14.75
Second	8–10	14	217	1593.21	10.02
Third	1–3	10	207	1584.13	21.21
Fourth	3–4	4	203	1581.16	25.03
Fifth	5–8	7	196	1579.23	28.46

value of money, the time limit for project optimization example would take six times and optimization process, can realize the optimal time limit, specific optimization process see Table 21.2.

Can be seen from the Table 21.2, in consideration of the time value of money, in the fifth round compression, as the event 6–7 compression 7 days, the contractor's earnings to achieve optimal. Thus in this mode, the optimal period project is 196 days, the contractor's earnings of 28. 46 yuan.

21.4 Conclusion

Based on the traditional time limit cost optimization model is established, on the basis of pay of time schedule based on dynamic optimization model. The difference is that with other studies of the model: (1) considering the payment schedule and pay for the time value of capital, and the objective function also include the associated with project total duration of indirect costs and project earnings. (2) based on network plan topology and continuous time cost function. (3) net present value maximization as optimized object, the optimization result is time limit and net present value income joint optimization, it and some of the research to determine the construction period under the restriction of the net present value of the different income optimization. Finally using a numerical model and the method are illustrated. This paper studies show that the optimal period and the net present value of the income and the owner is closely related to the payment. Quotes and duration of development strategy is an important reference on the contractors bidding projects.

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Chapter 22
The Microeconomic Basis for Solow Model on Economic Growth

Zhen He

Abstract Solow's economic growth model, also called the neoclassical economic growth model, is the cornerstone of the Modern Growth Theory. However, except that it's an exogenous growth modal, the aggregate production function and the social capital output per capita curve are "assumed" in it, so that it lacks of the foundation of microeconomics. The goal of this essay is to offer the strong microeconomics theory support for the aggregate production function and social capital output per capita curve which are the structural elements of Solow model.

Keywords Aggregate production function · Microeconomics theory · Social capital output per capita curve · Solow's economic growth model

22.1 Introduction

Robert M. Solow, who made a great contribution to the theory of economic growth, was awarded Nobel Prize in Economics in 1987 because he first created the Macroeconomic growth model. The economic growth model made by Solow is also called Solow economic growth model, Solow model or the exogenous economic growth model. At the same time, his model was called the neoclassical economic growth model as well, because it is the economic growth model in the framework of the neoclassical economics, known as the foundation of the modern economic growth theory.

Nevertheless, Solow model's obvious defect is that it's an exogenous growth model. The reason is that the savings rate, the rate of the population growth and the rate of technology advance are all assumed as exogenous variables in it, which

Z. He (✉)
School of Accounting, Zhengzhou Institute of Aeronautical Industry Management, Zhengzhou, China
e-mail: zhenhe598@yahoo.com

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means they are actually decided by the behavior of the people inside the economy. So scholars have been devoting themselves to those variables' endogenization, and have presented many endogenous economic growth models (Skousen 2001).

This dissertation thinks that Solow model still lacks the foundation of micro-economics, for some endogenous variables, such as the interest rate, etc., in the endogenous model are still macro variables, even if realizing Solow model's endogenization. But there again, to make exogenous model endogenization is to find the personal behavior hidden in the micro level of the model.

The micro foundation of macroeconomics theories is important, and the issue that the economists have been paying attention to. Fisher, Mises, Friedman successively made up the Missing Monetary Link between the macroeconomics and the microeconomics, establishing the foundation of the personal behavior hidden in macro currency and the microeconomics theory. Hicks made a great contribution to microcosmicizing Keynes's macroeconomics theory, being called the earliest pioneer for microcosmicizing the macroeconomics.

Solow Model lacks the foundation of the microeconomics lie in that: under the premise that there is no description in the connection with the microeconomics, it abruptly assumes a aggregate production function in an economic system shown below:

$$Y = A \cdot F(K, L) \tag{22.1}$$

In function (22.1), Y equals the aggregate output of the economic system, K equals the aggregate capital stock, L equals the aggregate labor, A equals the technology progress variable. The problem is whether the aggregate production function 'assumed' by Solow model can be derived from the production function of every manufacturer representing the personal behavior of the manufacturer.

Besides, for the visualization, only based on the aggregate production function but no description of the connection with the microeconomics theory, Solow model describes the Fig. 22.1 which shows the curve of the capital output social per capita (or fatigue), under the premise that it assumes Capital and labor

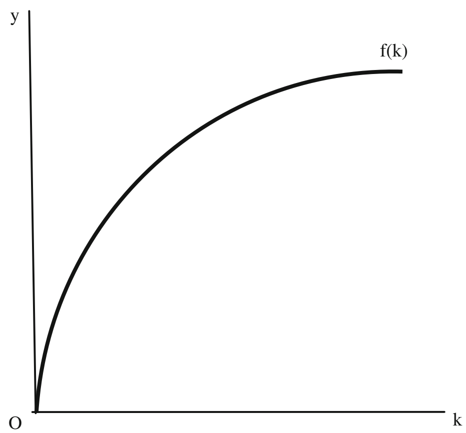


Fig. 22.1 The social production per capita function curve in Solow model

marginal production decline, constant returns to scale and "Inada Conditions". Some scholars straightly use empirical data to describe the curve of the aggregate production function (Cai 2002). Here is the problem: can the curve of the capital output social per capita (or fatigue) be theoretically derived?

22.2 The Microeconomics Foundation of the Aggregate Production Function

Generally, the form of Cobb-Douglas function is

$$f(x) = A\prod\nolimits_{i=1} x_i^{a_i} \tag{22.2}$$

In function (22.2), A is a constant; a_i is the elasticity of f(x) to x_i. If x_i is the consumption goods, then f(x) is a utility function; if x_i is the factors of the production, then f(x) a production function (Eatwell et al. 1987).

Assume the labor input of the manufacturer i is L_i, the capital is K_i, and the output is Y_i, the elasticity of Y_i to L_i and K_i are α and β, so we have the Cobb-Douglas production function as the following:

$$Y_i = A_i L_i^{\alpha} K_i^{\beta} \tag{22.3}$$

The marginal output of labor $MP_L = \frac{\Delta Y_L}{\Delta L}$, the marginal output of capital $MP_K = \frac{\Delta Y_K}{\Delta K}$, separately represent the increment of the output caused by the increment in the capital K (or the labor L) when the labor L (or the capital K) is constant. By Eq. (22.3), the marginal output of capital and labor input but the manufacturer i is

$$\frac{\Delta Y_{Li}}{\Delta L_i} = \alpha \cdot \frac{Y_i}{L_i} \tag{22.4}$$

$$\frac{\Delta Y_{K_i}}{\Delta K_i} = \beta \cdot \frac{Y_i}{K_i} \tag{22.5}$$

The Microeconomics theory indicates: the condition of the manufacturer's production equilibrium is that the ratio equals each other of each production factor's marginal output over its price. Assume the price of the labor is w, the price of the capital is r, the condition of the manufacturer i's production equilibrium is:

$$\frac{MP_{L_i}}{w} = \frac{MP_{K_i}}{r}$$

or

$$\frac{\Delta Y_{L_i}}{w \cdot \Delta L_i} = \frac{\Delta Y_{K_i}}{r \cdot \Delta K_i} \tag{22.6}$$

The function (22.6) is a monetary expression. When not using money, the function (22.6) can be:

$$\frac{\Delta Y_{L_i}}{\Delta L_i} = \frac{\Delta Y_{K_i}}{\Delta K_i} \tag{22.7}$$

The function (22.7) indicates: the condition of the manufacturer i's production equilibrium is that the ratio between each factor's input–output equals each other or has the same proportion (Homans 1961; Adams 1965; He 2011a).

For function (22.4) and (22.5) to be substitute into function (22.7), we have:

$$\alpha_i \cdot \frac{Y_i}{L_i} = \beta_i \cdot \frac{Y_i}{K_i} \tag{22.8}$$

After the same variables being cancelled, the function (22.8) will be:

$$\frac{K_i}{L_i} = \frac{\beta}{\alpha} \tag{22.9}$$

In which, α, β are the exogenous variables. Hendrik Samuel Houthakker found: when the manufacturer input production factors in Lyon Cardiff fixed ratio, and the fixed ratio of each manufacturer fits the Pareto distribution, the aggregate production function has the form of Cobb-Douglas production function (Sato et al. 1975). Based on function (22.9), the aggregate production function about labor and capital will be:

$$Y = AL^{\alpha}K^{\beta} \tag{22.10}$$

In the function (22.10), the aggregate labor L (or the aggregate capital K) is the sum of the each manufacturer's labor L_i (or capital K_i) in a certain time period, or the aggregate capital (or the aggregate labor) input in the economic system in the corresponding time period.

The function (22.10) is the general form of the social production function or the aggregate production function shown in the function (22.1). But, the function (22.10) is theoretically derived based on the single manufacturer production function, so it is strongly supported by microeconomics theory.

22.3 The Microeconomics Foundation of the Social Capital Output Per Capita Curve

To let the people learn and understand the economics theory straightly, economists usually use charts to represent the relevant economic models. Therefore, Solow model generally needs to describe the curve of the social capital output per capita (or fatigue).

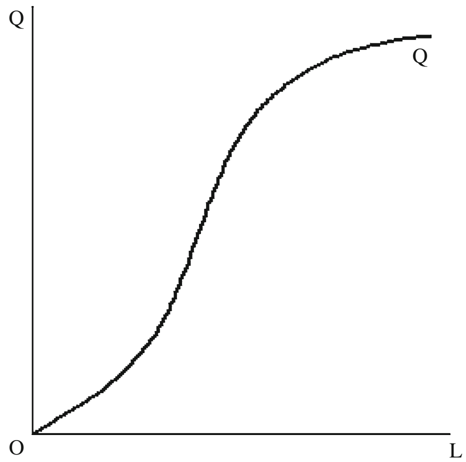


Fig. 22.2 The total output curve with one factor input

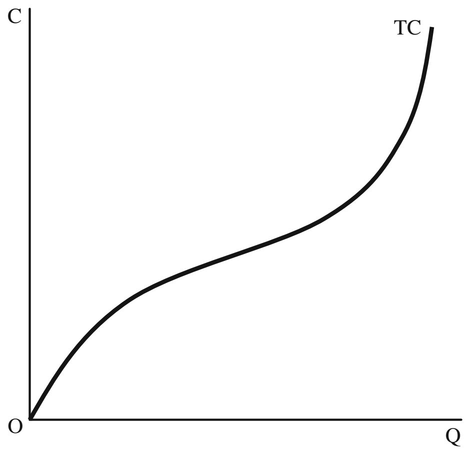
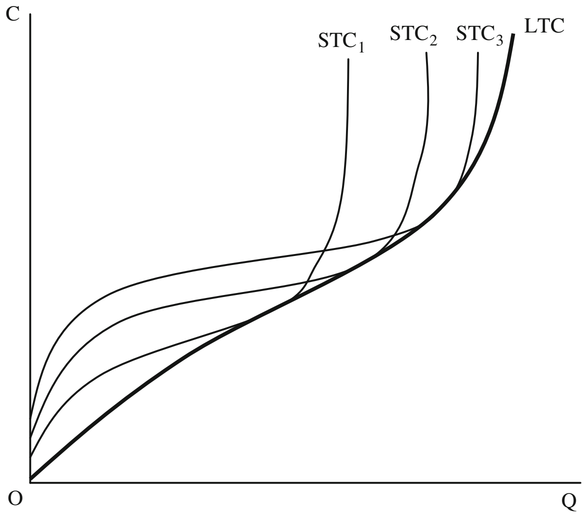


Fig. 22.3 The curve of the manufacturer‘s short-term total cost

Having the aggregate production function derived from microeconomics theory, basing on the assumptions including Capital and labor marginal production decline, constant returns to scale and "Inada Conditions" (He 2010), etc., there should be a capital production per capita curve that can be described. Nevertheless, we will derive it from the production function curve in the micro level.

What the Fig. 22.2 represents is situation that shows the output Q when the manufacturer inputs one factor. The Producers choose theory in Microeconomics tells us: in short term, the input labor is a variable production factor. Assume the price of the labor is constant, or, in the coordinate system L-Qas shown in Fig. 22.2, the price can be considered as an exogenous production factor, so the changing in the producer's costs C equals the changing in the labor input number. Therefore, we can switch the horizontal ordinate L to C, and switch the position of both x-axis and y-axis, there becomes Fig. 22.3, which is the reverse of the

Fig. 22.4 The long-term total cost curve is the envelope of the short-term



manufacturer's total cost curve and the manufacturer's total output curve (Huang 2005; He 2011b), the graphic that is rotated counter-clockwise 90° using y-axis as symmetry axis in Fig. 22.2. Because there is no price variable in either Figs. 22.2 or 22.3, the price can be considered as an exogenous factor or a constant.

Solow model is a long-term economic model. In fact, the Producers choose theory in Microeconomics indicates: in the long term, both the labor input and the capital input are the variable production variables, the long-term total cost curve LTC is the envelope curve of the short-term total cost curve, as shown in Fig. 22.4.

Similar to the relationship of the short-term total cost curve and the short-term total output curve, in the $k_i - y_i$ coordinate system as shown in Fig. 22.5, the price can be considered as an exogenous variable. This indicates: in the long term, the changing in the manufacturer's long-term total cost equals the changing in the quantity of the factor input; the long-term total cost curve and the long-term total output curve are reverse. To present with a circular function curve, the long-term labor input and the capital input can be presented as the capital per capita (or fatigue), and the output can be presented as the output per capita. Assume Fig. 22.4 represents the long-term total cost curve of the manufacturer i, we can switch k_i to C on x-axis, and y_i to Q on y-axis in Fig. 22.4, so there will be Fig. 22.5 that shows the capital output per capita (or fatigue) curve of the manufacturer i. This is the graphic that Fig. 22.4 is rotated counter-clockwise 90 degree, and then using y-axis as symmetry axis in Fig. 22.4.

Assume that there are n manufacturers in a society, the social aggregate production function has the homogeneity in the changing proportion of the output and the input; meanwhile, assume that the variable of the social capital input per capita is k, the social output per capita is y. Same with the principle that the industry Supply (or Production) curve is derived from the Supply (Production) curve of every manufacturer within the industry, we will have: the social capital

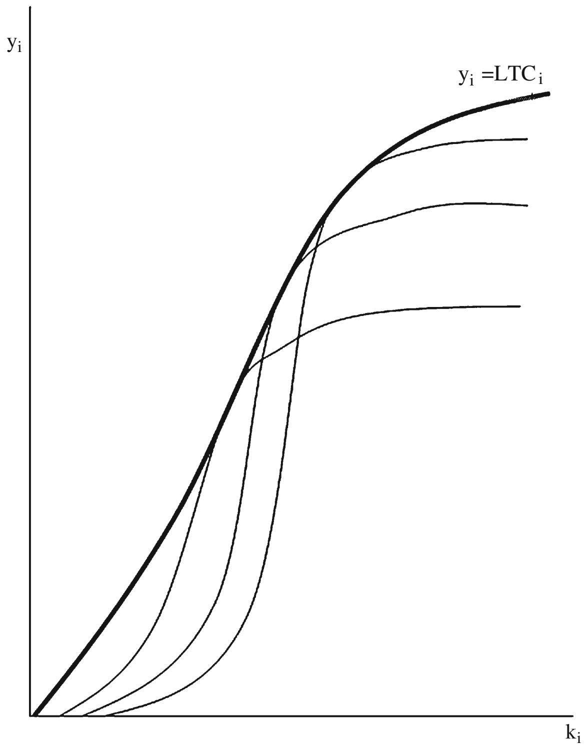


Fig. 22.5 T capital output per capita curve of manufacturer i

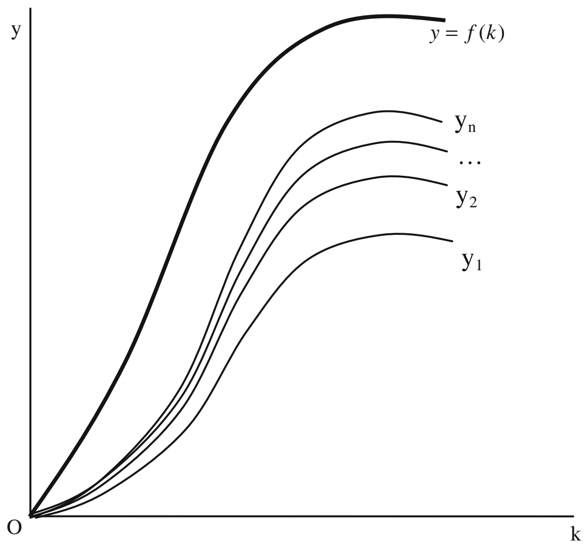


Fig. 22.6 The social capital output per capita curve

output per capita curve is like the situation shown in Fig. 22.5, meaning it is the curve that is gained after summing the x-axis and y-axis in the Supply (Production) curve of every manufacturer within the industry. Figure 22.6 can be derived from Fig. 22.5. Attention please, Fig. 22.6 is the theoretical form of the social capital output per capita curve to Fig. 22.1, and the different thing is that Fig. 22.6 has a strong support of the Microeconomics theory.

22.4 Conclusion

Due to the analysis above, the conclusion is as followings:

1. As the structured elements of Solow model, the aggregate production function and the social capital output per capita curve can now have the theoretical foundation of Microeconomics.
2. The Micro optimality can ensure the Macro optimality. From function (22.9) to function (22.10), we can see: if each manufacturer achieves the inputs with fixed proportion of optimal condition in Micro economy, meaning if there are an optimal α and β, it will make sure that the Macro economy will achieve the optimal condition. In fact, we can prove that there does exist the optimal α and β, meaning there will be an optimal proportion with L and K, an optimal proportion with A and K as well, and an optimal criteria curve for the capital output per capita curve (He 2010). Via the optimal proportion, it will ensure the strong connection between the physical capital, human capital, and technology advance (or R&D) to contribute to the economic growth together.

Of course, this article has its lack, which is no matter the derivation is from the production function in the micro level to the production function in the macro level, or no matter the derivation is from the production function curve in micro level to the production curve in the macro level, they are using the simple aggregation from the micro to the macro. The more appropriate and scientific way is to use the Superposition principle in Physics, and of course before that there should be the Field Theory and the Superstring Theory. All these need another article to discuss.

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Chapter 23
The Modeling Measure and Time Series Forecasting for Potential Demand in Chinese Residential Market

Peng-hui Chen and Jia-li Li

Abstract Our study establishes the measure model of potential demand in Chinese residential market based on the social and economic origin of exuberant potential demand. We can calculate the potential demand coefficient in Chinese residential market through the model and then substitute the time series data into the double exponential smoothing model to forecast the evolution trend of the potential demand in Chinese residential market.

Keywords Forecasting · Measure · Potential demand · Residential market

23.1 Introduction

The potential demand in Chinese residential market has remained exuberant, and it led to the in short supply and soaring prices phenomenon in Chinese residential market several years ago (Benjamin et al. 2004). Due to the tightening of residential policy in these 2 years, the residential prices went into a downward channel and the sales slowed down, but the exuberant potential demand has kept surging and it will erupt in a certain time (Li 1997). Our study finds that the exuberant potential demand in Chinese residential market has its social and economic origin. On this basis, we establish the measure model of potential demand in Chinese residential market. The empirical results obtained from the model measure were consistent with the reality. The potential demand coefficient in Chinese residential market is still in the exuberant interval. Further, we forecast the potential demand coefficient in Chinese residential market and find that it will fall into the moderate interval in the coming years, which means that the present situation in Chinese residential market may be reversed.

P. Chen (✉) · J. Li
School of Economics and Commerce, South China University of Technology, Guangzhou, China
e-mail: cphstudy@hotmail.com

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23.2 The Modeling Measure for Potential Demand in Chinese Residential Market

23.2.1 Method Setting

Through the analysis of the social and economic origin of exuberant potential demand in Chinese residential market, we find that each resident in the working age has a strong potential demand of buying residence in China. Each resident desires to have at least one residence (or each family desire to have two residences) and the strong potential demand of buying residence is extremely lacking flexibility. They will choose to buy residence immediately or postpone due to various reasons, these residences including new residences and second-hand residences. A resident buys more residences can be regarded as investment behavior of financial leasing with non-rigid residential demand character (Chiuri and Jappelli 2008). Until the resident thinks that the financial leasing investment period has ended, he or she will eventually resell the residences to other residents with rigid residential demand. Therefore the resident buys more residences is equivalent to increase the time, links and cost of buying residences by other residents with rigid residential demand, but it does not increase or decrease the potential demand in Chinese residential market (de Vries and Boelhouwer 2008).

The potential demand in Chinese residential market is not in a linear growth process, but nonlinearly changes with the Chinese population quantity, working aged population proportion and per-capita living space (Chen and Rutherford 2010).

$$Q_t = P_t \cdot W_t \cdot L_t \tag{23.1}$$

where Q_t is the potential demand in Chinese residential market (expressed in square meter), P_t is the Chinese population quantity, W_t is the Chinese working aged population proportion and L_t is the Chinese per-capita living space (expressed in square meter).

After the deduction of the accumulated sales volume that translate into actual behavior of buying residence in Chinese residential market,the surplus potential demand in Chinese residential market is:

$$q_t = Q_t - \sum_{t=1}^{n} St \tag{23.2}$$

where q_t is the surplus potential demand in Chinese residential market (expressed in square meter) and $\sum_{t=1}^{t=n} S_t$ is the accumulated sales volume that translates into actual behavior of buying residence in Chinese residential market (expressed in square meter). Transferring the formula (23.2) we obtain the potential demand conversion rate in Chinese residential market:

$$R_t = \sum\nolimits_{t=1}^{n} S_{\mathrm{t}} / Q_t \tag{23.3}$$

where R_t is the potential demand conversion rate in Chinese residential market. Transferring the formula (23.3) we can obtain the potential demand coefficient in Chinese residential market:

$$\lambda_t = 1 - R_t \tag{23.4}$$

where λ_t is the potential demand coefficient in Chinese residential market. The coefficient indicating that the exuberant levels of potential demand in Chinese residential market, its value interval is [0,1] (Murphy and King 2011). Its value interval between 0.7–1.0 indicates that the potential demand is exuberant in Chinese residential market; its value interval between 0.3–0.7 indicates that the potential demand is moderate in Chinese residential market; its value interval between 0.0–0.3 indicates that the potential demand is deficient in Chinese residential market (Pryce and Gibb 2006).

23.2.2 Measure Results

Table 23.1 is the measurement results of potential demand Q_t, surplus potential demand q_t, potential demand conversion rate R_t and potential demand coefficient λ_t in Chinese residential market from 2011 to 2020.

It can be seen from Table 23.1, The Chinese population quantity P_t, working aged population proportion Wt and per-capita living space L_t showed varying degrees of growth from 1995 to 2010, which makes the potential demand in Chinese residential market Q_t is also growing, at the meantime, the accumulated sales that translate into actual behavior of buying residence in Chinese residential market $\sum_{t=1}^{n} S_t$ is growing too. The potential demand coefficient in Chinese residential market λ_t has declined from 0.99 in 1995 to 0.82 in 2010. The exuberant level of potential demand in Chinese residential market has declined, but it still in the value interval between 0.7–1.0, indicating that the potential demand in Chinese residential market is still exuberant (Sirgy et al. 2005).

Further, we analyze the annual change rates of potential demand conversion in Chinese residential market (Shown in Fig. 23.1), we find that the annual change rate of potential demand that translate into actual behavior of buying residential displays a declining trend in Chinese residential market, indicating that the residence transfer business tax policy adjustment and the residence purchase limitation policy implementation produce stabilizing effect on the potential demand conversion in Chinese residential market, and promote the robust development in Chinese residential market (Sivam 2002).

Table 23.1 The potential demand change situation in Chinese residential market from 1995 to 2010

Annual	Formula (23.1)					Formula (23.2)	Formula (23.3)	Formula(23.4)
	P_t	W_t (%)	L_t	$Q_t = Pt \cdot Wt \cdot Lt$	$\sum_{t=1}^{n} S_t$	$q_t = Qt - \sum_{t=1}^{n} S_t$	$R_t = \sum_{t=1}^{n} S_t / Q_t$ (%)	$\lambda_t = 1 - R_t$
1995	1211210000	67.2	21.0	**17092595520**	189537600	**16903057920**	**1.11**	**0.99**
1996	1223890000	67.2	21.7	**17847253536**	255893200	**17591360336**	**1.43**	**0.99**
1997	1236260000	67.5	22.5	**18775698750**	324775500	**18450923250**	**1.73**	**0.98**
1998	1247610000	67.6	23.3	**19659289432**	419884900	**19239404532**	**2.14**	**0.98**
1999	1257860000	67.7	24.2	**20608023524**	538674200	**20069349324**	**2.61**	**0.97**
2000	1267430000	70.1	24.8	**22034017064**	690043100	**21343973964**	**3.13**	**0.97**
2001	1276270000	70.4	25.7	**23091297856**	875031000	**22216266856**	**3.79**	**0.96**
2002	1284530000	70.3	25.5	**23027127045**	1096202800	**21930924245**	**4.76**	**0.95**
2003	1292270000	70.4	26.3	**23881149600**	1381227500	**22499922100**	**5.78**	**0.94**
2004	1299880000	70.9	27.2	**25021845078**	1719426400	**23302418678**	**6.87**	**0.93**
2005	1307560000	72.0	28.8	**27066492000**	2217371600	**24849120400**	**8.19**	**0.92**
2006	1314480000	72.3	29.6	**28107164358**	2761292900	**25345871458**	**9.82**	**0.90**
2007	1321290000	72.5	30.9	**29566671491**	3452330800	**26114340691**	**11.68**	**0.88**
2008	1328020000	72.7	31.5	**30412322010**	4011195500	**26401126510**	**13.19**	**0.87**
2009	1334500000	73.0	32.4	**31602074308**	4864139700	**26737934608**	**15.39**	**0.85**
2010	1340910000	74.5	32.8	**32819646523**	5794655300	**27024991223**	**17.66**	**0.82**

Note The data source (P_t, W_t, L_t) from the China statistical yearbook 2010
The annual change rates of potential demand conversion produce stabilizing effect on the potential demand conversion in Chinese residential market.

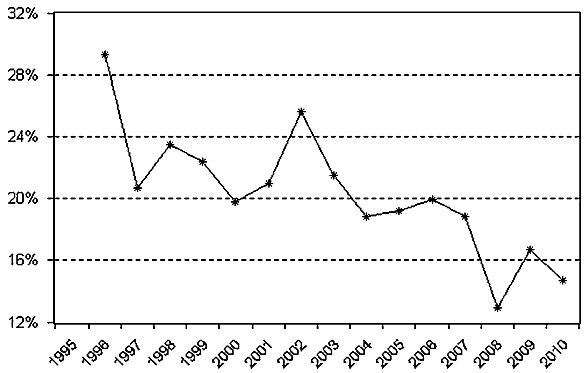

Fig. 23.1 The annual change rates of potential demand that translates into actual behavior of buying residence in Chinese residential market from 1995 to 2010

23.3 The Time Series Forecasting for Potential Demand in Chinese Residential Market

23.3.1 Method Selection

Because the potential demand in Chinese residential market is not linear growth, but nonlinearly changes with the Chinese population quantity, working aged population proportion and per-capita living space, the potential demand in Chinese residential market will be in a nonlinear changing trend, so the short-term forecasting of potential demand is more effective in Chinese residential market.

The exponential smoothing method is a common method in the production forecasting, and also in the trend forecasting of short-term economic development (Gardner 1981). Among all of the forecasting methods, the exponential smoothing method is the most used one. The simple whole period average method uses all of the past the time series data equally. The moving average method does not consider the longer-term data, and gives the recent data more weight in the weighted moving average method. The exponential smoothing method is compatible with the characters between the whole period average and the moving average, it does not abandon the past data, and gives the past data diminishing weight. That is, with the data far away, it gives the weights that gradually converge to zero (Taylor 2003). In other words, the exponential smoothing method is a time series analysis and forecasting method developing from the moving average method. It calculates the exponential smoothing value, with some sort of time series forecasting model to forecast the future phenomena. Its principle is that the exponential smoothing values of any time are the weighted average of the actual observed values at current time and the exponential smoothing value at the last period (Hamilton 1989). The basic formula of exponential smoothing method is:

$$S_t = a \cdot y_t + (1 - a)S_{t-1}$$

where S_t is the smoothed value of time t, y_t is the actual value of the time t; S_{t-1} is the smoothed values of time t-1 and a is a smoothing constant, its value interval is [0,1].

The Chinese population quantity P_t, working aged population proportion W_t and per-capita living space L_t time series data has their significant changing trends, so double exponential smoothing method is the more appropriate method to forecast them (Hwanga and Pedersenb 2004). Double exponential smoothing formula is:

$$S_t^{(2)} = aS_t^{(1)} + (1-a)S_{t-1}^{(2)}$$

where $S_t^{(2)}, S_{t-1}^{(2)}$ are t term and $t-1$ term respectively of the double exponential smoothing value a is smoothing coefficient. When $S_t^{(1)}$ and $S_t^{(2)}$ are known, the forecasting model of the double exponential smoothing method is as follows:

$$\hat{Y}_{t+T} = a_t + b_t \cdot T$$

where $\begin{cases} a_t = 2S_t^{(1)} - S_t^{(2)} \\ b_t = \dfrac{a}{1-a}\left(S_t^{(1)} - S_t^{(2)}\right) \end{cases}$ and T is the term value of forecast ahead.

23.3.2 Forecasting Results

We substitute the data of Chinese population quantity P_t, working aged population proportion W_t and per-capita living space L_t from 1995 to 2010 into the double exponential smoothing forecasting model to calculate the forecasting value of Chinese population quantity $\hat{P}_t$, working aged population proportion $\hat{W}_t$ and per-capita living space $\hat{L}_t$ from 2011 to 2020. Then we substitute the forecasting values into the formula (23.1) and calculate the forecasting value of the potential demand in Chinese residential market $\hat{Q}_t$ from 2011 to 2020.

Taking the data from 1995 to 2010 of accumulated sales that translates into actual behavior of buying residential in Chinese residential market $\sum_{t=1}^{n} S_t$ as the basis, substitute them into the double exponential smooth forecasting model to calculate the forecasting value of accumulated sales volume that translates into actual behavior of buying residence in Chinese residential market $\sum_{t=1}^{n} S_t$ from 2011 to 2020; substitute $\sum_{t=1}^{n} S_t$ into the formula (23.2) to calculate the forecasting value of surplus potential demand in Chinese residential market $\hat{q}_t$ from 2011 to 2020; substitute $\hat{q}_t$ into the formula (23.3) to calculate the forecasting value of conversion rate in Chinese residential market $\hat{R}_t$ from 2011 to 2020; then substitute $\hat{R}_t$ into the formula (23.4) to calculate the forecasting value of potential demand coefficient in Chinese residential market $\hat{\lambda}_t$ from 2011 to 2020.

Table 23.2 is the forecasting results of potential demand $\hat{Q}_t$, surplus potential demand q̂t, potential demand conversion rate $\hat{R}_t$ and potential demand coefficient $\hat{\lambda}_t$ in Chinese residential market from 2011 to 2020.

Table 23.2 The potential demand trend measure in Chinese residential market from 2011 to 2020

Annual	Formula (23.1)					Formula (23.2)	Formula (23.3)	Formula (23.4)
	$\hat{P}_t$	$\hat{W}_t$ (%)	$\hat{L}_t$	$\hat{Q}_t = \hat{P}_t \cdot \hat{W}_t \cdot \hat{L}_t$	$\sum_{t=1}^{n} \hat{S}_t$	$\hat{q}_t = \hat{Q}_t - \sum_{t=1}^{n} \hat{S}_t$	$\hat{R}_t = \sum_{t=1}^{n} \hat{S}_t / \hat{Q}_t$ (%)	$\hat{\lambda}_t = 1 - \hat{R}_t$
2011	1347319962	75.0	33.5	**33866183446**	6726310873	**27139872573**	**19.86**	**0.80**
2012	1353729853	75.6	34.1	**34890229715**	7666967854	**27223261861**	**21.97**	**0.78**
2013	1360139744	76.1	34.7	**35931114113**	8607624835	**27323489278**	**23.96**	**0.76**
2014	1366549635	76.6	35.3	**36988959162**	9548281816	**27440677346**	**25.81**	**0.74**
2015	1372959526	77.1	35.9	**38063887387**	10488938797	**27574948589**	**27.56**	**0.72**
2016	1379369418	77.6	36.6	**39156021309**	11429595778	**27726425531**	**29.19**	**0.71**
2017	1385779309	78.2	37.2	**40265483453**	12370252759	**27895230694**	**30.72**	**0.69**
2018	1392189200	78.7	37.8	**41392396342**	13310909740	**28081486602**	**32.16**	**0.68**
2019	1398599091	79.2	38.4	**42536882500**	14251566722	**28285315778**	**33.50**	**0.66**
2020	1405008982	79.7	39.0	**43699064448**	15192223703	**28506840746**	**34.77**	**0.65**

The potential demand will fall into a moderate level in Chinese residential market by 2020.

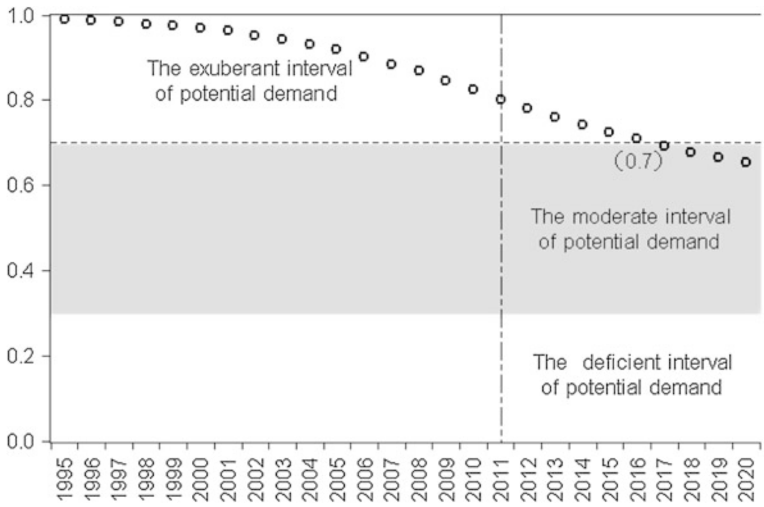

Fig. 23.2 The forecasting value of potential demand coefficient in Chinese residential market from 2011 to 2020

Figure 23.2 shows that from 2011 to 2020, the forecasting value showed varying degrees growth to Chinese population quantity $\hat{P}_t$, working aged population proportion $\hat{W}_t$ and per-capita living space $\hat{L}_t$, which makes the forecasting value of potential demand in Chinese residential market $\hat{Q}_t$ is also growing, at the meantime the forecasting value of accumulated residential sales volume that transformed into actual behavior of buying residence $\sum_{t=1}^{n} \hat{S}_t$ is growing too. The forecasting value of potential demand coefficient in Chinese residential market $\hat{\lambda}_t$ has declined from 0.80 in 2011 to 0.65 in 2020. This shows that by 2020, the potential demand will fall into a moderate level in Chinese residential market (Tu et al. 2008).

23.4 Conclusion

The exuberant potential demand in Chinese residential market has a series of social and economic origin. Through 15 years' residential system reform in China from 1995, the potential demand translates into actual behavior of buying residence in Chinese residential market to a certain extent, but the potential demand coefficient is still in an exuberant interval. According to the forecast results of potential demand in Chinese residential market, the potential demand coefficient in Chinese residential market will fall into the moderate interval in 2017, marking the period of exuberant potential demand which is brought by the residential system reform in china from 1995 and will have lasted for more than 20 years will end (Turnbull and Zahirovic-Herbert 2012).

Under the background of Chinese dual economy, the surplus potential demand in Chinese residential market has been difficult to translate into the actual behavior of buying residence in the moderate interval (Yao 2007). On the one hand, the government should start to prevent the risk of long-time recession in Chinese residential market; on the other hand, it should also need to speed up the improvement of the non-market residential security system.

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Chapter 24
The Relationship Between Human Capital and Urban Evolution: Data from Beijing, Tianjin, and Hebei Regions

Su-ying Gao, Zhen-kun Zhao, Hong-feng Zhang and Shu-jian Zhang

Abstract According to the research of urbanization and urban development, cities are evolving from junior to senior, and human capital plays a crucial role in this process. On the basis of the theory of urbanization and urban development, this article creatively puts forward the concept of urban evolution. On the human capital theory and the connotation of urban evolution, the paper builds a comprehensive evaluation index system, and then calculates composite scores of the region's urban evolution and human capital. And then it carries out an empirical research on the relationship between urban evolution and human capital on the data from Beijing, Tianjin, Hebei regions through correlation analysis and regression analysis. The results show that the relationship between human capital and urban evolution in the respective regions are different due to the different stages of economic development.

Keywords Beijing · Hebei · Human capital · Tianjin · Urban evolution

24.1 Introduction

City is a product of the Industrial Revolution, also a symbol of modern civilization, and a political, economic, cultural, educational and technological center, where the population is concentrated, where commerce and industry are developed, and where the main residents are non-agricultural (Zhou 2009). The accelerated development of urbanization has promoted growing number of cities arising in the world. Following developed countries appeared urban community

S. Gao (✉) · Z. Zhao · H. Zhang · S. Zhang
School of Economics and Management, Hebei University of Technology, Tianjin, People's Republic of China
e-mail: Sue2007@hebut.edu.cn

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and metropolis, the mainstream of urban development has transferred to developing countries, under the impetus of economic globalization.

However, economic development and social progress are not only reflected in the increase of the number of cities, but also reflected in the level of urban development. The last one is more importantly. Through the research of urban development, it can be found that the law of urban development is evolving from junior to senior. Urban development is a spiral process, which constantly breaks new level, promoting the urban towards a condition of orderly structure and perfect function. Therefore, this paper introduces the concept of urban evolution, including the general sense of urbanization and urban development. This concept covers population movements, lifestyle changes, regional economic structure changes, friendly ecological environment, sustainable resource use, economic prosperity, social harmony and progress and so on.

The concept of urban evolution shows that the factors affecting the urban evolution include population, structure, politic, economic, environment and other aspects. However, regardless of which aspect, it cannot leave the person's role. With the emergence of New Growth Theory, research of the role of human capital is becoming an important area of macroeconomics. On the one hand, human capital externality is considered to be one of the main factors of urban endogenous growths. On the other hand, the rapid expansion of urban population can bring pressure to the urban construction and ecological environment. Therefore, the research of the relationship between human capital and urban evolution is an important issue with great significance to regional economic development and social progress.

Research on human capital and urban evolution is bound to be based on the urban community. As the third-largest engine of economic growth in China, Beijing-Tianjin-Hebei is urban community with high degree of modernization in China's northern, after the Yangtze River Delta and Pearl River Delta. Over the years, economic development and urban evolution of Beijing-Tianjin-Hebei are relatively slow, contrasting with the rapid development of the Yangtze River Delta and the Pearl River Delta. Therefore, selecting Beijing-Tianjin-Hebei as objective to research the relationship between human capital and urban evolution has important practical significance. Based on the above considerations, the article carried out empirical research taking Beijing-Tianjin-Hebei as an example.

24.2 Literature Review

So far, domestic and foreign scholars have carried out a lot of researches on human capital, urbanization and urban development. The first one concerned to human capital and urbanization was Becker (1975). His main concern was the distribution of income in the process of urbanization. After that, Lucas (1988) further emphasized the role of cities in economic growth. Glaeser et al. (1995) summed up the effects of human capital on urbanization. Eaton and Eckstein (1997) developed an urbanization and growth model based on human capital accumulation. In this century, Henderson and Wang (2007) explored how urbanization coordinated the increase in the number of cities and the increase in size. Baldacci et al. (2008) explored the linked channels of social spending, human capital and economic growth. Andersson et al. (2009) studied the Swedish government's policy of scattering post-secondary education throughout the country. Crayen and Baten (2010) proposed human strategies and age accumulation to measure the uneven level of human capital. Although there are many research methods and point of view of urban evolution and human capital, not all methods are suitable for China's national conditions; therefore, we should selectively absorb advanced experience.

Domestic scholars, based on the reality of our country, also have undertaken extensive research. Xu (2001) believed that urbanization from the perspective of location theory contains the "rural urbanization" and "city urbanization". Zhu (2005) studied human capital across the Yangtze River Delta. Zhen et al. (2007) Jiangsu Province as example, carried out empirical research on the relationship between human capital investment, economic growth and the level of urbanization. Zheng and Lai (2008) investigated regional differences in the level of urbanization based on China's provincial-level panel data. Liu and Liu (2010) used empirical methods to study the contribution of human capital on the urbanization, Jiangxi Province as example. Zeng (2011) studied Shanghai which in the central position of Chinese modernization and found that the human capital advantage is an important factor in the rise of modern Shanghai. Studies of Beijing, Tianjin and Hebei were rarely seen, only a small number of studies in recent years. For example, Yu et al. (2010) pointed out that Beijing-Tianjin-Hebei and other developed areas had lead into a new stage of stable development of urbanization. Fan Fei and Sun Caizhi (2010) found a significant location difference of the level of urbanization in the coastal cities of Bohai Economic Rim.

In summary, there are much research perspective and methods in foreign; however, domestic researches are mainly based on regional human capital stock, investment in human capital and human capital index, researching relationship or differences. Moreover, the research subjects are concentrated in the Yangtze River Delta. Literature of the relationship between urbanization and human capital of Beijing-Tianjin-Hebei province is almost difficult to see. Selecting the region of Beijing-Tianjin-Hebei as the object and studying urbanization from the perspective of human capital are important to policy options for the region.

24.3 Definition and Comprehensive Evaluation

Human capital is a comprehensive reflection of workers' mental and physical abilities, is the sum of a variety of qualitative factors condensing in the body of workers, which has an economic value and can bring future benefits, including knowledge, skills, experience, health and other aspects. At present, the way widely used to measure the level of human capital is years of education. The disadvantage is that only focus on formal education, while ignoring other factors. Moreover, the choice of the function of the returns to education has a strong influence on the results of the measure. For a more comprehensive and objective measure of the level of human capital, evaluation system was built from the four aspects of education, job skills, health and population migration.

In this article, the urban evolution includes urbanization and urban development two aspects. First, urbanization is rich in content. Different disciplines have different understandings of urbanization. Urbanization in the economic sense usually refers to the transformation of the rural economy to urban economy, and the elements of this transformation process. Second, urban development, not only refers to urban economic development, also includes the development of population, spatial development, social development and environmental development. As a result, the urban evolution on the basis of urbanization and urban development covers regional economic structural change, economic prosperity and health, migration to urban, lifestyle change, urban ecological environment friendly, sustainable use of resources, social harmony and progress, etc.

Taking into account the limitations of the domestic statistics, this article selected five groups of indicators to reflect economic development, social development, population, living and ecological environment. The selection is in line with the principle of comprehensive, objective, actionable and comparative (Tables 24.1, 24.2).

Table 24.1 Comprehensive evaluation index system of human capital

Target layer	Rule layer	Index layer
Human capital (A1)	Education (B1)	Literacy rate of 6 years old and people over the age of 6 (X1)
		Average years of schooling (X2)
		Education expenditure to GDP (X3)
		Per capita expenditure on education (X4)
		Number of Students in higher education schools in every 10,000 (X5)
		Full-time teachers account for the proportion of employees (X6)
	Job skills (B2)	Number of professional and technical personnel in every 10,000 (X7)
		Average wage of employees (X8)
		Per year per 10,000 invention patents authorized (X9)
	Health (B3)	Per capita health care spending (X10)
		Number of health institutions (X11)
		Number of beds in health institutions (X12)
		Mortality rate (X13)
	Population migration (B4)	Per capita transportation and communication costs (X14)
		Passenger traffic of the whole society (X15)

Table 24.2 Evaluation index system of Urban evolution

Target layer	Rule layer	Index layer
Urban evolution (A1)	Economic development (B1)	GDP (X1)
		GDP per capita (X2)
		Proportion of Secondary industry in GDP (X3)
		Proportion of tertiary industry in GDP (X4)
		Revenue (X5)
	Social development (B2)	Public transport vehicles per million people (X6)
		Urban road area per capita (X7)
		The number of hospitals (X8)
		Urban community service facilities per million people (X9)
	Population (B3)	The population density (X10)
		The proportion of urban population in total population (X11)
		Staff and workers in urban units (X12)
	Living (B4)	Per capita disposable income (X13)
		Engel coefficient (X14)
		Possession of civil vehicles (X15)
	Ecological environment (B5)	Comprehensive utilization of industrial solid waste (X16)
		Wastewater discharge compliance rate (X17)
		Per capita green area (X18)

24.4 Empirical Analyses

24.4.1 Selection and Processing of the Index Value

Beijing, Tianjin and Hebei are the objects of study, so the index value is selected statistical data of 1995–2010 years in Beijing, Tianjin and Hebei. The original data comes from the Statistical Yearbook of Beijing, Tianjin and Hebei and China Statistical Yearbook, 1996–2011.

The raw data of indicators are different in terms of content, dimension and standards, so it is necessary to take the value of various indicators into a relatively uniform scale, and that is standardizing the data. Its purpose is to eliminate the difference between variables, thereby enhancing the comparability of the data. This article uses SPSS software to standardize the raw data. If the normalized values are stored in the variable beginning of *Z*, then:

$$ZX_i = \frac{x_i - \bar{x}}{SD} \tag{24.1}$$

x_i is the original value of the variable. $\bar{x}$ is the mean of the original values. *SD* is the standard deviation of the original values. The mean of the standardized variable is 0. The standard deviation of the standardized variable is 1. If ZX_i less than

0, it means that the value is below average; ZX_i greater than 0 indicates that the value is above average.

24.4.2 Index Weights and Composite Score

Evaluation of human capital and urban evolution needs to give different weights for each indicator. This paper used factor analysis, neither considering the impact of multi-collinearity, nor scrupling to the subjectivity of the scoring. Factor analysis is to examine how many of the original variables are condensed into a small number of factor variables with minimal information loss.

First of all, extract the factors according to the cumulative variance contribution rate. The extraction method is principal component analysis. If the cumulative variance contribution rate of a number of factors is greater than 85 %, you can consider these factors basically reflect the most information of the original variables. Therefore, extract these factors. The eigenvalues are $\lambda_1, \lambda_2 \ldots \lambda_k$, and the eigenvectors are $\mu_1, \mu_2 \cdots \mu_p$. The variance contribution rate is S_k, and it is calculated as follows:

$$S_k = \frac{\lambda_k}{\sum_{i=1}^{p} \lambda_i} \tag{24.2}$$

Then, using the regression method to calculate the coefficients of the factor score function. Score of each factor can be calculated according to the coefficient matrix. Further to calculate the composite score. Selecting variance contribution rate of factors as weights could get comprehensive evaluation. According to the idea of the linear weighted sum method, the composite score is calculated as follows: (Tables 24.3, 24.4)

$$F = \sum_{k=1}^{m} F_k S_k \tag{24.3}$$

F is the comprehensive score. F_k is score of the principal component.

In 1995, the level of human capital in Tianjin is far higher than that of Beijing and Hebei. In 1995–2010, the level of human capital in Beijing and Hebei were shown a rising trend. Level of human capital in Tianjin has continued to decline until 2005. So, in 2010, level of human capital in Beijing and Hebei is much higher than that in Tianjin. This is mainly because that the economic development of Tianjin before 2005 is relatively slow. The attraction of talent is not enough, a lot of talent flowing continuously into the Beijing and its neighboring parts of Hebei. With the proposal of the Bohai Economic Rim, the above situation can be improved.

The level of Beijing's urban evolution in general is rising, but the last 2 years there was a downward trend, mainly because that the increase in population have brought a lot of pressure to Beijing's infrastructure construction, housing,

Table 24.3 Composite score of Urban evolution

Years	Urban evolution		
	Beijing	Tianjin	Heibei
1995	−134.532	−133.522	−85.7681
1996	−105.255	−115.778	−80.995
1997	−84.172	−88.9313	−63.1069
1998	−53.5879	−39.486	−69.1217
1999	−45.8894	−22.6313	−61.6014
2000	−23.4252	−10.9376	−50.4461
2001	−3.40884	11.46323	−28.272
2002	7.081105	3.618659	−35.1157
2003	19.38873	4.26869	−21.0334
2004	19.84976	10.04443	−9.70719
2005	40.253	28.59476	25.79935
2006	67.55028	40.95793	44.16232
2007	71.41635	45.58255	61.70626
2008	70.36921	66.30102	91.22984
2009	87.74511	92.38998	108.9172
2010	66.61651	108.0653	173.3525

Table 24.4 Composite score of human capital

Years	Human capital		
	Beijing	Tianjin	Heibei
1995	−73.8169	20.20202	−130.009
1996	−79.5631	6.959302	−122.308
1997	−96.9521	2.942905	−79.7044
1998	−81.3427	−0.87653	−65.0586
1999	−70.3063	−2.27009	−38.3955
2000	−44.4972	−4.49755	−24.7391
2001	−35.1887	−6.79376	−3.53298
2002	−27.4929	−9.39988	10.4744
2003	0.682692	−10.1575	2.612647
2004	13.66696	−13.2089	29.29226
2005	34.33096	−12.6783	48.70755
2006	38.02233	−11.2271	54.65489
2007	59.82775	−1.62477	72.54881
2008	94.7041	3.165963	75.557
2009	112.099	16.16863	74.33987
2010	155.826	23.2955	95.5596

transportation and medical care. Developing of Tianjin's urban evolution is slow at the beginning of this century, the last 2 years has become rapidly. Level of urban evolution in Hebei has been improving steadily.

24.4.3 Correlation Analysis and Regression Analysis

The correlation analysis is a statistical analysis method to deal with the relationship between the variables. Correlation analysis is usually to determine the linear correlation between the variables based on correlation coefficient. The closer the absolute value of the correlation coefficient to 1, the higher the linear correlation between the variables; the absolute value of the correlation coefficient closer to 0 shows that the variable linear correlation is lower. Variable U represents urban evolution, and the variable H represents human capital, then using the SPSS software for correlation analysis could get results as in Table 24.5.

The correlation coefficient of Beijing urban evolution and human capital was 0.886, with a high degree of linear relationship; the correlation coefficient of Hebei urban evolution and human capital was 0.892, also a high degree of linear relationship; and the coefficient of Tianjin urban evolution and human capital did not pass the test of significance, indicating that the two do not have a linear relationship.

Regression analysis is a statistical analysis to determine the quantitative relationship of two or more variables. Regression model was established according to the Beijing-Tianjin-Hebei 1995–2010 urban evolution and human capital evaluation score data. Variable U represents the urban evolution, and the variable H represents human capital, then using the SPSS software for regression analysis could get results.

Can be seen by the regression results, linear equations have goodness of fit of 0.785 and 0.796 for Beijing and Tianjin. Quadratic and cubic equation has a better goodness of fit, are about 0.9. Linear equation fit is poor in Tianjin. Through the scatter plot found that Tianjin's data distribution is in a curve form using H2 as the dependent variable and U2 as the independent variable. In summary, the final regression results as in Table 24.12 (Tables 24.6, 24.7, 24.8, 24.9, 24.10, 24.11).

Table 24.5 Pearson correlation

	U1	H1	U2	H2	U3	H3
U1	1	0.886** (0)				
H1	0.886** (0)	1				
U2			1	−0.05 (0.855)		
H2			−0.05 (0.855)	1		
U3					1	0.892** (0)
H3					0.892** (0)	1

**$p < 0.01$, two-tailed test

Table 24.6 Model of U1 and H1

Equation	Model				
	R^2	F	df1	df2	Sig.
Linear	0.785	51.198	1	14	0.000
Reciprocal	0.012	0.171	1	14	0.685
Quadratic	0.892	53.409	2	13	0.000
Cubic	0.893	33.375	3	12	0.000

U1 is the dependent variable, and H1 is the independent variable

Table 24.7 Parameter estimates

Equation	Parameter estimates			
	Con.	b1	b2	b3
Linear	2.295E − 15	0.792		
Reciprocal	−1.916	20.629		
Quadratic	22.884	0.954	−0.004	
Cubic	21.087	1.020	−0.004	−7.442E − 6

U1 is the dependent variable, and H1 is the independent variable

Table 24.8 Model of U2 and H2

Equation	Model				
	R^2	F	df1	df2	Sig.
Linear	0.002	0.035	1	14	0.855
Reciprocal	0.172	2.910	1	14	0.110
Quadratic	0.850	36.851	2	13	0.000
Cubic	0.898	35.355	3	12	0.000

U2 is the dependent variable, and H2 is the independent variable

Table 24.9 Parameter estimates

Equation	Parameter estimates			
	Con.	b1	b2	b3
Linear	−2.079E − 15	−0.008		
Reciprocal	1.954	−49.985		
Quadratic	−8.913	0.054	0.002	
Cubic	−8.792	−0.038	0.002	8.818E − 6

U2 is the dependent variable, and H2 is the independent variable

Table 24.10 Model of U3 and H3

Equation	Model				
	R^2	F	df1	df2	Sig.
Linear	0.796	54.499	1	14	0.000
Reciprocal	0.005	0.064	1	14	0.804
Quadratic	0.956	142.354	2	13	0.000
Cubic	0.983	228.055	3	12	0.000

U3 is the dependent variable, and H3 is the independent variable

Table 24.11 Parameter estimates

Equation	Parameter estimates			
	Con.	b1	b2	b3
Linear	−3.403E − 15	0.958		
Reciprocal	−0.534	40.947		
Quadratic	−32.156	1.176	0.007	
Cubic	−37.308	0.773	0.009	4.926E − 5

U3 is the dependent variable, and H3 is the independent variable

Table 24.12 Regression equation

	Equation	R^2
Beijing	$U1 = 22.884 + 0.954H1 - 0.004H1^2$	0.892
Tianjin	$H1 = -8.913 + 0.054U1 + 0.002U2^2$	0.850
Hebei	$U3 = -32.156 + 1.176H3 + 0.007H3^2$	0.956

24.5 Conclusion

Through the analysis we can find the interaction between human capital and urban evolution, but there are different effects in different areas. The different relationships between human capital and urban evolution relate to the different stages of economic development. Beijing is ahead of Tianjin and Hebei in the aspect of economic development. Beijing's human capital agglomeration effects are obvious. However, human capital has also challenged urban development. Due to the radiation effects of Beijing, human capital also gathered to Hebei. Tianjin has been identified as the third pole of China's economic growth. The investment of the State is large. So urban development is fast, which strongly attracts human capital. Based on these conclusions, the following policy recommendations were proposed:

First, agglomeration of human capital helps to promote urban evolution. Therefore, we should give full play to the role of human capital, increasing investment in education, improving infrastructure, going to form a virtuous cycle of human capital and economic development.

Second, the relationship between human capital and urban evolution is not simply positive. The level of human capital should be compatible with the stage of economic development. Therefore, when formulating policies, we should focus on the match of talent introduction and economic development.

Third, in our country, human capital differences within the region become one of the main factors that affect the balanced growth of regional economy. In order to narrow the gap of economic development within the region, it is necessary to improve the state of the internal human capital inequality.

In short, facing the competitive pressures from home and abroad, Beijing, Tianjin and Hebei must rely on the development and accumulation of human capital, promoting the rational allocation of human capital to ensure good and fast urban evolution process through the reduction of disparities and strengthen cooperation, enhancing the regional comprehensive strength and competitiveness.

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Chapter 25
Xijiang Gold Waterway Industrial Layout and Path Selection

Lu Ma, Wei Zhou and Jie-fei Zhu

Abstract Xijiang gold waterway has a very important strategic position and resource advantage. However, its development still exists different level of problem, especially the industrial spatial layout is unreasonable, its potentiality cannot be played well, seriously restricting the pace of economic development, so how to design industrial layout of Xijiang gold waterway is directly related to the development of quality and speed. This paper in addition to follow dominant industry choice of general principle, also considers the factor endowment structure of Xijiang. The comparative advantages of the regional division of labor in the national division of labor and national industrial policy implementation process are in the strategic position. We put forward the dominant industry selection index system of Xijiang gold waterway and come to a reasonable industrial layout that combines with the actual situation of Xijiang.

Keywords Agglomeration · Dominant industry · Industrial layout · Xijiang gold waterway

25.1 Introduction

With the globalization of economy and the development of regional economic integration, the implementation of the strategy on the great development of the west, China-ASEAN Free Trade Area has put into operation; Pan-Pearl River

L. Ma (✉) · W. Zhou · J. Zhu
School of Management, Guangxi University of Science and Technology,
Liuzhou, People's Republic of China
e-mail: malu6655@163.com

W. Zhou
e-mail: zw6630@126.com

J. Zhu
e-mail: zhujiefei1985@163.com

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Delta has also cooperated with the Pan-Beibu Gulf economic area step by step. 2008 October, Guangxi district party committee and government considered the situation, made "build Xijiang gold waterway, promote the coordinated development of regional economy" major strategic decision making. In recent years, the Central People's Government and Guangxi attach great importance to the construction of Xijiang gold waterway, put forward a series of planning and implementation of programs, have made gratifying achievements and played a tremendous role in promoting the Guangxi regional economic development.

Xijiang is an important part of Pearl River water system, known as the "golden waterway" said, originated in the Yunnan and Guizhou, through Guangxi, into Guangdong and Hong Kong and Macao, is one of the main frame horizontal of our country inland waterway planning "two horizontal and one vertical two net". It is mainly composed of 1,480 km inland river that connecting Nanning, Guigang, Wuzhou, Baise, Liuzhou and Chongzuo, and covers through Hechi, Guilin, Yulin and Hezhou regions of Guangxi inland river channel 1,621 km, is large artery that connected Pearl River Delta economic circle and the Beibu Gulf Economic Zone and flows to Chian-ASEAN Free Trade District National.

Xijiang gold waterway has a very important strategic position and resource advantage. However, its development still exists different level of problem, especially the industrial spatial layout is unreasonable, its potentiality cannot play well, seriously restricting the pace of economic development, so how to design industrial layout of Xijiang gold waterway is directly related to quality and speed of the development. Xijiang gold waterway flows through 11 cities, involving 38 industries. From an objective perspective, the inside of each city is a subsystem, its economy has relative independence and integrity, and the 38 fractionize industries in regional interior should also be widely distributed. But the study of Xijiang gold waterway industrial layout emphasis is not put each industry specific spatial layout or space for each specific industry layout problem, but use some evaluation index system of dominant industry analysis to find out dominant industry of each city, and the study of the distribution.

25.2 Construction of the Evaluation Index System of Dominant Industry

Dominant industry is to show a country or area in a certain stage of economic development, playing a guiding and leading role in its industrial structure and economic development, and has broad market prospect and technical progress ability (Jiang 2008). It has spread effect, structure transformation effect and technology progress effect and so on. To establish the dominant industry, we must define an evaluation system firstly.

According to dominant industry theories and characteristics, western academic circles put forward the choice of dominant industry standards, mainly has

Hirschman benchmark, Rostow benchmark and Shinohara datum (Zhu 2007). And as an evaluation index system, the choice of index can reflect economic characteristics and evaluation requirements of evaluation target (Wang and Zhang 2009). In light of different target evaluation index system, the index collection, object, scope of application and evaluation methods has big difference, therefore this article in addition to follow dominant industry choice of general principle, also considered the factor endowment structure of Xijiang. The comparative advantages of the regional division of labor in the national division of labor and national industrial policy implementation process are in the strategic position (Porter 1988). We put forward the dominant industry selection index system of Xijiang gold waterway (Zhang 2004). The index system consists of industry agglomeration scale, industrial agglomeration potential, industrial agglomeration effect, industrial comparative advantage and technological progress of 5 indexes and 17 secondary indexes(Zn) (Zhang 2008), as shown in Table 25.1.

This paper selects the Xijiang 11 cities and industries as analysis object, and using cluster analysis to the above indexes of the reasonable classification validation, draw Table 25.2. Through the analysis, we can conclude that evaluation index system of dominant industry above is reasonable.

25.3 Empirical Study of the Dominant Industry Selection of Xijiang Gold Waterway

The following we calculated each index value by the data of each city statistical yearbook and China statistical yearbook in 2008–2010. Using SPSS17.0 software to carry on the analysis, we found that the coefficient of each type of secondary indexes are high, each type of secondary indexes show a strong linear relationship and extract the common factor. The KMO of each index are: industrial agglomeration scale is 0.766; industrial agglomeration potential is 0.75; industrial agglomeration effect is 0.781; industrial comparative advantage is 0.753. The KMO values are greater than 0.7 and the Bartlett test to reject the null hypothesis. So the correlation coefficient matrix is unlikely to be the unit matrix and suitable for factor analysis. According to the mathematical model of factor analysis method, we calculated comprehensive score of five indexes, as shown in Table 25.3.

Through the empirical analysis, we come to the top ten dominant industries of Xijiang, as shown in Table 25.3. At the same time we could find that the score of each type of these industries is not uniform. The score of industrial agglomeration scale and comparative advantage is significantly low (Edwards 1998), illustrating that the amount of enterprise of Xijiang is fewer than national, the scale is not strong enough and the comparative advantage is not obvious. The score of

Table 25.1 The dominant industry selection index system description

Index		Indexes explain
Industrial	Proportion of sales revenue Z_1	Certain industrial sector of sales revenue accounted for the proportion of the total amount of industrial sales revenue
Agglomeration	Proportion of output value of scale Z_2	Certain industrial sector of output value accounted for the proportion of the total amount of industrial output value
Scale	Proportion of profit and tax Z_3	Certain industrial sector of profit and tax accounted for the proportion of the total amount of industrial profit and tax
I_1	Proportion of employed personsZ_4	Certain industrial sector of employed persons accounted for the proportion of the total amount of industrial employed persons
	Proportion of total assets Z_5	Certain industrial sector of total assets accounted for the proportion of the total amount of industrial total assets
Industrial	Speed of output value growth Z_6	Certain industrial sector of the average growth speed of output value from 2008 to 2010
Agglomeration	Speed of sales revenue growth Z_7	Certain industrial sector of the average growth speed of sales revenue from 2008 to 2010
Potential	Employment growth Rate Z_8	Certain industrial sector of employed persons growth accounted for the proportion of the amount of employed persons of base period
I_2	The contribution rate of total assetsZ_9	Certain industrial sector of output value accounted for the proportion of the amount of total assets
Industrial	Profit rate of output value Z_{10}	Certain industrial sector of profit accounted for the proportion of the total amount of output value
Agglomeration	Profit rate of sales revenue Z_{11}	Certain industrial sector of profit accounted for the proportion of the total amount of sales revenue
Effect	Profit and tax rate of output value Z_{12}	Certain industrial sector of profit and tax accounted for the proportion of the total amount of output value
I_3	Rate of return on total assets Z_{13}	Certain industrial sector of profit accounted for the proportion of the amount of average total assets
Industrial	Market share Z_{14}	Certain industrial sector of sales revenue accounted for the national corresponding sector of sales revenue
Comparative	Location quotient of total output value Z_{15}	Certain industrial sector accounts for the proportion of the total output value of the district and the national corresponding sector accounts for the proportion of the total national output value ratio
Advantage I_4	Location quotient of employed persons Z_{16}	Certain industrial sector accounts for the proportion of the amount of employed persons of the district and the national corresponding sector accounts for the proportion of the national amount of employed persons ratio
Technological progress I_5	The rising rate of labor productivity Z_{17}	Certain industrial sector of employed persons growth rate accounted for the proportion of the amount of employed persons growth rate of base period

Table 25.2 Cluster member

Index cluster	7	6	5	4	3
Zscore(Z_1)	1	1	1	1	1
Zscore(Z_2)	1	1	1	1	1
Zscore(Z_3)	1	1	1	1	1
Zscore(Z_4)	1	1	1	1	1
Zscore(Z_5)	1	1	1	1	1
Zscore(Z_6)	2	2	2	2	2
Zscore(Z_7)	2	2	2	2	2
Zscore(Z_8)	2	2	2	2	2
Zscore(Z_9)	3	3	2	2	2
Zscore(Z_{10})	4	4	3	3	2
Zscore(Z_{11})	4	4	3	3	2
Zscore(Z_{12})	4	4	3	3	2
Zscore(Z_{13})	5	4	3	3	2
Zscore(Z_{14})	6	5	4	1	1
Zscore(Z_{15})	6	5	4	1	1
Zscore(Z_{16})	6	5	4	1	1
Zscore(Z_{17})	7	6	5	4	3

Table 25.3 The dominant industry selection index system comprehensive score

Sector	I_1	I_2	I_3	I_4	I_5	Total score
Oil processing, coking and nuclear fuel processing	0.004	0.793	0.043	0.001	0.839	1.680
Garments, shoes and accessories manufacturing	0.004	0.587	0.147	0.003	0.535	1.275
Ferrous metals mining and dressing	0.010	0.599	0.175	0.013	0.254	1.052
Instruments, meters, cultural and office machinery	0.002	0.499	0.101	0.003	0.338	0.943
Recovery and processing of waste resources and materials	0.004	0.984	0.104	0.014	-0.327	0.779
Transport equipment manufacturing	0.156	0.380	0.064	0.023	0.134	0.757
Furniture manufacturing	0.003	0.522	0.042	0.005	0.178	0.750
Nonmetal mineral products	0.062	0.316	0.109	0.016	0.205	0.708
Smelting and pressing of nonferrous metals	0.074	0.319	0.059	0.020	0.234	0.707
Timber processing, bamboo, cane, palm fiber and straw products	0.032	0.462	0.065	0.036	0.082	0.677

industrial effect and technology process is also not ideal. Its associate effect and technology needs further improvement, in order to promote industrial development. The score of industrial potential is high, illustrating that industry of Xijiang gold waterway has strong potential for development and is worth for government to invest and develop (Keller 1996). Only the advantage of the dominant industry of Xijiang play well, can we carry on the reasonable layout to achieve.

25.4 Conclusion

The Xijiang gold waterway originated in the southwest hinterland and flows into the Pearl River Delta, with convenient transportation, industrial foundation is better and the natural resources is superior etc. However, if we devote to develop a strong competitiveness of the regional economy, still need further to integrate resources and agglomerate advantages. In recent years, Guangxi economy development is rapid, but the overall level is still in the national average level below (Wang and Wang 2009). The regional economy development of Xijiang is imbalance. Only the overall development of Nanning, Liuzhou and Guilin is better. Through the empirical analysis, we come to the top ten dominant industries. By adopting the Poland economists Zaremba and Ma Lishi's point-axis development theory, combining with the current situation of industrial layout of each city, and following the principle of the industrial agglomeration, industrial association, facilities sharing and resources and performance pay equal attention, we elaborate on the industrial layout of the top ten dominant industries (Bi 2007).

Oil Processing, Coking and Nuclear Fuel Processing could be established with Nanning and Liuzhou as the center, forming industrial agglomeration with Guigang, Yulin and Baise at the same time (Manyuan 2010). Garments, Shoes and Accessories Manufacturing could be established with Nanning as the center, forming industrial agglomeration with Wuzhou, Guigang and Yulin at the same time. Ferrous Metals Mining and Dressing could be established with Liuzhou as the center, forming industrial agglomeration with Guigang, Yulin, Chongzuo and Hezhou at the same time. Instruments, Meters, Cultural and Office Machinery could be established with Nanning and Guilin as the center, forming industrial agglomeration with Guigang, Yulin and Wuzhou at the same time. Recovery and Processing of Waste Resources and Materials could be established with Liuzhou as the center, forming industrial agglomeration with Wuzhou, Baise, Hezhou and Laibin at the same time. Transport Equipment Manufacturing could be established with Liuzhou as the center, forming industrial agglomeration with Wuzhou, Guigang and Yulin at the same time (Rosent 2001). Furniture Manufacturing could be established with Nanning Liuzhou and Guilin as the axis, forming industrial agglomeration with Wuzhou, Yulin and Chongzuo at the same time. Smelting and Pressing of Nonferrous Metals could be established with Liuzhou as the center, forming industrial agglomeration with Wuzhou, Baise and Hechi at the same time. Nonmetal Mineral Products and Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products could be established with Nanning, Liuzhou and Guilin as the axis, forming industrial agglomeration with others at the same time (Zhang and Chen 2010). Focusing on the development of these dominant industries, we could develop its related industries at the same time and give full play to the role of industrial agglomeration to form a relatively reasonable industrial layout.

Considering the factor endowment structure and the reality of the economic and social development in Xijiang gold waterway, we could rely on the natural resource advantages of Baise, Hechi and Chongzuo and other resource-rich areas to focus on the development of Production and Supply of Electric Power, Heating Power and Smelting and Pressing of Nonferous Metals etc. Nanning could be focused on the development of the high-tech and high added value of Metal Products and Chemical Products etc. (Lv 2006). Guilin could also be relied on its abundant forest resources to vigorously develop Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products. As industrial towns, Liuzhou and Laibin could be furthered intensify the development of metallurgical industry, power industry, machinery industry, building materials industry and the mining industry and other heavy industries etc. Guigang, Yulin, Wuzhou and Hezhou are rich in forest resources, mineral resources and tourism resources, they are the main timber products areas and important forest products base of Guangxi. We could focus on the development of Timber Processing and Stone Processing. Only taking full advantage of the regional resource, can we make it complementary to the industrial layout (Na and Zhang 2009).

According to the empirical analysis results, we propose to strengthen the construction of the dominant industries and give a key support to the weak links. For example, increasing investment of country and government and the utilization of foreign investment, for helping and supporting specific regional transport and communications construction, river management, ecological environment restoration and port construction of key area (Zhang and Zhou 2009); improving investment environment and strengthening the development of energy and major raw material resource, and concentrating strength to build some key projects and support some reasonable dominant industries for regional characteristics. In addition, in order to further play the effect of investment and improve the investment environment, we also can adopt preferential tax policies to encourage enterprises to invest and attract more enterprises to invest in the west underdeveloped region. In that way, we could achieve the central government's macro-control functions well.

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Chapter 26
A Cost Estimation Model of Government Investment Projects Based on BP Neural Networks

Meng-su Li and Xing Bi

Abstract An investment estimation model of government investment projects is built in this paper based on BP Neural Networks method. From the viewpoint of minimization of the life circle cost, it can reduce the calculating work furthest with the method of prominence theory and extract the items of significant cost and significant factors from historical information of engineering cost, thus estimate accurately engineering cost of projects. In spite of the error between predictor of BP neural network and actual value may be large, even value of multiple operations can nearly eliminate the random so that the estimation result has high precision.

Keywords BP neural networks · Government investment projects · Significant factors

26.1 Introduction

In the stage of feasibility study of government investment projects, investment estimation is a very important part in earlier stage of projects and its accuracy has direct impact to the investment of government project. The major feature of investment estimation is that many factors can affect engineering cost between which there is a highly nonlinear mapping relationship (Hu 2003). In traditional investment estimation methods, quota indexes have determinacy and planning or engineering cost and its influence factors have linear relationship. Based on lots of historical information of completed projects this paper uses neural networks to estimate projects and extract interior relationship between engineering cost and its influence factors, analyses and forecasts CSIs (Cost Significant Items) and significant factor, thus estimate accurately engineering cost of projects (Liu and Hu 2010).

M. Li (✉) · X. Bi
School of Management, Tianjin University, Tianjin, China
e-mail: kennynancy601@126.com

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26.2 Cost-Significant

Cost-significant (CS) stems from the prominence theory. A project could be broken up as many items and the cost of these items are distributed unevenly. If ranking by cost form high to low, top 20 % items are Cost Significant Items (CSIs) and the others are non-CSIs. If a project is fit for the prominence theory, then top 80 % CSIs of total project cost should be accounted for 20 % of total amount. In spite of the cost of non-CSIs has small impaction to the total cost (about 20 %), but its computational effort is more than that of CSIs (Chen et al. 2009).

So just pay attention to CSIs of projects could reduce working amount and ensure precision of investment estimation.

Using CSIs in the Whole Life Costing (WLC) of government investment project could simplify computation program of WLC and the formula is (Zhang et al. 2006):

$$NPV_j = \frac{1}{csf}\sum_{i=1}^{n}\sum_{t=1}^{T} C_{(csi)jt}(1+d)^{-t} - D(1+d_D)^{-T} \tag{26.1}$$

In the above formula, $C_{(csi)}$ is significant items of construction cost and operation cost such as construction and install cost, equipment cost, maintenance cost, insurance cost and so on (Zweiri and Whidborne 2003). T is the whole stage from feasibility study to the end. d is annual discount rate. D is net value of disposal proceeds subtracts disposal cost; csf is significant factor; NPV_j is sum of present value of cost in the whole life cycle of project J.

26.3 Investment Estimation Model Based on BP Neural Networks

Using mean theory in the historical bill of quantities (BOQ) to analyst items, whole cost, value of significant factor of engineering project CSIs, then analyst and arrange these values which are imported to neural networks so as to complete the nonlinear mapping from the input layer—engineering feature to the output layer—CSIs data (Tsai 2006). Neural network model draws this information automatically which is stored into neural network as net value. So, engineering technologist could put relevant information into neural network based on features of projects to get CSIs and significant factors (Wang et al. 2004).

Neural network investment estimation model has three parts. They are Input preprocessing module, neural network module and output processing module, and the core is neural network module.

The structure of BP neural network is multiple. It contains the input layer, the hidden layer, and the output layer, all layers are mutual connection but the same layers do not connect with each other (Zhang et al. 2008). Property of network is closed related to sample used to practice, and a good sample set pay attention to not only scale but also quality.

Model index selection

1. Set the number of the hidden layers. Three hidden layers can meet all demands; and the more the hidden layers, the bigger network structure and the time of learning and training. This paper set the number of hidden layer is one.
2. Set the parameter of BP neural network structure. As the Kolmogorov theorem, the number of hidden layer can be set 2m + 1 (Liu 2011) (m is the number of input data).
3. Set the initial value. Normally the initial value is chosen randomly as random function (−1, 1).
4. Choose node function. BP algorithm correct error and transmit reversed to the hidden layer. Select Sigmoid function as node output function and its advantage is that any data could be conversed to number between 0 and 1 (Wu et al. 2005).

26.4 Case Study

This paper takes TBM (Tunnel Boring Machine) digging railway tunnel "unit digging life cycle cost" for example, by collecting and arranging industrial data such as TBM digging cost, Lining of water fee, anchor shotcrete support fee, equipment installation cost, vertical inclined fee, construction cost, tunnel operation and maintenance cost, analyzing different CSIs and csf data of projects (Yu et al. 2008). Feature of project should refer to analyze of industrial data and professors' experience, such as Table 26.1. In order to explain problems and simplify calculation, this paper selects CSIs total sum of 19 typical projects to build 3 levels BP neural network to build estimation model for CSIs and csf of life cycle cost for new tunnel.

Firstly, describe project feature factors quantitatively. Project feature is what could show project characteristic and factors which reflect CSIs and csf. Selection of project feature should refer to analyze of industrial engineering materials and professors' experience (Ye and Zhong 2009). By analyzing factors which impact cost of tunnel projects and set tunnel length, type of wall rock, type of TBM, utilization rate, lining type, lining method, shotcrete and rock bolt support, type of track bed as project feature, then assignment according to statistics and different types as Table 26.1.

Then, build cost estimation model. This model uses three levels BP neural networks and selects sigmoid function as node output function. Input items of model are expressed $I_1 \sim I_8$; output items are expressed by O_1, O_2. There are 17 hidden items. Initial values are random value between (−1, 1) (Bai and Jin 2005).

Based on complexity of input–output mapping, this paper collects 15 training sample and 4 test sample and then use BP neural network provided by mat lab to build model. The process of building BP neural as follows:

Table 26.1 Quantization table tunnel dug by TBM

	1	2	3	4	5	6
Tunnel length	0–5	5–10	10–20	20–30	30–40	40-
Type of wall rock	I	II	III	IV	V	VI
Type of TBM	Domestic cantilever trolley	Open type small diameter 5 m	Shield type small diameter 5 m	Open-type 5 m	Single shield 8–9 m	Double shield 8–9 m
Utilization rate(%)	10	20	30	40	50	60
Lining type	I	II	III	IV	V	VI
Lining method	Cast-in-place lining trolley	Precast lining trolley	TBM cast-in-place	Prefabrication of TBM	Made in factory	
Shotcrete and rock bolt support	Do not need	Rock bolt	Net	Rock bolt net	Grid mesh	Grid mesh net
Type of track bed	Ordinary wooden sleeper	Ordinary integral ballast bed	Reinforced sleepers	Strengthen integral ballast bed	High strength steel sleepers	High strength monolithic track bed

Table 26.2 Result listing of running 20 times for BP neural networks

	16	17	18	19		16	17	18	19
1	1.060	1.536	0.973	0.948	11	1.598	1.589	0.950	0.824
2	1.610	1.610	0.959	0.827	12	1.546	1.490	0.998	0.888
3	1.610	1.584	1.022	0.845	13	1.562	1.446	1.098	1.073
4	1.605	1.533	0.951	1.054	14	1.495	1.409	1.087	1.079
5	1.606	1.509	0.973	0.760	15	1.601	1.253	0.900	0.512
6	1.606	1.572	0.976	0.919	16	1.609	1.533	0.920	1.064
7	1.609	1.610	1.511	0.988	17	1.598	1.578	1.114	0.871
8	1.600	1.563	0.976	0.980	18	1.497	1.271	1.008	1.015
9	1.610	1.544	1.556	1.138	19	1.598	1.517	1.020	0.886
10	1.606	1.547	1.025	0.867	20	1.594	1.532	1.042	0.854

1. Standardizing output O_1, O_2, the method is:

$$x_{ji} = \left(x_{ji} - \min\left(x_j\right)\right) / \left(\max\left(x_j\right) - \min\left(x_j\right)\right) \tag{26.2}$$

x_{ji} represents the value of I_j in the ith sample. x_j is the corresponding vector of I_j (Zhang et al. 2008).

2. Building BP network. Input indexes are 8 input items, 17 hidden items and 1 output item.
3. Training BP network. Take engineering data as training sample and the largest Iterations are 200.
4. Take engineering data (from the 16th to 19th) as testing sample and the input of neural network.

Using neural network to forecast 16th, 17th, 18th and 19th group of data. Owing to the forecast result of neural network is not unique so we run 20 times as shown in Table 26.2, its mean value is regarded as foresee value of O_1 and compared with actual value, as shown in the Table 26.3. Using same method to forecast significant factor O_2, as shown in the Table 26.2. O_1/O_2 is the assessment value of WLC, and it is multiplied by relevant tunnel length can get the investment estimation of the project (Gao et al. 2006).

Table 26.3 Analysis results

Sample number	16	17	18	19
O_1 predictor	1.578	1.471	1.033	0.920
O_1 actual value	1.607	1.406	1.019	0.941
O_1 relative error %	−1.79	4.64	1.38	−2.27
O_2 predictor	0.806	0.800	0.800	0.798
O_2 actual value	0.820	0.831	0.807	0.789
O_2 relative error %	−1.71	−3.78	−0.94	0.56
Predictor WLC	1.958	1.839	1.291	1.153
Actual value WLC	1.960	1.692	1.263	1.193
Relative error %	−1.02	8.69	2.22	−3.35

It follows that CSIs and csf of engineering feature for industrial project should satisfy the investment estimation, preliminary estimate, amended estimate, design for the budget of construction drawing project and budget depth. In spite of every forecast result of BP neural network is different and has certain randomness, however, counting even value by multiple operations could eliminate the randomness very well (Zheng and Li 2008). As the Table 26.3 shows, the error between predictor and actual value ($\leq\pm5$ %) is so small that the result could satisfy the accuracy requirement of investment estimation. Some error of forecast for single operation of neural network is large but counting even value by multiple operations could keep high accuracy of forecast.

26.5 Conclusion

Based on BP neural method this paper builds investment estimation model, puts forward CSIs to reduce computational effort to the most degree and minimize life cycle cost, and makes the best use of neural network to extract CSIs and csf from industrial data of engineering cost. Because of neural network has high fault tolerance, it has the function of auto fit and auto correction to CSIs and csf. Besides, neural network processes data in parallel so its processing speed is astonishing which satisfy the demand of quick estimation. In spite of the error between predictor of BP neural network and actual value may be very large so the predictor is random. However, counting even value by multiple estimation can nearly eliminate the random so that the estimation result has high precision which could meet the precision demand of engineering investment estimation.

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Chapter 27
Chance-Constrained Programming Model for Optimal Project Selection and Scheduling

Tian-yi Zhao and Xiao-xia Huang

Abstract This study discusses the optimizing project selection and scheduling problems. In real life, cash inflows and cash outflows of each project are uncertain, we regard them as stochastic variables consequently. Considering time value of capital, Net present value is used as the standard to measure the projects and introduce chance-constraints to control the uncertainty and formulate the model. According to the logical relationship and the characters of projects, we introduce implicit enumeration algorithm to select appropriate projects and schedule them in a reasonable order. Finally, a numerical example is given to express the thought of the model.

Keywords Chance-constrained programming · Project selection · Implicit enumeration algorithm

27.1 Introduction

Traditional project selection study is to select projects in order to maximize the whole profits, while in recent years scholars gradually recognize the importance of scheduling problem. Different projects have their own characters: different construction durations, lifetime durations, returns and the like. Considering time value of the capital, these characters may influence the selected results, for this reason appear especially important. Liu and Wang (2011) and Chen and Askin (2009) systematically study the project selection and scheduling, while the returns of projects are definite value. Huang introduces chance-constrained programming to handle uncertainty in (Huang 2006) and employs net present value to measure

T. Zhao · X. Huang (✉)
Dongling School of Economics and Management, University of Science and Technology Beijing, Beijing, China
e-mail: hxiaoxia@manage.ustb.edu.cn

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capital in (Huang 2007). Carazo et al. (2010) propose a multiobjective binary programming model for portfolio selection. Sefair and Medalia (2005) considers the covariance among different projects, and Ahsan and Gunawan (2010) studies the cost and schedule problems of international development projects. Henry et al. further assesses the subsequent impact of predictability on project success in (Henry et al. 2007). In solving period, Brucker et al. (1998) introduces a branch and bound algorithm and Dzeng and Lee employs genetic algorithm (GA) in (Dzeng and Lee 2007).

This paper will follow the thought of NPV, meanwhile, introduce chance-constraints to project selection and scheduling problem. We regard NPV as the index to evaluate the earnings-generating capacity. The rest of the paper is organized as follows. Section 27.2 formulates the mathematical model of chance-constrained NPV programming model. The algorithm and a numerical example are provided in Sect. 27.3. Section 27.4 gives the concluding remarks.

27.2 Mathematical Model Formulation

We will select projects and schedule them in a reasonable order from n projects. Let x_i denote decision variables for project selection, which is zero–one variable:

$$x_i = \begin{cases} 1 & \text{if project } i \text{ is selected,} \\ 0 & \text{otherwise,} \end{cases} \tag{27.1}$$

where $i = 1, 2, \ldots, n,$ respectively.

NPV is a vital index of dynamic evaluation for project investment and is to evaluate the earnings-generating capacity during the whole counting period. NPV is defined as the sum of net cash flow discounted to zero time reference using preset discount rate. For each project, there are three periods, before-construction period, construction period and lifetime. Assume that s_i as the construction start time of project i, τ_i as the construction period duration of project i, and T_i as the lifetime duration of project i. Let IC_{it} denote the initial cost at time t in the construction period of project i, CI_{it} and CO_{it} as the cash inflow and outflow at time t in the lifetime of project i, respectively. As a result, the NPV of project i at zero time reference can be formed as:

$$NPV_i = \sum_{t=S_i+\tau_i}^{S_i+\tau_i+T_i} \frac{CI_{it} - CO_{it}}{(1+r)^t} - \sum_{q=S_i}^{S_i+\tau_i-1} \frac{IC_{it}}{(1+r)^q}, \tag{27.2}$$

where $i = 1, 2, \ldots, n,$ respectively.

Cash flow consists of initial cost, cash inflow and cash outflow, which are all uncertain. In order to come close reality, we assume these three are stochastic variables. The ultimate purpose of modeling is to maximize NPV value of selected projects. Because of the stochastic variables, the goal cannot be a crisp number, we can set the goal as maximizing NPV at a preset confidence level. The constraints can be changed to the requirement that credibility of investment not exceeding budgeting should be equal or greater than a preset level. The object function and constraints of chance-constrained programming model are listed beneath.

$$\max \bar{f}. \tag{27.3}$$

$$\Pr\left\{\sum_{i=1}^{n} x_i NPV_i \geq \bar{f}\right\} \geq \alpha, \text{ for } i = 1, 2, \ldots n. \tag{27.4}$$

$$\Pr\left\{\sum_{i=1}^{n} x_i NPV_i \leq 0\right\} \leq \beta, \text{ for } i = 1, 2, \ldots n, \tag{27.5}$$

where (27.3) is the object function and (27.4) and (27.5) are chance-constraints. In Eq. (27.4) is to make sure the sum NPV of selected projects greater and better, then the investment would acquire more profits. In Eq. (27.5) is to make sure the sum NPV of selected projects no less than zero, because if the NPV is below zero, returns cannot achieve the expected standard and the investment is failure.

The model also presents the logical relation among the alternative projects. There are three different kinds of relationship among the projects: interdependent, exclusive and mutual independence. If the two projects are interdependent, then one of the two is selected, the other one must be selected, and vice versa, one of the two is not selected, the other one should not be selected. One of the two projects is selected, the other one should not be selected if the two projects are exclusive. If the two projects are mutual independence, then whether to choose one project, has nothing to do with the other project. The mathematical form of logical relationship above is shown as follows:

$$x_i = x_j, \text{ for } i, j = 1, 2, \ldots n. \text{ and } i \neq j. \tag{27.6}$$

$$x_i \neq x_k, \text{ for } i, k = 1, 2, \ldots n. \text{ and } i \neq k. \tag{27.7}$$

In (27.6), project i and project j are interdependent, so they should be selected or not to be selected at the same time. In (27.7), project i and project k are exclusive, so their results of to be selected should be opposite.

We have already denoted s_i the construction start time of project i and τ_i the construction period duration of project i. Among the alternative projects, there is one special relation which is succession relation. When one selected project is the successor of another project, its construction start time should not be earlier than complement time of the project which is succeeded. Let project l be the successor of project i, Eq. (27.8) below shows their relation.

$$s_l - s_i \geq \tau_i, \text{ for } i, l = 1, 2, \ldots n, \text{ and } i \neq l. \tag{27.8}$$

Assume that f_i as the construction finish time of project i. Each selected project should be finished before their own milestone time and also before the deadline of constructive period.

$$s_i + \tau_i = f_i, \text{ for } i = 1, 2, \ldots n. \tag{27.9}$$

$$f_i \leq M_i, \text{ for } i = 1, 2, \ldots n. \tag{27.10}$$

$$f_i \leq DL, \text{ for } i = 1, 2, \ldots n, \tag{27.11}$$

where M_i is the milestone of project i and DL is deadline of constructive period.

The capital can be invested to accomplish the projects is limited. Let W_t denote the capital can be used to construct at time t, we assume that there is no cash inflow in the construction period, so the net cash flow derives from initial cost. Thus, the sum of the initial cost of all the projects on construction should be no greater than W_t. We formulate the constraint in chance-constrained form, then (27.12) is acquired.

$$\Pr\left\{\sum_{i=1}^{n} x_i IC_{it} \leq W_t\right\} \geq \gamma. \tag{27.12}$$

where $i = 1, 2, \ldots n,$ and $t = 0, 1, 2, \ldots, DL - 1.$

From the above, the chance-constrained programming model for optimizing project selection and scheduling problem is obtained.

$$\begin{cases} \max \bar{f} \\ \textit{subject to}: \\ \quad \Pr\left\{\sum_{i=1}^{n} x_i NPV_i \geq \bar{f}\right\} \geq \alpha \\ \quad \Pr\left\{\sum_{i=1}^{n} x_i NPV_i \leq 0\right\} \leq \beta \\ \quad x_i = x_j \\ \quad x_i \neq x_k \\ \quad s_l - s_i \geq \tau_i \\ \quad f_i \leq M_i \\ \quad f_i \leq DL \\ \quad \Pr\left\{\sum_{i=1}^{n} x_i IC_{it} \leq W_t\right\} \geq \gamma, \end{cases} \tag{27.13}$$

where $i, j, k, l = 1, 2, \ldots n,$ and $i \neq j, i \neq k, i \neq l$. For the last constraint, t should be bounded as $t = 0, 1, 2, \ldots, DL - 1.$

27.3 Algorithm and a Numerical Example

In this section, we introduce one kind of implicit enumeration algorithm. We can divide the constraints into three categories. One is constraint of logical relationship, one is constraint of time, another one is constraint of capital budget. According to constraint categories, we can acquire the procedure of the algorithm.

Step 1. Screen out the probable project groups on the basis of logical relationship of projects,
Step 2. Calculate the sum value of NPV of each probable project group on the condition of budget and time constraints,
Step 3. Compare the value of $\bar{f}$, select the maximal one, and the group is the final solution.

By means of calculation above, we can acquire the maximal NPV at a preset level, and homologous group to be constructed. To further illustrate the thought and algorithm of the model, a numerical example is presented below.

In the numerical example, we assume that the investor's object is to maximize the total NPV with a predetermined confidence level 0.95, and to make sure that the probability of the total NPV less than zero is less than a predetermined confidence level 0.05. The logical relation among the alternative projects and the milestone time of each project are given in Table 27.1. Also there exists the deadline of the construction period. W_t is assumed as \$80,000 and it is required the total cash outflow at time t should be less than W_t with a predetermined confidence level 0.95. The construction period and lifetime of project i with cash flow for each period are shown in Table 27.2 ($r = 5.25\ \%$).

In Table 27.2, N(a, b) represents the variable follows a normal distribution, with a mean of a and variance of b. In the first two years of lifetime, the projects operate well, so the cash inflow and cash outflow every year are accordingly high. In the next two years, competitors appear, the returns decrease under influence. In the rest years of lifetime, the production and operation mode are stable, the cash flows would increase than the two years before.

We solve the example applying the implicit enumeration algorithm, the optimal solution is in Table 27.3.

Table 27.1 Logical relation and time restrict

Project	Successor	Inter-dependency	Exclusive	Milestone time	Deadline
A	B	G, D	–		12
B	G	–	E	6[a]	
C	D, E	–	–		
D	–	A	F		
E	F	–	B		
F	G	–	D	8	
G	–	A	–		

[a] time unit: year

Table 27.2 Construction period, lifetime and cash flow

Project	Duration		$t < s_i$	$s_i \le t < s_{i+}\tau_i$	$s_{i+}\tau_i \le t < s_{i+}\tau_i + 2$		$s_{i+}\tau_i + 2 \le t < s_{i+}\tau_i + 4$		$s_{i+}\tau_i + 4 \le t < s_{i+}\tau_i + T_i$	
	τ_i	T_i	Cash flow	IC_{it}	CI_{it}	CO_{it}	CI_{it}	CO_{it}	CI_{it}	CO_{it}
A	3[b]	8	0[c]	N(4, 1)	N(8, 1)	N(2, 0.1)	N(7, 1.1)	N(2, 0.5)	N(10, 2)	N(3, 1)
B	2	7	0	N(8, 2)	N(12, 1)	N(1, 0.2)	N(10, 2)	N(1, 0.2)	N(14, 3)	N(2, 0.9)
C	2	8	0	N(3, 1)	N(11, 1.5)	N(3, 1)	N(9, 1)	N(2, 0.5)	N(10, 1)	N(3, 1)
D	3	6	0	N(5, 1.5)	N(10, 1.8)	N(1, 0.3)	N(8, 1)	N(1, 0.1)	N(9, 2)	N(1, 0.1)
E	4	6	0	N(4, 2)	N(8, 1.2)	N(3, 0.8)	N(5, 1.1)	N(2, 0.6)	N(7, 3)	N(2, 0.2)
F	3	5	0	N(6, 1.5)	N(8, 1)	N(2, 1)	N(7, 2)	N(2, 0.7)	N(8, 3)	N(2, 0.3)
G	3	7	0	N(5, 1)	N(10, 1.1)	N(2, 0.2)	N(6, 1)	N(1, 0.1)	N(9, 1.5)	N(1, 0.2)

[b] time unit: year

[c] capital unit: $10,000

Table 27.3 Selected project and start time

Selected project	Start time	$\bar{f}$
A	0[d]	49.9459[e]
D	4	
G	8	

[d] time unit: year
[e] capital unit: $10,000

From Table 27.3, we can acquire the optimal solution is to select project A, D, and G to construct, and the start construction time of project A is zero, project D is the fourth year, project G is the eighth year. The sum value of NPV is no less than $499,459 at 95 % level.

27.4 Conclusions

We proposes a model for optimizing project selection and scheduling problem in this paper. Chance-constrained programming is provided to manage the uncertainty of cash flows. In the solving period, an implicit enumeration algorithm is employed and the result of the numerical example shows the idea and application of the model. While the iterations would add following the increase of project scale, so how to develop the algorithm is vital in further study, probably improve existing algorithm or try new algorithm.

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Chapter 28
A Study on Photovoltaic Internet Pricing Problem Under Bargaining Game Analysis

Wu-jun Cao and Qi Zheng

Abstract As a renewable energy, PV gradually highlights its clean, no pollution, recycling and other advantages. However, the high costs of production makes the prices of photovoltaic products have been high. In this paper, under the conditions of incomplete information, it gets the price of the two sides quote in the negotiation process, and analyzes the conditions they conclude the transaction by establishing a bargaining game model between grid company and photovoltaic enterprise. So that it makes the parties gain more interests and promotes the rapid development of photovoltaic industry.

Keywords Photovoltaic enterprise · Grid company · Internet pricing · Incomplete information · Bargaining game

28.1 Introduction

At present, Wind energy, hydroenergy, geothermy and solar energy are mainly common renewable energy resources. Solar energy is the most available renewable energy resource of all. Compared with wind energy, solar energy has better stability and it is affected little by season and monsoon; Compared with hydroenergy, solar energy has little location limitation; geothermy and hydroenergy are the same, which have much location limitation. At the same time, it is hard for us to find the places where enough geothermy can generate electricity (Lang 2008). As

W. Cao (✉) · Q. Zheng
Department of Management Engineering,
Zhengzhou University, Zhengzhou, China
e-mail: caowujun@zzu.edu.cn

Q. Zheng
e-mail: zhengqi.zq@163.com

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photovoltaic power generation matures, People's awareness of eco-environmental protection increases. PV power industry is stepping into a rapidly increasing stage with policy push by government from various countries (Yu 2010). PV generation has become main way of solving the shortage of primary energy sources. As for the industry which has a good prospect development, the determination of tariff price is the key factor limiting its development.

From the overseas development situation, the determination of PV tariff price is primarily promoted by governmental policy (Wang 2010). Subsidy policies abroad are classified into 3 categories: Firstly, PV installation system is subsidized directly, such as Japan. Secondly, setting the tariff for photovoltaic power generation. In Germany, they take compulsory feed-in for PV power generation and fix feed-in tariff. Meanwhile, the tariff price is decreased every year. They make PV power generation enter the market by laws and regulations and bring in the law of market economy to better play the role of market mechanism. Thirdly, it is subsidy programs that mixed the two support policies in the State of California, United States. In this scenario, the investment subsidies imposed on small and medium-sized system, system implementation of the tariff law (Chiappafreddo and Gagliardi 2010).

In China, PV industry is still in the initial stage of development. Relevant supporting policies need perfecting and the photovoltaic industry chain is supposed to cultivate. The high cost of PV industry is the important factor of the high photovoltaic electricity price (Qin et al. 2010). High price may lead to enterprises' vicious competition, which is bad for the development of PV industry. Low price may lead to the following situations: low cost enterprises make high prices, high cost enterprises make low prices. As a result, it may lead to false quotation (Shi 2010). At present, the research on photovoltaic grid price determination in the academic is still lacking. This paper attempts to establish a Bayesian game model of Internet pricing, which is in a fully competitive market environment, whose objection are grid company and photovoltaic enterprises (Fan and Xu 2008). The results will provide the theory of reference of Internet pricing for us.

28.2 Establishment of Bargaining Game Model of Photovoltaic Electricity Price

28.2.1 Descriptions of Bargaining Game Model

PV enterprises and grid companies realize their transaction by signing a contract. The two parties negotiate the internet pricing with each other in order to realize the deal (Zou and Wang 2005). In this study, suppose that supply power q is a constant. The two parties only bargain on internet pricing P^*. We use P_v and P_e respectively represent quotation bottom line, which plays decisive role in its negotiation.

Bargaining game between PV enterprises and grid companies, if $P_v > P_e$, which means expectation from grid companies on internet pricing is lower than that of PV enterprises. At the time, both of the parties can't realize their deals. When $P_v \leq P_e$, the deals can be realized. In this study, the author discusses about bargaining game photovoltaic electricity price between PV enterprises and grid companies.

28.2.2 Hypothesis of Bargaining Game Model

Generally speaking, there are two basic hypothesizes. Firstly, economic man: each party involved pursues their own maximum benefits. Secondly, perfectly rational hypothesis: each party involved should have full analysis ability. In this study, we make several hypothesizes based on the basic hypothesis. The specifics are as follows:

1. Suppose both PV enterprises and grid companies are risk neutral whose decision rule is to maximize their expected return.
2. PV enterprises and grid companies remained independent of each other in the other party's bid expectation, and obedience to evenly distribution in the known interval.
3. The discussion is under the environment of perfectly competitive market. The government would not participate.

28.3 Bargaining Game Model's Solving Process

28.3.1 Parameter Establishment

During the course of dealing, one of the party bids, the other party can accept or refuse. If the quotation is accepted, bargaining game would come to an end; if it is refused, the declining party would quote once again, while the other party chooses to accept or refuse it. They won't negotiate with each other until one party accepts the other one.

In the bargaining game, So-called incomplete information refers to PV enterprises and grid companies don't know each other's expectations of feed-in tariff. P_v and P_e are personal information. PV enterprises judge P_e is obedience to evenly distribution in [m, n]; Grid companies judge P_v is obedience to evenly distribution in [m, n].We think that both PV enterprises and grid companies have strong learning capacity. They continuously change their expectations according to the other party's quotation.

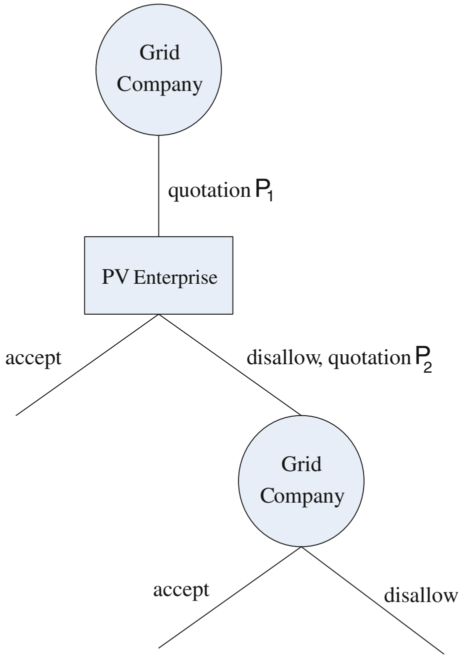

Fig. 28.1 Bargaining game structure in both sides

In the unlimited bargaining game, according to the way put forward by Shaked and Sutton to solve the problem of bargaining game, participants' bargaining game at any stage equals to the whole bargaining from the first time (Zhang 2004). Therefore, we can apply backward induction to find bargaining game equilibrium (Fig. 28.1).

28.3.2 Using Backward Induction to Solve

According to the three stages, we use backward induction to solve:

1. When t = 2, PV enterprises quote P_2, PV enterprises choose to accept or refuse. At the time, revenues of the two sides would be consumed. Suppose PV enterprises and grid companies' consumption coefficients are γ_v, γ_e respectively, grid companies' revenue is $\gamma_e(P_2 - P_e)q$.

   If $\gamma_e(P_2 - P_e)q \geq 0$, we can conclude that

$$P_2 \geq P_e \tag{28.1}$$

Grid companies would accept PV enterprises' price, its revenue is $\gamma_e(P_2 - P_e)q$.

PV enterprises' quotation needs to be met the condition that is to maximize its expectation revenue.

$$\begin{aligned}&\max[\gamma_v(P_v - P_2)q * \Pr ob(P_2 \geq P_e)\\&+ 0 * \Pr ob(P_2 < P_e)]\end{aligned} \tag{28.2}$$

In (28.2), $\gamma_v(P_v - P_2)q * \Pr ob(P_2 \geq P_e)$ is PV enterprises' expectation revenue when grid companies accept P_2, $0 * \Pr ob(P_2 < P_e)$ is PV enterprises' expectation revenue when grid companies refuse P_2.

Estimated by PV enterprises, we can get:

$$\Pr ob(P_2 \geq P_e) = \frac{P_2 - m}{P_1 - m} \tag{28.3}$$

Substitute (28.3) into (28.2), derivation of P_2 in (28.2), we can get the optimal bid from PV enterprises.

$$P_2 = \frac{P_v + m}{2} \tag{28.4}$$

Therefore, when grid companies accept PV enterprises' quotation, the revenue of grid companies and PV enterprises respectively is:

$$R_e = \frac{P_v + m - 2P_e}{2} q\gamma_e \tag{28.5}$$

$$R_v = \frac{P_v - m}{2} q\gamma_v \tag{28.6}$$

2. When $t = 1$, if grid companies at the first stage quotation P_1 makes $(P_v - P_1)q \geq \frac{P_v - m}{2} q\gamma_v$, that is $P_v \geq \frac{2P_1 - m\gamma_v}{2 - \gamma_v}$, PV enterprises would accept the quotation from grid companies, otherwise they would refuse the quotation. Similarly, grid companies know PV enterprises' selective mode at the first bargaining stage and revenue PV enterprises' selective mode bring to both sides (Wang and Han 2008). Therefore, Grid companies' quotation would make P_1 to maximize its expectation revenue.

$$\begin{aligned}&\max[(P_1 - P_e)q * \Pr ob(P_v \geq \frac{2P_1 - m\gamma_v}{2 - \gamma_v}) +\\&\frac{P_v + m - 2P_e}{2} q\gamma_e * \Pr ob(P_v < \frac{2P_1 - m\gamma_v}{2 - \gamma_v})\\&* \Pr ob(P_2 \geq P_e)]\end{aligned} \tag{28.7}$$

Derivation of P_1 in (28.7), then make it equal to 0;

$$P_1 = \frac{2P_e + n(2 - \gamma_v) + m\gamma_v}{4} \tag{28.8}$$

28.3.3 Results of Model Solution

We can conclude from above, Nash Equilibrium of grid companies and PV enterprises in bargaining game are:

1. When t = 1 in grid companies, they quote $P_1 = \frac{2P_e+n(2-\gamma_v)+m\gamma_v}{4}$.
2. When $P_v \geq \frac{2P_1-m\gamma_v}{2-\gamma_v}$ is met, that is $P_v \geq \frac{2P_e+n(2-\gamma_v)-m\gamma_v}{2(2-\gamma_v)}$. PV enterprises accept the quotation p1 from grid companies, bargaining game would come to an end. If it is not met, they continue to bargain.
3. When t = 2, grid companies estimate P_6 evenly distributed in $[m, P_1]$. Its quotation is $P_2 = \frac{P_v+m}{2}$.
4. When $P_2 \geq P_e$, grid companies accept their quotation, otherwise they refuse.

28.4 Results Analysis

There are two Nash Equilibrium influence factor: one is consumption coefficients γ_v, the other are quotation bottom line estimates P_e and P_v.

When t = 1, quotation P_1 in grid company is rational, because in order to avoid loss during the deal (Zhang 2004), it would raise the price to realize the deal with PV enterprise at a fairly high price. Its quotation wouldn't be higher than its quotation bottle line P_e. That is $P_1 \geq P_e$. According to (28.8), we can get:

$$P_1 = \frac{2P_e + n(2 - \gamma_v) + m\gamma_v}{4} \leq P_e \tag{28.9}$$

Solving (28.9), we can get:

$$\frac{2(n - P_e)}{n - m} \leq \gamma_v < 1 \tag{28.10}$$

If PV enterprise accepts the quotation from grid company when t = 1, then the following must be met:

$$n \geq P_v \geq \frac{2P_e + n(2 - \gamma_v) - m\gamma_v}{2(2 - \gamma_v)} \tag{28.11}$$

$$0 < \gamma_v \leq \frac{2(n - P_e)}{n - m} \tag{28.12}$$

From (28.11) and (28.12), we know:

When $\gamma_v = \frac{2(n-P_e)}{n-m}$, grid company and PV enterprise make a deal when t = 1, grid company quotes $P_1 = P_e$, PV enterprise accepts quotation made by grid company. Contract would be finally written when $P^* = P_e$.

When $\frac{2(n-P_e)}{n-m} \le \gamma_v < 1$, grid company quotes $P_1 < P_e$, but at the time it is $P_e > n$, which clash with $m < P_e < n$. Therefore, bargaining game steps into the second stage. When t = 2, PV enterprise quotes $P_2 = \frac{P_v+m}{2}$, grid company accepts its quotation, the contract finally written when $P^* = \frac{P_v+m}{2}$.

When $0 < \gamma_v < \frac{2(n-P_e)}{n-m}$, grid company and PV enterprise can't make a deal.

28.5 Conclusion

In this study, the author establishes bargaining game model of grid companies and PV enterprises, analyzing the quotations and the final deal condition between the both sides. We can make a conclusion: (1) When $\gamma_v = \frac{2(n-P_e)}{n-m}$, grid company and PV enterprise make a deal when t = 1, grid company quotes $P_1 = P_e$, contract is finally written at $P^* = P_e$. (2) When $\frac{2(n-P_e)}{n-m} \le \gamma_v < 1$, bargaining game steps into the second stage, PV enterprise quotes $P_2 = \frac{P_v+m}{2}$, contract is finally written at $P^* = \frac{P_v+m}{2}$. (3) When $0 < \gamma_v < \frac{2(n-P_e)}{n-m}$, grid company and PV enterprise can't make a deal.

This is a study on bargaining game of photovoltaic electricity price under the environment of complete competitive market. The author gains the equilibrium solution by the model only providing the lead-in tariff with theory analysis. It also supplies reference to various enterprises. Moreover, with the further explore, we develop the bargaining game between a PV power industry and an grid company into that of two PV power industries and an grid company or into a bargaining game among PV equipment supply, PV power industry and grid company, which we will complete in the future.

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Chapter 29
The Structure of Construction Enterprise and Its Competitive Strategic Choice in China

Yu-lin Wang and Wei Zhou

Abstract The intense competition in the market has exerted much pressure on construction enterprises from both home and abroad to the extent that these enterprises spend every minute in choosing survival and development strategies. This paper first introduces an overview of competitive strategy theory in which the structure of construction enterprises is analyzed through five kinds of competitiveness models and three kinds of competition strategies is analyzed from their strengths and weaknesses. Then, it points out how different construction enterprises take the opportunity in the competition. Last, this paper proposes some suggestions about competition strategy formulation.

Keywords Construction enterprise · Competitive strategies · Five kinds of competitiveness models · Strategic choice

29.1 Introduction

Nowadays, in the 21st century, the building industry is undergoing a changeable market in China, with every enterprise in it sparing no effort to gain the front-runner. They compete in marketing, price, technology, service and etc. But this all-round competition is not very good. The enterprises must break traditional inappropriate chain to gain lasting existence and development. To achieve this goal, they should look into the industry environment, allocate the privileged inner resources rationally and fashion their strong competitive power, which requires a clear, long and comprehensive enterprise competition strategy to follow. So, the enterprises in building industry ought based on the analysis of the outer

Y. Wang · W. Zhou (✉)
The Center for the Studies of Information Resources, University of Wuhan, Wuhan, China
e-mail: zhouwei15229@163.com

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environment as well as the inner capability and resources, to seize the chance, play to the strengths, avoid the threats and overcome weakness to explore a desirable competition strategy.

29.2 The Competitive Strategy and Influencing Factor of Enterprise

29.2.1 The Concept of the Theory of Enterprise Competitive Strategy

The word "competition" has many meanings (Minzberg et al. 1998). In western economics, the mainstream viewpoint is as follows (Zhou et al. 2008): the reason for market economy to exist is competition, which can promote the sustaining optimization and maximum utilization of social resources. So, competition is a main feature of market economy, an inevitable outcome of history development.

The word "strategy" first appeared in the military field. These days, the word "strategy" has been applied to political and economic fields and its meaning is extended vastly, including the dominant, global and life-and-death maneuver, project or countermeasure. When strategy is used in enterprise management, enterprise strategy comes into being.

Enterprise strategy is a strategic system, with competitive strategy, development strategy, technology-development strategy, marketing strategy and Informatization strategy included. Namely, competitive strategy is just a part of it, which is employed to seek a favorable competitive position in a certain industry (Wen et al. 2005). It is a stratagem to solve global, long and fundamental enterprise problems and can help to put enterprise in a profitable and steady place according to all kinds of industry-oriented competitiveness.

29.2.2 The Development of the Theory of Enterprise Competitive Strategy

The theory of enterprise competition strategy comes from the enterprise strategic theory, experiencing the shift from the study of key points in enterprise strategic theory to competition among enterprises. It has three developing phases:

The first one involves in traditional fundamental strategic management theories based on environmental and market analysis. Accordingly, the enterprise strategy is established by analyzing the internal and external enterprise environment. This theory includes Chandler's idea that the enterprise environment and enterprise strategy come before organizational structure of the enterprise, Ansoff matrix about product market, Andrews' SWOT Analysis, Boston Consulting Group Growth-Share Matrix (BCG), PEST analysis and etc.

The second one focuses on competitive strategy theory grounded on market structure and competitive advantages, whose representative achievement is the competitive strategy of Porter. Porter came up with three basic competitive strategies by analyzing the industry's market structure. Since the traditional competitive strategic theory failed to penetrate into competitors and competitive factors, Porter's results can do perfect compensation. Besides, Porter thinks that industry attractiveness controls the profits and market structure determines competitive strategy.

The last one emphasizes on competitive strategic theory concerning resources and capabilities. It pays much attention to the enterprise's own characteristics which is always neglected by the former two theories. The third-generation theory thinks highly of the uniqueness an enterprise possesses, considering it the source of super-profits. The uniqueness is just what the enterprise owns exclusively, such as special resources and capabilities. This theory has two representative thoughts, Wernerfelt's resource-based view (RBV) and Prahalad and Hamel's core competitiveness respectively (Fornell and Wernerfelt 1987). The theory of enterprise competitive strategy is different from the traditional ones in that the former mainly studies the market competition to establish and maintain the competitive advantages.

29.2.3 The Influencing Factor of Enterprise Competitive Strategic Formulation

When talking about enterprise competitive strategy, strategic formulation is inevitable. It is not enough for enterprises to know the theories. Instead, they must also know how to formulate relevant enterprise competitive strategies to reach their goals which are what enterprises and business decision makes are concerned with. Thus, Dan Schendal put forward strategic management pattern based on the collection of fruits in Pittsburgh. The pattern takes goal determination, environmental analysis, strategic formulation, evaluation, selection, implementation and control into consideration, which makes competitive strategy useful to strategic problems happening to enterprises. It means that strategy should be formulated on behalf of enterprises (Cheng 2005).

Environmental analysis is the basis on which the enterprise competitive strategy is formulated. However, due to the more intricate and turbulent enterprise environment, enterprise strategy becomes a central agenda to enterprises. There are many methods of environmental analysis, such as, PEST analysis, SWOT analysis and five kinds of competitiveness models of Potter's. Furthermore, Potter's method wins wide recognition among enterprises and academics about competitive strategic formulation because he extracted five kinds of crucial competitiveness from a series of factors which have an effect on enterprises and their competitive behaviors. And the potential gains in an industry are determined by the interaction among these five kinds of competitiveness. So, the challenges an enterprise is faced with are how to find its own suitable place in an industry, how to discover the favorable factors and how to avoid the negative factors.

With his method, Potter raised three viable competitive strategies, whose advantages and disadvantages are evaluated and analyzed to pick up the best competitive strategy for an enterprise, a goal that the strategic evaluation and formulation purses when taking the purpose of competitive strategy, the environment as well as enterprise's own features into account.

Strategic implementation and control reflects the dynamic strategic management. In modern times, the competition becomes increasingly fierce, and plan always changes very fast, so it is urgent for an enterprise to obtain a flexible, variable and market-adaptable strategy.

29.3 The Industry Structure of Our Country's Construction

Industry structure is very important to the enterprise competition strategy, meaning that the analysis of the construction's industry structures is vital for the construction enterprise to formulate competition strategy. According to Michael Porter's, "five competitive forces analysis model", the state of competition in the construction industry depends on the five basic competition: existing competitors in the construction industry, the bargaining ability of building materials supplies, the bargaining ability of building products buyers, the potential entrants of construction industry and producers of substitution. The followings will analyze construction industry according to the five competitions (Potter 1988a).

29.3.1 Existing Competitors in the Construction Industry

Since the benefits between each other in the construction enterprise are closely linked, building enterprises formulate their own competitive strategies in order to gain more advantages relate to their competitors. However, when enterprises are implementing their competitive strategies, conflicts and antagonism phenomenon will inevitably appear, which have made up the competition between existing construction buildings.

Either domestic or foreign construction market, construction industry is the one that with a huge number of enterprises but a small rate of leading enterprises. According to statistics, there are almost 97,000 construction enterprises, but the first class enterprises just account for about 5.6 %, the main structure in the industry is small and medium-sized enterprises. They have serious phenomenon of homogenization and seldom distinguish, which lead enterprise to badly compete on the same level, even trap into excessive competition.

29.3.2 The Supplier of Building Raw Material

The force of suppliers mostly depends on the inputs they supply to buyers. The raw material supplied by supplier accounts for a big proportion in the cost of construction enterprise. Building raw material is not just very important for construction enterprise to construct and produce, it also influences the quality and servant of constructive products directly, which provide supplier a strong bargaining ability to sell the material with a higher price. However, in order to maintain the stability and development of supplier and construction enterprise, the cooperation between the two is always supplied in a form of long-term contract, which can solve the problems of quality and cost by cooperation. Therefore, the bargaining ability of building raw material supplier is less intense.

29.3.3 The Buyers of Constructive Products

The buyers influence profitability of existing enterprises mainly through the ability of asking for a lower price and higher quality and service. Thanks to continued rise of infrastructure construction in our country, the tendency of buying a large number of constructive products is still very strong; all construction enterprises can get a lot of order forms and contracts for the construction of infrastructure and cities. However, on the other hand, at the constructive market, buyers would rather choose the products with a lower price under the condition of supplying similar products by construction enterprises; thus, the ability of construction enterprise to control the constructive products price is weaker than the buyers.

29.3.4 The Potential Competitor in the Constructive Industry

Constructive industry is a kind of intensive enterprise which needs a heavy capital and operation finance. If the potential constructive enterprises want to enter into the circle of construction, they would pay a high price and will be easily boycotted and damaged by competitors at the initial stage. Again, as the series of constructive products is so similar to each other, the economy of scale and scope works a strong function. Therefore, the society highlights that the qualifications and record of service and the prestige of a construction enterprise are important, which make the barrier to enter the constructive industry very high. However, the suppliers of constructive raw material who know clearly about the construction may turn into potential competitors; at the same time, with the end of the transition period of China accessing to the WTO and the gradual opening of domestic constructive market have provided conditions for them to enter in. The two enterprises mentioned above are the most powerful potential competitors in constructive industry.

29.3.5 The Threaten of Constructive Alternatives

Two enterprises in the same industry or not may appear competing behaviors, because their products are alternatives to each other. The competition based on alternatives will influence the existing competitive strategy of enterprises in the industry by all kinds of forms. According to constructive industry, however, constructive products are always designed and produced to meet buyer's requirements, and quite different from batch process, which have unique qualities. It means that almost no obvious threats happen to alternatives.

29.4 The Competitive Strategy of Constructive Industry and How to Carry it Out

When Porter's "five competitive forces analysis model" is analyzing the competitiveness among the enterprises, it also provides us enterprises three competitive strategies: differentiation strategy, cost leadership strategy and target concentration strategy (Potter 1988b).

29.4.1 Differentiation Strategy

Making the divers products and service supplied by enterprise to form some unique things in the whole industry is called differentiation strategy. There is obvious difference between the products of construction enterprise and its competitors', which are determined by the single quality of construction enterprise. That is beneficial to carrying out the differentiation strategy and gaining lasting competitiveness. To carry out differentiation strategies, following measures may be adopted.

1. *Difference in Products*

Difference in products is the main way to realize differentiation strategy of construction enterprise. Under the background that products of construction have substitutability between each other, construction enterprise should put more effort into the following aspects: the design of products, the creation of the environment, constructive material and so on. At the same time, it also needs construction enterprise to trail the new bright points in the industry development constantly, focus on transformation and application of constructive industry in technical achievements, adds the new technology which can meet the buyer's requirements to the constructive products to ensure the leading position in the field of developing constructive product.

2. *Difference in Brands*

Difference in brands starts at the figure of brands. The development of constructive industry is long and periodically, which makes it possible for constructive industry to build its own unique brand according to its characteristic. At the point of difference in brands, enterprise should make great efforts to create a brand of constructive product, realize the operation of brand and set a good credit by good image of brand. The style of advertising design and the format of brand building should be characteristic, the raising of the image of brand should be emphasized, which make the enterprise more forceful and lively, the image of enterprise and product root in publics and the diversity in brands boldly. The cognitive diversity of brand among public safeguard brand image.

29.4.2 Cost Leadership Strategy

The cost leadership strategy, also called the lowest cost strategy, regards the lowest cost as the powerful weapon, which means that the total cost of enterprise lower than its competitors', even become the lowest one in the industry by using an effective way to get advantages in the competition (Cheah and Kang 2007).

To operate the cost leadership strategy effectively, several measures can be considered:

First of all, the sense of controlling cost should be promoted in the intranet to make sure that staffs know the importance of it. Controlling cost needs not only the proper management of project and finance manager but also the effort from all the staff of enterprise. Relevant index of controlling cost established in constructive enterprise are regarded as principle which encourage workers to saving cost and take advantage of existing resources.

Secondly, effective technical measures are adopted to control material cost. During the whole process of a program, the material cost often account for 60 % (Wang et al. 2007), thus controlling cost must emphasize on reinforcing of controlling material cost. To control the material cost effectively, some necessary work must be done including basic activities before purchasing (investigating materials market, developing a reasonable material planning), the management of using material at the construction site. Therefore, unwanted wastage at each stage can be decreased when the measures above are strict performed and enterprise adjust their measures to local conditions.

Thirdly, strengthening the staff management and reducing the wastage on cost of labor demand a powerful control of choosing and managing the contracting team. The first step to manage staff is to choose a good contracting team whose labor cost and product quality influence the whole quality and cost of the program (Tan 2010). Construction enterprise should take all kinds of factors into account to choose a proper contracting team.

Finally, a good financial management assists to the counting accuracy and integrality after the project fishing. The recording of the consumption and expenses about staff, materials, machine and so on should be put down in the construction stage, which can check out if there is any error when analyzing and resorting those recordings. It is apparently that the completion management is the final period of the management of enterprise cost; it is also the key point for enterprise to realize profit reality (Newbert 2007).

29.4.3 The Concentration of Target Strategy

The construction enterprises in our country may have mastered some advanced technology in the practice long-term construction contracting, but lack the creation of technology. Competitive strength can be brought to the construction enterprise by the concentration strategy.

In order to carry out the strategy, it is necessary for construction enterprises to form a target system of core competence after knowing the advantage of construction enterprise, enforce the development and re-creation of technology, highlight leading product of proprietary intellectual property rights which promote the competitive strength and sustainable development ability.

Nowadays, the existing barriers of construction are caused by the character of construction itself. At first, the discontinuity of project organization constructive industry has no benefit for accumulating technological experience and transferring technologies. There are some temporary organizations, such as owner, design units, construction unit, materials and equipment supply unit. While the item is completed, the organization is dismissed, some new ones will be organized according to new contracts (Hou and Ye 2009). This discontinuity without sharing, reflecting, accumulating of knowledge and experience blocks the activities of construction enterprise at constructive market. Secondly, the predicted market demand is the precondition of technology creation, but the construction products are uncertain. Then, the barriers of development of enterprise are happened by the stationarity and the immobility of constructive products. Finally, the design of construction and separation of construction limit construction enterprise march into other constructive fields. If construction enterprises want to develop other markets, it will take a high price because of the need of dealing with different architectural firms, so a lot of efficiency and profit will be reduced. Thus the target concentration strategy is one of the best competitive strategies for the current construction enterprise.

29.5 The Choice of Competitive Strategy in Construction Industry

Potter presented the method for the analysis of the competitiveness in an industry by five competitive models, and provided three competition strategies to improve the competence of the enterprise (Potter 1988c). But, when it comes to construction industries, the consideration changes and the method should be decided on the characteristics of the trade itself and the adaptation degree. So in order to ascertain the suitable scope, it needs to know clearly what are the advantages and disadvantages of three kinds of competitive strategy.

29.5.1 The Advantages and Disadvantages of Competitive Strategy

The implement of differentiation strategy can strengthen customer loyalty to the construction enterprise, reduce the sensitivity of the building products prices, avoid excessive competition in the industry, and moreover, form unique brand effect and maintain leading position in particular fields (Chinowsky 2000). The barriers derived from loyalty of customer make the competitors cost a lot to gain customers and business, which raises the competitive threshold. To achieve the effect of differentiation, the input of enterprises is very high, and the cost paid by enterprises will be a part of the cost of the products. To some extent, the additional price weakens the competitive ability of the construction enterprise.

Next talking about the strategy of cost leadership. Since the fierce competition in the construction industry, the advantages of a lower cost can perform a good foundation for the price war, making competitors quit because of the pressure from competition and weakening some potential threat from those who try to enter the industry. But in order to maintain the cost advantage, the amount of funding is invested in the technological innovation process, thus improving the launch obstacles. In addition, too much attention is focused on the production cost and ignored the needs of the enterprises, which is not benefit to long-term development of the enterprise.

Operating target concentration strategy is to make the technology and management specialize to gain the competitiveness in technology and process, use advanced information technology to innovation, attract good professional and innovative technology talents. The strategy makes the enterprise can get better and more in the long run, and at the same time, the relative concentration of enterprise resource can guarantee the costs and technical advantage and make the operation of the enterprise and goal more clear and less risk. Its limitations are that the scope for enterprise competition is narrow, and once lose these business areas, enterprise will be falling into the dangerous situation.

29.5.2 The Choice of Competitive Strategy for Construction Enterprises

Construction industry in our country is in a relatively healthy growth period, that is to say, demand is relatively strong, building enterprise is numerous, but the scale and strength is far behind, and each enterprise makes full use of their own resources to improve market share and gain a competitive advantage and corporate profits. So the market competition is fierce. Through the above analysis, in this paper we put forward different competition strategies for the construction enterprises in different scale.

For those strong construction companies, differentiation strategy may be an alternative strategy. Large construction enterprise can give full play to their advantages through the product differentiation and brand differentiation. At the same time and constantly improve them and avoids weaknesses to cope with threats in construction market and to gain greater development.

For the powerful construction enterprise, the cost leadership strategy is more appropriate. They may strictly control cost and reduce the cost of every stage in the whole production process, so they can control project scale, optimize cost, and increase the market share.

For those potential entrants or foreign construction enterprise, they can take the aim concentration strategy as the best choice. By the subdivision of construction market, centralizing resource aims at a specific area and a particular consumer area in construction market, developing goods to satisfy special needs, the construction enterprise can gain competitive advantages and take a place in the market.

It need to point out that, if two or all of the three competition strategy are used in construction industry at the same time, the advantages and characteristics of competitive strategy of all sorts may be not obvious, just as the middle layer of sandwich which may add additional press to enterprise. Construction enterprises should choose one of the competition strategies, not their mixture.

29.6 Conclusion

The competitiveness of construction enterprise and its competitive strategy is inseparable; in turn the enterprise competition strategy is designed according to competition ability of construction enterprise. With the competition between the construction enterprises constantly upgrade, competition is increasingly fierce. Only careful analysis the competition ability of the enterprise, can construction enterprise create their own competitive advantage and grasp the disadvantages of competition strategy. Finally, through the reasonable using competition strategy, enterprise can make continued progress and development, possessing a place in construction industry.

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Chapter 30
Research on Energy Saving of the Existing Public Building in China

Mei Wang and Yi Wang

Abstract In this paper, in order to evaluate the economic performance of energy-saving retrofitting in existing buildings, we have researched the Chinese public building energy consumption structure. An existing public building was taken as an example in order to best evaluate the economic performance based on comparison between the annual electricity consumption before and after retrofitting, and also to analyze energy conservation of retrofitting. The results show that selecting the appropriate energy-saving technology can lead to a more satisfactory economic benefit in energy-saving commitments over the coming years.

Keywords Existing public building · Energy consumption analysis · Energy saving retrofitting · Economic evaluation

30.1 Introduction

China is a high energy consumption country. The construction industry consumes roughly a third of the energy in the process of construction and use. Up to 2010, Chinese public building amassed some 45 billion square meters, and the area of the public building is 10.7 % of the urban–rural house area (Building Energy Research Center of Tsinghua University 2007). But the public building energy consumption is 20.7 % in construction energy consumption. Chinese energy supply security will suffer stress when the public consumption remains obstinately high, which makes energy-saving retrofitting an imperative in China's future.

M. Wang (✉)
School of Management, Xi'an University of Architecture &Technology,
Xi'an, China
e-mail: iceagemay@126.com

Y. Wang
China United Northwest Institute for Engineering Design & Reash,
Hangzhou, China

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30.2 The Status of Chinese Public Building

There is 20 billion square meters of new floor space created in China every year, but 80 $\sim$ 90 % of it doesn't reach the International Energy Conservation standard, and the unit floor area heating consumption is three times that of developed countries (Liu and Wei 2010). The public construction segment makes up 16 % of the entire Chinese construction area, and although large public structures are just 11 % of all Chinese structures, their energy consumption is 19 % of total. According to the survey, Chinese public construction's power consumption is up to 1.41 billion tce. The electric power consumption of average unit area is 48.6 kWh/(m^2 a), and the energy consumption of unit area are 18.1 kgce/m^2.

30.3 Analyze the Consists of Public Building Energy Consumption

Heating and refrigeration consume 50 $\sim$ 60 % energy of the public building energy consumption all year round, and lighting costs 20 $\sim$ 50 %. 20 $\sim$ 50 % of energies are consumed by the building envelop in refrigeration energy consumption (Building Energy Research Center of Tsinghua University 2010). Therefore, public building energy saving is focus on building envelop, heating and lighting equipment.

30.3.1 Building Envelop Energy Consumption

Building envelop thermal performance determines heating and refrigeration energy indication (Ye 2006). Handing practices to building envelop are usually constructed: (1) Wall. Solid clay brick masonry wall is 240 mm thick, 20 mm thick wipe inside and outside the mixed mortar, heat transfer coefficient K value of approximately 1.873 W/(m K)and the value of the national energy efficiency standards for the 0.52 W/(m K) is three times that. (2) Roof. Does not reach the roof thermal energy standard, which will influence the performance of roof insulation. (3) Doors and windows. Most are wooden doors and steel windows, which have a large gap rate, thus it is difficult to ensure the quality of the indoor environment (Zimmermann 2009).

30.3.2 Heating System Energy

The heating energy of our country is about 1.3 million tons of coal throughout a year. The average energy expended is 2–3 times of developed countries with a similar climate. Heat loss of heating system is about 15–30 %. Heating system design and construction lack necessary adjustment and measurement instruments, which result in high energy expending heating systems.

30.3.3 Air Conditioning System Energy

Different types of air conditioning energy systems within public buildings range between the 13 $\sim$ 45 kw • h/(m • a) (Rosenfeld and Shohet 1999). Unreasonable building design and ventilation, unreasonable system and selection of equipment and operating methods, and unreasonable operating systems have led to the high energy consumption with in air conditioning systems of public buildings (Pugh 1991).

30.3.4 Building Energy Consumption of Electrical Equipment

Survey indicates that building energy consumption of electrical equipment mainly reflects in the following areas: (1) Equipment efficiency. Not using the right equipment leads to low efficiency and high energy consumption, resulting in energy waste. (2) Air-conditioning equipment. Public buildings are always equipped with central air conditioning, while air conditioning cold caloric needs long-distance transport, during which losses of energy consumption in the transportation process are caused. (3) User habits. Actions such as daytime lights, keeping computers and air conditioning working when get off work all seem to be insignificant, but the amount of potential actual energy saving could be huge (Zhou et al. 2010).

30.4 Existing Public Energy Saving Benefit Analysis

30.4.1 Simulation of Energy Consumption Data

To achieve lower energy consumption is both the target of energy-saving in public buildings and the evaluation criteria. Accurately measuring or calculating the amount of energy consumption is fundamental for the proper economic evaluation of existing public buildings' energy saving transformation (Ji et al. 2010). Building energy simulation software can simulate the total energy consumption and the sub-entry energy consumption of reconstruction,which can be used to compare the levels of energy saving before and after, and so achieving the comparison and analysis of energy level of the energy saving transformation.

30.4.2 Energy Transformation of the Economic Model

When conducting the economic evaluation of public buildings energy-efficiency, we must consider the relationship between the energy-saving one-time investment and the building energy costs. We must also take into account both the economic and energy-saving standards of the comprehensive benefits. In this paper, by using the financial evaluation method to conduct the economic evaluation of public buildings' energy saving transformation, we analyzed and calculated the costs of energy-saving and energy saving benefits after the transformation, and calculated the economic evaluation index of the energy-saving project, all to study the profitability of energy-saving projects and best judge the economic feasibility of energy saving.

30.4.3 Calculation of the Cost of Energy-Saving

The main difference between energy-saving building and non- energy-saving building is the material fee of the direct expense of a project, therefore, the estimation of the energy-saving construction cost is largely the analysis of the cost of consumption of energy-saving materials. Energy-saving costs include energy-saving materials' costs and construction costs.

$$\mathrm{I}_0 = \sum_{\mathrm{i}=1}^{\mathrm{k}} (\mathrm{a}_\mathrm{i} + \mathrm{b}_\mathrm{i})\mathrm{s}_\mathrm{i} \tag{30.1}$$

The equation (30.1) shows the energy saving cost, the unit price of i kind construction materials used in the energy-saving building, the unit cost of construction of i kind materials used in the transformation, the quantity of i kind energy saving materials used in the energy saving building, while k is for the type of the energy-saving building materials used in energy-saving building.

30.4.4 Calculation of Energy-Saving Benefits

The reduced energy consumption fees of public buildings energy-saving transformation can be called energy-saving gains. The characteristics of public buildings in China's energy consumption are as follows: heating energy consumption is mainly in the north while air-conditioning and lighting energy consumption is in the south. Therefore, the income can be estimated with energy consumption index:

$$\mathrm{I}'_0 = \left(Q_t - Q'_t\right)\mathrm{p} \tag{30.2}$$

Equation (30.2) shows the energy saving benefits of the existing public buildings and the power consumption difference of the energy-saving construction transformation; p is for energy prices.

30.4.5 Analysis Model of Financial Evaluation of Energy-Saving Project

In this paper, giving full consideration to energy prices and the discount rate, the actual energy efficiency has an impact on the cost changes of existing public buildings' energy-saving.Energy efficiency also impacts uponcumulative annual net cash flow and net cash flow in calculating the energy-saving payback period, and in clarifying the economic benefits enjoyed during the operation period. Energy cost savings per year in net cash flow (Liu 1991) used $\mathrm{NCT_t}$:

$$\mathrm{NCT_t} = \alpha \mathrm{p}\left(\mathrm{Q_t} - \mathrm{Q_t'}\right)(\mathrm{F/P}, \mu, t)(\mathrm{P/F}, \mathrm{i}, t) \tag{30.3}$$

Because Energy-efficient buildings reduce energy consumption, the energy-efficient gains achieved by Energy-efficient buildings besides cost of its available energy saving in economic life used $\mathrm{ANCT_t}$:

$$\mathrm{ANCT_t} = \sum\nolimits_{t=1}^{n-1} \alpha \mathrm{p}\left(\mathrm{Q_t} - \mathrm{Q_t'}\right)(\mathrm{F/P}, \mu, t)(\mathrm{P/F}, \mathrm{i}, t) - \gamma \mathrm{I_0} \tag{30.4}$$

Energy-efficient buildings in the course of the time of energy-saving benefits cover the cost of it's energy saving retrofitting could be represented by dynamic investment recovery period $\mathrm{P_t'}$:

$$\mathrm{P_t'} = m - 1 + \frac{|\mathrm{ANCT_{m-1}}|}{\mathrm{NCT_m}} \tag{30.5}$$

In Eq. (30.5),(F/P, μ, n) is payment of the final value of the coefficient; $(\mathrm{P/F}, \mathrm{i}, \mathrm{n})$ is discount factor is construction phases of economic life; α is actual energy saving efficiency; μ is the growth rate of energy prices; i is discount rate; is the year when cumulative NPV began to appear positive age.

30.5 Example Analysis

30.5.1 Engineering Overview

In this paper, the total construction area of 12,700 square meters of a University Library is to be usedas an example of before and after annual energy consumption, energy-saving and cost analysis of energy saving. The library is located in Xi'an, and is in possession of anopen-shelf reading room, lecture hall, meeting rooms, other electronic reading rooms and various administrative spaces. The height of these respective spaces is 2.9 meters, witha total of five layers. The building includes outer walls of reinforced concrete, an exterior wall outside the mortar, and brush brown acrylic paint. Retrofitting of the library before the insulation is

Table 30.1 Overview of existing public buildings envelope

Name	Materials	Heat transfer coefficient/(W/(m^2 K))
Roof	20 mm thick surface layer of fine aggregate concrete, waterproof layer, 110 mm thick reinforced concrete layer, 25 mm thick plaster	2.7
Wall	20 mm thick cement mortar, 180 mm thick clay brick, 20 mm thick gray lime mortar	2.53
Window	Steel single layer pull/push window	5.0

regarded as beingpoor and has had a significant impact to the students self-study and borrowing experience. Table 30.1 is envelope overview.

30.5.2 Determination of Energy-Saving Design

1. Roof

Roof heat transfer coefficient 2.7 W/(m • K); this higher than the "public building energy efficiency design standards"; The roof being capped with 25 mm thick extruded polyethylene board.

2. Wall

Wall heat transfer coefficient is 2.53 W/(m • K); higher than the "public building energy efficiency design standards". Aerated concrete blocks are used to achieve better thermal insulation properties.

3. Window

The project for the single-layer steel sliding sash windows, the heat transfer coefficient is 5.0 W/(m • K); the plastic-steel windows can reduce the external radiation on the human body, both hot and cold, and also dust with a good sound insulation effect. When making energy-saving windows, the original single-layer hollow glass windows are replaced by single-layer steel sliding-sash window frames, which do not move.

30.5.3 Building Energy Consumption After Energy-Saving

After the transformation of existing public buildings to maintain the structure summarized in Table 30.2:

The statistics, the library before and after the years of energy-saving power consumption, see Table 30.3:

Table 30.2 Energy saving design

Name	Material	Coefficient of heat transfer/(W/(m^2 K))
Roof	25 Mm thick extruded polyphone board	0.97
Wall	200 mm thick aerated concrete block	0.75
Window	Empty glass window	2.7

Table 30.3 The library's electric power consumption before and after retrofitting

Name	Years power consumption (kWh/m^2)
The library before energy saving transformation	898,760
The library after energy saving transformation	436,237

30.5.4 Energy Consumption Analysis Based on Economic Evaluation of Energy Saving

Cost and Energy Saving Energy Saving Calculation of earnings.

The cost of energy-saving type (30.1) calculated with reference to the 2009 "construction project in Shaanxi Province lists" computing the price of materials. Cost Analysis of Energy Saving in Table 30.4 below:

The current price of electricity in Shaanxi Province is 0.7486 RMB/kWh, energy saving retrofitting cost $I_0 = 852{,}618.82$ RMB, the profit after energy saving retrofitting could be work out by Eq. (30.2). This library can save energy fee I_0'=346,244.72 yuan after retrofitting.

30.5.5 Financial Analysis of Energy Saving

The assumed energy price growth rate is 7 %. Assumed public building actual energy-saving efficiency is 100 %, with a discount rate of 6 %. Because the public building energy-saving operational period must be short relative to its cost, the cost of the energy-saving rate-of-change is 100 %, the construction age is 1a, and operation period is 49a; where 1a refers to one full year.

$$\mathrm{NCT_t} = 100\% \times 346244.72 \times (\mathrm{F/P}, 7\%, 3)\,(\mathrm{P/F}, 6\%, 3)$$

$$\mathrm{ANCT_t} = \sum\nolimits_{t=1}^{49} 100\% \times 346244.72 \times (\mathrm{F/P}, 7\%, t)(\mathrm{P/F}, 6\%, t) - 852618.82$$

Table 30.4 Cost of energy saving retrofitting

Energy-saving technology reform	Quantities (m^2)	Comprehensive unit price (yuan)	Total price (yuan)
25 mm thick extruded polyphone board	532.73	108.26	57,673.34
200 mm thick aerated concrete block	4,260.26	88.86	378,566.70
Empty glass window	2,036.58	204.45	416,378.78
Amount	–	–	852,618.82

When $ANCT_t \geq 0$, force t to assume integral values, the calculation shows that $ANCT_2 = -150296.37$ yuan, $ANCT_3 = 205819.78$ yuan, $t \geq 3a$.

Compute dynamic investment recovery period P_t' :

$$NCT_t = 100\% \times 346244.72 \times (F/P, 7\%, 3)\,(P/F, 6\%, 3) = 356116.16$$

$$P_t' = 3 - 1 + \frac{|-150296.37|}{356116.16} = 2.4a$$

Through analysis, the electric power consumption fell 51.46 % after retrofitting, this in line with requirements that energy-saving buildings should save energy at around the 50 %mark after retrofitting. When energy prices rose 7 %, the dynamic investment recovery period sits at 2.4a. Chinese ‘Public Building Energy Efficiency Design Standards’ allow for the increasing of energy-efficient buildings only provided that the payback period does not exceed ten years, so retro-fitting is feasible in the library.

30.6 Conclusion

This paper analyzes the composition of public building energy consumption and, on this basis, selected energy-saving measures in public buildings, as well as the use of financial analysis and economic evaluation of existing public buildings for energy saving. The results show that existing public buildings would be best served by taking full advantage of the energy-saving thermal performance of building envelope improvements as well as the use of natural ventilation; both with the view to improve energy efficiency and to reduce energy-saving costs associated with the running and maintenance of existing public buildings.

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Chapter 31
Method of Product Development Cost Estimating Based on ProA Hierarchical Decomposition

Wen-hui Liu, Xiao-hui Zhao and Ya-wen Dong

Abstract To realize the cost estimating of product development, a estimating method based on Activity and its Process (ProA) hierarchical decomposition was presented integrating with product development process modeling. Cost attributes of ProA Input and Output Item and ProA conversion operations were firstly studied. Cost transfer between ProA Input and Output Item were analyzed in detail, and rules for cost estimating of ProA were also formulated. Finally, the method of the cost estimating was presented, and simulation based on Matlab environments was also conducted.

Keywords Activity-based costing · Cost estimating · Hierarchical decomposition · Product development

31.1 Introduction

As to product development project, cost estimating is important for its technical and economic evaluation; product cost optimization and control and market pricing (Guo 2005). Along with the increase of individuation requirements which demand short-cycle and low-volume, the proportion of development cost in the product life cycle cost rises sharply (Xiaode 2003).

W. Liu (✉)
School of Mechanical & Electrical, Northwest Polytechnic University,
Xi'an, China
e-mail: liuwenhui1976@163.com

W. Liu · X. Zhao · Y. Dong
School of Mechanical & Electrical, Xi'an Polytechnic University,
Xi'an, China
e-mail: xhuizhao@xpu.edu.cn

Y. Dong
e-mail: dongyawen231@163.com

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At present, the researches about product cost estimating mainly take the product as the subject matter and roughly presume product development cost using the product attributes (Folley et al. 1992; Mileham et al. 1993; Chen and Wang 2007; Seo et al. 2002). Because multi-projects are intercrossed concurrent, the cost estimating about the single product development project is difficult. In order to solve this problem, a mentality is proposed that collecting the research and development project cost and assigning it to the new product cost using Activity-Based Costing in Ref. (Cao et al. 2005). Based on Ref. (BenAriech and Qian 2003) in which improved Activity-Based Costing is used for estimating product development cost, Ref. (Qian and BenArieh 2008) analyzes the estimating method of activity cost driver with specific product examples and thus brings up to the product development cost.

However, the estimation about product development cost is not only to obtain the product development cost. The manifestation of cost driver, cost transfer and value chain in the product development operation flow needs to model the development process (Park and Simpson 2005; Qian et al. 2005). The Ref. (Min 2004; Cao et al. 2008) take Activity and its Process (ProA) as basic unit of the product development modeling. That constructing product development process based on the ProA, which avoids ambiguity to the process and the activity, can better support dynamic programming of product development (Cao et al. 2008). In view of this, this paper takes the product development process as the subject matter, quotes the concept of ProA and uses Activity-Based Costing to further research the cost attributes and cost transfer of ProA and establish a estimating method based on ProA hierarchical decomposition to better support cost decision-making of the product development project.

31.2 ProA of Product Development and Its Cost Attributes

31.2.1 Basic Dependent Concepts

The product development process may be decomposed into a series of sub-process and the sub-sub-process…, each sub-process and sub-sub-process are composed of a set of linked activities which correspond to implementation process. There will be logical difficulty when using formalized method to define process and activity in decomposition course. To avoid ambiguity and solve the difficulty, Ref. (Min 2004) proposes that integrating the process and activities as ProA and taking ProA as basic unit of the product development process and also makes detail study on ProA Input and Output Items, conversion operations and ProA hierarchical decomposition. This paper will take these concepts and the research results as foundation of the product development cost estimating. Using the definitions about ProA Input and Output Items and ProA conversion operations in Ref. (Cao et al. 2008) ProA Input and Output Items and ProA conversion operations are summarized as follows with the need of cost estimating.

Definition 31.1 ProA Inputs. The things that will be used up and transfer into output when the product development ProA is implemented.

Definition 31.2 ProA Outputs. The things transform from inputs when using certain resources to implement ProA.

ProA Inputs set:

$$\begin{aligned} IN &= \left(in_1, \ldots, in_i, \ldots in_p\right) \\ i &= 1, 2, \ldots, p, \quad 1 \le p \le 6 \end{aligned} \tag{31.1}$$

ProA Outputs set:

$$\begin{aligned} OUT &= \left(out_1, \ldots, out_j, \ldots out_q\right) \\ j &= 1, 2, \ldots, q, \quad 1 \le q \le 6 \end{aligned} \tag{31.2}$$

The input and output items of a ProA are usually less than 6 (Min 2004; Cao et al. 2008).

Definition 31.3 ProA resources. The roles which support the execution of ProA.

ProA resource set :

$$\begin{aligned} R &= (r_1, \ldots, r_k, \ldots r_m) \\ k &= 1, 2, \ldots, m; 1 \le m \le 6 \end{aligned} \tag{31.3}$$

Definition 31.4 ProA conversion operations. The process of converting ProA Inputs into Outputs using certain resources. It is expressed as:

$$OUT^T = \Phi(IN) \tag{31.4}$$

The conversion operation Φ_j of ProA Output Item uses up resources to finish the conversion from IN_{Φ_j} to out_j, which actually includes a series of activities. Assume that the enterprise has implemented the activity cost management and sets up m activities according to the operation flow and product characteristics. These m activities are $(a_1, \ldots a_s \ldots a_m)$ and their cost driver rates are $(d_1, \ldots d_s \ldots d_m)$. The product development group may determine activity drivers' consumption $\left(l_{j_1}, \ldots l_{js} \ldots l_{jm}\right)$ respond to $(a_1, \ldots a_s \ldots a_m)$ that caused by Φ_j using experience or probability estimation (Zheng and Fan 2007) according to the enterprise' historic data. Here, $l_{js} \ge 0$ and it indicates that this conversion operation does not consume the activity a_m when $l_{js} = 0$.

Definition 31.5 ProA Granularity (Cao et al. 2008). It is a value that measure ProA activity size and the complexity of process to describe ProA decomposition degree in the product development process.

31.2.2 ProA Hierarchical Decomposition

Set a product development project as ProA$^{(0)}$,the 2–9 sub-ProA$^{(0)}$ that decomposed are presented as ProA$_i^{(1)}$, $i \in R, 1 \le i \le 9$, ProA$_i^{(1)}$ can be decomposed into ProA$_{ij}^{(2)}$, $i,j \in R, 1 \le i, j \le 9$. Following the hierarchical decomposition of ProA, its input and output items and resources are correspondingly decomposed. Conversion operations completed by father ProA can be separately completed by its sub-ProA. As shown in Fig. 31.1, ProA$^{(0)}$ Input, ProA$_i^{(1)}$ Input and ProA$_{ij}^{(1)}$ Input Items are called External Input Items, ProA$^{(0)}$ Output, ProA$_i^{(1)}$ Output and ProA$_{ij}^{(1)}$ Output Items are called External Output Items.

31.2.3 Cost Transfer Between ProA Input and Output Items

Along with ProA hierarchical decomposition, the input–output relations among each sub- ProA and sub-sub- ProA are clear gradually. The mutual quotation among internal input and output items build relationship between one ProA and another ProA. So, mutual restrictions arise about ProA execution sequence and time. And also, it will cause cost transfer between input and output items of up-down stream ProA. Such condition exists that multiple ProA may take the same internal output item as their input item. As shown in Fig. 31.1, ProA$_{1,3}^{(2)}$ and ProA$_{2,2}^{(2)}$ simultaneously quote a internal output item in ProA$_{1,2}^{(2)}$ as their input item. So, we consider the cost of this internal output item is also quoted and is shared by ProA$_{1,3}^{(2)}$ and ProA$_{2,2}^{(2)}$. Thus, the cost between related internal input and output items maintain balance in the process of ProA hierarchical decomposition. Similarly, certain ProA output items are both external output items and internal output items. Such as the output item in ProA$_{2,3}^{(2)}$, one part of the cost is outputted, the other part flows into ProA$_{2,4}^{(2)}$. As the product development progresses, each external input

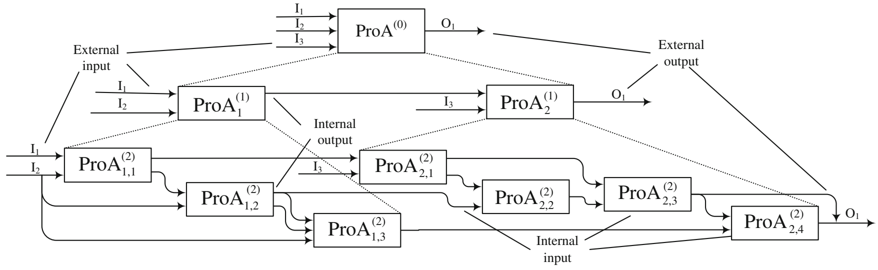

Fig. 31.1 ProA hierarchical decomposition

items cost and activity cost caused by convention operations are accumulated progressively and outputted finally. So, in the product development process, how the value on the activity chain accumulates and transfers in the enterprise is manifested.

31.2.4 Cost Attributes of ProA

31.2.4.1 Cost Attributes of Input Set

The cost attributes of input item "in_i" is expressed as:

$$AC_{in_i} = (P_{in_i}, N_{in_i}, C_{in_i}) \tag{31.5}$$

P_{in_i} is the original cost of in_i. When in_i is a external input item, P_{in_i} is determined by the developer according to the enterprise' historic data and experience; When in_i is a internal input item, P_{in_i} is determined by the original cost of the quoted internal output item.

N_{in_i} is cost distribution factor. When in_i is communal or derives from the output item of certain ProA and also is simultaneously the input item of this ProA and the external output item of product development process, only part of the P_{in_i} flows into this ProA as input item cost and its distribution rate is N_{in_i}. In this case, the value of N_{in_i} is $(0, 1)$, otherwise, the value of N_{in_i} is 1. Note that if certain ProA shares the same input item, the sum of each ProA's $N_{in_i}$is 1.

C_{in_i} is the actual input cost of the input item, the cost that input item's original cost P_{in_i} distributes into the ProA.

$$C_{in_i} = P_{in_i} \cdot N_{in_i} \tag{31.6}$$

The cost attributes of ProA input set is:

$$AC_{IN} = \sum_{i=1}^{p} C_{in_i} = \sum_{i=1}^{p} P_{in_i} N_{in_i} \tag{31.7}$$

31.2.4.2 Cost Attributes of Output Set

The cost attributes of ProA output set "out_j" is:

$$AC_{out_j} = \left(P_{out_j}, N_{out_j}, C_{out_j}\right) \tag{31.8}$$

P_{out_j} is the original cost of output item, the cost value that determined by input item cost and conversion operations cost.

N_{out_j} is external output factor. When out_j is only the external output item, the value of N_{out_j} is 1, which indicates that its cost flows out completely as part of the

$\text{ProA}^{(0)}$ output cost of product development project. When out_j is only the internal output item, the value of N_{out_j} is 0, which indicates that its cost flows into other ProA. When out_j is not only the external output item but the internal output item, the value of N_{out_j} is $(0, 1)$, which indicates the output cost proportion of the external output item in this output item's original cost P_{out_j}. The sum of N_{out_j} and N_{in_i} is 1, $N_{in_i}$is the distribution factor of the internal input item that quotes this output item.

C_{out_j} is the actual external output cost of the output item. And,

$$C_{out_j} = P_{out_j} \cdot N_{out_j} \tag{31.9}$$

The cost attributes of ProA output set is:

$$AC_{OUT} = (AP_{OUT}, AWC_{OUT}) \tag{31.10}$$

Here,

$$\begin{cases} AP_{OUT} = \sum\limits_{j=1}^{q} AP_{out_j} \\ AWC_{OUT} = \sum\limits_{j=1}^{q} AC_{out_j} \end{cases} \tag{31.11}$$

AP_{OUT} means the original cost of ProA output set and AWC_{OUT} means external output cost of output set.

31.2.4.3 Cost Attributes of Conversion Operations

The cost attributes of Φ are:

$$AC_{\mathrm{Pr}\,oA} = \sum_{j=1}^{q} C_{\Phi_j} \tag{31.12}$$

Here, C_{Φ_j} is activity cost that consumed by Φ_j.

$$\begin{aligned} C_{\Phi_j} &= \left(l_{j1}, \ldots, l_{js}, \ldots l_{jm}\right)(d_1, \ldots d_s \ldots d_m)^T \\ &= \sum_{s=1}^{m} l_{js} \cdot d_s \end{aligned} \tag{31.13}$$

31.3 Cost Estimating Rules Of ProA

Definition 31.6 Cost Contribution. In order to get certain output item, all input items cost consumed in the process of converting the inputs to output item is called the cost contribution of input items to the output item.

Along with the unceasing decomposition of product development process, ProA granularity and the number of ProA input items become fewer and fewer and the input cost is less and less. It is necessary to atomize ProA, neglect the correspondence between input and output items and only care about the cost of input and output items. Set the rules below:

Rule 31.1 The cost contribution of input items to output items is consistent. That is:

As to $\forall in_i \in IN$ $(in_i \in IN_{\Phi_j} \vee in_i \notin IN_{\Phi_j})$, the cost contribution portion that in_i contributes to out_j in the cost of in_i is $1/q$ (q is the number of output items).

The rule leads to the expression of ProA output item cost:

$$AC_{out_j} = C_{\Phi_j} + AC_{IN}/q = C_{\Phi_j} + \sum_{i=1}^{p} C_{in_i} \Big/ q \tag{31.14}$$

According to the rule, the maximum error of cost contribution that ProA input item provides to output item is:

$$\delta_{\max} = |C_{in_i} - 1/qC_{in_i}| = (1 - 1/q)C_{in_i} \tag{31.15}$$

With ProA hierarchical decomposition, the input item cost C_{in_i} is less and less, the number of output items q also reduces, so the error becomes smaller and smaller. To reduce the estimating error, we should make the ProA granularity smaller to reduce the output items when ProA input item cost is higher. It proves that this error only affects the cost transfer between ProA and doesn't influence the total cost of the product development.

Rule 31.2 when several ProA quote the same input item, each ProA should share the quoted input cost according to its cost distribution factor.

The rule can balance the incoming and outgoing of the cost between the related ProA input and output items of up-down stream in product development process, and achieve cost transfer and recurrence relations between ProA.

31.4 The Cost Estimating Method Based on ProA Hierarchical Decomposition

Based on the recurrence element rule of cost estimating above, the process of cost estimating based on ProA hierarchical decomposition is described in Fig. 31.2.

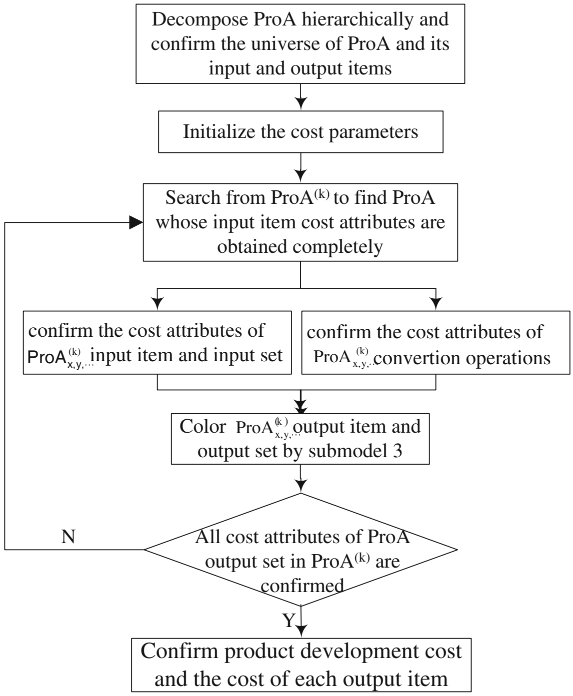

Fig. 31.2 The process of cost estimating based on ProA hierarchical decomposition

31.4.1 Confirm the Universe of Product Development ProA and Input and Output Items

As shown in Fig. 31.1, the process of product development and input and output items are decomposed hierarchically. The input and output items of the top layer ProA$^{(0)}$ are recorded as $I^{(0)} = (I_{[0-1]}, I_{[0-2]}, \ldots)$ and $O^{(0)} = \left(O_{[0-1]}, O_{[0-2]}, \ldots\right)$.

As the decomposition of ProA$^{(0)}$ and its input and output items, the next layer ProA$^{(1)}$ is obtained and ProA$^{(1)}$ = (ProA$_1^{(1)}$, ProA$_2^{(1)}$,…, ProA$_n^{(1)}$). The sets of ProA$^{(1)}$ input and output items are $I^{(1)} = (I_{[1-1]}, I_{[1-2]}, \ldots, I_{[2-1]}, I_{[2-2]}, \ldots)$ and $O^{(1)} = (O_{[1-1]}, O_{[1-2]}, \ldots, O_{[2-1]}, O_{[2-2]}, \ldots)$. Similarly, we can sequentially decompose ProA$^{(1)}$ to obtain different layers of ProA and its input and output items. Until ProA is no longer decomposed,the bottom layer of ProA set is recorded as ProA$^{(n)}$ and its input and output items sets are $I^{(n)}$ and $O^{(n)}$.

The universe of product development ProA is recorded as U_{ProA} then U_{ProA} = (ProA$^{(0)}$, ProA$^{(1)}$,…, ProA$^{(k)}$). The universe of ProA input and output items are recorded as $U_I = \left(I^{(0)}, I^{(1)}, \ldots I^{(n)}\right)$ and $U_O = \left(O^{(0)}, O^{(1)}, \ldots O^{(n)}\right)$. As to $\forall$ProA $\in \mathrm{U_{ProA}}$, ProA input set $IN \subset U_I$, ProA output set $OUT \subset U_O$, ProA input item $in_i \subset U_I$ and ProA output item $out_j \subset U_O$.

31.4.2 Initialize the Cost Parameters

Firstly, using experience and probability estimation to estimate the activities required by each ProA conversion operation and the consumed quantity $\left(l_{j_1}, \ldots l_{js} \ldots l_{jm}\right)$ of activity drivers according to enterprise's historical data, so as to confirm the cost of ProA conversion operation Φ_j. Then, give the cost value of all external input items, cost distribution factor N_{in_i} of each ProA input item and external output factor N_{out_j} of each output item in the process of hierarchical decomposition.

31.4.3 Confirm the Cost Attributes of ProA Input and Output Items in Term of Cost Estimating Rules

1. Suppose the process of product development is decomposed to layer k, searching from $\mathrm{ProA}^{(k)}$ to find $\mathrm{ProA}^{(k)}_{x,y,\ldots}$ whose input item cost attributes are obtained completely.
2. Confirm the cost attributes of $\mathrm{ProA}^{(k)}_{x,y,\ldots}$ input set by Eq. (31.9).
3. Get the cost C_{Φ_j} of each conversion operation due to the estimated activity drivers quantity $\left(l_{j_1}, \ldots l_{js} \ldots l_{jm}\right)$ and activity drivers rates $(d_1, \ldots d_s \ldots d_m)$ required by conversion operations. So, the cost attributes of $\mathrm{ProA}^{(k)}_{1,\ldots}$ conversion operations are obtained by Eq. (31.12).
4. By Cost Estimating Rules, according to external output factor N_{out_j} of output item determined by the developer, confirm cost attributes of output item. Then the cost attributes of $\mathrm{ProA}^{(k)}_{x,y,\ldots}$ output set are obtained by Eq. (31.11) and cost estimating rules.
5. $\mathrm{ProA}^{(k)}_{x,y,\ldots}$ output items are usually the input items of downstream ProA or output items of the whole product development process, based on this, we can confirm the cost attributes of input items of downstream ProA.
6. Judge that whether the cost attributes of ProA output set in ProA $^{(k)}$ are all confirmed, or return to 1.

31.4.4 Product Development Cost

When the cost of output set in ProA $^{(k)}$ is all confirmed, searching from ProA $^{(k)}$ to find all the ProA output items then sum the external output cost, that is the sum of ProA output set in ProA $^{(k)}$ and this sum value is the product development cost. Now, we get not only the product development cost but the cost of each output item.

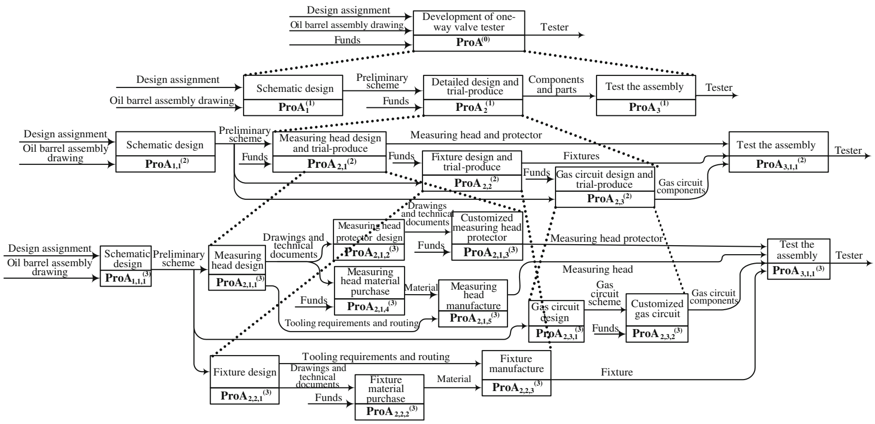

Fig. 31.3 The development process model of testing part based on ProA hierarchical decomposition

31.5 Simulation Example

In order to carry out other assembly tasks, we need to test the flexibility of the one-way valve after one-way valve group of the car oil pump are assembled in oil barrel. The design of the testing part is the core of one-way valve tester. As shown in Fig. 31.3, on the basis of design target, the development process model of one-way valve testing part is builded based on ProA hierarchical decomposition.

As shown in Table 31.1, the activities and activity drivers in product development are setted according to the characteristics of business process and activity driver rates are calculated in term of resources consumed by activities in nearly one year.

Table 31.1 The set-up of activities and activity drivers in the process of product development

Activity codes	Activity names	Activity drivers	Activity driver rates (yuan/activity unit)
a_1	Discussion	Task time	20
a_2	Documentation	Task time	20
a_3	Drawing design	Number of drawing	100
a_4	Checking the drawing	Number of drawing	30
a_5	Process design	Task time	20
a_6	Process audit	Task time	20
a_7	Tooling preparation	Task time	15
a_8	Material purchase	Material quantity	5
a_9	Basic trial-producing	Task time	18
a_{10}	NC trial-producing	Task time	250
a_{11}	Assembling	Task time	20
a_{12}	Testing	Task time	40

Table 31.2 Initialization of the cost parameters

ProA codes	Input items			Output items and their conversion operations		
	Input items	Cost distribution factors	External input item cost	Output items	Activities consumed by output items conversion operations	External output factors
$\mathrm{ProA}^{(3)}_{1,1,1}$	$I_{1,1,1-1}$,$I_{1,1,1-2}$	1, 1	$I_{1,1,1-1} = 0$, $I_{1,1,1-2=}0$	$O_{1,1,1}$	$\phi_{1,1,1} = (10,4,1,1,0,0,0,0,0,0,\ 0,0)$	0
$\mathrm{ProA}^{(3)}_{2,1,1}$	$I_{2,1,1}$	1/3	NULL	$O_{2,1,1-1}$	$\phi_{2,1,1-1} = (8,4,12,12,0,0,0,0,0,0,0,0)$	0
				$O_{2,1,1-2}$	$\phi_{2,1,1-2} = (0,0,0,0,36,16,0,0,0,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,1,2}$	$I_{2,1,2}$	1/3	NULL	$O_{2,1,2}$	$\phi_{2,1,2} = (3,4,1,1,0,0,0,0,0,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,1,3}$	$I_{2,1,3-1}$,$I_{2,1,3-2}$	1, 1	$I_{2,1,3-2} = 150$	$O_{2,1,3}$	$\phi_{2,1,3} = (0,0,0,0,0,0,0,3,0,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,1,4}$	$I_{2,1,4-1}$,$I_{2,1,4-2}$	1/3, 1	$I_{2,1,4-2} = 150$	$O_{2,1,4}$	$\phi_{2,1,4} = (0,0,0,0,0,0,0,9,0,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,1,5}$	$I_{2,1,5\text{-}1}$,$I_{2,1,5-2}$	1/3, 1	NULL	$O_{2,1,5}$	$\phi_{2,1,5} = (0,0,0,0,0,0,35,0,35,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,2,1}$	$I_{2,2,1}$	1/3	NULL	$O_{2,2,1-1}$	$\phi_{2,2,1-1} = (6,4,6,6,0,0,0,0,0,0,0,0)$	0
				$O_{2,2,1-2}$	$\phi_{2,2,1-2} = (0,0,0,0,16,8,0,0,0,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,2,2}$	$I_{2,2,2-1}$,$I_{2,2,2-2}$	1/2, 1	$I_{2,2,2-2} = 150$	$O_{2,2,2}$	$\phi_{2,2,2} = (0,0,0,0,0,0,0,6,0,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,2,3}$	$I_{2,2,3-1}$,$I_{2,2,3-2}$	1/2, 1	NULL	$O_{2,2,3}$	$\phi_{2,2,3} = (0,0,0,0,0,0,15,0,15,\ 0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,3,1}$	$I_{2,3,1}$	1/3	NULL	$O_{2,3,1}$	$\phi_{2,3,1} = (2,2,1,1,0,0,0,0,0,0,0,0)$	0
$\mathrm{ProA}^{(3)}_{2,3,2}$	$I_{2,3,2-1}$,$I_{2,3,2-2}$	1, 1	$I_{2,3,2-2} = 5{,}800$	$O_{2,3,2}$	$\phi_{2,3,2} = (0,0,0,0,0,0,0,11,0,\ 0,0,0)$	0
$\mathrm{ProA}^{(3)}_{3,3,1}$	$I_{3,1,1-1}$,$I_{3,1,1-2}$, $I_{3,1,1-3}$,$I_{3,1,1-4}$	1, 1, 1, 1	NULL	$O_{3,1,1}$	$\phi_{3,1,1} = (0,0,0,0,0,0,0,0,0,0,2,2)$	1

Table 31.3 Simulation result

ProA codes	Output items	Output items cost (¥)	External output factors of output items
$\mathrm{ProA}_{1,1,1}^{(3)}$	$O_{1,1,1}$	410	0
$\mathrm{ProA}_{2,1,1}^{(3)}$	$O_{2,1,1-1}$	1,868.34	0
	$O_{2,1,1-2}$	1,108.33	0
$\mathrm{ProA}_{2,1,2}^{(3)}$	$O_{2,1,2}$	1,204.16	0
$\mathrm{ProA}_{2,1,3}^{(3)}$	$O_{2,1,3}$	1,369.16	0
$\mathrm{ProA}_{2,1,4}^{(3)}$	$O_{2,1,4}$	1,129.16	0
$\mathrm{ProA}_{2,1,5}^{(3)}$	$O_{2,1,5}$	3,392.49	0
$\mathrm{ProA}_{2,2,1}^{(3)}$	$O_{2,2,1\text{-}1}$	548.34	0
	$O_{2,2,1-2}$	1,048.34	0
$\mathrm{ProA}_{2,2,2}^{(3)}$	$O_{2,2,2}$	1,228.34	0
$\mathrm{ProA}_{2,2,3}^{(3)}$	$O_{2,2,3}$	2,271.68	0
$\mathrm{ProA}_{2,3,1}^{(3)}$	$O_{2,3,1}$	346.67	0
$\mathrm{ProA}_{2,3,2}^{(3)}$	$O_{2,3,2}$	6,201.67	0
$\mathrm{ProA}_{3,3,1}^{(3)}$	$O_{3,1,1}$	13,355	1
Product development cost		13,355	

As shown in Table 31.2, the product development group and experts initialize the input and output items and conversion operations of the 12 ProA in the third layer of the hierarchical decomposition in Fig. 31.3.

According to this estimating method, the simulation model in Matlab environments for polychromatic sets recurrence element model is builded. The cost of product development process is estimated by the simulation model and the simulation result is shown is Table 31.3.

Considering the case above, the cost estimating method of product development based on ProA hierarchical decomposition can be analyzed as follows:

The estimating method is flexible. As the hierarchical decomposition continues, the estimating accuracy is promoted gradually.

Based on this estimating method, the enterprise can know the cost of the product development and each output item, the organization can know well about how the value on the product development activity chain accumulates and transfers in the enterprise, and also the method can well support the cost analysis of operation process and the improvement of business process.

The estimating method is based on the process- oriented cost analysis and is useful for the cost estimating of the product life cycle and cost analysis of business process, thereby supporting the function cost analysis of the business process.

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Chapter 32
Empirical Analysis on Influencing Factors to the Capital Structure of GEM Board Listed Companies in China

Shi-chang Lu and Xue Luo

Abstract Taking the GEM (Growth Enterprises Market) Board listed company in China as research subjects, using factor analysis and regression analysis methods, this article analyzes influencing factors of the capital structures. The result shows that: there is negative relationship between the operation situation, operation security, operation efficiency and capital structure, that is, the profitability, cash flow, debt-paying ability and operating ability of the company are negatively related to capital structure; while there is positive relationship between operating prospect, operating ability and capital structure, that is, the scale, growth potential and mortgage assets are positively related to capital structure.

Keywords Capital structure · Factor analysis · GEM board · Influencing factors · Regression analysis

32.1 Introduction

The purpose of establishing GEM Board in China is to promote the development of enterprises which have potentials and are technically innovative. As one layer of China's stock market, it has common features and functions (Wang and Zhang 2011). Meanwhile, as a relatively independent market, it plays a special role. Therefore, choosing GEM Board listed companies as research subjects and analyzing the influencing factors of capital structure have realistic meaning and research value.

S. Lu (✉) · X. Luo
College of Business Administration, Liaoning Technical University, Huludao, China
e-mail: lorna881123@126.com

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32.2 Literature Review

The factors which influence the capital structure are as follows: the scale, profitability, growth potential, asset structure and internal resources of the company. There are three points of view on the relationship between company scale and capital structure: Xiao (2004) holds the idea that they are positively related, Lu and Yu (1998) think the relationship is not obvious Wang and Yang (2002), think they are negatively related. As to the relationship between profitability and capital structure, Hong and Shen (2000) and Tong (2010) agree they are positively related while Lu and Yu (1998), Hu and Zhu (2011) think they are negatively related. To the relationship between growth potential and capital structure, Zhang et al. (2000) and Wang (2011) think they are positively related, Hong and Shen (2000) and Yuan (2011) agree the relationship is not obvious, Shen and Zhu (1999), Xiao and Wu (2002) think they are negatively related. To the relationship between asset structure and capital structure, Lu and Yu (1998), Liu and Ye (2011) think they are positively related. To the relationship between internal resources and capital structure, and Tong (2010) think they are negatively related.

The above results indicate that scholars' opinions vary. Therefore, this article aims to find out the factors which influence the capital structure of China's GEM Board listed companies so as to promote their development.

32.3 Analysis on Influencing Factors

32.3.1 Sample Choice and Data Source

On October 30, 2009, China's first group companies in GEM went on the market in Shenzhen Stock Exchange. By February 24, 2012, 291 companies have been listed in GEM. We choose 100 companies at random as our research subjects, among which one company has been ruled out because of illegal operation and eight companies are eliminated because of losing parts of the data. Therefore, 91 companies are left to be research subjects.

32.3.2 Variable Illustration

Based on the scholars' researches, combined with features of these companies and their capital structures, we analyze the influencing factors according to the following financial index (Lu and Meng 2012) (Table 32.1).

Table 32.1 Variable Desigh

Variable	Definition method			Calculation Formula
Dependent variable	Capital structure	Assets-liabilities ratio	Y	Annual total debts in the end/annual total assets in the end
	Company scale	Natural logarithm of total assets	X_1	Ln(total assets)
		Natural logarithm of main business revenue	X_2	Ln(main business revenue)
	Profitability	Main business profit margins	X_3	Main business profit/main business revenue
		Total assets profit margins	X_4	Net profit/total assets
		Net assets profit margins	X_5	Net profit/net assets
	Growth potential	Total assets growth rate	X_6	Annual asset growth/last year's total assets in the end
		Main business revenue growth rate	X_7	(Annual main business revenue-last year's main business revenue)main business revenue in the end
Independent variable	Debt-paying ability	Liquidity ratio	X_8	Current asset in the end/current liability in the end
		Quick ratio	X_9	(Current asset-stock in the end)/current liability in the end
	Cash flow	Return rate of operating cash	X_{10}	Net flow of operating cash/total assets
		Net operating cash flow for per-share	X_{11}	Net operating cash flow/number of common stock
	Operation ability	Inventory turnover ratio	X_{12}	Annual main business cost/
		Total assets turnover ratio	X_{13}	Annual main business revenue/annual average total assets
		Accounts receivable turnover ratio	X_{14}	Annual main business revenue/annual accounts receivable balance
	Asset structure	Fixed assets ratio	X_{15}	Fixed assets in the end/total assets in the end
		Mortgage assets ratio	X_{16}	(Fixed assets in the end + inventory)/total assets in the end

32.3.3 *Empirical Research*

32.3.3.1 Factor Analysis

(a) Determine if the variables are suitable for factor analysis (Table 32.2)

From the above table, based on Kaiser's test, it seems that it isn't suitable for factor analysis because its KMO is 0.539. But its obvious probability of BST is 0.000, which is 0.05 lower than obvious level. It is suitable for this analysis. Therefore, we think the 16 indicators are suitable for factor analysis.

(b) Establish Factor Variable (Table 32.3)

From the table, we can see eigenvalues of 5 factors are bigger than one and their cumulative contribution rates of variance are bigger than 80 %. So we can explain it using 5 factors instead of 16.

(c) Factor Variable Naming Explained (Table 32.4)

From the table, we can draw the following conclusions and name each factor as follows:

Factor 1 offers information about main business profit margins, total assets profit margins, net assets profit margins, return rate of operating cash, net operating cash flow for per-share, namely, the operating situation of a company.
Factor 2 offers information about ln total assets, ln main business revenue growth rate, total assets growth rate, namely, the operating prospect of a company.
Factor 3 offers information about liquidity ratio and quick ratio which reflect the debt-paying ability and liquidity of the company, namely, the operating security of a company.
Factor 4 offers information about fixed assets ratio and mortgage assets ratio, namely, the operating power of a company (Le 2011).
Factor 5 offers information about inventory turnover ratio, accounts receivable turnover ratio, total assets turnover ratio, namely the operating efficiency of a company.

Table 32.2 KMO and Bartlett's test

Kaiser–Meyer–Olkin test		0.539
Bartlett sphericity test	Approximate Chi square	1766.962
	df	120
	Sig.	0.000

Table 32.3 Total variance explained

Component	Initial eigenvalues			Extraction of square and loading		
	Total	Variance contribution rate %	Cumulative contribution rate %	Total	Variance contribution rate %	Cumulative contribution rate %
1	3.755	23.470	23.470	3.451	21.567	21.567
2	3.464	21.653	45.123	2.781	17.378	38.945
3	2.669	16.682	61.805	2.644	16.524	55.469
4	1.459	9.119	70.924	2.409	15.058	70.527
5	1.306	8.164	79.088	1.370	8.562	79.088
6	0.907	5.668	84.756			
7	0.756	4.725	89.481			
8	0.621	3.884	93.365			
9	0.422	2.638	96.003			
10	0.311	1.946	97.949			
11	0.123	0.772	98.720			
12	0.085	0.532	99.253			
13	0.065	0.406	99.659			
14	0.043	0.266	99.925			
15	0.011	0.071	99.996			
16	0.001	0.004	100.000			

Table 32.4 Rotated component matrix

Variable	Factor				
	1	2	3	4	5
Ln total assets	0.122	0.813	0.074	−0.489	−0.060
Ln main business revenue	0.048	0.858	−0.283	−0.139	−0.030
Main business profit margins	0.716	−0.168	0.461	−0.092	−0.180
Total assets profit margins	0.911	0.125	−0.055	0.013	−0.165
Net assets profit margins	0.812	0.311	−0.230	0.023	−0.186
Total assets growth rate	−0.033	0.778	0.189	−0.173	0.036
Main business revenue growth rate	0.270	0.795	0.022	0.075	0.004
Liquidity ratio	0.068	−0.285	0.884	−0.034	−0.004
Quick ratio	0.076	−0.286	0.887	−0.038	0.000
Return rate of operating cash	0.809	−0.070	0.056	0.077	0.441
Net operating cash flow for per-share	0.737	−0.114	0.213	0.013	0.387
Inventory turnover ratio	−0.128	−0.139	$2.533E-5$	−0.039	0.649
Total assets turnover ratio	−0.301	0.528	−0.173	0.019	0.683
Accounts receivable turnover ratio	0.187	0.299	−0.019	0.073	0.704
Fixed assets ratio	0.092	0.017	−0.078	0.964	0.030
Mortgage assets ratio	0.009	0.101	−0.114	0.962	−0.035

Table 32.5 Coefficients

Model		Nonstandardized coefficients		Standardized coefficients	t	Sig.
		B	Standard error	Beta		
1	(Constant)	0.142	0.009		15.948	0.000
	F_1	−0.028	0.009	−0.251	−3.170	0.002
	F_2	0.043	0.009	0.380	4.795	0.000
	F_3	−0.057	0.009	−0.500	−6.313	0.000
	F_4	0.003	0.009	0.027	0.345	0.731
	F_5	−0.011	0.009	−0.096	−1.210	0.229

32.3.3.2 Establishment of the Regression Model

The above table indicates that the P value of T test for constancy, factor 1, factor 2 and factor 3 are lower than 0.05, which means their coefficients are bigger or smaller than 0. Factor 1, factor 2 and factor 5 have negative relationship with debt ratio. While factor 2 and factor 4 have positive relationship with debt ratio. But their P value of T test is higher than 0.05, which means their coefficients are near 0. So we can get the regression equation as follows (Table 32.5):

$$Y = 0.142 - 0.028F_1 + 0.043F_2 - 0.057F_3 + 0.003F_4 - 0.011F_5$$

32.4 Conclusion

Conclusion 1: Compared to traditional companies, 90 % of the companies in GEM have great growth potential and high profitability and are technologically innovative, so they can satisfy their capital needs and lower the chances of running into debt by reserving surplus, hence affecting the capital structures of these companies.

Conclusion 2: Most of the companies in GEM are technologically innovative companies; they have more floating assets but less fixed assets or real estate, so their liquidity ratio and quick ratio are high. Therefore, when they are in great need of fund, they can change assets into cash and lower the chances of running into debt.

Conclusion 3: The negative relationship between operating ability and debt ratio is not obvious because the 100 companies we choose as research subjects are not classified. This results in the obscure regression results.

Conclusion 4: The GEM provides good financing ways for small and medium-sized enterprises. Their scales are relatively small, fixed assets and real estate are less. It is hard for them to get loan from the bank so they have less mortgage assets and lower debt ratio.

Conclusion 5: As most of these companies are technologically innovative, they have less mortgage assets. Their fewer chances to get bank loan lower their debt ratio. All these factors have affected the capital structure of these companies. Because of lacking mortgaged property, they have lower assets debt ratio. So their debt will not change with the mortgage assets.

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Chapter 33
Measure Strategic Cost Based on Activity-Based Costing Method

Ming-ming Wang and Dong-ping Han

Abstract In present, within this highly competitive environment, cost management has become a critical survival skill for many firms. These firms integrate the cost factor into the establishment of a long-term and external competitive advantage, and this phenomenon suggests the need to reposition the management of cost as a strategic method instead of simply cutting costs. Strategic cost measurement is an important factor of strategic cost management, which, to a large extent, has been ignored in previous academic discussion. The purpose of this paper is to describe the measurement of strategic cost management. And this paper consists of two main parts: analyzes the continents of strategic costs based on ABC, and then identifies a way to measure the strategic cost accurately. The additional third part is a supplementary discussion: how to make the measurement work and how to use the information to assist strategic decision-makers, followed by a short further discussion.

Keywords Strategic cost management · Cost driver · Strategic cost measurement · Strategic management evaluation

33.1 Introduction

The idea of "strategic cost management" was born at Cranfield School of Management, through research in value management and consequent work at BP. In 1990, the head of strategic planning at BP Chemicals, Simon Woolley, was faced with the problem of helping the management team review costs in the light of external and competitive pressure (Grundy 1996). Simon was concerned that the cost, which needed to be managed for the longer term, should reflect the BP's

M. Wang (✉) · D. Han
School of Management, Harbin Institute of Technology,
150001 Harbin, People's Republic of China

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approach of Value Based Management. BP saw cost as a strategic issue, and had managed it in this way, which led the researchers focus on the sustainability of cost improvements.

Simultaneously Shank and Govindarajan presented an analysis-driven framework on this subject. They analyzed the relative importance of several management accounting methods depending on whether the firm was pursuing cost leadership, cost differentiation, or cost-focus strategies (Govindarajan and Shank 1992). They suggested that companies choosing cost leadership would put the most emphasis on the traditional cost accounting applications. They would use standard costs to assess performance and product cost as an input to pricing decisions, and use the flexible budgeting for manufacturing cost control. They would perceive meeting budgets and the analysis of competitors' costs to be of great importance. On the other hand, those companies which differentiate their products as a way of achieving competitive advantage would consider marketing cost analysis to be critical to their success. They would consider the flexible budgeting and the meeting of budget to be of only moderate importance, and rank standard cost for performance assessment, rank product cost for pricing decisions, and use competitor cost analysis of little importance. Shank and Govindarajan published a book named "strategic cost management" in which they added other important strategic cost management factors, and established the management control systems.

Although Michael E. Porter detailed specific ways in which managers could position their firms to have a strategic advantage over their competitors ten years before strategic cost management was defined, his internal and external value chain theory is widely used by the researchers in strategic cost management (Porter 1985). The value chain for any firm is the linked set of value-creating activities from basic raw material sources for component suppliers through to the ultimate end–use product delivered into the final consumers' hands. Value chain analysis (together with cost driver analysis and strategic positioning analysis) becomes a basic tool of strategic cost management.

Kaplan argues that traditional management accounting systems produce misleading management information (Cooper and Kaplan 1988). Historically, costs were allocated in relation to the physical use of production assets, including both capital and labor. But as the service element grew as a proportion of the value chain of most businesses, the traditional bases of cost allocation became increasingly irrelevant. There are often more important activities which underpin the value added within the production process than those associated with physical operations. Kaplan proposed that managers should adopt "Activity Based Costing" or "ABC" as a new cost management method. "Activity-based costing is a powerful tool" Robin Cooper and Robert S. Kaplan pointed out, "…ABC analysis permits managers to understand the sources of cost variability and reveals actions they can take to reduce demands on their organizational resources…" by measuring costs right, manager can make right decisions. On the other hand, bad information on product costs leads to bad competitive strategy (Cooper and Kaplan 1991). "ABC is designed to provide more accurate information about product costs…".

Business management is a continuously cycling four stages: formulate Strategies, communicate strategies, develop and carry out tactics to implement the Strategies, and then monitor success at achieving strategic objectives by developing and implementing controls (Trussel and Bitner 1998). Cost information plays a role at each of these stages. From this perspective, strategic cost management can be defined as the managerial use of cost information explicitly directed at one or more of the four stages of the strategic management cycle. Then it is quite obvious that cost is essential in both internal strategic analysis and external competitive analysis. But if we want to know how to get detailed cost information, what is the score of a certain strategy, or how to lower a certain kind of cost, the published papers do not seem like could provide us much information.

33.2 Preparation Before Measuring

Firms utilize different strategies to gain competitive advantage over their competitor, and they use cost leadership, differentiation, and competitor analysis as powerful weapons to accomplish this task. No matter what strategy they are using, they still want to reduce costs to maximize their profits. This purpose makes strategic cost measuring and evaluating important in strategic management. Only if the decision makers know what their current accurate costs are, and which kind of costs is unusual, can they make right management movements to minimize the costs or try another strategy. Strategic management is famous mostly because it emphasizes on making decisions between management, employees, and especially attaches importance to external environment. We can always find phrases like "supplier relationships" or "pay attention to our competitors" and so on, all of which are sending us a strong signal that external environment is very important in strategic cost management. Correspondingly, the cost based on exploring the external environment is a characteristic factor compared to traditional cost management (Trussel and Bitner 1998). However, how to measure this important cost has been long forgotten. The main concern of activity-based costing is the concept of cost driver. And with an enlarged concept of cost driver (non-activity based), a whole picture of SMC measurement could be drew thoroughly.

Activity-based costing (ABC) is designed to provide more accurate information about production and support activities and product costs so that management can focus on the products and processes with the most leverage for increasing profits. It helps managers make better decisions about product design, pricing, marketing, and mix, and it encourages continual operating improvements. Although it is a system that is used to determine the full costs of services and products more accurately, it can do a lot more than that, and providing he cost analysis of other cost objects is one example. Traditional costing approaches have been largely based on the use of single cost drivers to measure or analysis cost behavior. But real life is not that simple, firms always have economic activities with multiple cost drivers. The careful selection of activity and cost drivers in ABC is the key to achieving the benefits of this cost system. Generally, ABC begins with the identification of activities that use overhead resources and pooling the respective activity costs into cost pools. Second, cost drivers are determined to measure the amount of activities that are required by different cost objects. Finally, costs are allocated to the cost objects in proportion to their respective cost driver demand. ABC is well known for its cost-allocating accuracy, but the expensed capital is always beyond consideration. Although the expensed cost does not count in the cost of products, it does occupy the company resources. It is necessary to take expensed cost seriously. Besides, strategic cost management is outstanding because it introduces a new cost-managing way: managing cost to make firms more competitive by jumping out from the factory (that means the ABC method should be widened).

Before measuring strategic cost, we have to do an elaborate preparation.

1. Identify the target firm which we are about to analysis.

If it is a simple small firm that only has one type product, a dozen staff, and several machines, then the strategic cost management is not quite necessary to be used, because the information cost of strategic cost management is quite large. We have to make sure the target firm produces different kinds of goods or services, and has complicated production lines, and the overhead costs must be very high. Only in this situation, using ABC can provide strategic cost management more accuracy information on the cost side.

2. Make a list that contains detailed costs. Manager can get this information from accountants', technician or other professional staff by interviewing, consulting or reading subsidiary ledger.
3. Find out cost drivers. In strategic cost management it is acknowledged that cost is caused, or driven, by many factors that are interrelated in complex ways. Understanding cost behavior means understanding the complex interplay of the set of cost drivers in any given situation. Before actually choose the cost drivers, we have to do some groundwork: distinguish cost drivers (Shank 1989). Cost drivers can be broken into two categories, structural kind and executional kind. Structural cost drivers are the causes of expenditure which are already set before the company begins to run, such as expenditure of scale, scope, experience, technology, complexity. Executional cost drivers are those determinants of a firm's cost position which hinge on its ability to execute successfully, including work force involvement, capacity utilization, product configuration, exploiting linkages with the involvers in the value chain. After discriminating what are cost drivers and what kind are they, we can select cost drivers to make preparation for the measurement of strategic cost. This process should follow 3 steps:

   (a) Determine the activity centers.
   Activity centers were discussed in the process view. The activity center is defined as series of value-added activities that happen for the same reason. This concept of activity center is much broader than the "activity center" definition that we are already familiar with. It could be beyond the manufacturing shop, and also take non-value-added and not-for-profit activities

into account. Strategic cost contains extensive range of resource-consuming subjects, including internal and external aspects. Determining which activity center we want to analysis is crucial, especially in cost measurement. Because of the limited budget and available time, usually we can not have an overall cost measurement. Costing is something we want to do to get further information about the expenditure in a certain activity and this kind of information derivates from the initial cost information which can not tell us any thing but a number. After costing, we can get detailed cost information, and this information is assigned to a certain activity center in which we can use the information to evaluate and to help decision-maker to make the right strategy.

(b) Pick cost drivers in the activity center or centers we choose (Homburg 2001). Cost is used to improve the firm performance but not all the activity drivers aim to improve the firm performance. Picking cost drivers means the selection should contain all kinds of cost drivers.

We can explain this by the examples below:

The first class of initiative can be illustrated by an insurance company. The company redesigns claims settlement process for clients so that it is simpler, faster, and less stressful on the clients to remedy their losses. When the clients want to buy insurance products, this company seems pretty much attractive. Then this initiative strengthens the strategic position of this company. Simultaneously, the insurance company redesigns its accounts payable system to fit the new claims settlement process. This movement has no strategic significance other than to make the firm more profitable. If the insurance company finds that they have too much staff stuck at sales department, so human resources manager decides to downsize this department. A few months later, this manger would have an earful criticism because the sales performance is so lame. This cost-reduction initiative leads to extreme low sales performance, so that we can not just take cost as the only factors to make further decision.

The cost drivers are chosen for further study, and paying attention to the character of each kind of the cost drivers could be helpful in accurate cost measurement and cost analysis. If the cost drivers aimed to strengthen the firm’s strategic position, the decision-maker should know how many resources did these cost drivers and how well are strategic position strengthened. When the improvement was not so obvious and the expenses are overly obvious, the strategic plan should definitely renew.

(c) Assign costs to the cost drivers. In this step, we want to get detailed cost information attached to each cost driver. This woke would not be completed if the accountants recorded cost information in terms of categories rather than cost drivers in the first place. Luckily, as the activity-based management is widely used in many firms, it is possible to calculate costs by the drivers.

33.3 Measuring Strategic Cost

We can not allocate costs by direct labor and machine hours like the traditional costing method did. The new method ask us to allocate costs based on the drivers, so distinguishing the expenses in different hierarchies makes clear what happened in each hierarchies and why it happened(Cooper and Slagmulder 1998). It provides a structured way of thinking about the relationship between activities (or non-activity-based movements) and the resources they consume. After the preparation expenses could be allocated to the cost objects in different firm hierarchies (we can also call them the activity centers but they do contain non- activity-based centers).

The firm hierarchies can be divided into two categories: activity-based expenses, and non-activity-based expenses.

Activity-based expenses are the expenses which are related to activity processes (Cooper and Kaplan 1991). When managers segregate activities in this way, a hierarchy emerges. Some activities like drilling a hole of machining a surface are performed on individual units. Others-setups, material movements and first part inspections-allow batches of units to be processed. Still others-engineering product specifications, process engineering, product enhancements, and engineering change notices-provide overall capability that enables the m = company to produce the product. And plant management, building and grounds maintenance and heating and lighting sustain the manufacturing facility (Schniederjans and Garvin 1997).

Non-activity-based expenses are hard to identify and allocated to a certain product. In this part, manager exerts capitals in external cost to gain competitive advantages. The external cost is used to build cooperative relationships with suppliers and dealers and the other co-partners in value chain. Others-improving consumer satisfaction aims to gain comparative advantage over competitors. Further more, the cost on knowing what our competitors are doing is crucial to analyze competitors. Environment protection is another external cost spender. Sometimes this kind of cost happed because of statutory and regulatory requirements. Internal cost for long-term strategy happens in form of quality control, research & design cost, knowledge creation, and others.

The feature of strategic cost management is that it takes non-activity-based expenses into account, especially the cost according to competitor analysis. Through the firm hierarchies, we can notice that the initial investment can be divided into two parts ultimately: capitalized cost and expensed cost. Capitalized cost is the defray that happens to fulfill the main business, so it ought to enter the costs of products, services or other property. Expensing the cost is to write off the entire amount in the first year, and ought to deduct the profit.

Since we have gotten the hierarchies, a list of available cost drivers in each firm hierarchies can be made (the non- activity-based cost drivers can be classified to different department where they took place). Then assign costs to the cost drivers, and measure the costs.

J Activities are measured by J cost drivers, and j is the jth cost driver $(j \in J)$.
I is a set of products or cost objects, and i is the ith cost object $(i \in I)$.

Cj is the total cost of the jth cost driver.
Ei is the total cost of the ith cost objects. Ei contains both capitalized cost and expensed cost.
Qij is the use of jth cost driver j by cost object i.
Rij is the jth cost driver rate by the ith cost objects, we can call it "cost driver rate" for short.

$$R_{ij} = \frac{Q_{ij}}{\sum_{i=1}^{n} Q_{ij}}, \tag{1}$$

$0 < R_{ij} < 1$, and $\sum_{i=1}^{n} R_{ij} = 1$

The total cost of the ith cost object is

$$E_i = \sum_{j=1}^{m} R_{ij} C_{ij} = [R_{i1} \quad R_{i2} \quad ,,, \quad R_{im}] \begin{bmatrix} C_1 \\ C_2 \\ , \\ , \\ C_3 \end{bmatrix} \quad i = 1, \ldots, I \tag{2}$$

$$\begin{bmatrix} E_1 \\ E_2 \\ , \\ , \\ E_n \end{bmatrix} = \begin{bmatrix} R_{11} & R_{12} & , & , & R_{1m} \\ R_{21} & R_{22} & , & , & R_{2m} \\ , & & & & , \\ , & & & & , \\ R_{n1} & R_{n2} & , & , & R_{nm} \end{bmatrix} \begin{bmatrix} C_1 \\ C_2 \\ , \\ , \\ C_m \end{bmatrix} \quad \mathrm{E} = \mathrm{RC} \tag{3}$$

E is a matrix of the costs on cost objects individually, through which we can easily tell the cost structure.
R is a matrix of cost driver rates, and it reflects the percentage of the use of single cost driver by individual cost object from the use of same one driver by the whole objects.
C is a matrix of the total cost of one cost driver, and it is easy to make a comparison among different cost drivers.

Several writers point out that, strategic cost management increases information cost. Besides there are lots of cost drivers, which makes it even harder to calculate the cost by cost drivers. Furthermore, it is often desirable to focus management attention on only a few main cost drivers. Since the selected cost drivers are used to allocate overall overhead costs, they must also bear the overhead costs corresponding to non-selected cost drivers. But luckily, as some optimal cost driver selection theories are invented, strategic cost measurement can be practical.

The effects of replacing one cost driver by another one to optimized the model (Wang et al. 2003).

To eliminate cost driver m by using only simple cost driver replacements, overhead costs Cm is allocated by one of the remaining J−1 cost drivers. If cost driver $k \neq m$ is chosen as the respective allocation basis, its overhead costs increase from Ck to Ck + Cm, and the accuracy loss for cost object i is

$$\mathrm{E_i} - \mathrm{E_i^m} = \mathrm{C_m}(R_{im} - R_{ik}).$$

Carsten Homburg proposed an optimal cost driver selection theory which brings this theory to completion. That is to eliminate one cost driver by a set of the remaining drivers instead of using only simple cost driver replacements (Lord 1996).

In this combination each cost driver is assigned a certain weight determining the portion of Cm to be allocated on the basis of this cost driver. If in allocating overhead costs Cm, a weight of $\lambda_{mk} \geq 0$ is assigned to cost driver $k \neq m$, its new overhead cost is Ck + $\lambda_{mk} \times \mathrm{C_m}$, and the accuracy loss for cost object i is

$$\mathrm{E_i} - \mathrm{E_i^m} = \mathrm{C_m}\left(R_{im} - \sum_{k=1}^{J} \lambda_{mk} \times R_{ik}\right) \tag{4}$$

To have weights that are consistent with the replacement of cost driver m, one must set $\lambda_{m.m} = 0$. Furthermore, requiring convex combinations $\sum_{k=1}^{J} \lambda_{m.k} = 1$ ensures that precisely the overhead costs Dm are allocated.

This restricted version of the model is familiar to an approach proposed by Babad and Balachandran (1993) where only simple replacements of cost drivers are feasible. In addition, it reduces the danger of overweighting selected cost drivers.

33.4 Conclusion

In this paper a cost measurement system was proposed. Firm expenses hierarchies are introduced to exposes the relationships between economic movements and resource consumption. Only when these relationships are clarified, can we identify the cost drivers that hide behind those movements. A calculation model and two cost-driver-selection models were used to fulfill the strategic cost measurement task. Then an evaluation system was built, and part of which applies the out put of strategic cost measurement. And there are still a lot researches need to be done. Here are some further discussions:

1. Accounting information should be more accuracy. Sometimes, decision-maker should not use accounting numbers to drive decisions, for the managers may decorate the accounting data, the accuracy of the numbers is not totally reliable. Accounting numbers should be used to guide decisions with care.
2. Strategic cost measuring plays of an influencing role more than an informing role. Proponents of strategic management accounting, by comparison, consider that detailed financial quantification is essential. Based in many cases on informal guesses, one could question any comparability between one firm and

its competitors. Some writers assert that the concepts of strategic planning and positioning only cover part of business strategy. Strategies may be deliberate, that is, achieved as planned. However, in many cases strategies emerge from interaction between management, employees and the environment. Accordingly, in some cases the emergent strategy may differ from the strategy originally planned by management. Because the situation changes dramatically, so that means strategy can not be planned. Well this view surely is not believable. Pasteur Louis said: chances favor the minds that are prepared, similarly, a strategic plan is always necessary for strategic cost management. All we need is a flexible plan which is insensitive to the environment, or it is just too risky.

3. Over the past few years, in most industries has put the spotlight very much on costs. Sometimes this spotlight has been focused purely internally and without regard for the interdependencies within the business system. More rarely has cost management been sensitized to avoid the negative impact on competitive position. We must all amplify the message that this generates weaker financial performance–poor cost management destroys shareholder value. Strategic cost management is therefore not merely a philosophy uniting different management disciplines. It is a practical way of overcoming the narrow and political budget games which traditionally beset cost management.

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Chapter 34 The Influences of Sports Consumption on Expanding Domestic Needs and Its Function of Promoting Economic Growth

Xin-jian Luo, Yu-hua Qiu and Yu-qin Liu

Abstract Stimulating the people's consumption needs and adopting positive financial policies are the basic guarantee of the sustained development of our national economy. This essay mainly analyzes the effects of stimulating the sports consumption on the expansion of domestic needs and economic growth. Owing to the close relationship of sports with other industries, the increased consumption in sports will in turn lead to the development of many relevant industries. Also, the stimulation of economic growth from sports consumption is subject to little influence of the whole economic environment. Finally, the sports consumption generally tends to increase with the change of the people's life consumption structure. All these indicate that the positive influences of stimulating sports consumption and economic growth can be predicted. But as far as the present state of our sports consumption is concerned, it is impractical to anticipate a great contribution of sports consumption to our economic growth in a short time. The article proposes that we should have an objective evaluation of the function of our present sports consumption.

Keywords Sports consumption · Economic growth · Promote · Sports · Influence

34.1 Introduction

With the 20 years of reform and opening-up, the mode of Chinese economy has been changed from a planned economy to a socialist market economic. Gradually, the increasing economic of the main constraint has also been controlled by the market demands. National buyer's market is gradually formed, and the market

X. Luo · Y. Qiu (✉) · Y. Liu
Department of Sports, China University of Geosciences (Wuhan),
Wuhan, China
e-mail: honeyqyh@163.com

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economy of inherent characteristics and consumer's demands should be paid more attention by those enterprises for their production. The social consumption demands are becoming the main force of the growing of National economics (Tasman Asia Pacific and Emxt and Young 1998).

But can Sports consumption become a hotspot of period consumption and in future? And what kind of roles can Sports consumption play on promoting China's national economy? Those become the hot topic for the physical education scholars and our government. This paper discussed how Sports consumption can become an important way of boosting domestic demand and the understanding and evaluation of sports consumption in the expansion of domestic demand and the function of promoting the economic growth. The applicable criteria that follow.

34.2 A Large Number of Economic Growth can be Made by Sports Industry and Other Related Industries in the Fields of Consumption

There is a closely relationship between sports industry and many other industries, new industries can be formed on the edge across many emerging industry, a developing sports consumption can push a large number of industry department's spending (Sub-committee on the study of sport Canada 1998). All that contributes a lot for the expansion of domestic demand and can promote the economic growth. In fact, in the American economic structure of the existing 42 sectors, and the sports industry is listed as industrial correlativeness degree of the eighth (Brenda and Pitts 1998). It explains the cross area of the directly and indirectly influence on the fields of consumption. So a positive development of the sports consumption can promote the development of these new industries. The some typical fields can be:

34.2.1 The Sports Advertising Industry

First, confirm that you have the correct template for your paper size. This template has been tailored for output on the US-letter paper size. If you are using A4-sized paper, please close this file and download the file for "MSW A4 format".

34.2.2 Maintaining the Integrity of the Specifications

Nowadays, the sports hot has go around the world, and be warm welcomed in many developed countries in sports. Sports became one part in people's daily life. Many international smart enterprise and advertising agent zeroed in on sports extensive social participation (General office of State Council 1999). The athletes and the athletic sports were used as the way to enter the big market. So every event (especially important international events), not only show the brilliant match itself, but also show the advertising war between enterprises. Now, it is popular for using the image of the sports on the media advertising in every country. By the promotion of sports, there are more than 4,000 companies become the “sports promotion” full-time departments in United States in order to improve the awareness of the product amongst the public (The organization Department of the Central Committee of the CPC 2000). With the developing of Chinese socialist market economy, the sports advertising industry in our country sports should also be pay more and more attention by companies, and this market should be actively developed in future.

34.2.3 Sports Tourism

Sports tourism is a new industry. With the developing of the social economic and pursuit of public spiritual life, the sports activities have become the main content in people’s the leisure life. Different from other general tourism, Sports tourism has the characters of diversity, thrilling and strong interest and others. Thus it has a broad prospect of prosperous. Sports tourism has become backbone industry in many countries. In China, the first international sports tourism company was set up in 1988. Many new tourist projects (such as since the automobile, motorcycle, bicycle tourism, mountaineering tourism, martial arts tourism, skiing hunting tourism) has been made up since then (Tian 2007). It not only stimulated domestic resident tourist consumption demand, but also attract a large number of overseas visitors to our country, and it played a positive role on the increasing in national foreign reserves.

We can foresee, along with the increasing of our country people’s income level, Chinese sports tourism industry will have a huge development.

34.2.4 Sports Fitness Entertainment

This industry mainly offer the service of gymnasium rehabilitation, entertainment venues, equipment and the technical service for the consumers (Xu et al. 2007). Many includes popularity of sports, such as gymnasium, gymnastics, badminton, table tennis, martial arts, qigong, skating and so on. Usually this kind of movement on the project are called “light sport” project to distinguish with those sports which need to pay more physical (like ball games). Light sport project has a broad mass base, it can play an important role to improve people’s living quality, and expand employment, improve people’s health level and also can improve labor efficiency. With the rising standard of people’s live, more spare time can be used for the public. This kind of sport should be a broad market demand, and can play a positive role in economic growth.

34.3 The Trends of Sports Consumption Growth Suggest that it will Play a More and More Important Role for the Economic Growth

Generally, with the developing of Chinese residents' sports consumption level, a growing trend can be seen in residents' consumption. There are three main reason: the first, the improvement of people's living standard will increase the people's social consumer demand, the consumer areas and consumption quality will also expand and improve accordingly, the cultural consumption will increase, the public needs will be diversified. Second, in the view of social consumption demand, having the basic consumption of existence, consumer demand will be increased mainly to the need of development and enjoy the sports consumption. Third, with the promotion and popularization of "national fitness program" "lifetime sports", a great sports consumption demand will increase more and more fast. Public will change the traditional ideas of "cost no money or less" on physical exercise to that "voluntary spend money on health, enjoyment, and the pursuit of happiness, health and long life" (Zhang and Zhang 2000). The increase of free time for the residents to participate in physical activities provides the opportunities and conditions directly. With the development of the residents' income and the enhancement of scientific culture, a scientific, standardized needs of physical activity will increasing more fast; By the end of the century, the structure of population age will be changed a lot, our country will enter an aging society. So the demands of the old people in sports consumption will be more and more urgent. From the above analysis, we can realize clearly that sports consumption demand growth situation shows that it will produce more and more important role in increasing the expansion of domestic demand and promoting economic development.

34.4 Economic Growth Depends on Sports Consumption More than the Influence of Economic Environment

In 1990s, there is a strange phenomenon has caused many economists attention. Both the developed countries and emerging developing countries, along with the global economic depression or regional economic depression, most industry development speed will slow down or stagnation, but sports industry and its relevant industries always can contrarian upward. Economics theory tells us that: the fundamental reason is that market consumption demand to meet the caused by the change of consumption structure of the national evolution of industrial structure. The reason why sports industry and related industries can grow against the economic worsening environment is that it was caused by the rising public demand. So why sports consumption in the economic environment deteriorated can remains strong momentum of the rise, the basic reason is following: first, in the economic developed countries, the effect of professional sports almost more than any other in the national life hot spots. Because of the sports industry, there is a special business content, the market has unlimited development space. Second, the world sports population growth sharply to sports products demand increase greatly. According to the 1995 census, the proportion of the total population of sports population, Japan for 63 %, Germany for 61 %, American for 56 %, Norway for 52 %; According to the survey, in 1996 China's sports population over 16 years old of the total population of ratio of 15.5 % (31.4 %, including 7–15 years old student, and military officers and soldiers) (Meek 1997). it show that our country sports population is higher than the average level of the developing countries, but is lower than those developed countries and moderately developed countries. The reason for the increase of the sports population is mainly caused by the needs of people's leisure and entertainment, but has less relationship with the change of the economic environment degree. The third, the large international event can stimulate sports consumption demand, and promote the economic growth, and even reduce some relief economic environment deterioration of pressure. The use of sports intangible assets is engaged in business activities for the global economy, and had brought great benefits. In 1988, there are nearly $10.1 billion incomes are from the issuance of Olympics commemorative coins, the content such as stamps. In 1996 the United States ABC company spends a staggering amount of $1.2 billion for the Atlanta Olympics television rights, but had cleared over 100 million dollars incomes by reasonable management (Australia Bureau of Statistics 1997).

34.5 An Objective Understanding Should be Made on the Role of the Present Situation of Present Sports Consumption Level Between Economic Growth

It is still too early for us to expect that sports consumption can make a greater contribution to the economic growth in a short time. Main reasons are the following several aspects:

The first, the sports consumption level and personal disposable income depends more on the future income expect. At present, people's sports consumption behavior is limited by the residents' limited personal disposable income and the expected income in future. Nowadays, for the level of the world of relatively popular leisure sports consumption, for example, in 1996, the study of Japanese economist show that, recreational sports market development level and market structure and per capita disposable income growth basic are positively correlated, the relationship between the main consumption expenditure structure by decision. Sports consumption level and at the same time and personal income expectations of future residents about. The economics theory tells us: the consumer is income function, the strength of the expected consumption changes reflect people's expectations of income.

Second, Chinese sports fitness entertainment market at present or the regional market, in the Midwest, sports entertainment market has not really formed, and distributed mainly in some cities. The sports competition demonstration market, it is main or seasonal or different market, and influenced by the non-economic factors, we cannot see a stability market. Obviously, the sports industry is in the two main market of the development of the existing level and the actual market size also suggests that we still have a long way to go.

Third, sports consumption structure in our country is singleness, according to the survey data, the mainly sports consumption for Chinese urban residents is to buy sportswear, such as consumer material primarily socks, 81.0 % (not including sports equipment and other sports physical material, this part of the accounts for 9.5 %); so the total sports consumption and other labor service consumptions of the residents in our country can be add up to about 10 %. But in American, the national survey statistics show that 1998 American sports consumption amount of \$47 billion, of which only in various games spent watching the cost of tickets for \$6.4 billion, accounting for about 14 % in the bowling, golf, and other aspects of the expenses also has amounted to \$6.2 billion (Liu 2006). Compared with Sports consumption and sports consumption physical labor services, there are many different features. Such as sports physical consumption material has certain durability, people won't repeat purchase in a short time, and a family used to buy sports physical consumption spending won't long-term stability data growth, this indicates that physical real consumption material demand is limited, but the sports consumption demand of labor services are universal and limitless. Due to the characteristics of sports service products, it decided that it has broad market, and the need of our country's current sports service has not been satisfied yet. It is limited that only use the demand of growing sports consumption in the condition of the sports market in China. Therefore, actively explore the sports service market, so as to make a big contribution to economic growth is very important.

To sum up, we can expect that the growing sports consumption in the expansion of domestic demand will play an important role in promoting the economic growth. But from the current situation of Chinese sports consumption, we can hardly expect that the sports consumption can make a big contribution to economic growth in a short time. So how to improve the sports industry for the national economy and made it as a new growth point, is a long way for us to go. We should establish confidence, change the idea, and positive efforts to increase relevant work of strength, to push forward China's sports consumption, and contribute to our the national economy development which is sustained, stable and healthy.

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Chapter 35
The Analysis of Environmental Population Capacity for the Yunyang County Based on the Ecological Footprint

Jia-jun He and Xue-jun Wang

Abstract The great change have happen to the residents life and economic of reservoir region as the successful completion of three gorges dam project and the impoundment of reservoir. The sustainable development of the residents and regional economic become research hotspot on reservoir area. Among them, the analysis of population and environment is one of the key in the three gorges dam reservoir area. Based on the ecological footprint method, the article discuss population environmental capacity of Yunyang County in Chongqing, establish ecological footprint model, analysis and forecast environmental population capacity by the data of Yunyang County. At last, the paper draws out useful policy suggestions.

Keywords The ecological footprint · The ecological carrying capacity · The ecological deficit

35.1 Introduction

In the stage the three gorges dam project from completion into the normal operation, the main tasks of the project also are transformed from construction to operation management. The formation of reservoir results in population migration and changes. At the same time, the quality and climate conditions of different land are changing along with reforestation of the national implementation and the project of natural forest protection. Local residents also work from traditional agricultural production into various kinds, such as processing industry and work out etc. Now there is problem that need analyze and understand urgently whether or not the environment can support the need of resident's survival and

J. He (✉) · X. Wang
The College of Economy and Management, Wuhan University, Wuhan, China
e-mail: hjj1618@163.com.cn

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development in the present and long-term. So it is the effective guarantee to complete the following work of the three gorges dam project and keep the sustainable development of reservoir area that establish appropriate model of environmental population capacity, track and forecast the trend of change on the environmental population capacity.

35.2 The Ecological Footprint

The professor Morris put forward the concept of ecological footprint who works in Canada British Columbia University. The notion shows that the population within designated unit (a person, a city, a state or all mankind) needs how many biological productive lands and the water area to produce needful resources and absorb deuterogenic waste in the current technology conditions. William and Wackernagel explained the concept from different aspects in 1996 later: a biological productive region space which can continue to provide resources or absorb waste (Wackernagel et al. 1999).

The ecological footprint transforms resources everyone consumes into the global united productive area. Through the calculation of difference on regional ecological footprint between the overall supply and overall demand (ecological deficit or surplus), there can reflect the different of ecological environment status accurately in the world. The ecological footprint not only can reflect personal or the local resource consumption intensity, but can reflect the supply capacity of regional resources and the total resource consumption (Wackernagel and Monfreda 2004). At the same time it reveals the ecological threshold for human survive. Through comparing demand of human and supply of nature in the same unit, it can measure the sustainable development with regional comparability. In Applications, the ecological footprint depends on the population scale, the material life level, the technical conditions and ecological productivity. The results of the assessment make the press and magnitude of biosphere clear in every time and space where be analyzed.

35.3 The Model of Environmental Population Capacity Based on Ecological Footprint

The calculation of environmental population capacity base on two simple facts: there can keep most of the consumption of resources and most of the waste; these resources and most waste can are converted to biological productive land.

The calculation of the environmental population capacity is divided into two parts, which conclude calculation of the ecological footprint and ecological carrying capacity. When ecological carrying capacity is greater than the ecological footprint, the difference is said as ecological surplus, express the resources the per capita takes up is still in permitted range of the ecological carrying capacity. When ecological footprint is greater than ecological bearing capacity, the difference is said as ecological deficit, express resources the per capita takes up is more than ecological carrying capacity. The ecological deficit shows that human load of the area exceed its ecological capacity. For meeting the demand in the existing level to the life consumption of population, this area either import lack resources from outside region to balance the ecological footprint, or consume natural capital stock to make up for the deficiency.

In the calculation of the ecological footprint, the biological productive area considerate mainly six types: fossil energy land, farmland, forest land, meadow, construction land and waters. Because ecological productivity is different at variety of biological productive land types, the calculation must uses the world average productivity to convert consumption and absorptive amount of waste into biological productive area. So there introduce equilibrium factor to make biological productive land of different types into equivalent ecological productivity, that can make ecological footprint aggregated.

The equilibrium factor is the ratio of biological productivity of per unit area with some kind of biological productive land and average productive land in World. It is a added coefficient in process of equalizing different land type with the development of technology and different of management level, or the effects such as environmental pollution and soil degradation, the land productivity of different types will change, the ratio between the productive forces and the world (that is, equilibrium factor) can also be different. So the year researched is different, the equilibrium factor isn't unanimous completely. According with research of Wackernagel to the changes of equilibrium factor on six kinds of biological productive land from 1961 to 1999, in the nearly 40 years, equilibrium factors only exist minor changes in all kinds of biological productive land of the world. Thus, the paper adopts the research result of Wackernagel in 1997, which is shown as Table 35.1.

So the computation formula of ecological footprint (Helmut et al. 2001):

$$ef = \sum R_j \times A_i = \sum R_j \times \frac{P_i + I_i - E_i}{Y_i \times N} \quad (\mathrm{i} = 1, 2, 3, 4, 5, 6;\ \mathrm{j} = 1, 2, 3, 4, 5, 6) \tag{35.1}$$

The computation formula of the ecological footprint in total area:

$$EF = N \times ef \tag{35.2}$$

Table 35.1 The equilibrium factor

Types of land	The equilibrium factor
Farmland	2.8
Meadow	0.5
Forest land	1.1
Waters	0.2
Construction land	2.8
Fossil energy land	1.1

In formula, the ef means ecological footprint of per capita (hm^2/people); the R_j expresses the equilibrium factor; the A_i shows component of ecological footprint; the i means the type of consumer goods; the j expresses the types of biological productive land; the P_i means average production ability of the first i kind of consumer goods; the I_i shows the inputs or imports quantity of the first i kind of consumer goods; the E_i means output or exports quantity of the first i kind of consumer goods; the Y_i shows the world average production of the first i kind of consumer goods; the EF means the total ecological footprint for regional population (hm^2); the N means total area population.

In the calculation of the ecological bearing capacity, there need introduce yield factors. The yield factor is said productivity coefficient also. It is a parameter which can convert ecological productive land into comparability for various countries and areas. In the calculation of ecological carrying capacity, because the productivity has big difference in different countries or regions even same type unit land, the actual area of biological production land is not compared directly in different countries or regions, which needs to be regulated. The difference of yield factor can be calculated by comparing local production in different countries or regions with average yield of the world.

According to the growth trend of the cultivated land yield factor of Chongqing, which is calculated by the world average yields as the benchmark, there structure prediction model (Kathryn et al. 1998; Mccool 1994). The model is shown as formula 35.3.

$$y = 1.3587e^{0.0496x} \left(\mathrm{R}^2 = 0.89\right) \tag{35.3}$$

In formula, the y means yield factors of farmland in the year predicted; the x expresses the year change and make 2001 to 1. The grown rate of other type land yield factor is calculated by refer to the grown rate of farmland. So the yield factors forecasted in 2015 and 2020 are shown as Table 35.2.

So the computation formula of ecological carrying capacity:

$$ec = A_j \times R_j \times Y_j \quad (\mathrm{j} = 1, 2, 3, 4, 5, 6) \tag{35.4}$$

The calculation of regional ecological bearing capacity:

$$EC = N \times ec \tag{35.5}$$

Table 35.2 The yield factor

Types of land	The yield factor (2015)	The yield factor (2020)
Farmland	2.86	3.66
Meadow	1.87	2.4
Forest land	0.39	0.5
Waters	2.06	2.64
Construction land	2.86	3.66
Fossil energy land	0	0

In formula, the ec means ecological bearing of per person; the A_j shows the component of per capita productive biological area; the R_j means equilibrium factor; the Y_j express yield factors; the EC means regional ecological carrying capacity (hm^2); the j shows the land types.

35.4 The Analysis of Environmental Population Capacity for Yunyang County

The paper uses the related data of Yunyang County to analysis environmental population capacity according with the model above. Taking statistical yearbook of the Yunyang County as the main data sources, the research calculate and forecast ecological footprint of the county in 2008, 2015 and 2020, at same time, the paper apply land use data as data source to calculate the ecological carrying capacity of the year.

The calculation of the ecological footprint can be divided into three parts: the biological resources consumption, energy consumption and trade adjustment of export and import (Jiang et al. 2005). Because of the lack of domestic trade details of import and export, the part of trade adjustment cannot be calculated, so the paper only calculate the biological resources consumption and energy consumption. Considering the statistical differences, lack of biological resources consumption data and actual situation, the research supposes it is consistent basically in biological resources yield and the biological resources consumption in Yunyang County. Therefore, there calculate with the biological resources yield instead of consumption.

Using 2009 statistical yearbook of Yunyang County, the research apply the model of environmental population capacity to calculate the per capita the ecological footprint in 2008. The scholar Xie and Xu (2008) researched ecological footprint of Chongqing city from 1997 to 2006 and draw out the relation about the ecological footprint per capita and GDP per capita, as shown below.

$$\mathrm{ef} = 0.88071 + 0.05109 * GDP\left(\mathrm{R}^2 = 0.93\right) \tag{35.6}$$

In formula, the ef means per capita ecological footprint (hm^2). According to the per capita GDP growth trend of Yunyang County from 2000 to 2008, the paper structure prediction model (Qin 2008), as shown below.

$$Y = 1514.6\, e^{0.1287x}\left(\mathrm{R}^2 = 0.99\right) \tag{35.7}$$

In formula, the Y means per capita GDP (Yuan); the x shows year change and make 2000 year to 1. According with it, the paper forecast per capita GDP of Yunyang County, namely 11,874 Yuan in 2015, 22,598 Yuan in 2020. According to the formula 35.6, the per capita ecological footprint is drawn out for Yuntang County in 2015 and 2020, which is show as Table 35.3.

Table 35.3 The per capita ecological footprint Of Yunyang County

Years	Per capita ecological footprint (hm^2)
2008	1.1651
2015	1.4874
2020	2.0352

Table 35.4 The per capita ecological carrying capacity Of Yunyang County

Years	The per capita ecological carrying capacity
2008	0.6049
2015	1.0326
2020	1.4783

Table 35.5 The per capita ecological deficit in Yunyang County

Years	2008 (hm^2)	2015 (hm^2)	2020 (hm^2)
Ecological footprint/per capita	1.1651	1.4874	2.0352
Ecological carrying capacity/per capita	0.6049	1.0326	1.4783
The ecological deficit or surplus/per capita	−0.5602	−0.4547	−0.5569

The model of population prediction use geometric progression (Chen and Gao 2007; Zhong et al. 2000), as shown below.

$$P = P_0(1 + k)^n \tag{35.8}$$

In formula, the P means the population in the year forecasted (2015 and 2020); the P_0 shows the population of benchmark year (2000); the K expresses the natural population growth rate (5.75 ‰); the N means the differences in predicted year and benchmark year (15 and 20).

Combining with the data of land use, yield factors and population, the per capita ecological carrying capacity is calculated for Yunyang County in 2008, 2015 and 2020. The results are shown as Table 35.4.

So the per capita ecological deficit can be calculated by the per capita ecological carrying capacity and the per capita ecological footprint for Yunyang County in 2008, 2015 and 2020, shown as Table 35.5.

35.5 The Conclusion and Policy Suggestions

The analysis above shows that population environmental capacity model established has good application and the population environment is the overload in Yunyang County. The development model of the Yunyang County is in an unsustainable position. Therefore, it is imperative to protect and improve the ecological environment more positively. In the course of research, the author finds and summarize following several aspects to improve.

1. *Controlling the transition strictly of existing cultivated land, expanding the grassland*. According to dynamic monitoring of the changes of land use, the cultivated land area and the area of the grass reduce gradually and the construction land is increasing gradually, that leads directly to the ecological footprint low in Yunyang County. Thus, in the future of economic development plan, there need control the land conversion strictly and increase the shrub and grass (Wanyan and Wang 2007).
2. *Strengthening comprehensive management of the small watershed, improving soil erosion conditions*. There need combine the engineering measures, biological measures and cultivation measures in the process of soil and water loss management, closing the economic, ecological and social benefits together.
3. *Managing water point source, non-point source pollution and make full use of water resources*. The policy must keep the prevention mainly, supplemented by management in the future development, make sure of the water resources to get rational use.
4. *Preventing ecological environment pollution in the rural*. There must prevent and treat the pollution of the rural ecological environment by control of domestic sewage, chemical fertilizers, etc.

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Chapter 36
The Research on Human Capital and Economic Development of Reservoir Area: Based on the Empirical Study of Yunyang

Zhuo Ren and Jia-jun He

Abstract By doing so, the paper tried to investigate the relationship between human capital and economy development in Yunyang reservoir area from the perspective of human capital. A composite evaluation indicator system of human capital for Yunyang is formed on the basis of previous research, according to which the regional human capital evaluation model and human capital index (H) is obtained by factor analysis and regression analysis. Furthermore, a mathematical model is built through correlation Analysis between H (as well as three key elements) and the regional per capita GDP, which make it possible to provide quantitative advices on the policy decision-making with respect to the effect of human capital investment on economic development in Yunyang reservoir.

Keywords Regional human capital composite index · Economy development · Evaluation model · Empirical study

36.1 Indicator Selection and Calculation of Regional Human Capital Composite Evaluation System

Taking the features of Yunyang reservoir in Three Gorges Project into account, indicators from the aspects of formal education, vocational training, health care and social security are selected according to the principle of data accuracy and availability. The final list of composite evaluation indicator system is presented in Table 36.1 (Dong 2008, Liu 2005).

Z. Ren (✉)
The College of Economy and Management, Wuhan University,
Wuhan, People's Republic of China
e-mail: syrenzhuo@hotmail.com

J. He
The Yangtze River Engineering Supervision and Consultation Co., Ltd,
Wuhan, People's Republic of China

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Table 36.1 The regional human capital composite evaluation indicator system

Level I indicators	Level II indicators	Level III Indicators	Unit
Regional human capital composite evaluation indicator system	Education (H_1)	Education expenses proportion in GDP	%
		College and above proportion in total population	
		College students (specialist included) proportion in total population	
		High school students proportion in total population	
		Teacher to student ratio of high school	
		Teacher to student ratio of secondary school	
		Teacher to student ratio of junior high school	
		Teacher to student ratio of primary school	
	Vocational training (H_2)	Vocational education fund proportion in GDP	
		Emigrant vocational education fund proportion in immigration investment	
		Trainee proportion in labor force	
	Health (H_3)	Health expenditure proportion in GDP	
		Doctors per 10,000 persons	
		Hospital beds per 10,000 persons	
		Health professionals proportion in medical staff	
		Practicing (assistant) doctors proportion in medical staff	
		Registered nurses proportion in medical staff	
	Social Security (H_4)	Social Security expenditure proportion in GDP	
		Pension and social assistance expenditure proportion in GDP	
		Endowment insurance proportion in total population	
		Basic medical insurance proportion in total population	

According to the accessible data in hand, there are missing values in college and above proportion in total population, health expenditure, Social Security expenditure and pension and social assistance expenditure, which requires curve fitting for the missing data in the first place (Ma 2002).

A regression analysis (t = 1 to t = 17) of curve fit for the entire period was applied on the data from 1992 to 2008. The curve fitting models are analyzed by SPSS17.0 and the best fit models are selected by the value of R^2, independent variable t test, F-test value and p(sig) (Lu 2004, Yunyang County Bureau of Statistics 1992–2009).[1,2]

36.2 The Regional Human Capital Composite Index of Yunyang Reservoir Area

36.2.1 Factor Analysis on Regional Human Capital

The calculation results from SPSS17.0 showed that the KMO value of indicator samples is 0.665, the Approx Chi Square of Bartlett test is 257.918, and the significance probability of χ^2 is 0.000 (less than 1 %), which means that the data is statistically correlated. The rotated component matrix is presented in Table 36.2.

In the Table 36.2, the common factor X1 is defined as "population quality, medical technology and social security", which is also called "Human Capital Quality"; the common factor X2, which is positively affected by health expenditure proportion in GDP and education fund proportion in GDP, is defined as "government human capital investment"; the common factor X3 is defined as "education and health service quality" which includes "doctors per 10,000 persons, hospital beds per 10,000 persons, teacher to student ratio of middle school and teacher to student ratio of primary school" (Long 2008, Shujing and Chaoming 2006, Xu 2003).

Table 36.2 The rotated component matrixes

	Component		
	X1	X2	X3
Education fund proportion in GDP	0.364	0.797	
College and above proportion in total population	0.467	0.742	
Middle school students proportion in total population	0.968	0.227	
Students admitted to university proportion in high school students	0.847	0.481	0.159
Health expenditure proportion in GDP	−0.129	0.867	0.397
Doctors per 10,000 persons	−0.778	−0.262	0.134
Hospital beds per 10,000 persons	0.179	0.637	0.685
Health professionals proportion in medical staff	0.481	0.111	−0.683
Practicing (assistant) doctors proportion in medical staff	0.03	−0.111	−0.913
Registered nurses proportion in medical staff	0.919	0.351	
Pension and social assistance expenditure proportion in GDP	0.937	0.114	
Teacher-student ratio of middle school	−0.862		0.436
Teacher-student ratio of primary school	−0.818	0.24	0.485

[1] The data and specific process can be obtained by contacting the author.

[2] "Social security expenditure" has no statistical significance, so we considered replacing the indicator.

In factors, the common factor X1 makes the greatest contribution to H, which is 46.349 %, while the contribution from X2 and X3 is 22.453 and 18.545 % respectively. As a result, it is the improvement of medical technology and social security that is essential for the improvement of human capital in Yunyang reservoir. Increasing investment on medical and health services and education, as well as improving health services and education quality are also required accordingly.

36.2.2 Calculation of Regional Human Capital Composite Index (H)

The factor score function of the initial variables on the common factors of human capital in Yunyang reservoir area is also conducted.

The score functions of the three principal components are as follows:

$$\begin{aligned} X1 = {} & -0.049 \times H13 + 0.203 \times H15 + 0.146 \times H19 - 0.020 \\ & \times H33 - 0.148 \times H34 + 0.162 \times H35 + 0.228 \times H40; \end{aligned} \tag{36.1}$$

$$X2 = 0.384 \times H11 + 0.396 \times H30; \tag{36.2}$$

$$X3 = 0.011 \times H31 + 0.255 \times H32 + 0.118 \times H17 + 0.070 \times H18 \tag{36.3}$$

Scores of the three common factors are calculated according to the score functions, and the composite score of regional human capital are also obtained by weighting calculation on the common factor scores.

The weight of each factor can be calculated by the following formula:

$$X_n = \frac{\text{factor variance contribution rate}}{\text{cumulative contribution rate}} \times 100\,\% \tag{36.4}$$

According to the formula and the data, the weights of X1, X2 and X3 are 53.06, 25.71 and 21.23 % respectively. As follows is the calculation formula of Regional Human Capital Composite Index of Yunyang reservoir area:

$$H = 0.5306 \times X1 + 0.2571 \times X2 + 0.2123 \times X3 \tag{36.5}$$

Z score standardization ($Z = (X - X')/S$) is used to standardize the common factors: X stands for the initial score, X' stands for average of initial scores and S stands for the standard deviation of initial scores. What's more, the analysis process required Z score to be converted into T score (H): The average of the normalized Z score is 50 and the standard deviation is 10, so $T = 10Z + 50$.

As an increasing function, the value interval of Regional human capital composite index (H) is (0, 100): $H = 0$ represents the minimum stock of human capital, while $H = 100$ represents the maximum stock of human capital.

36.3 Yunyang Reservoir Human Capital Economic Growth Relational Model

36.3.1 Econometric Model of Regional Human Capital and Economic Development

Based on the regression analysis on per capita GDP and human capital, we chose H as the independent variable and per capita GDP of Yunyang as dependent variable to establish the econometric model (Robert and Daniel 2003, Wei 2002, Yin 2008).

A linear regression of regional human capital to per capita GDP is conducted by "enter regression" method provided in SPSS17.0 with data obtained from the previous analysis. The regression result is:

$$Y = -2903.951 + 101.953H \tag{36.6}$$

$$R^2 = 0.696,\ F = 34.285,\ P = 0.0001;$$

The F-test and p value indicates that the regression model is statistically significant. According to the model, the regional per capita GDP increases by 101.95 Yuan for 1 unit increase in H. 69.6 % of the changes of per capita GDP can be explained by H, which has a significant effect on per capita GDP.

36.3.2 Relationship Analysis Between Regional Human Capital Elements and Economic Development

Previous data analysis demonstrated that the main elements that affected the regional human capital level of Yunyang reservoir are X1, X2 and X3 in order of decreasing importance.

The econometric model is thus established with the three elements as independent variable and per capita GDP of Yunyang as dependent variable. Using backward regression provided in SPSS17.0, we converted the three indicators of regional human capital into T score and carried out a linear regression to per capita GDP, the result of which is presented in Table 36.3.

The model function can be obtained accordingly:

$$Y = -2721.708 + 103.859TX1 + 40.826T\,X2 - 46.377T\,X3 + \varepsilon \tag{36.7}$$

$R^2 = 0.86$, adjusted $R^2 = 0.828$, F statistic is 26.67; Therefore the model passed the significance test, so are X1, X2 and X3, which means that the components of human capital all have significant correlation with regional economic development.

According to the model, per capita GDP increases by 103.86 Yuan for 1 unit increase of TX1 (population Quality, medical technology and social security

Table 36.3 The analysis on the relationship between regional human capital elements and economic development

Model	R	R Square	Adjusted R square	Std. error of the estimate
Model summary				
1	0.928[a]	0.860	0.828	506.90988

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
Coefficients[a]						
1	(Constant)	−2721.708	781.710		−3.482	0.004
	TX1[b]	103.859	15.367	0.850	6.758	0.000
	TX2	40.826	16.706	0.334	2.444	0.030
	TX3	−46.377	15.611	−0.379	−2.971	0.011

[a] Dependent Variable: per capita GDP
[b] *See* footnote 3

level); increases by 40.83 Yuan for 1 unit increase of TX2 (level of Government investment on human capital); decreases by 46.37 Yuan for 1 unit increase of TX3 (education and health service quality).[3]

36.4 Conclusions and Policy Suggestions

The study used 17-year macro statistical data of Yunyang reservoir to establish a regional human capital econometric model and obtained the regional human capital composite index H and what's more, the econometric model on H (as well as three elements) and regional per capita GDP.

The evaluation model on regional human capital presented in the paper is predictive to the change of human capital stock. According to the H-function equation, Yunyang reservoir should put most attention on raising medical technology and social security level, increasing investment on medical, health services and education, and improving health services and education quality to improve the human capital level.

According to the econometric model on H and the regional per capita GDP, when H increases by 1 unit, the regional per capita GDP increases by 101.95 Yuan. According to the econometric model on H elements and per capita GDP, when TX1 (population Quality, medical technology and social security level) increases by 1 unit, per capita GDP increases by 103.86 Yuan; when TX2 (level of Government investment on human capital) increases by 1 unit, per capita GDP increases by 40.83 Yuan; when TX3 (education and health service quality)

[3] TX1 stands for the value of X1 that has been T-score converted, so does TX2 and TX3.

increases by 1 unit, per capita GDP decreases by 46.37 Yuan. In combination with the H evaluation model, the conclusions provide useful perspectives for the immigration investment policy decision-making.

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Chapter 37
Research on Coal Enterprises Activity-Based Costing Accounting Model Based on ERP

Yan-hui Hou, Min Hao, Wei Wang, Hong-tao Yue and Yong-jun Ding

Abstract Enterprise Resource Planning (ERP) and Activity-Based Costing (ABC) have the different management fields, but they still have the basis for integration, such as the same costing objects, ideas for cost management and management purposes. In this study, based on the system integration thinking and basic concepts of ERP and ABC, the theoretical and practical integration model and framework (based on J2EE platform and web service) of them was constructed. Furthermore, the ABC accounting model of coal enterprises was discussed. This study worked out a new feasible method for ABC accounting in coal enterprises.

Keywords Activity-based costing management · ERP · Integration · Accounting model · Web service

Y. Hou (✉) · M. Hao
Department of Economic and Management, ShanDong University of Science and Technology, Qingdao, China
e-mail: Coolhyh@126.com

M. Hao
e-mail: candyca4145@sina.com

W. Wang
The Principal's Office, ShanDong University of Science and Technology, Qingdao, China
e-mail: W1969@sdust.edu.cn

H. Yue
Mechanical and Electrical Team, Xinglongzhuang Coal Mine, Jining, China
e-mail: hongtaoyue@sina.com

Y. Ding
Electrical and Mechanical Division, Wanfu Coal Mine, Heze, China
e-mail: dyjjdd@126.com

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37.1 Introduction

Although there are different standpoints and functions between ERP and ABC, it is feasible to integrate the ideas of activity based costing management into the use of ERP systems, using ERP's advantages of strong computing power and detailed data. Thus, we can collect, calculate and analyze the activities which consume the resource in supply chain from the design stage, in order to distinguish the value-added and non value-added activities, and take measures to minimize non value-added (or value-added is not strong) activities to optimize resource allocation. Meanwhile, we can implement different activity management in the field of cost accounting, which brings the cost within a predetermined range and controls it more effectively.

37.2 Integration Between ABC and ERP

37.2.1 The Integration Framework from Perspective of New Coal Enterprise ERP

37.2.1.1 Theory Integration Between ABC and ERP

For coal enterprises, ABC and ERP can be integrated in the following aspects: (1) Analyzing every activity in activity chain using the method of ABC to identify value added and no value added activities, restructuring and optimizing the business process of supply chain (Zhuang 2006). (2) According to resource driver and cost driver, calculating activity costs with the method of ABC is more scientific and reasonable. So it provides the foundation for the quotas in EPR and the BOM's making. The model was showed in Fig. 37.1.

37.2.1.2 Implementation Integration Between ABC and ERP

We can integrate ABC and ERP, with integrating the concept of ABC into ERP, to build an activity-based ERP system, which can deepen the level of enterprise management to operational level. In the traditional ERP, main production schedule which guides the entire process of production and operation management drives the capacity requirement planning and material requirements planning (Xia 2006). The traditional functional departments and the basic production units are in the layer of planning and production management. Yet, in activity-based ERP, it starts from the main activity-based production planning, which on one hand drives the capacity requirement planning and material requirements planning, and on the other hand guides the activities of production and operation in activity chain management. And the activities are in the layer of planning and production

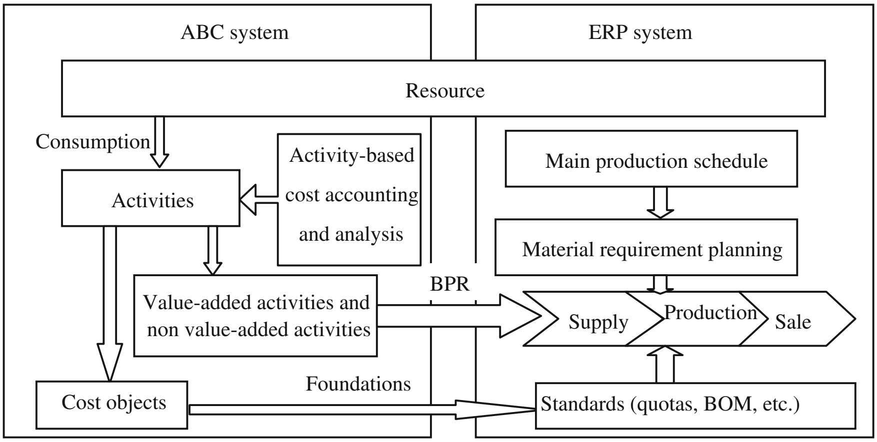

Fig. 37.1 Theory integration model between ABC and ERP

management (Xu and Hua 2003; Baxendale and Jama 2003; Shaw 1998). As to the coal enterprises, the material consumption doesn't constitute the product as an entity. So there are some kinds of specialties in the relationship between production schedule and material requirement, between activity and activity division. The activity-based ERP model is shown in Fig. 37.2 (Khozein 2011; Schulze et al. 2012; Bushong 2008).

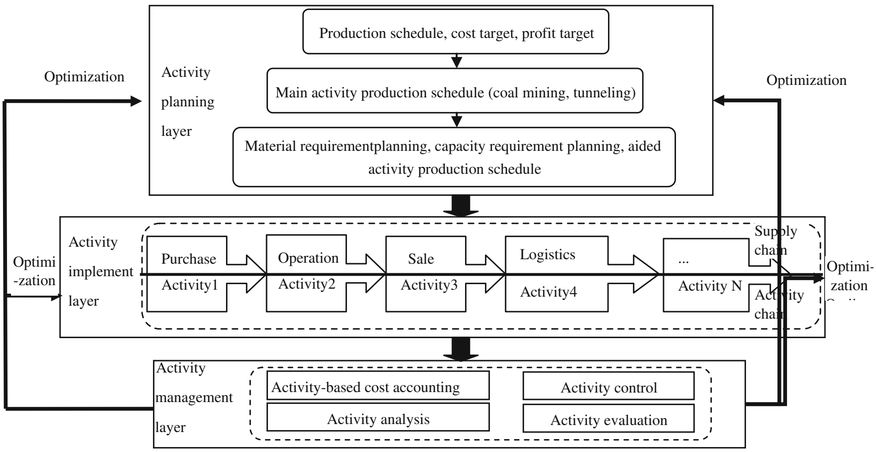

Fig. 37.2 Implementation integration model between ABC and ERP

37.2.2 The Integration Framework from Perspective of Existing Coal Enterprise ERP Based on J2EE Platform and Web Service

On J2EE Platform, implementation framework of EAI based on web services (shown in Fig. 37.3) includes three parts those are client, middle layer and background system (Zhanting et al. 2004). Client allows customers to find and call web services in different ways (web browser or enterprise application programs), so as to achieve the client's connection. The middle layer is responsible for developing, deploying and publishing web services, and connects client with background system. It also can be divided into presentation layer, business layer and the integration layer (Marks 2004; Monica 2001). Presentation layer is comprised of the web components (JSP, Servlets etc.) and responsible for handling request/response of HTTP, XML and other, session management and calling of the business layer components, etc. Business layer uses EJB Session Bean to achieve the logic functions of company's core business, meanwhile transforms the related business logic into web services, and published it to the UDDI server; integration layer is responsible for disposing communication and connections between business logic and background systems, such as using EJB Entity Bean to access corporate databases and using J2EE Connector Architecture (J2EE Connector Architecture, JCA) to reach integrations between business logic and enterprise information systems, etc. Background systems afford supporting environment for enterprise application integration, including corporate databases and enterprise information systems (Meehan 2001; Ferguson 2001; Houlding and Govindasamy 2003).

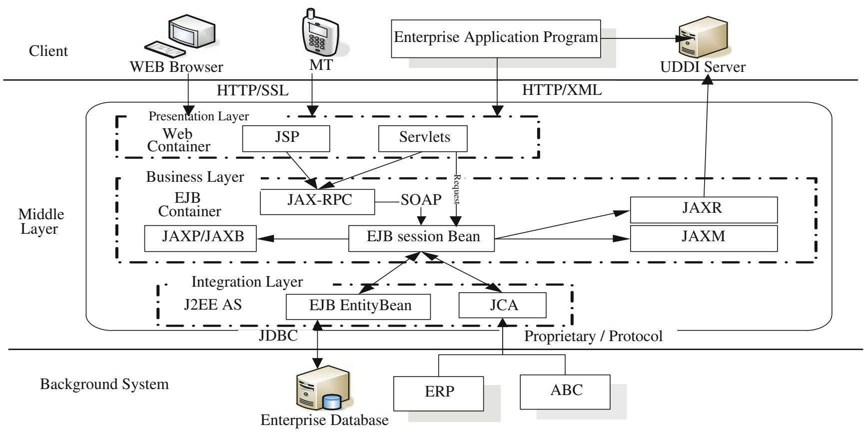

Fig. 37.3 Implementation framework of ERP and ABC based on J2EE platform and web service

37.3 Accouting Model of Activity-Based Cost Based on ERP for Coal Enterprises

37.3.1 Basic Procedures of Activity-Based Cost Accounting Based on ERP for Coal Enterprises

The core idea of activity-based cost accounting is "activities consume resources and products consume activities". According to the basic accounting principle above, the procedures of activity-based cost accounting based on ERP for coal enterprises consist of the following three steps:

Step 1. Identifying and calculating resource consumption, allocating the resource consumption value into various resource pools.

This step is only a process of value classification. It is neither necessary nor possible to directly credit the consumption value into activities, so the value of resource consumption is always classified by resource types in a larger range than activities'. Its basic work is to establish calculating standards of resource value and calculate the value of various resources, such as: human resource, material resource, financial resource, information resource, technology resource, etc.

The resource consumption is divided into the controllable cost and the uncontrollable costs. For coal enterprises, controllable costs generally include material costs, wage costs, electricity fees, repairs fees, rental fees, etc. And other costs occurring in the chains underground and over ground are classified as uncontrollable costs.

Step 2. Determining the activity driver and resource driver.

Determine the activities according to the principle of activity division, and make every activity to be ensured. Once it is decided, no change shall be made arbitrarily. The basic rules of activity costing should be carried out through this entire process. The amount of the activity determines that of resource consumption, and it has noting to do with the level of final product output. The relationship of the amount between resource consumption and activity is often described as resource driver. Resource driver reflects the patterns, causes and conditions when activities consume resources.

For coal enterprises, we should choose the right resource consumption driver for the consumption of controllable cost, in terms of resource character, and then calculate the amount of resource driver, which is the basis to allocate the resource consumption to every activity. The accurately-measured cost should be counted to the corresponding activity. Meanwhile, the cost which can't be accurately measured or is co-consumed by several resources can not be imputed to a special activity, and it should be allocated by resource driver.

Of the controllable costs for the underground part, material costs and wage costs can be directly counted, but electricity, repairs and rental fees, for their specialty in operation and management, may need to be allocated by resource driver. Generally, the electricity fee chooses the actual start time and power as resource driver. The large amount of repairs fee can choose the actual load as resource driver. And rental fees can choose actual occupancy time as resource driver.

Step 3. Allocating the resource value pool to the activity value pool, and determining every activity cost.

Coal enterprises just have a single product. So there is no need to allocate the activity cost to various products. Finally, we can get the cost of coal products by summarizing the controllable cost and the uncontrollable cost of every activity which have been calculated in step two. During the implementation of the three steps above, the data about resource costs can be obtained from the EPR financial modules, and the data that can't get directly need to be entered manually.

37.3.2 Business Process of Activity-Based Cost Accounting Under ERP for Coal Enterprises

Considering the activity-based cost accounting, management theory and the character of the coal production process, we can use the ideas of activity-based cost accounting to calculate every activity's activity cost by the feature of production organization in cost accounting. Ultimately, we can calculate the cost of coal products (Jiang 2005). Figure 37.4 shows the business process.

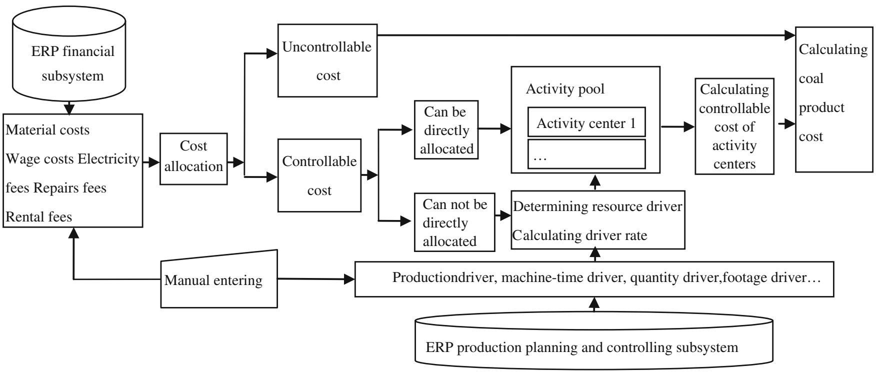

Fig. 37.4 Business process of coal enterprises activity-based cost accounting under ERP

37.4 Summary

In conclusion, ERP and ABC have the different management fields, but they have the basis for integration: the same costing objects, the same ideas for cost management and the same management purposes. So it is necessary and feasible for the integration between the two. We can integrate the enterprise resource management into activity-based costing management (This article mainly refers to the activity-based cost accounting), which will provide the activity-based costing management with timely and reliable raw data. Instead of manual operation, computer and network will speed up the cost accounting. So it is more effective to carry out the activity-based costing management among coal enterprises. Meanwhile, the feedback of original information can show us the formation process and resource consumption of every activity timely. Tracing the origin through the activity analysis, we can continuously improve operation processes and production methods by the principal of uniting function and economy to rationally allocate the limited resources. Finally we can achieve the goal of sustainable cost reduction.

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Chapter 38
The Empirical Study on Influence Factors of Word-of-Mouth Value of Customer Equity

Lin Sun, Ai-wu Cheng and Huang-juan Wang

Abstract The research of the measure of customer equity has been given more emphasis by domestic and foreign scholars, but the study of word-of-mouth value which is regarded as one of the important composition of customer equity is scarce. On the basis of theoretical analysis of word-of-mouth value by domestic and foreign scholars, this paper establishes a concept model of influence factors of word-of-mouth value of customer equity, and verifies the concept model by structural equation model. The results improve that many factors of word-of-mouth infector and receiver have great impact on the value of word-of-mouth.

Keywords Customer equity · Influence factors · Structural equation model · Word-of-mouth value

38.1 Foreword

Nowadays the spread of word-of-mouth is considered as the cheapest and high reliability tool of dissemination of information for its characteristics as fast speed, low price and be accepted easily. The spread of word-of-mouth of customer plays an important role in increasing the value of customer equity by cutting down

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L. Sun · A. Cheng (✉) · H. Wang
Department of Management, Xi'an Polytechnic University,
Xi'an, China
e-mail: cheng1955@126.com

L. Sun
e-mail: 348428012@qq.com

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customer cost and improving competitive ability of enterprises. Therefore, it is one of the important composition of customer equity. To make the best use of the value of customer word-of-mouth, the research of the factors of the value of word-of-mouth in customer life cycle is essential. These factors can help enterprises identify the valuable customer and take effective measures to consolidate, maintain and increase customer equity. However, recent research, especially the empirical research of influence factors of customer word-of-mouth is scarce. Based on this background, this paper establishes a concept model of influence factors of customer word-of-mouth value under traditional spread of word-of-mouth model from word-of-mouth infector and word-of-mouth receiver, and verifies the concept model by structural equation model. Finally, the key influence factors of the value of customer word-of-mouth and their connection are obtained. The results of this paper might have stimulative effect on perfecting and deepening the research of customer equity, and provide some reference for establishing measure model of the value of customer word-of-mouth.

38.2 Literature Review

Since the conception of customer equity was proposed by Robert Blattberg and John Deighton in 1996, the relevant research has achieved a series of fruition and the area and composition of the research has been improved step by step. In 2000, Rust et al. observed that customer equity was made up of equity value, brand equity and maintain equity (Rust et al. 2000). After that, Hein (2003) and other scholars suggest that customer lifetime value consists of basis potential, growth potential, network potential and learning potential, of which network potential means the cash flow brought by the new customers who are affected with spread of customer word-of-mouth. At this point, the value of word-of-mouth is viewed as an important composition of the value of customer equity. Julian Villanueva and other researchers (2006) further describe the long-lasting effects from word-of-mouth recommendation to the value of enterprise and customer equity by empirical study using VAR model. Domestic scholars also analyze the value of word-of-mouth of customer equity, such as Tao Wang believes customer lifetime value is the sum of customer purchase value, customer word-of-mouth value, customer information value, customer knowledge value and customer dealing value (Wang and Xu 2002). Zhang and other scholars (2006) discuss the issue from a different perspective, they put forward that customer equity consists of repurchase value, increase purchase value, premium purchase value, cross purchase value, word-of-mouth value and information value.

Under these analyses, we conclude that the relation of customer word-of-mouth value and customer equity is generally accepted, but only a few scholars make a theoretical analysis of the influence factors of customer equity word-of-mouth value, there is still lack of further empirical research. In this situation, a model of the influence factors of customer equity word-of-mouth value is presented in this article, and it is also analyzed and verified.

38.3 Model and Hypothesis

The process of spread of word-of-mouth includes two subjects, the infector and the receiver, and an object, the information. The three factors are indispensable to spread of word-of-mouth. Any of them affects efficiency. For enterprises, customer word-of-mouth value is the most direct embodiment of the effect of spread of word-of-mouth.

Arndt (1967) defines spread of word-of-mouth as "face to face verbal communication between the infector and the receiver". Anderson considers that the value created by customers in the process of promoting the brand which increase sales volume and proceeds forms customer word-of-mouth value, and the value is relevant to the strength and the scale of influence of the customers themselves (Wang and Lan 2002). Huang and Cheng (2008) suggest that customer word-of-mouth value embodies the direct proceeds brought by the influenced people, therefore, the purchase value of influenced people has positive correlation with customer word-of-mouth value.

In the research of the influence factors of customer word-of-mouth value, Gilly et al. (1998) observes that there are mainly three influence factors of purchase decision of the receiver: characteristic of sources of information, homogeneity of infector and receiver and characteristic of receiver. Bansal and Voyer (2000) further demonstrate Gilly's viewpoint, they divide the influence factors of purchase decision of the receiver into interpersonal factors and inhuman interpersonal factors. Liu and Chen (2007) conclude that the influence factors of the infector are spread desire, spread ability and spread opportunity; the influence factors of the receiver are characters of the receiver, receive desire, receive ability and so on. Zhang (2009) indicates that the influence factors of the infector include spread motive, spread ability and spread opportunity; the influence factors of the receiver are involved degree and expert knowledge. At the same time, she considers relation strength of infector and receiver, comparability of population statistics and comparability of cognition as important influence factors. Huang (2008) believes that the main influence factors of word-of-mouth value of customer equity include potential customer purchase capacity, potential customer purchase probability and potential customer purchase value, and establishes a measure model of word-of-mouth value of customer equity.

Based on the works previously, we don't discuss the information of word-of-mouth in order to simplify the research in this paper. We sum up the influence factors of the infector in spread desire, spread ability and spread opportunity, the influence factors of the receiver are summed up in receive desire, receive ability, relation strength of infector and receiver and homogeneity. And we consider these seven factors as independent variable. As for the composition of word-of-mouth

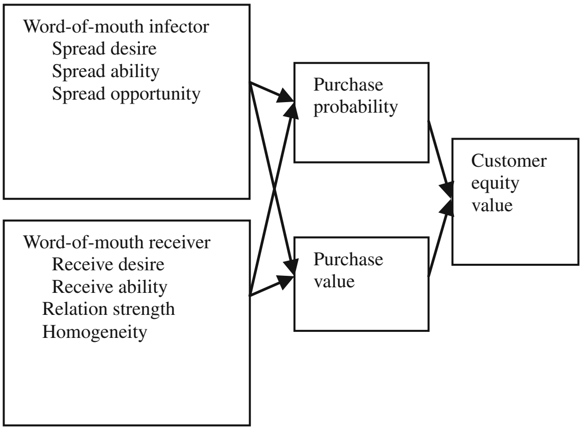

Fig. 38.1 A concept model of influence factors of word-of-mouth value of customer equity

value of customer equity, we use the measure model of word-of-mouth value established by Chuan Huang for reference, and consider purchase probability and purchase value as dependent variable. Finally, we establish a concept model of influence factors of word-of-mouth value of customer equity. As shown in Fig. 38.1.

In accordance with the factors above, we put forward the following assumptions considering the research object.

1. As the subject of the information spread, the word-of-mouth infector's many factors may have a direct impact on word-of-mouth value. The influence factors of the infector are spread desire, spread ability and spread opportunity. We can propose the following hypotheses according to the analyses.

H1a the spread desire of the infector has positive correlation with purchase probability

H1b the spread desire of the infector has positive correlation with purchase value

H2a the spread ability of the infector has positive correlation with purchase probability

H2b the spread ability of the infector has positive correlation with purchase value

H3a the spread opportunity of the infector has positive correlation with purchase probability

H3b the spread opportunity of the infector has positive correlation with purchase value

2. The receiver is a direct embodiment of the results of spread of word-of-mouth. Consumers will keep what they need and screen out what they don't want after they received a great deal of information. In this process, receive desire, receive ability, relation strength of infector and receiver and homogeneity of the receiver will have impact on purchase decision. We can propose the following hypotheses according to the analyses.

H4a the receive desire of the receiver has positive correlation with purchase probability
H4b the receive desire of the receiver has positive correlation with purchase value
H5a the receive ability of the receiver has positive correlation with purchase probability
H5b the receive ability of the receiver has positive correlation with purchase value
H6a the relation strength of infector and receiver has positive correlation with purchase probability
H6b the relation strength of infector and receiver has positive correlation with purchase value
H7a the homogeneity of infector and receiver has positive correlation with purchase probability
H7b the homogeneity of infector and receiver has positive correlation with purchase value

38.4 Research Method

38.4.1 Questionnaire Design and Data Analysis

The scale of this paper is presented by using mature scale from home and abroad and considering the characteristics of word-of-mouth spread. The research objects are people who use computer frequently, mainly including the social relations of the author and college students. This survey uses the method of random sampling, which is mainly in the form of paper questionnaire and e-questionnaire. We send out altogether 300 questionnaires and got back 251. The valid questionnaires are 221 and the ratio of callback of valid questionnaire is 73.67 %, which comply to the requirements of statistical analysis.

This paper analyses reliability and validity of the data using SPSS16.0 (Ni 2010). The reliability of the data is tested by inner consistency, coefficient α of individual element in this table is more than 0.7, the outcome shows this table has good credibility.

The validity of measuring variable includes content validity and construct validity. Content validity is a subjective evaluation indexes. The measurement of each variable is formed from mature research by domestic and foreign scholars, so content validity is good. Construct validity is an ability of measurement through scale, which measures a series of assumptions of variables' relation caused by theory. The paper verifies validity of the scale by the principal component analysis. First, we do Bartlett's Test of Sphericity, the value of KMO is more than 0.6, then pick up a component only after varimax rotation, accounting for more than 55 % of the variance, the probability of significance is 0. 000. This shows that the data of the samples are suited to factor analysis and the design of the whole scale has a good construct validity.

38.4.2 Verification of the Concept Model

The article tests variables' relation which is under the assumption of the theory model by structural equation model, and analyses the results of the path coefficients of the model using software Amos7.0. When firstly fit the model, according to the standard of CR > 1.96 in structural parameters and their statistical coefficients, the results of statistical indicators of the goodness of fit from the structural model show that the data fit well. The road map of structural equation of the influence factors of word-of-mouth value of customer equity is shown in Fig. 38.2.

The results of analysis of path coefficients are as follows: (1) "spread desire → purchase value" (C.R. = 1.275, P = 0.033), C.R. is less than critical C.R. = 1.96, it doesn't pass significance testing, namely the structural parameter is 0 in the statistical sense. This indicates that spread desire has nothing to do with purchase value; (2) The values of C.R. of other structural parameters are more than 1.96, they all pass significance testing, and the values are all positive. Therefore,

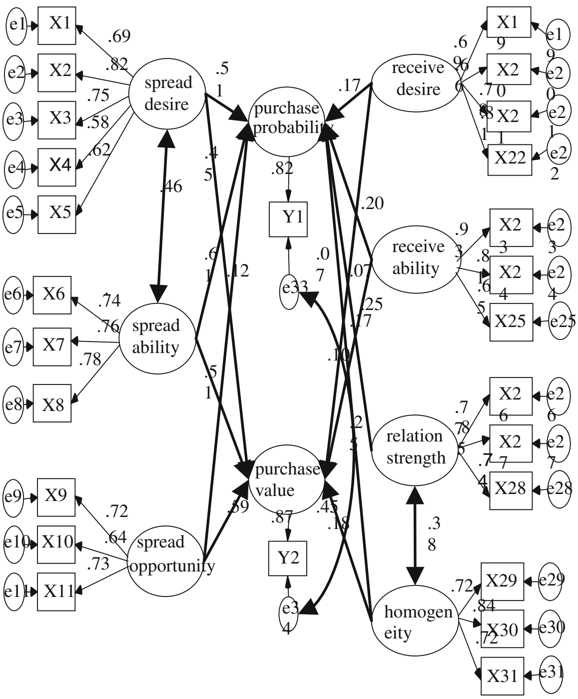

Fig. 38.2 Road map of structural equation of the influence factors of word-of-mouth value of customer equity

Table 38.1 Path coefficients of structural equation model and results of hypothesis testing

Hypothesis	Standard coefficient	C.R.	P	Conclusion
H1a	0.499	6.762	***	Support
H1b	0.548	8.702	***	Support
H2a	0.415	6.212	***	Support
H2b	0.487	7.942	***	Support
H3a	0.498	7.030	***	Support
H3b	0.574	8.974	***	Support
H4a	0.161	2.673	***	Support
H4b	0.057	1.275	0.033	Support
H5a	0.195	3.348	0.008	Support
H5b	0.092	2.132	0.002	Support
H6a	0.237	3.531	***	Support
H6b	0.077	1.988	0.018	Support
H7a	0.223	3.271	0.001	Support
H7b	0.150	2.954	0.003	Support

Ps *** means there is significance under the level of 0.001

there is a positive relationship between the variables. The path coefficients of structural equation model and results of hypothesis testing are given in Table 38.1.

38.5 Conclusion and Inspire

According to the analyses above, we can summarize as follows:

1. The word-of-mouth value of customer equity is measured in purchase probability and purchase value, and it is affected by seven factors, such as spread desire, spread ability and spread opportunity of the infector, receive desire, receive ability, relation strength of infector and receiver and homogeneity of the receiver.
2. Among the purchase probability path coefficients, the influence factors are in the following descending order: spread desire, spread opportunity, spread ability, relation strength, homogeneity, receive ability and receive desire; among the purchase value path coefficients, the influence factors are in the following descending order: spread opportunity, spread desire, spread ability, homogeneity, receive ability and receive desire.

In conclusion, to make the best use of customer equity, the effective utilization of customer word-of-mouth spread is essential. Companies have to take advantaged measures, increase the spread desire and opportunity of the loyal customers, which can bring more customers, increase the amount of customer purchase and make more profits for enterprises.

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Chapter 39
Analysis of Recycling Cost and Recycling Benefit of the Recycling Economic Project

Hua Wang and Xin Ni

Abstract According to the cycling economic theory, this paper discussed the features of recycling cost and recycling benefit of the recycling economic project, and recognized the composition of recycling cost and recycling benefit, and constructed two evaluation models for the recycling economic project as recycling economic net present value and recycling benefit ratio.

Keywords Recycling economy · Cost-benefit · Project evaluatio

39.1 Introduction

Construction project is an important method and process to allocate and use resource, its result is direct related with the national sustainable development goals (The national development and reform commission 2006). But the current project feasibility evaluation process of our country, usually evaluate the project through two methods: financial evaluation and national economic evaluation. And it lacks of recycling economy ability evaluation and the suitable method and system for the recycling economy project, therefore the recycling economy project cannot be specifically evaluated through the recycling cost and benefit and the recycling economic internalization process does not have basic approach and assessment criteria to follow which radically impedes implementation and enforcement of

H. Wang (✉)
School of Management, Shenyang University of Technology,
Shenyang, China
e-mail: llyywwhh@163.com

X. Ni
Graduate School, Shenyang University of Technology,
Shenyang, China
e-mail: hellonixin@hotmail.com

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Chinese recycling economy goals in construction project previous management process. The result is recycling economy project invests cannot be distinguished with other projects in the evaluation process. Therefore, this paper has study the composition of recycling cost and recycling benefit, and constructed basic evaluation models and indexes for the construction project under recycling economy, contribute d the recycling cost and benefit of construction project to the project value evaluation system, and to control the admission of the large investment construction project which damages the environment at the beginning of approving and decision (Wang and Wang 2011).

39.2 Features of Recycling Cost and Benefit

Recycling costs and benefits of the developing recycling economy project come mainly from three sources: the cost and benefit of reducing, the cost and benefit of recycling and reusing, environmental cost and benefit of the recycling economy project (Dajian 2000). The cost and benefit of reducing comes from reducing the usage amount at the beginning of the production, adopting the alternate resource or reducing the pollution (Tan 2010). The cost and benefit of recycling and reusing comes from translating salvaged material to resource and recycling and reusing inside the project and among the enterprises (Ren 2006). Environmental cost and benefit of the recycling economy project means the environmental cost and benefit as developing recycling economy requirement comes from cleaner production, bio-safety disposal and the pay and relief of the tax and fees (Zhong 2005).

39.2.1 Features of Recycling Cost

1. *Upfront Costs*

Recycling economy project requires large amount costs to input in advance, the cost even occurs at the design stage before the project actual operation. According to recycling economy's requiring, experts need to be invited to plan and demonstrate the project, requisite machines and equipments need to be bought, technicians need to be employed and the former workers need to be retrained. Consequently, recycling cost will occurred in quantity at the earlier of the project.

2. *Marginal Diminishing Costs*

With the increasing of the product output, recycling cost has a tendency of marginal diminishing. The upfront recycling cost every production shares decrease by the increase of the output while the resource and energy costs and the pollutant charge increase under the traditional mode of production, for the reason that the technological superiority of recycling economy will manifest through mass production.

39.2.2 Features of Recycling Benefit

1. *Long-term Benefits*

Recycling economy project inputs large amount at the beginning of the operation. So the marginal cost of the production is high and the recycling benefit is low. But with the operation lasting, marginal cost diminishing and recycling benefit increase. The competitiveness of the project and the production also increase because of the advancement of recycling economy. Because of above reason, the recycling benefits have a long-term feature.

2. *Uncertain Benefits*

The recycling economy project risks will cause the benefits uncertainty. The risks mainly come from two resources, the operational risk and the estimation risk. One operational risk comes from technology risk for the recycling economy technology which belongs to innovative and high technology and the unanticipated conditions lead to project failure. The other is the estimation risk that the estimation of the recycling benefit may be different from the actual, for the recycling project is a new emerging thing and the relative researches and practices are lacking. These two risks lead to an uncertain recycling benefit.

39.3 Consisting of Recycling Cost and Recycling Benefit of the Recycling Economic Project

Recycling cost and recycling benefit of the recycling economic project mainly comes from three parts: resource reduction, resource recycling and reuse, and environment cost and benefit of recycling economic project.

39.3.1 Consisting of Recycling Cost and Recycling Benefit of Resource Reduction

There are various methods to implement resource reduction. One is simply reduce the usage amount by improving the efficiency of resource use or other technologic methods. The other is using other cleanly and efficiently resources instead of original resources to produce. So the amount of new resource exploitation and usage can be reduced. The key factor to implement resource reduction is targeted improving the production technology and process while ensuring the same production capacity and product quality.

1. *Consisting of Recycling Cost of Resource Reduction*

The main costs of resource reduction are as follows:

(a) The cost of alternative resources usage

Practically, many recycling economic projects use new kind of clean energy and materials instead of the environmental pollution and inefficient energy and materials, so they can reduce the amount of original resources and sum amount of resources. But the unit price or total price of the alternative resources may be high than the original resources. Therefore, the cost of alternative resources usage is a important part of the cost of resource reduction.

(b) The recycling cost of resource reduction technology

As the use amounts and the use types of resource both may change in the recycling economic project, the production process should be targeted designed. And buy the specialized machines and equipments and rebuild the factory. This kind of costs like equipment investment and operating and maintenance fees are the costs of resource reduction technology.

(c) The cost of management and human resource

As resource reduction may cause the increase of the production processes and the total work, more workers may be needed. And as resource reduction technology is usually advanced, technicians need to be employed to assist and support to design, production and maintenance. The original workers need to be educated and new workers need to be employed. All the reasons above can cause the human cost increase. The resource reductionmakes production process more complex, and harder to operate and manage the project, so the management costs like the operation and the monitoring costs will increase.

2. *Consisting of Recycling Benefit of Resource Reduction*

(a) Benefit of resource reduction

The resource supply becomes decreasing, and the resource price becomes bullish today. Resource reduction can cut off the production cost through improving resource using efficiency and reducing the using amount. The price of the saving resource is the benefit of resource reduction. There are two ways to cut off the cost and increase the benefit, one is the benefit of improving original resource using efficiency to reducing the resource usage mount while the other is changing the production technology, using other economical and efficient resources to reducing the original resource usage.

(b) Invisible benefits

For the resource reduction is an important measures to protect the environment, the production using the resource reduction technology has an environmental brand image and a social reputation, and the enterprise will advertise that to strengthen the consumers' identification. This kind of publicity can bring about benefits by increasing the sales volume and improving the enterprise image.

39.3.2 Consisting of Recycling Cost and Recycling Benefit of Resource Recycling and Reuse

Resource recycling and reuse usually have two meanings in actual production. One is using the recycled resource for production and the other is recycling and reusing the underused resource in the project production process.

1. *Consisting of Recycling Cost of Resource Recycling and Reuse*

   (a) The cost of recycled resource usage

Recycled resource means use the production and consumption waste, the byproduct, and the excess material as production materials through recycling and deposing. The cost of recycled resource usage contains the cost of buying the resource, recycling and sorting the resource, and transporting the resource.

(b) The cost of recycling and reusing technology

Most of the recycled resources have low conversion rates, low heat values and much impurity content. Therefore they probably need to be sorted and special processed before put into production and need specialized machines or equipments. Consequently, expenditures of buying and maintaining the equipments constitute the cost of recycling and reusing technology.

(c) Resource recycling production cost

Resource recycling production cost means the cost of using the byproduct and excess material which come from the project production process to produce. Resource recycling production cost including the cost of recycling production equipments, deposing the byproduct for production and the relative labor and other resources.

(d) The cost of resource recycling and processing

It contains the costs of collection, transportation, and storing and the fees of inspection, classification, cleaning and disassembly.

(e) The cost of management and human resource

Similar like the resource reduction's influence, resource recycling and reuse also can lead to this kind of costs.

2. *Consisting of Recycling Benefit of Resource Recycling and Reuse*

(a) The benefit of recycled resource usage

Recycled resource is not only good for the environment but also low-cost for most of the recycled resources are transformed from the waste. The price spread between the new resources and the recycled resources is the benefit of recycled resource usage.

(b) Resource recycling product benefit

Recycling economy project uses the byproduct to produce other products. Resource recycling product benefit means sales income of these products.

(c) The cost of resource recycling

It contains: the income of selling the resource to the specialized recycling company after collection and sorting, the saving costs and fees of landfill and pollution discharge for the waste reduction which due to the resource recycling.

(d) Invisible benefits

Due to the enhancement of the social environmental awareness, the product uses the recycled and reused materials is more competitive in the market. The increase of product competitiveness and improvement of product image are the invisible benefits of resource recycling and reuse.

39.3.3 Consisting of Environmental Cost and Benefit of the Recycling Economy Project

1. *Consisting of Environmental Cost of the Recycling Economy Project*

(a) Preventive environmental cost

It contains the following parts: The fees of building and operating the environmental management system (Cheng 2007), the fees of environmental protection consulting and judgment, the cost of buying, using and maintaining related equipments and the fees of labor and welfare.

(b) Administrable environmental cost

Administrable environmental cost contains the fees of environmental protective measures, the fees of environmental protective equipments and the fees of bio-safety disposing the emission.

(c) Losing environmental cost

Losing environmental cost mainly contains the fees of disposing the emission, pollution discharge fees, pollution cleanup fees, the fees of processing environmental pollution accident, and the fees of recovering the environment (Wu 2009).

2. *Consisting of Environmental Benefit of the Recycling Economy Project*

Environmental benefit of the recycling economy project contains the following parts: the saving interest of national concessional loan in low-rate or non-rate for the recycling economic project (Xie and Hu 2007), tax preference, subsidy and bonus from government and reduced pollution discharge fees and the related penalty and reparations by clear production (Li and Liu 2010).

39.4 Comprehensive Models of Recycling Cost and Benefit

According to the constitution of recycling cost and benefit, the following models can be built:

Total cost of recycling economy project:

$$Cr = C_{\text{Resource Reduction}} + C_{\text{Resource Recycling and Reuse}} + C_{\text{Environment}} \tag{39.1}$$

Total benefit of recycling economy project

$$Rr = R_{\text{Resource Reduction}} + R_{\text{Resource Recycling and Reuse}} + R_{\text{Environment}} \tag{39.2}$$

Among the total cost of recycling economy project, the cost of resource reduction:

$$\begin{aligned} C_{\text{Resource Reduction}} &= C_{\text{Alternative Resources}} + C_{\text{Reduction Technology}} + C_{\text{Management}} \\ &= \sum_{i=1}^{n} C_i * Q_i + \sum_{j=1}^{n} C_j * Q_j + C_{\text{Management}} \end{aligned} \tag{39.3}$$

In this equation, C_i represents the unit price of alternate resource numbered i, Q_i represents the amount of alternate resource numbered i, C_j represents the unit price of the technology or equipment numbered j, Q_j represents the amount of the technology or equipment numbered j.

The cost of resource recycling and reuse:

$$\begin{aligned} C_{\text{Resource Recycling and Reuse}} &= C_{\text{Recycling Resource}} + C_{\text{Recycling Technology}} \\ &\quad + C_{\text{Recycling Production}} + C_{\text{Recycling and Processing}} + C_{\text{Management}} \\ &= \sum_{k=1}^{n} C_k * Q_k + \sum_{l=1}^{n} C_l * Q_l + \sum_{m=1}^{n} C_m * Q_m \\ &\quad + \sum_{n=1}^{n} C_n * Q_n + C_{\text{Management}} \end{aligned} \tag{39.4}$$

In this equation, C_k represents the unit price of the recycling resource numbered k, Q_k represents the amount of the recycling resource numbered k, C_l represents the unit price of the technology or equipment numbered l, Q_l represents the amount of the technology or equipment numbered l. C_m represents the unit production cost of the product numbered m, Q_m represents the production amount of the product numbered m. C_n represents the unit recycling cost of the resource numbered n, Q_n represents the recycling amount of the resource numbered m.

The environmental cost of the recycling economy project:

$$C_{\text{Environmental}} = C_{\text{Preventive}} + C_{\text{Administrble}} + C_{\text{Losing}} \tag{39.5}$$

Among the total benefit of recycling economy project, the benefit of resource reduction:

$$R_{\text{Resource Reduction}} = R_{\text{Reduction}} + R_{\text{Invisible}} = \sum_{i=1}^{n} R_i * Q_i + \sum_{j=1}^{n} R_j * Q_j \tag{39.6}$$

In this equation, R_i represents the unit price of resource numbered i, Q_i represents the reduction amount of resource numbered i, R_j represents the unit price of product numbered j, Q_j represents the additional sales amount of the product numbered j as the resource reduction.

The benefit of resource recycling and reuse:

$$\begin{aligned} R_{\text{Resource Recycling and Reuse}} &= R_{\text{Recyclied Resource Usage}} \\ &\quad + R_{\text{Resource Recycling Product}} + R_{\text{Resource Recycling}} + R_{\text{Invisible}} \\ &= \sum_{k=1}^{n} R_k * Q_k + \sum_{l=1}^{n} R_l * Q_l + \sum_{m=1}^{n} R_m * Q_m + \sum_{n=1}^{n} R_n * Q_n \end{aligned} \tag{39.7}$$

In this equation, R_k represents the unit saving cost of the recycling resource numbered k, Q_k represents the usage amount of the recycling resource numbered k, R_l represents the unit price of the recycling product numbered l, Q_l represents the sale amount of the recycling product numbered l. R_m represents the unit price of the recycling resource numbered m, Q_m represents amount of the amount of the recycling resource m. R_n represents the unit price of the product numbered n, Q_n represents the addition sale amount of the product numbered m as resource recycling and reuse.

The environmental benefit of the recycling economy project:

$$R_{\text{Environmental}} = R_{\text{Interest}} + R_{\text{Subsidy}} + R_{\text{ReducedFees}} \tag{39.8}$$

In conclusion, the recycling economy cost and benefit can be shown as the following equation:

$$\begin{aligned} Cr = & \sum_{i=1}^{n} C_i * Q_i + \sum_{j=1}^{n} C_j * Q_j + \sum_{k=1}^{n} C_k * Q_k \\ & + \sum_{l=1}^{n} C_l * Q_l + \sum_{m=1}^{n} C_m * Q_m + \sum_{n=1}^{n} C_n * Q_n \\ & + C_{\text{Management}} + C_{\text{Preventive}} + C_{\text{Administrable}} + C_{\text{Losing}} \end{aligned} \tag{39.9}$$

$$\begin{aligned} Rr = & \sum_{i=1}^{n} R_i * Q_i + \sum_{j=1}^{n} R_j * Q_j + \sum_{k=1}^{n} R_k * Q_k \\ & + \sum_{l=1}^{n} R_l * Q_l + \sum_{m=1}^{n} R_m * Q_m + \sum_{n=1}^{n} R_n * Q_n \\ & + R_{\text{Interest}} + R_{\text{Subsidy}} + R_{\text{Reduced Fees}} \end{aligned} \tag{39.10}$$

39.5 Evaluations and Suggestion of the Recycling Economy Cost and Benefit Models

Recycling economy project feasibility has two methods to evaluate, recycling cost-effectiveness and recycling economic net present value.

39.5.1 Recycling Cost-Effectiveness

The formula of recycling cost-effectiveness is:

$$RNPV = \sum_{i=1}^{n} (CI - CO + E_1 - E_2 + Rr - Cr)_i \, (1 + r)^{-i} \tag{39.11}$$

In this equation, Rr_i represents the recycling benefits in the year i, Cr_i represents the recycling cost in the year i, r represents the rate, i represents the time (in the measure of years).

39.5.2 Recycling Economic Net Present Value

The formula of recycling economic net present value is:

$$RNPV = \sum_{i=1}^{n} (CI - CO + E_1 - E_2 + Rr - Cr)_i (1 + r)^{-i} \tag{39.12}$$

In this equation, Rr_i represents the recycling benefits in the year i, Cr_i represents the recycling cost in the year i, r represents the rate, i represents the time (in the measure of years).

When the recycling cost-effectiveness of the project RPVB < 1 or the recycling economic net present value RNPV > 0, the return level of the resource which the project put into the recycling economy can be accept. The project is recycling feasible, and can be invested. If not, which means the benefit of recycling economy is less than the cost, the project is recycling infeasible, and need to be adjusted to be feasible or abandon the project.

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Chapter 40
The Innovation of Training Model for New Bonded Logistics Personnel

Jun Zhang

Abstract In order to effectively explore the inherent regularities of bonded logistics personnel training, the present paper summarizes and analyzes the characteristics of the demand for the new bonded logistics personnel in four areas of professional competence including innovation, quality, ethics, and professionalism based on systematically researching the current exploratory training of the personnel in China. At the same time, comes up with a new training mode for the bonded logistics talents from a new perspective according to the actual demand from the enterprises and the training status in Chongqing Technology and Business University.

Keywords Bonded logistics personnel · Innovation · Professionalism · Training model

Until June 2011, China's State Council has approved the establishment of 102 custom special supervised areas of the bonded zones, bonded logistics parks and comprehensive free trade zones, etc. According to the statistics, the import and export value of these regulatory regions has accounted for about 13.0 % of the total foreign trade. These areas have also become the main carriers of the development of bonded economy of local governments and the hubs for the operation of bonded logistics. At the same time, the bonded logistics business is one of the core businesses of our custom special supervised areas. Therefore, trainings for the bonded logistics personnel are urgently needed (Liu et al. 2012).

J. Zhang (✉)
Department of Business Planning, Chongqing Technology and Business University, Chongqing 400067, China
e-mail: well-moon@163.com

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40.1 Research Status of Bonded Logistics Personnel Training in China

According to the capacity and knowledge what an international logistics personnel should have, an integration of modular courses and an addition of courses about international logistics knowledge and skills were recommended (Wang et al. 2008). Bonded logistics, World Logistics geographical practices, etc. were proposed to set up. Other measures like teaching reforms in the higher professions in terms of foreign economic and trade were also mentioned to accelerate the training of bonded logistics personnel (Wei 2009). Exploring the contradiction between the logistics personnel training and the actual demand in China and taking the personnel training mode reform of logistics management major in Shanghai Ocean University as an example, tried to explore a new way to adapt to the training in China (Zheng 2010). According to the demand for logistics personnel in the construction and development of bonded port area in Chongqing, analyzed the problems which existed in the current cultivation of logistics management major, and explored the education direction of the students in vocational colleges (Liu and Yin 2011).

In summary, many scholars in China have done exploratory researches on China's bonded logistics personnel training model from different perspectives, and have made some preliminary achievements, but there still are some areas for improving : (1) Fail to pay full attention to the fact that the bonded logistics is a service science with strong practicality Wang (2011). The teaching methods and the way of personnel training are relatively homogeneous. (2) The position of the bonded logistics personnel training is relatively vague and the objectives are not clear enough. (3) Can not fully understand the multidisciplinary characteristics of logistics, and the courses are not yet a scientific and complete system.

40.2 Professionalism of the New Bonded Logistics Personnel

New bonded logistics personnel should not only have a strong sense of social responsibility and the spirit of innovation, but also have a deep understanding of economics and management. They should have profound theories and techniques of modern logistics management and be familiar with the processes of customs supervision and bonded policies. Other requirements include having knowledge of the rules of international trade, international finance and the process of international exhibition; a strong practical ability; the ability of engaging in various types of bonded logistics and the related professional activities in the new international economic environment. Therefore, the new bonded logistics personnel must possess the following qualities:

40.2.1 Inter-Disciplinary Professional Competence

On the basis of having basic knowledge of modern logistics management, international logistics operations, bonded, customs clearance, financial operations, etc., new bonded logistics personnel should also have the professional competence of multi-cross and integration, such as business negotiation, business etiquette, marketing, planning, cooperation, communication, and information processing. Embodiments are as follow: acquiring modern logistics knowledge, which are closely related to transportation, storage, processing in circulation, loading and unloading, distribution, information processing, etc. Optimize the organizing and scheduling of logistics transportation; efficiently operating the people, financial and material involved in the international logistics business processes. Be able to plan and design a specialized logistics system. Understand the operation and application of modern logistics facilities and equipments, and be familiar with the relevant national laws and regulations, economic policies, as well as business English, IT, shipping agents, international marketing, international trade and settlement, international insurance and other related knowledge. Be acquainted with the customer and market demand for services in both domestic and abroad.

40.2.2 Continued Ability to Innovate

Bonded logistics personnel should have the quality of continuing innovating the product, market, technology, management, etc. On one hand, they should have innovative spirit like entrepreneurs, understand and explore new situations and new things that occur in the activities of bonded logistics with a strong sense of curiosity and passion. These talents should be keen to discover the inherent regularities of new things as well as to maximize the potential value of new things. On the other hand, they should have an innovative ability of creative thinking and imaging to fully find the effective applies of the internet, internet of things, cloud computing and other new technologies and ideas to the bonded logistics business.

40.2.3 Comprehensive Quality

Related enterprises within the custom special supervised areas (bonded zones, bonded logistics park, etc.) are heavily involved in the professional businesses of international logistics, international trade, customs clearance and bonded. These inevitably require the bonded logistics personnel to have a strong ability of listening, speaking, reading and writing of foreign languages and to acquire the prevailing international logistics practices, logistics standards and different technologies and methods of logistics operation. The students are also required to equip themselves with a cross-cultural knowledge, as well as the analyzing capabilities of folk customs and psychological characteristics in countries all around the world. At the same time, they should also both revolutionize the way of thinking and the ideas from an international perspective and absorb advanced ideas of management and operation from international logistics enterprises bravely in order to adapt to the needs of economic globalization.

40.2.4 Excellent Professional Ethics

Although the economic benefits produced by good morals, qualities and ethics are not as obvious as that produced by the professional skills and scientific knowledge, they are the indispensable spiritual pillar of personal life skills, business developments and the prosperity of countries. Bonded logistics personnel with excellence ethics: (1) Have strong political and ideological qualities and comprehensively set a lofty view of the world, life and values as well as actively demonstrate positive images of the nation and the region. (2) Considering bonded logistics is a comprehensive service industries across multiple industries and sectors, bonded logistics personnel should "love and devotion, devote to duty", which focus on the life-long learning of the industry, and constantly improve their professional qualities. (3) They should also be willing to sacrifice, to comply with laws and arrangements in order to make the services to meet the truly needs of customers.

40.3 New Bonded Logistics Personnel Training Model Innovation

With the advent of the knowledge economy and information era, the logistics industry will inevitably develop to internationalize. If China wants to gain a firm status in the increasingly fierce international economic competition, we should not only create a robust and highly efficient logistics system, but also cultivate a group of high-quality logistics personnel and a number of elites in this field. For this, our country has already conducted some initial exploration for the training of bonded logistics personnel, which includes: (1) Relevant training given by education institutions, which mainly reflected in the professional training in terms of international trade (Li 2011), port transportation (Wang 2011), and aviation logistics. (2) International logistician certification system, for example, the International Logistician Certification Office of SASAC has issued an examination system of international logistics specialist certification to train senior professionals in business decisions, risk management and practices. (3) Studying tours in foreign free trade zone refer to understanding and learning the inner knowledge of decision-making and operation management of the bonded logistics progressively by on-site observing, communicating and summarizing. However, generally speaking, the training of bonded logistics talents in China still seems to like “wade across the stream by feeling the way” and cannot meet the demand effectively. In order to cultivate the right talents who achieve the professionalism that mentioned above better, colleges and universities can carry out the management of the Education Service Alliance to follow the laws of the bonded logistics education and to diversify the ways of running a school. For these reason, the training of new bonded logistics talents can be considered from the following aspects:

40.3.1 Grasp the Demanding Characteristics of Talents and Make Tailored Training Programs for the Bonded Logistics Personnel

Build up Bonded Logistics Education Service Alliance, which develops tailored training programs for the bonded logistics personnel following the professional characteristics of logistics management and laws of the training. This is based on conducting field research and in-depth study of the demand for the bonded logistics personnel in the custom special supervised areas (bonded zones, bonded Logistics Park, etc.) and related production enterprises, commercial enterprises, as well as third-party logistics companies, financial institutions, etc. At the same time, we can invite relevant departments and business managers to participate in the development of training program for the bonded logistics personnel in universities and hold information exchange meeting for education service demand on a regular basis as well as revise and improve the training program timely. Take the Logistics Management Program in Chongqing Technology and Business University as an example. After a long-term exploration, this major has already build a long-term cooperation mechanism with several government departments of Chongqing (such as the Commission of Economy and Information, the Development and Reform Commission, the Business Committee, the Administrative Committee of the Bonded Port Area and Customs, etc.), financial institutions banks, insurance companies, etc., import and export enterprises, as well as the third-party logistics companies. These education partners go into the school with ideas provided the resources to solve the problems of the school’s weakness and ensure the quality, and the feasibility of the training program.

40.3.2 Integrate Education Service Transfer System and Improve the Bonded Logistics Personnel-Training Mode

Integrated education service transfer system within the Bonded Logistics Education Service Alliance and especially integrate the teaching ability of teachers, selections of textbooks, teaching environment of schools, off-campus bases of internship and practice, academic queries and other factors effectively, as well as the following "three crosses" to realize continuous improvement of the training mode. That is: (1) inter-disciplinary cross within the campus, refers to teaching the knowledge that reflect the main needs of professionalism by developing a system of the training curriculum, integrating teaching resources of logistics management, economy, trade, e-commerce, business management and other related disciplines, as well as establishing and accumulating relevant case base. (2) Cross between the inside and outside of school's teaching resources means that our teachers are mainly responsible for teaching fundamental theoretical knowledge, but the more practical courses should be taught by the primary practical managers who are recruited from the first line of relevant enterprises or bonded port areas. In addition, special lectures on bonded logistics expertise and industry dynamics can be carried out by specialists of logistics management from multinational companies for students on a regular basis. (3) Cross between theory and practice refers to strengthening the cooperation between schools and enterprises or schools and ports through establishing specialized training practice base and setting up credit system of summer placement training to ensure that the students are familiar with the bonded logistics chain, customs clearance, bonded professional business policies and the relevant practices. These practices will in return to boost the deepening of the specialization theory.

40.3.3 Leverage the Service Innovative Ideas to Reinforce School-Enterprise Cooperation in Education Services Union

Education services, which require the full participation of universities, enterprises, governments, industry associations, training intermediaries and parents, are innovative activities carried out under certain social, managerial, and technical tracks. The education services is not only an alliance which reinforces the close communication and "seamlessness" but also takes personnel training as a system engineering as well as handles a range of issues including the information sharing of talents' supply and demand, supervision of training process, in accordance with the requirements of the service innovation (Ren 2011). Namely: (1) Invite high-level experts from the relevant government departments, industry associations and training intermediaries to introduce policies and theories and to analyze the developing trend of the industry as well as to guide the students from a macro level regularly. (2) Invite senior business executives to go into the classroom to introduce business operations and business processes, which are both business-related, practical and professional, thus getting the requirements of talents in terms of knowledge, ability and comprehensive quality as well as stimulating the students' passion. (3) Strengthen the cooperation and exchange with foreign universities, learning their advanced experience of logistics personnel training, in addition, organize foreign scholars' on-site lectures to guide students and have a better understanding of the profiles of international logistics personnel training. (4) According to the compound and innovative characteristics of bonded logistics personnel, the integration of teaching resources between various disciplines and faculties is required to lay a solid development platform for the bonded logistics personnel training together.

40.3.4 Aim at Realizing Win–Win Situation Within the Subjects of the Alliance, and Evaluate the Quality of Personnel Training Dynamically

The objectives of Education Service Alliance are striving to enable students to study, teachers to enjoy the teaching, schools to gain education reputation and companies or ports to get the right talents through joint efforts. To achieve this goal, we should evaluate and enhance the quality of bonded logistics talents dynamically, that is: (1) further improve the management of credit system (Tian and Zheng 2011). Actively encourage students to strengthen their bonded logistics knowledge and skills through general education, main-minor system and cross-professional elective. (2) Encourage students to participate in periodic national logistics designing contest for college students. Improve the practical and planning abilities and coordination capacity of the students with the combination of theoretical knowledge and practice actively. (3) Encourage students to obtain certificates of logistics/logistics manager/customs declarer/Chinese logistics professional managers or other related qualifications, which are issued by the certification authorities either at home or abroad actively. (4) Emphasize on social evaluation of the students' quality. Train the ones who can apply what they have learned through the following ways: adjust the training program of the bonded logistics personnel timely and dynamically according to the feedback of the partnerships and the employers; amend the teaching content and curriculum system to ensure that the training is in accordance with the development of social and economic.

40.4 Conclusion

Bonded logistics talent is a new type of logistics management personnel, which has emerged with the rapid development of China's various types of custom special supervised areas in recent years. There is a need of continued attention and systematic study for its demand characteristics and inherent laws of personnel training. Only through dynamically revising and improving the training model and training program can we foster more bonded logistics personnel who are in line with the actual needs.

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Chapter 41
A Research on Building a Perfect Accounting Supervision

Yu Shi and Ping-ping Shi

Abstract Accounting supervision is both one of the basic functions of accountancy and a major part of economic supervision. Nowadays, Chinese weak accounting supervision basically results from the faulty designed supervision system. This paper is to analyze the situation and problems of the current accounting supervision to propose suggestions on the improvement of accounting supervision system.

Keywords Accounting supervision · Accounting supervision system · Problem · Perfect

41.1 Introduction

With the continuously intensified innovation in enterprises, to build a perfect accounting supervision system has around extensive concerns in many sectors of society. According to Article 21st in "Accountancy Law", every organization should set up a perfect internal accounting supervision system. For that, accounting supervision system is a necessary management system for every enterprise. It has been confirmed by a large amount of evidences that a bad performance on accounting supervision easily leads to economic crimes. An intensive accounting supervision would maintain an ordered and smooth accountancy. Therefore, it is of significance to build, perfect and improve accounting supervision for defending social economic order and upgrading accounting quality (Ministry of Finance of the People's Republic of China 1999).

Y. Shi (✉) · P. Shi
Faculty of Economics and Management Huai-yin Institute of Technology, Huai-an, China
e-mail: shi_shanal@163.com

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41.2 Literature Review

As one of the major parts of economic supervision, accounting supervision has two meanings, first that both accounting units and accountants objectively report economic activities by using real accounting information and carry out the supervision on authenticity and completeness of accounting information. The second concerns about the supervision on accountancy and accounting. Accountancy should be supervised by the internal concerned departments, the external organizations, the department of finance and auditing (Wang 2010).

After 30 years of reform and opening-up, Chinese economy has been globalizing while accounting supervision is developing rapidly. The amendments and implementation of "Accountancy Law" bring up a "Three in One" accounting supervision, namely internal supervision, social supervision, and state supervision (Li et al. 2006).

41.2.1 Internal Supervision

The internal accounting supervision is essentially a kind of microcosmic supervision involving the separate control over incompatible duties, authorization of control, the control of accounting system, budget, property saving, risk, internal report, and electronic information technology. To supervise the internal accountancy, accounting units and staff are playing significant roles (Jiao 2008).

41.2.2 Civilian Supervision

Civilian supervision, namely civilian auditing supervision, is a kind of agency like accounting firms. They, a kind of external supervision, in accordance with law, audit the clients' economic activities and make an objective evaluation.

41.2.3 Government Supervision

National supervision, or government supervision, is an external supervision. It states that on behalf of the state benefits governments supervise enterprises and the accountants and carry out administrative punishment on accountancy crimes. It involves the types of supervision like finance, audit and tax (Jiang 2010).

41.3 The Research on the Current Accounting Supervision System

41.3.1 Ambiguous Major Function

The internal supervision, state supervision and civilian supervision come together to construct a combined accounting supervision, but show distinguished differences between duties, targets, operation and function. The related regulations define that basic duties of the supervision should stick to state laws and legislation, but do not concrete and distinguish them. So, three kinds of supervision get confused with each other and make the undesirable function even worse (Chen 2009).

41.3.2 Bad Supervision Repetitive Work and Weak Function

The lack of deterrent influences the practical effect and the long-term effectiveness of government supervision. Undistinguished duties result in repeated check and buck passing. Firstly, governments have cognitive misunderstandings about accounting supervision. They invigorate enterprises by authorizing and allowing them to remain more profits. They do not manage but tolerate enterprises economic activities. Secondly, governments fail to carry out enough supervision. So that some civilian agencies and enterprises take advantage of each other and cheat in capital funds checking, evaluation, audit and statement. It ruins the expectation that supported by the civilian agencies, governments macroscopic supervision system would function perfectly. What's more, governments' supervision is free from restriction. It is hard to evaluate the effectiveness (Wu 2010).

41.3.3 Non-Standard Supervision Brings an Undesirable Expectation

1. Accounting firms are lack of independence and commit offence consequently: Being independent is the spirit of audit. It makes audit possible and facilitates its development. However, accounting firms are suffering from a low degree of independence. It is even worse to say that the ineffective regulation, weak investigation and punishment, imperfect auditing rules, confused legal liability could be found in Chinese Stock Markets. These problems lead to the abnormal activities among accounting firms.
2. The lack of responsibility among the certified public accountant influence audit quality: In China, the amount of certified public accountant has increased significantly but is still far from the demand. Among them, a big number is of no great virtue and conscientiousness. So, they lack responsibility and bring abnormal activities to firms.

41.3.4 Lack the Publicity of Accounting Information

Accounting information is originally private, so the privately-owned enterprises would not be motivated to make their accounting information known to the public. Even for tax consideration, governments have no title to order them to disclose the information. Considering shareholders benefits, the listed enterprises are forced to disclose the accounting information. The concealment and inadequacy of accounting information would decide the evaluation of statement readers on the financial situation and business. Consequently, it would slow down the effectiveness of government's decisions and bank credit decisions (Liu 2010).

41.3.5 No Function of the Internal Supervision

As supervisors, accountants are dependent. Their interests are particularly restricted to the organization and leaders. So, it is a tough job for them to continue their supervision. Consequently, it is easy to see "Everything should be ordered." For that, the internal supervision loses its values (Cui 2010).

41.4 Analysis

41.4.1 Flaws in Legislation

The bad accounting supervision and wrong accounting information result from the flaws in law environments. First, ambiguity and bad operation would affect the performance and implementation of laws and bring ineffectiveness to accounting supervision. Secondly, if the accounting law is of no science, it is hard to judge its accuracy and would accordingly influence the implementation. Thirdly, the punishment and implementation are crucial to the quality of information. Objectively speaking, ineffectiveness punishment would indulge crimes and spread the bad supervision.

41.4.2 Defeats in Political-Economic Environment

Considering the imperfect legal systems, economic management heavily relies on diversified means of administration. If governments fail to function properly, and even tolerate and take part with the illegal activities, it would be the advantages to breed undesirable supervision of accountancy (Lijuan and Zhu 2009).

41.5 Suggestion

To implement the "Three in One" in new "Accountancy Law", it is definitely necessary to construct a matching system of implementing accounting supervision.

41.5.1 To Facilitate Legislation and Provide Legal Guarantee

First, it is necessary to perfect legal system of accountancy to guarantee a legal supported supervision. The rules should be further specified to decrease the subjectivity and flexibility. It is important to improve and perfect the punishment and sharpen the punishment to the people cheating in reporting accounting information. The second is to tighten the supervision to make sure that registered accountants would fully do their duties. The constraining power and rules are decisive points for supervising the registered accountants.

41.5.2 To Improve the External Accounting Supervision

Firstly, it is necessary to improve and perfect the official's evaluation system of the local region, governments and institutions. Nowadays, finance and accountancy suffer from falsifying and boasting. It is basically motivated by the leaders' benefits and performance. In the past, although accountants are forced to do certain jobs, they are frequently investigated for crimes. The second is to strengthen the legal education, by emphasizing "There are laws to go by". The laws should be strictly enforced. The breakers must be dealt with.

41.5.3 Clearly Defined Duties and Reasonably Divided Commission

To prevent repetitive supervision happening, the administration departments like tax, finance and audit should set up a responsibility system to divide duties properly. Specifically, tax supervision should play the major roles in supervising accountancy while finance one focuses on accounting information quality. The quality of accounting information would have an impact on the social economic order. Auditing supervision is concerned with national investment projects.

41.5.4 To Facilitate the System Building of the Internal Accounting Management

The first is to set up a voucher schemes to provide a basis for supervision. To be followed, it is significant to design a perfect account book scheme to make sure that the reported accounting information is complete. The third is to set up a scientific accounting procedure and policies. It is beneficial for accountants to master the means and procedure of accounting practice and maintain a consistent policy. Finally, a regular check system is of significance for keeping accounting information effective and valuable.

41.5.5 To Building a Disclosure System

Firstly, a public disclosure system would restrain information publishing and reporting and force the enterprises to make accounting information available to the public. The second is to build and disclose accounting information database. Thirdly, it is suggested to open a particular website for publishing accounting information. Finally, it would be helpful to arrange a discussion forum of accounting information to welcome the public queries and research reports. The disclosure system would settle to a certain concern that enterprises change accounting statements for certain reasons.

41.5.6 To Encourage Civilian Operation

Considering that accounting information under the current economic situation shares the characters with the common products, it is inevitable and necessary to encourage civilian operation. Being civilian refers to the public, organizations and social agencies. Civilian operation would effectively replenish the governments' supervision so as to bring a more expansive room for social accounting supervision.

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Chapter 42
An Empirical Research on High-Tech Enterprises in Zhejiang Province Between Enterprise S&T Investment and Performance: Enterprises Competitiveness as an Intermediary Variable

Cheng Hua, Yu-peng Zhang and Xiao-gang Yang

Abstract Based on literature search, and the data from 307 high-tech enterprises in Zhejiang Province (2008–2010), the paper constructs a model of enterprise investment in science and technology, enterprises competitiveness and performance, and proceeds empirical analysis. The results shows as follow: the S&T (science and technology) input of high-tech enterprises in Zhejiang province is significant positive correlated with performance. Enterprises competitiveness has part intermediary effect between R&D expenditure and enterprise sales revenue. The number of R&D staff is not significant with performance. Enterprises performance has lag effect to S&T input. The effect of R&D expenditure to performance is better when the interactive role is considered, which returns to scale turns into increasing from decreasing.

Keywords Enterprise investment in S&T · Enterprises competitiveness · Intermediary effect · Performance

42.1 Introduction

The relationship between performance and enterprise investment in S&T (science and technology) has always been the focus of research. Based on the data collected from 307 high-tech enterprises in Zhejiang Province, the paper puts research on enterprise competitiveness, which as a bridge in connecting the input of science

C. Hua (✉) · Y. Zhang · X. Yang
Department of Technology Innovation, University of Zhejiang Sci-ech,
Hangzhou, China
e-mail: ddz1217@163.com

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and technology in high-tech enterprises and performance, where lag and interactive effects are considered.

42.2 Literature Review

The S&T input is mainly about the input used to support scientific and technological activities, including the R&D expenditure and the R&D staff. Enterprise performance means the evaluation of enterprise profit capability, the internal and external resources allocation and the efficiency of resources utilization, including enterprise sales revenue, net profit etc.

Los and Verspagen (2000) found that the spillover effect of R&D expenditure has positive effect on enterprise productivity in a different level of influence degree in the high, middle and low technological enterprise. Hsieh et al. (2003), based on American pharmaceutical and chemical enterprises in the 1975–1996, found that the gain from R&D expenditure was greater than capital assets. Hu and Jefferson (2004); Hu (2001), based on large and medium-sized industrial enterprises in Beijing, China, found that R&D expenditure has significant influence on enterprise performance both in large and medium-sizes industrial enterprises, but the degree and effect size was different in different industries and the effect will gradually become smaller as time goes on

There are not a consistent conclusion between R&D from different industries or regions. Some found that enterprise R&D expenditure is correlation with performance (Liang and Zhang 2006; Yuepin and Wang 2011), some found R&D expenditure is irrelevant with performance (Zhu and Herui 2004; Liang and Zhang 2005), the others found R&D expenditure has lag effect on performance (Hewei 2003; Zhou and Zeng 2011).

Most of the study focused on the two variables: R&D expenditure and performance, seldom on the interactive effect of capital input and other variables such as human capital input.

Based on literature review, and data from 307 high-tech enterprises in Zhejiang Province, the paper explored the enterprises competitiveness as a bridge in connecting between input of science and technology in high-tech enterprises and performance, and lag and interactive effects was introduced.

42.3 Model Construction

42.3.1 Variable Selection

Based on literature review, the competitiveness of enterprises is divided into three dimensions, with the characterization of nine indicators. Since 2008 to 2010 the environment of innovation has little change, each indicators chooses three years average. Enterprise investment in science and technology included R&D expenditure and numbers of R&D staff. In order to study the lag effect, independent variables are selected in 2008. In order to avoid the autocorrelation, DW value is used to identification. The sales revenue is the dependent variables on the behalf of enterprise performance, current (2008), lag 1(2009) and lag 2(2010). See Table 42.1

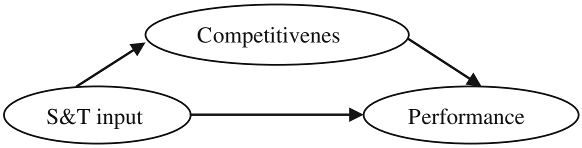
Table 42.1 Variable selection

Level 1 index	Level 2 index	Level 3 index	Unit
S&T input	Capital investment	R&D expenditure	Ten thousand yuan
	Human capital investment	The number of R&D staff	
	R&D intensity	Proportion of R&D expenditure in Sales revenue	%
The competitiveness of enterprises	Innovation ability	Number of authorized patents for invention by thousand R&D personnel	Each
		The number of patent application	Each
		Sales revenue of new products	Ten thousand yuan
		Proportion of new products' sales revenue in sales revenue	%
	HR elements	The number of employees	Each
		Proportion of the educated above junior college in total staff	%
		Proportion of senior technical labor and technician in total staff	%
	Manufacture technology level	Annual added value	Ten thousand yuan
		The overall labor productivity	%
Performance	Direct performance	Sales revenue	Ten thousand yuan

Note 1. Enterprises competitiveness index's' selection is according to Jinpei (2003), Liang and Zhang (2005). 2. R&D intensity is correlation with R&D expenditure, so it will not be included in equation as an independent variable, but it will be imported in interactive analysis

42.3.2 Model Construction

Theory Model



Equation Construction

$$Y = c_1X1 + c_2X2 + e_1 \tag{42.1}$$

$$M = a_1X1 + a_2X2 + e_2 \tag{42.2}$$

$$Y = c'_1X1 + c'_2X2 + bM + e_3 \tag{42.3}$$

$$Y = d_1X1 + d_2X2 + d_3\Delta_1 + d_4\Delta_2 + d_5\Delta_3 + e_4 \tag{42.4}$$

X1 = R&D expenditure, X2 = the number of R&D staff, M = competitiveness, Y = Sales revenue, Δ_1=R&D input × R&D intensity, Δ_2=R&D expenditure × the number of R&D staff, Δ_3=R&D intensity × the number of R&D staff.

42.4 Empirical Analysis

42.4.1 A. Sample Selection

Based on the database of Zhejiang innovation enterprises construction platform, this paper collected the data of 307 high-tech enterprises in Zhejiang Province from 2008 to 2010. The sample involves 12 regions, including: Hangzhou, Shaoxing, Jiaxing, Ningbo, Jinhua, Wenzhou, Taizhou, Quzhou, Huzhou, Lishui, Yiwu and Zhoushan, and mainly involved in 11 industry, including: equipment manufacturing industry, automobile industry, building materials industry, electronic information industry, medicine industry, petrochemical industry, light industrial food industry, nonferrous metal industry, PV and other new energy industry, textile industry and steel industry.

42.4.2 Factor Analysis (Based on the Sample after Standardization)

Firstly, this paper will extract factors from intermediary variable M by PCA (principal component analysis). KMO = 0.634 > 0.6, and pass the Bartlett' test of sphericity. Each variables' communality is bigger than 0.5 basically, so the

Table 42.2 Total variance explained

Component	Total	% of Variance	Cumulative %
1	2.631	29.232	29.232
2	1.23	13.668	42.901
3	1.168	12.98	55.881
4	1.062	11.802	67.683

variables can be quite comprehensive to explain the competitiveness of enterprises. With the characteristic value > 1 and the rotated component matrix, picking out four main factors. Regarding four main factors' variance contribution as explain intensity to calculate the competitiveness of enterprises' total score F. See Table 42.2

$F = 0.29232 \times F1 + 0.13668 \times F2 + 0.1298 \times F3 + 0.11802 \times F4$

42.4.3 Intermediary Effect Analysis

Current: using stepwise regression, the paper finds that the number of R&D staff is not significant and is removed. Because the DW value is 1.842, there is no autocorrelation between intermediary variable and each independent variable. Using stepwise regression, the paper finds that R&D expenditure passes the test and the coefficient to intermediary variable is 0.736 (note: the result of Eq. 42.2 is all the same in the three periods, so the paper will no longer marked it in the table below). Using stepwise regression, the paper finds that the competitiveness of enterprises has part intermediary effect between R&D expenditure and the performance, and the coefficient is $0.077 \times 0.736 \ll 0.835$ (the direct effect).

Table 42.3 The Result of Stepwise Regression Analysis

Sales revenue	Index		Equation 1			Equation 3	
		Coefficient	T	Sig	Coefficient	T	Sig
Current	R&D expenditure	0.892	34.375***	0	0.835	21.892***	0
	M				0.077	2.031**	0.043
	R^2	0.795	0.798				
	$adjR^2$	0.794	0.796				
Lag1	R&D expenditure	0.914	39.339***	0	0.8	24.092***	0
	M				0.154	4.646***	0
	R^2	0.835	0.846				
	$adjR^2$	0.835	0.845				
Lag2	R&D expenditure	0.899	35.926***	0	0.829	22.629***	0
	M				0.095	2.605***	0.01
	R^2	0.809	0.813				
	$adjR^2$	0.808	0.812				

*significance in 10 % level, **significance in 5 % level, ***significance in 1 % level

Table 42.4 The result of interaction analysis

Sales revenue	Current			Lag1			Lag2		
Index	Coefficient	T	Sig	Coefficient	T	Sig	Coefficient	T	Sig
R&D expenditure	1.406	29.08***	0	1.095	39.905***	0	1.093	36.631***	0
$\triangle_1$	−0.445	−8.185***	0	−0.418	−7.849***	0	−0.457	−7.895***	0
$\triangle_2$	−0.36	−7.959***	0						
$\triangle_3$	0.191	4.063***	0	0.181	3.931***	0	0.213	4.256***	0
R^2/adjR^2		0.873/0.871		0.878/0.877				0.856/0.854	

* significance in 10 % level, ** significance in 5 % level, *** significance in 1 % level

Lag1: The number of R&D staff is not significant and is removed. The competitiveness of enterprises has part intermediary effect between R&D expenditure and the performance, the coefficient is $0.154 \times 0.736 \ll 0.8$(the direct effect). Lag2: all the same, and the coefficient is $0.095 \times 0.736 \ll 0.829$ (the direct effect). See Table 42.3

42.4.4 Interaction Analysis

Current: Based on the result of above, Eq. 42.4 was modified to Eq. 42.4': $Y = d_1X1 + d_3\triangle_1 + d_4\triangle_2 + d_5\triangle_3 + e_4$. Using stepwise regression, this paper finds that the interactive effect of R&D intensity and numbers of R&D staff significantly promotes the increasing of sales revenue, while the interactive effect of R&D expenditure and R&D intensity has significantly negative effect on sales revenue, so as the interactive effect of R&D expenditure and numbers of R&D staff.

Lag1: paper finds that the interactive effect of R&D intensity and numbers of R&D staff significantly promotes the increasing of sales revenue, there is a complementary relationship between R&D intensity and numbers of R&D staff, while the interactive effect of R&D expenditure and R&D intensity has significantly negative effect on sales revenue. Paper gets the same result in Lag 2. Refer to Table 42.4

42.5 Conclusion

42.5.1 Conclusion

On the whole, the S&T input of high-tech enterprises in Zhejiang province is significant positive correlated with its performance. The competitiveness of enterprises has part intermediary effect between the R&D expenditure and enterprise sales revenue. The effect of R&D expenditure on the sales revenue presents inverted U type in the three periods, which means that the S&T input not only affects the present sales revenue, but also the sales revenue in the future.

The R&D expenditure affects enterprise sales revenue in two ways, first, it had direct effect, second, it affects by its intermediary role—the competitiveness of enterprises, which is smaller than the direct effect. The number of R&D staff is not related to the enterprise sales revenue. According to the study, R&D expenditure has still been the main input in high-tech enterprises in Zhejiang province recently, and human capital investment doesn't play an important role.

The interactive effect of R&D intensity and numbers of R&D staff significantly promotes the increasing of sales revenue in the three periods, while the interactive effect of R&D expenditure and R&D intensity has significantly negative effect on sales revenue in the three periods, and the interactive effect of R&D expenditure and numbers of R&D staff also has negative effect on present sales revenue.

The essence of R&D expenditure and R&D intensity is representative of quality and quantity of input. The study shows that even though the quantity of R&D expenditure input has been increasing recently, there is a certain lack of coordination between the number of R&D staff and R&D intensity, not only in the current period, but also in lag 1 or lag2 periods. After importing the interactive items, the R&D expenditure has greater effect on sales revenue than before, which returns to scale turns into increasing from decreasing in three periods. The result demonstrates that, under the interactive effect of internal factor of S&T input, the effect of S&T input is better than in single factor, and has greater contribute on enterprise performance.

42.5.2 Shortage

Due to the data of availability, the paper only covers lag effects in two periods, the long-term effects by input of science and technology should be observed. Upon the case data of enterprises in Zhejiang Province, the implication of the research in nationwide remains further study.

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Chapter 43
The Salary Determination Model for Independent Colleges: Based on a Survey of Hubei Province Independent Colleges

Xiao-bai Lu and Cun Cheng

Abstract This paper reports a survey of the current salary structures and scales of the so-called independent colleges in Hubei province. Some problems are found to exist in the current practices. To address the problems, the paper, from the perspective of relevant labor theories of value, proposes a salary determination model specifically for the independent colleges.

Keywords Independent colleges · Salary · Determination model

43.1 Research Problem

Against the backdrop of the MOE policy to encourage private capital to enter higher education thereby easing the tension between increasing demands for higher education and the limited provision of state-run higher education, since 1999 a new system of higher education supplementary to the existing state-run system has emerged. The so-called independent colleges (IC) have, to a great extent, helped meet the social needs for higher education by pulling together the efforts of state-run colleges and universities and the private sector. However, ICs are still a new phenomenon. As such, they inevitably face problems of different nature in their development. Some of these problems are highlighted by the sheer rapidity of their own development.

At present, Hubei province has the largest number of ICs in China. Its 31 ICs (4 declared independence from their mother institutions) account for 10 % of the national figure of 322. In terms of quality, Hubei's ICs have earned high rankings

X. Lu (✉) · C. Cheng
College of Management, Wuhan University of Science and Technology, Wuhan, China
e-mail: lvxiaobai@126.com

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Table 43.1 Average Salary

Average salary				
Years	Hubei		Wuhan	
	Annual average (¥)	Increase	Annual average (¥)	Increase
2007	17,397	–	22,999	–
2008	22,739	30.7 %	27,212	18.3 %
2009	23,709	4.3 %	32,429	19.1 %
2010	28,092	18.5 %	33,320	2.7 %

Note 2011 information unavailable

in the recent two years' national evaluations. Therefore, for our investigation of ICs' salary systems, Hubei's ICs can be taken as a representative sample.

Recent years have witnessed steady rises in salaries due to the national minimum wage law as well as the changing economic situations. As shown in Table 43.1, there has been substantial salary increases in Hubei province and the city of Wuhan. In this context, the ICs in Hubei province have felt considerable external pressure to raise their salary standards. In the past two years the ICs have adjusted their salary systems and raised their salary standards to varying degrees. However, introduced primarily in consideration of their own internal situations and in response to the external pressure, rather than anticipated results, the salary rises have led to more complaints from the teachers. The ICs seem to be trapped in a vicious circle of salary rises and complaints. Therefore, to inform salary policies and practice, it seems necessary to study ICs' salary system problems from both internal and external perspectives.

43.2 Status Quo of Salary Systems of Hubei's Ics

15 ICs participated in the investigation, including 6 affiliated to 211 Project universities, 3 to first-tier universities and 6 to second-tier universities. 16 waves of interviews were held with the middle and upper echelons of the administrative staff of each IC. Meanwhile, questionnaires were sent to 300 teachers, 255 of whom returned valid responses.

Figure 43.1 and Table 43.2 display IC teachers' years of age and years of employment respectively. Teachers aged 35 and below accounted for 64 % of the participants while 69 % of the teachers had an employment history of less than 8 years. The findings indicate that ICs in Hubei province tend to have a relatively young faculty.

Figure 43.2 shows that ICs in Hubei province tend to have a well-educated faculty, with 73 % teachers holding advanced academic degrees, indicating that this population as a whole has a strong knowledge base and professional competence. Obviously, the ICs in Hubei possess high values of human capital.

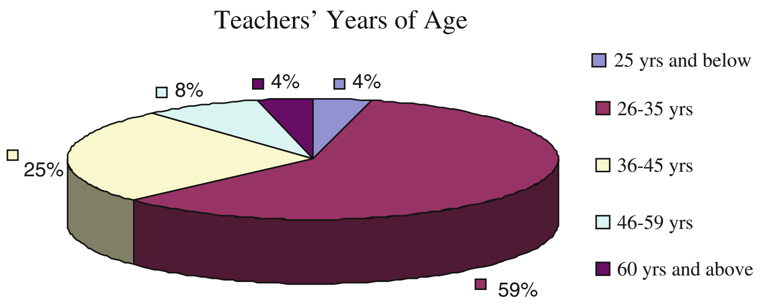

Fig. 43.1 IC teachers' years of age and years of employment

Table 43.2 IC teachers' years of age and years of employment

Teachers' years of employment	
Years	%
Less than 3	29.76
3-8	39.29
9-17	16.67
18-30	9.92
30 and more	4.37

Figures 43.3 and 43.4 shows the extent to which teachers were satisfied towards the salaries their ICs provided and in comparison with those of other institutions. 71 % of the participants felt that their salaries were about the average or high compared with other teachers within their college, suggesting satisfaction over their situations within the college. On the contrary, when compared with other

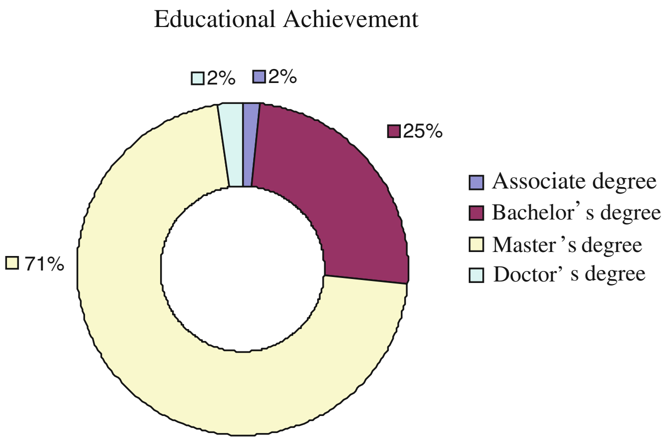

Fig. 43.2 Educational Achievement

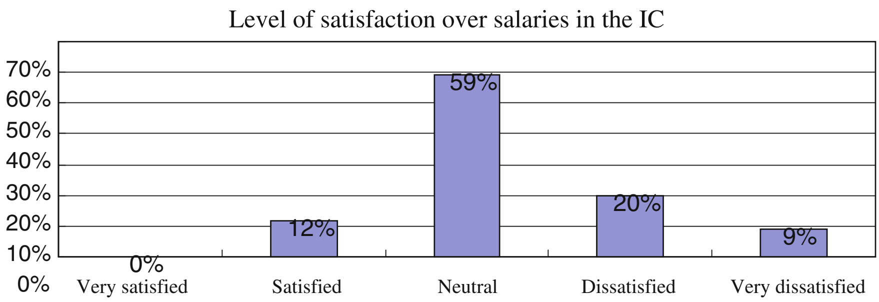

Fig. 43.3 Level of satisfaction over salaries in the IC

institutions, 73 % of participants reported that their salaries were low or very low, indicating dissatisfaction over their social status. These data suggest that ICs in Hubei have internal equality but lack external competitiveness. This may result in potentially high teacher turnover rates.

43.3 A Salary Determination Model for Independent Colleges

43.3.1 A Theoretical Framework

The concept of human capital has two important aspects: (1) human capital exists in the human being which is the sum total of his or her knowledge, skills, and physical energy (i.e., health). And (2) human capital is realized by investments in food and health care, education, in-service training, personal expenses incurred in seeking employment, and travel expenses (Theodore 1990). According to the labor turnover model, businesses suffer loses because they have to pay for additional recruitment and training efforts due to employees' resignations (Jeong 2002). One solution to this problem is for the company to set up salary standards that are sufficiently high to prevent employees from leaving their jobs (Mulligan 1997). Other factors being equal, salaries higher than those offered by other organizations may weaken employees' desire to switch to other jobs, thus reducing labor turnover.

43.3.2 A Salary Determination Model for Independent Colleges

IC teachers are a special population. They have these four characteristics: (1) As intellectuals, they are knowledgeable, highly skilled, and healthy and therefore represent high values of human capital in the labor market; (2) For IC teachers, teaching is a full-time occupation; (3) Work in an IC, particularly classroom teaching, is relatively independent (Lv 2006). Teaching quality largely depends upon the individual teacher's personal efforts. Since supervision is costly and unreliable, teachers' work performance becomes a major determinant of labor efficiency (Lv 1833); and (4) unlike public colleges and universities, ICs obtain human resources through the labor market. This results in employment contracts having limited binding power. The teachers do not have a sense of belonging and are free to change jobs (Lv 2006).

In light of the human capital theory and the characteristics of IC teachers, we propose the following: (1) The more human capital an individual has, the more productive he or she is, and the higher he or she should be priced in the labor market; (2) Wages should reflect the market prices of human capital; and (3) Although human capital is formed by the functioning of a multitude of factors, IC salary offers should be based on the two major constituents of human capital, namely, the value of knowledge and that of skills (Zhang 2000; Dou 2003). Thus

$$\mathrm{W} = \mathrm{W_a} + \mathrm{W_j} \tag{43.1}$$

where W is the total of wages, W_a is the wages for knowledge, and W_j is the wages for skills; all wages are on an annual basis.

Further research shows that knowledge-based human capital can be broken down to capital in the form of generable knowledge and capital in the form of advanced knowledge. The former represents the average social value of human capital while the latter represents the surplus value. Both need to be priced.

Using as a baseline the value of the knowledge acquired from investing for an undergraduate degree, an analysis of Hubei IC teachers' educational achievement levels revealed that the overall human capital of Hubei IC teachers is larger than the baseline value and that their human capital is larger than the social average. (See Fig. 43.2). Although the average social wages as determined by the government is low hence an inadequate index of average social value, it is still a useful measure.

Apparently, IC teachers' surplus human capital is the value formed through educational investment made beyond an undergraduate degree. Due to the difficulty in assessing this surplus value, rather than using the actual value of educational investment as an index, we propose that the surplus human capital value is to be indexed by chance social earnings. Chance social earnings are the total of wages that the IC teachers could have made if they had been working over the same period of their graduate education. Here the wages refer to the average social wages determined by the government. Thus

$$\mathrm{W_a} = \mathrm{G_s} + \lambda \times \mathrm{G_s} \times \mathrm{N} \tag{43.2}$$

where $\mathrm{G_s}$ is the previous years' average social wages; N is the number of years of graduate education; λ is the adjusted coefficient.

Skill-based wage is the price of the professional skills component of human capital. A teacher's professional skills consist of the skills he or she brought to the

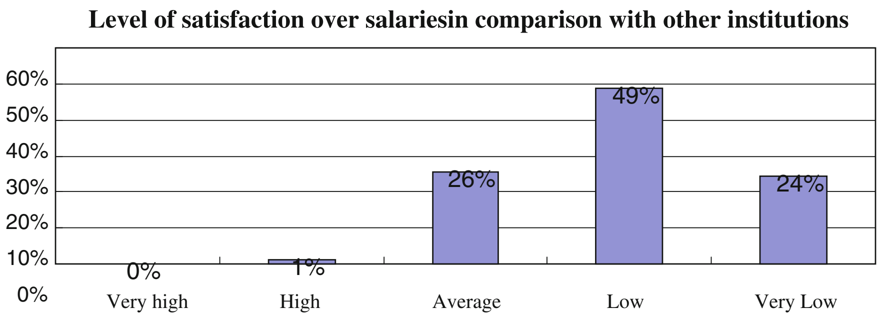

Fig. 43.4 Level of satisfaction over salaries in comparison with other institutions

present job and the skills acquired through additional investment while in service. Measuring the value of skills is not easy. However, we assume that a teacher competent for his or her current post is qualified in terms of skills required for the post. These skills may not be all his or her skills, but the teacher at least possesses the skills minimally required for the job. Therefore, the price of the value of a particular post can be taken as the minimal value of the professional skills of the teacher on that post.

However, in the current IC financial system, post wages are exclusively based on the colleges' financial situations and their arbitrary decisions. This practice, of course, is closely related to colleges' value orientation.

We propose the following formula for determining skill-based wages:

$$W_j = W_g = \gamma \times OP \tag{43.3}$$

where W_g is post wage, OP is the college's revenue of the current fiscal year, and γ is the revenue distribution co-efficient.

Plugging (43.2) and (43.3) into (43.1), we obtain

$$W = G_s + \lambda \times G_s \times N + \gamma \times OP \tag{43.4}$$

Applying (43.4) to obtain the derivative of G_s, then

$$DW/dGs = 1 + \lambda \times N + 0$$

$$\lambda = [(dW/dG_s) - 1]/N \tag{43.5}$$

Plugging (43.5) into (43.4), we obtain

$$W = (dW/dG_s) \times G_s + \gamma \times OP \tag{43.6}$$

When social human capital freely flows in the labor market, an organization's wage determination is constrained by external factors. While the labor market allows convenient personnel flow and ICs generally lack external competitiveness as indicated in Fig. 43.4, IC teachers tend to have a desire to transfer. Given a new job opportunity, for an individual IC teacher, whether to transfer to a new job depends upon how the current salary compares with that offered by the new job. All other factors being equal, an individual's current income is this individual's current salary whereas job transfer gains are the difference between the external salary offer and the transfer costs. When pre-transfer and post transfer salaries are equal, rather than salaries, other factors will influence the decision whether to transfer to the other job. When the post transfer salary is higher than the pre-transfer salary, the probability of a transfer increases. Therefore, a necessary condition for a transfer not to happen is that the pre-transfer income is equal to or larger than the post transfer salary.

$$W \geq W_u - C \tag{43.7}$$

where W_u is the external salary offer and C is the transfer costs

External salary offers are usually indexed by the average salaries in the same occupation. We examined the whereabouts of the resigned teachers from one of the ICs participating in our research. We found that some teachers had transferred to other ICs, but that significantly more had landed in regular colleges and universities. Consequently, in addition to average salaries for the same occupation, average salaries for other occupations that teachers with special expertise may transfer to should be taken into consideration when examining external salary offers. Job transfer costs are mainly the payments that the teacher is obliged to make to compensate the college for what it has spent on the teacher.

In conclusion, we propose the following wage determination model for ICs:

$$\begin{cases} W = (dW/dG_s) \cdot G_s + \gamma \cdot OP \text{ (A)} \\ W \geq W_u - C \text{ (B)} \end{cases}$$

This model accounts for the vicious circle of salary rises and complaints. According to (A), wages based on surplus human capital rises with rises in social salary (G_s) standards rises. Salary adjustments should not reflect G_s increases alone. Even when OP and γ are held constant, salary rises that reflect G_s increases alone are not sufficiently adequate to insure teacher satisfaction. In fact, for some ICs, salary increases are smaller than G_s increases. Salary rises should be synchronous with increases of (dW/dG_s) G_s. Similarly, (B) explains not only the low satisfaction level of teachers over salary rises but also the high frequency of resignations of the teachers own volition. When his or her salary (W) does not satisfy (B), a teacher will inevitably be dissatisfied and a job transfer will inevitably happen with an external job offer.

Because of the restrictions imposed by the authorities on student recruitment and tuition charges, increases in revenues (OP) of ICs are limited. When the size of student population is stable over a period of time, OP becomes a constant. Then the value of revenue distribution coefficient γ reflects how much of the OP the college is willing to distribute to the teachers. It reflects the accumulated result of several distributions. Figure 43.3 reveals a positive tendency of ICs' OP in favor of teachers, indicating the value placed on the teaching staff and the teachers' satisfaction.

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Author Biography

Author Bio Professor Ms. Lu Xiaobai was born in December 1962. She holds a bachelor's degree in regional economics and a Master of Economics degree. For years, she served a listed company in its human resources management department. Currently, she serves the School of Management, Wuhan University of Science and Technology (WUST). She is engaged in human resources management teaching and research. Meanwhile, she is vice dean of the City College, an independent college affiliated to WUST. She can be reached at City College, Wuhan University of Science and Technology 1 Huangjia Dawan Road, Donghu Fengjingqu Wuhan, Hubei Prov. 430070

Chapter 44
Analysis of Determinants Affecting Cash Dividends Policy of Listed Producing Companies in China

Xiao-yan Liu and Xiao-ming Liu

Abstract Distributing cash dividends is the main means of paying cash to shareholders. Correct cash dividends policy contributes to benefiting the companies in many aspects such as the increase of the firm value. Also because the institutional background of China's corporate sector is unique, the situation of factors that affecting the cash dividends policy in China remains complicated and different from foreign countries. Therefore, we engage to seek the factors that play an important role on cash dividends paid. The analytic and empirical research result shows that the profitability is significantly related to cash dividends while size and growth have negative relationship with cash dividends paid in producing listed companies. This is helpful for listed firm regulators and management, as well as investors.

Keywords Cash dividends · Profitability · Growth · Liquidity · Size

44.1 Introduction

Distributing Cash dividends is the main means of paying cash to shareholders. The research on payout policy is an important area of corporate finance. Correct cash dividends policy contributes to benefiting the companies in many aspects such as the increase of the firm value (Yuan 2001). On the contrary, incorrect cash dividends policy brings damages to the development of the company both in current situation and in future. Accordingly, pay or not pay cash dividends, how much should pay, it is a controversial question (Black 1976).

X. Liu (✉) · X. Liu
School of Economics and Management, North China Electric Power University, Beijing, China
e-mail: lliu716@sina.com

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Many foreign scholars have researched the cash dividends policy since the last century. However, researches based on data of Chinese capital market have not been reformed for a long time. Also because the institutional background of China's corporate sector is unique, the situation of factors that affecting the cash dividends policy in China remains complicated and different from foreign countries (Yuan 2005). First, most listed firms in the Shanghai and Shenzhen stock exchanges in China are carve outs of state-owned enterprises, ownership by the state is very high, and a majority or controlling ownership is hold by the government, especially in big scale industries such as producing industry. Second, before the stock reform, a large fraction of the stocks of listed firms are not available in the open market, but restricted in the ownership by state-owned enterprises as reserved shares. Investors, creditors and other outside users are not strong enough to let the management, to make decisions for the best interest of all shareholders because of the major ownership of the state. Along with the completion of stock reform, changes have occurred. Previous researches have found that the ownership structure of corporate sector in China is different from those in the U.S. and Europe. This paper engages to identify the key factors affecting cash dividends policy in China through an empirical research method, taking the producing industry as the sample. Suggestions from this research results are helpful both to governance regulators and investors.

44.2 Literatures Review

The determinants of firms' dividend policies have long been studied for a long time as a difficult title. Theories of dividend policy include the major following: (1) the bird in hand theory according to this theory, cash dividends are considered like a bird on hand while the retained earnings are like a bird in the forest; (2) the dividend signaling theory (Miller and Modigliani 1961; Healy and Palepu 1988) thinks by distributing cash dividends, the future information of companies can be released; (3) agency theory (Jensen 1976) insists that by the means of payout of cash to stockholders, management has less cash to control, meanwhile agency cost can be decreased and the equity of minority shareholders can be protected; (4) under the clientele effect theory (Miller and Modigliani 1961), firms investors preferred cash dividends for its tax benefit while single investors preferred capital gains; and (5) The behavior of the major shareholders seizing the Minority shareholders' interests theory.

In China, among the related theories, it seems that the signaling theory is often adapted by researchers, as well as the agency theory. The institutional background and high ownership concentration are the two important factors distinguishing Chinese listed companies from those in foreign counties. Some empirical research results indicate that Ownership by the state influences the payout ratio of cash dividends and stock dividends: the larger the ownership by the state, the lower cash dividends and higher stock dividend. Several other determinants also play important role on dividend policies of Chinese listed companies in deferent degrees such as size, growth, profitability, liquidity, leverage.

However among the factors affecting the cash dividends policy, which ones are the most important determinants? There is little research concentrating on this question. In this paper, by taking the producing companies as sample, we analyze the most important factors that have influence the cash dividends deeply in China. This is helpful for the listed company regulators and managements, as well as investors.

44.3 Empirical Analysis

44.3.1 Research Hypothesis

Based on the above theories, we find that among factors affecting the cash dividends policy profitability is the most powerful one, at the same time growth, size and liquidity work on cash dividend distributing too.

Profitability is also the resource of cash dividend. Only the firms with profit can be able to pay cash to stockholders. To be able to make payout, a firm must keep revenues exceed expenses. After distributing the earnings inside the firm, the remained earnings could be considered to pay to owners outside the firm.

For investment purpose, enough earnings should be kept inside the corporation and less cash dividends should be distributed at the same time. Therefore, we conclude the research hypothesis: the higher profitability, the more cash dividends. In researches on profitability to cash dividend policy, deferent indexes such as return on equity (ROE) and earnings per share (EPS) are used. According to the agency theory, the goal of management is to earn profit for stockholders. Therefore, return of equity is thought the best index to evaluate the efficiency of management's job rather than other ratios such as EPS. In our research, we take ROE as the main explaining proxy to cash dividend.

Besides the profitability, the size and the liquidity are important factors that can have big influence on cash dividends policy. Keeping liquidity situation good is the base for operating and development of a listed corporation. Under the current accounting system, profit in the current period always differs from cash balance of the firm on the accrual basis. If there is not enough cash on hand, cash dividends cannot be paid even though there is a positive profit. Increasing the turn over rate of all kinds of assets makes the current assets enough to satisfy the demand of payout. The high assets turn over rate, the more cash to be distribute.

Based on the above analysis, the following research hypothesis is proposed:

The profitability is positively related to cash dividends, that is, the higher profitability of a listed company, the higher cash dividends could be paid.

44.3.2 Model Selection and Sample

Based on the previous research, we take cash dividends per share (DPS) as the explained variable, the ROE as a proxy variable of profitability, as well as the net income increasing rate (NIIR), the log of total assets (TA) and turn over rate of total assets (TATOR) as control variables on behalf of growth, size and liquidity of a corporation. The linear multi-regression model adopted is as follows:

$$\mathrm{DPS} = \alpha + \beta 1 * \mathrm{ROE} + \beta 2 * \mathrm{NIIR} + \beta 3 * \mathrm{TA} + \beta 4 * \mathrm{TATOR} + \varepsilon$$

In this paper, we choose A-share producing corporations listed in Shanghai stock market as our sample, which paid cash dividends in year 2009. In order to keep the sample effective, we exclude ST and *ST companies, as well as those whose earnings is negative or data is unavailable. As a result, we select 52 companies in our sample. All the data is from CCER financial database and Wanfang Finance. In analyzing the data, SPSS software is used.

44.3.3 Empirical Analysis Result

From Table 44.1, we can find that the coefficient of ROE to DPS is positive (0.750) with t (8.132) and sig. (0.000) in model (1), indicating the ROE and DPS are significantly positively related at 0.01 level. The coefficient of TATOR to DPS is positive, but not significant (t: 1.410; sig: 0.135). The coefficients of NIIR to DPS and TA to DPS are negative, significant at 0.1 level. At the same, the fact that the each VIF of the variables is less than 2 show that there is no multilinearity in model (1). Therefore, the results tell us that the higher return on equity, the more cash per share paid. On the contrary, the bigger size and higher level the firm is, the less cash paid to shareholders. Also, the higher level of growth the firms are, the more cash dividend distributed (Black 1976).

Table 44.1 Coefficients

Model (1)	Unstandardized coefficients		Standardized coefficients	t	Sig.	Co linearity statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.012	0.522		1.939	0.059		
ROE	0.168	0.021	0.750***	8.132	0.000	0.975	1.025
NIIR	−0.024	0.013	−0.177*	−1.841	0.072	0.899	1.113
TA	−0.042	0.023	−0.172*	−1.858	0.069	0.969	1.032
TATOR	0.062	0.044	0.135	1.410	0.165	0.907	1.103

* Correlation is significant at the 0.1 level (2-tailed)
*** Correlation is significant at the 0.01 level (2-tailed)

44.4 Conclusions

As analyzed above, through the empirical analysis we conclude the following results:

Firstly, consistently with the whole listed companies in China, producing industry pay less cash dividends. It is not uncommon to pay no cash dividends to shareholders nor pay high cash dividends.

Secondly, except liquidity, determinants of profitability, growth and firm size are all related with cash dividends in producing listed companies in different degrees. Especially profitability is significantly positively related with cash dividends, and growth and firm size are negatively related with cash dividends paid. That is, currently in China, when listed companies determine distribution of cash dividend, they will consider the profitability, growth and firm size more than other factors. And the more retained earnings, the more cash paid to shareholders as dividends.

In summary, under the unique institutional environment and capital market situation of China, among the determinants that affecting cash dividends policy of producing listed companies in producing industry, profitability is the most important one. This is important to both managements and investors for corporate governance and economic decisions.

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Chapter 45
Research on Regional Technical Innovation and Old City's Development Through Suzhou's Practice

Xiao-ran Hu, Cheng-yang Xie and Chi Wang

Abstract It seems difficult to balance economic development and historic city preservation. However, Suzhou has shown a success in its attempt to achieve sustainable development. This thesis analyzes the practice of Suzhou in the three aspects: industry division, commuting and Chinese culture, aiming to cast light on the sustainable development of cities in China and even around the world.

Keywords Regional innovation · Sustainable development · Industry division and cooperation

45.1 Introduction

Problems such as land limitation, pollution, congestion and so forth are inevitable during the development of a city. Literatures concerning urbanization problems have demonstrated two different approaches to addressing these issues, namely building out and building up. Though these two measures have apparently identical results, their essences differ totally and trigger different problems.

Building out, or suburbanization, once a trend in the US after World War II, is now widely adopted in many developed cities in China. It stresses the growth of areas on the fringes of major cities and has been discussed intensively in many

X. Hu (✉)
Columbia College, Columbia University, New York, USA
e-mail: xiaoran_hu_2012@yeah.net

X. Hu · C. Xie
School of Economics and Management, Southeast University, Nanjing, China
e-mail: xiechengyang@yahoo.cn

C. Wang
School of Foreign Languages, Southeast University, Nanjing, China
e-mail: wangchi_seu@126.com

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aspects (Bertinelli and Black 2004; Sato and Yamamoto 2005; Chen and Gao 2011). Through suburbanization, the function of the whole city is divided into two parts: working and dwelling. The residents of a metropolis working in downtown usually choose to live in suburbs and commute to work by automobile or public transport.

Building up means that to build more skyscrapers in downtown to accomodate more immigrants. To some economists, building up is a more effective way than building out to deal with urban problems, for an abundance of closely connected vertical buildings can decrease the pressure on roads, cut the expenditure of long commuting and promote the communication between neighbors. For instance, in his *new book* “*Triumph of the City*” a Harvard economist Edward Glaeser argues that tall buildings are greener than sprawl, and they foster social capital and creativity (Lin et al. 2004). He also quotes both positive and negative cases, including Hong Kong, Singapore, Mumbai and Paris, to support his view.

Supporters of building up highlight the importance of compact and green buildings to social innovation and sustained development Glaeser (2011), while proponents of building out point out that high building will decrease the quality of life, which is increasingly crucial to attract valuable innovative residents. They argue by contrast that development of sub-centers helps to capture benefits from knowledge spillovers and offsets diminishing returns from urban congestion, thus stimulating more sustainable urban growth (Berliant and Wang 2008).

Both views seem rational and have their own limitations. To this day there is still no consensus over this debate. However, one certain thing is that, while the two sides argue from economists’ points of view, some issues such as historic preservation which is usually associated with height limit are hardly isolated economic problem but also pivotal to cities’ sustainable development. Taking into account these additional non-economic factors, we find that problems become more complex and it seems not easy to find a balance among all these issues (Persky and Kurban 2003). However, as development today is a process of experimentation and learning in particular context, Suzhou, one of the most ancient and prosperous cities in China, has found a way, according to its own features, to shed light on this conundrum. In the rest of this thesis, the case of Suzhou’s practice will be analyzed in order to reveal how it has achieved this success and provide some inspirations for other cities’ development heading down a more sustainable path.

45.2 Suzhou’s Success

Renowned for its rich cultural heritages and prosperous economy, Suzhou city, which is located in the south of Jiangsu province, is one of the most developed cities in China.

Suzhou’s development has a direct correlation with the growth of its satellite cities. It is the steady integration development between central area and outskirt districts that has created Suzhou's remarkable achievements both in economy and historic protection. Among the satellite cities, Suzhou Industrial Park (SIP) is undoubtedly the most representative one. In the following papers, we will take SIP as an example to elaborate on the interaction between the old and new cities in Suzhou.

45.2.1 Sustainability

Indeed, it seems difficult to balance the demand of providing additional desirable space and the need to preserve a green and historic city in the process of industrialization. However, by means of building satellite cities around the downtown, the Suzhou Municipal Government has successfully eased the pressure of increasing cost, pollution and congestions during the process of industrialization while keeping pristine taste of historic Suzhou.

Nowadays, the characteristics of quaint streets, classic gardens and waterways in old downtown are still well preserved, while over hundreds of square miles of green space have been opened up in the satellite cities. Meanwhile, environment-friendly industries in satellite cities are encouraged by Suzhou Municipal Government. Thus they can provide more green products and service to guarantee its sustainable development, and in one of its satellite cities an "environmental business incubator," consisting of 50 small R&D firms, has been set up.

Thanks to its perfect balance between preserving the ancient and building the modern, Suzhou stood out in the World Expo 2010 Shanghai, and we can see that Suzhou has found a sustainable path for the city's development in the long run.

45.2.2 Innovation and Economic Development

Since China adopted its reform and opening-up policy, the city has become a textbook case of China's rapid and lucrative expansion to the world: in 2011, the city's Gross Domestic Product (GDP) has risen to RMB 916.89 billion, ranking 6th among all the cities in China. It is undoubted that Suzhou is the second largest industrial city in the Yangtze River Delta, only behind Shanghai.

Meanwhile, innovation activities in Suzhou, especially in the new city SIP, are in full swing. We use the number of patents to reflect the innovation fruits in Suzhou and get Fig. 45.1:

The left bars represent the number of patent applications in each year while the right bars show the number of the approved ones. Patents might not reflect all the activities of innovation, because not all commercially valuable new ideas are patented. However, it is a reasonable one and has been widely adopted in many studies on innovation (Acs et al. 2002; Jaffe et al. 1993; Lee et al. 2004). According to Fig. 45.1, innovative activities represented by patent counts have multiplied almost 10 times from 2001 to 2010.

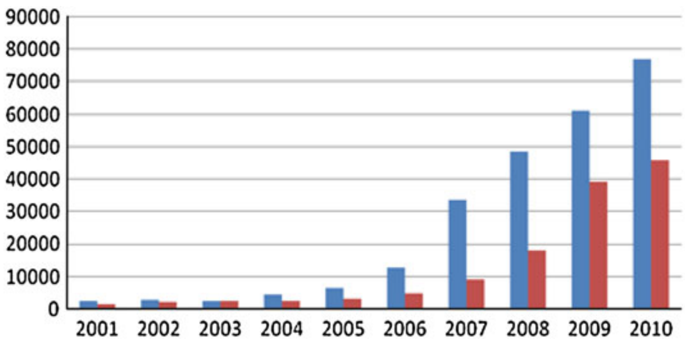


Fig. 45.1 Number of patent applications and approvals in recent 10 years. *Source* Suzhou science and technology statistical yearbook 2011, with time series spliced together by authors

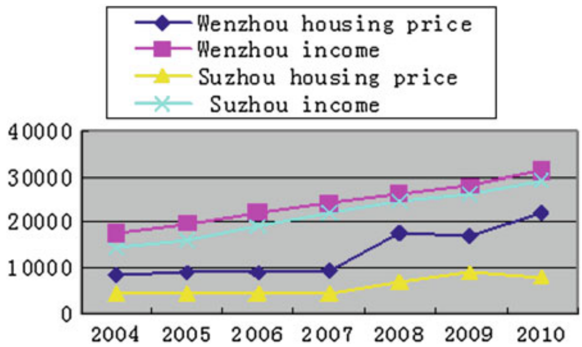
45.2.3 Housing Price

Although the height limit on buildings has been carried out for more than two decades, housing price in Suzhou has hiked slowly compared to its income increase, and the situation as Glaeser described: "a thorny problem of skyrocketing rent and housing price" has never occurred.

To support the point above, we choose Wenzhou, another costal city, to make a comparison. There are many similarities between Wenzhou and Suzhou in their economic development. For example, they are both the hot places for foreign investment and their development both started from OEM. Therefore, these similarities ensure that this comparison makes sense.

Figure 45.2 exhibits the changes of housing price and disposal income in Suzhou *vs.* Wenzhou. It can be clearly seen that, though both of them have had a thriving and robust economic development in recent 5 years, the growth in housing price of Suzhou is much slower and more stable than that in Wenzhou.

Fig. 45.2 Comparison of housing price and disposable income between Wenzhou and Suzhou



45.3 Two Cities in Suzhou

45.3.1 Old City

The old city here refers to the urban core of Suzhou which covers an area of 90 km^2, and the history of the old city can be tracked back to 2,500 years ago. Being the cradle of Wu Culture, the old city has rich cultural heritages, and its unique characteristics are always attached with the "classical gardens, winding streets and bridges, simple black, gray and white architectures". Besides that, since the Song Dynasty (960–1279), it has always been an important center of China's silk industry.

Since the adoption of the reform and opening-up policy, Suzhou, benefiting from its advantage of location, has gained the favor of foreign investments, and the old city witnessed a rapid expansion of manufacturing industries during the 1990s (Anwar 2006). However, accompanying the city's booming economy, some urban problems like congestion, pollution and land intension followed and snowballed. This ambitious city, nevertheless, was not going to destroy its past in order to meet the future. Therefore, a series of policies aiming to preserve its culture relics and sites were gradually implemented, the seven-story height limit on buildings being one of them. Thanks to its adherence to these policies, till today, the old city still preserves its unique landscape of "small bridge, flowing water, white wall, black tile, cultural relics and classic gardens" that contribute to its status as one of the top tourist attractions in China.

45.3.2 New City: SIP

The one we call new city is China-Singapore Suzhou Industrial Park (SIP), which is located in the east of the old downtown with an initial area of 80 km^2 in 1994 and then enlarged to 288 km^2. As an important economic cooperation project between Chinese and Singapore government, the new city is aimed not only to accomodate more immigrants but also to push Suzhou's economy and innovation to a new height.

Compared with that in the old city, transportation in the new city is more diverse and convenient. Thanks to its wise site selection, the new city can be connected to domestic and foreign metropolis easily via well-developed network of highways, railways, waterways, and airlines. Under the guideline of Singapore government, all the infrastructures inside the new city are constructed according to high-standard of "9 utilities and leveled land" (Bronzini and Piselli 2009, Jansson 2008). Besides that, investment policies implemented within the new city, including tariff reduction and exemption, provide investors preferential treatments that would be unequaled elsewhere.

Due to all these advantages above, the new city rapidly attracted attentions of foreign manufacturing giants and became a hot area of investment during the 1990s (Moreno et al. 2002). It was the manufacturing industry which later became SIP's leading industry, and helped to form the financial base for the new city's further development.

At the beginning of the new century, China entered a new stage of development that focused on transformation and upgrading. To coordinate with this main rhythm and to enhance its competitiveness worldwide, Suzhou Municipal Government began to put stress on innovation. It is absolutely true that innovative activity is not necessarily performed by scientists or engineers, but the group of people is most likely to do the same. Being aware of the importance of talent pooling, Suzhou embarked on attracting prestigious universities from both home and abroad to locate their branch campus in a specific district within the new city, which later became the well-known Suzhou Dushu Lake Science and Education Innovation District and has contributed a lot to both old and new cities' development.

Nowadays, innovation activities within SIP are in full swing. Besides the innovation district above, another 5 key areas which perform different but complementary functions have been erected to ensure smooth and independent running of the new city.

In addition, the new city has bred its own lifestyle labeled with fashion, innovation and vigor, and is attracting more and more young talents worldwide to flock in and strive to realize their dreams, thus making Suzhou become oriental Silicon Valley.

45.4 Linkages Between the Two Cities

45.4.1 Industry Division and Cooperation

As described above, the leading industry within the new city is still manufacturing, which includes IT and machinery production. They are currently being vigorously motivated toward high-end and scale development. Meanwhile, supported by the government, the emerging industries inside SIP are thriving in recent years and they include nanotechnologies, optical new energy, bio-pharmaceutical, converged communications, software, animation and game, environmental protection. The latest data issued by Suzhou Bureau of Statistics indicate that in 2010, the output value of emerging industries in SIP is RMB 147.2 billion, accounting for 45.4 % of scale industries. Besides that, modern service industries such as finance and logistics have set their first steps.

For old city, it seemed impossible to make any progress because of its' limited space and narrow streets due to the policies to preserve its original style. However, another economic opportunity emerged: after a three-decade persistent economic growth, the domestic spiritual and cultural demands were growing. Meanwhile, China's miraculous rise and wealth of culture deposits began to attract a growing number of international tourists to set their foot on this wondering land (Smith et al. 1776). Suzhou, as one of the most typical Chinese ancient cities south of the Yangtze River, would definitely be an important tourist attraction. With awareness of this trend, based on natural endowment, the development of old city was oriented to tourism and traditional commerce like silk and embroidery by Suzhou Municipal Government. The orientation was undoubtedly correct and the fruits from tourism can be shown on the table below: from 2000 to 2010 earnings from domestic tourists have almost tripled while foreign exchange earnings of tourism have multiplied six times (Table 45.1).

Figure 45.3 depicts the industrial division between two cities:

The line with "▲" shows the portion of the output value from the secondary industry in regional GDP of old city. By comparison, the ratio of the output value from the tertiary industry to regional GDP of old city is shown by line with"×". In the same figure, bars are used to present the scale of the secondary industry in SIP and the tertiary industry in the old city respectively. It can be seen that after a slight rise in 2004, the portion of secondary industry in old city declined constantly while the ratio of tertiary industry gained a persistent increase after 2004 by contrast. That phenomenon corresponds well with the development orientation for the old city which was made by the Suzhou Municipal Government. Meanwhile, as to the new city, we can see a rapid and continuous expansion of the scale of the secondary industry.

The underlying industrial linkages between two cities seem like that: Through attracting foreign tourists to the old city, Suzhou gained the opportunity to present itself worldwide. Meanwhile, when the inventors of tourists see the comprehensive infrastructures, advanced communication networks as well as unequaled preferential policies in SIP, they would possibly make an investment decision. In addition, the development of cultural and innovation industries helps to expose the ancient city to the nation and the world as well. Just like what had happened in Japan, being influenced by its favorite movies or animations, tourists would be drawn to the city of the films' origin.

45.4.2 Commuting and Transportation

Transportation, as a big problem that affects the residents' choice of working and living place, has been widely discussed in existing literatures, varying from commuting cost (Ommeren and Fosgerau 2009; Sorek 2009) to commuting time (Ommeren and Rietveld 2005) and to commuting distance(Clark et al. 2003).

Table 45.1 Tourism in Suzhou

	2000	2005	2010
Foreign exchange earnings of tourism (USD 10,000)	20,135	63,905	125,059
Earnings from domestic tourists (100 million Yuan)	380.28	772.79	917.76

Source Suzhou statistical yearbook 2011

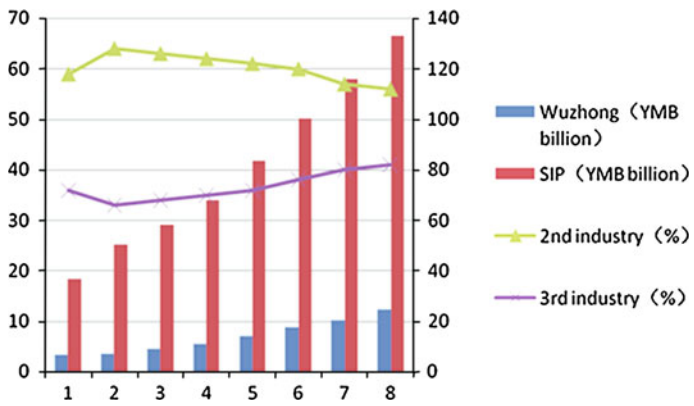


Fig. 45.3 Industry divisions between two cities. *Source* Suzhou bureau of statistics, with time series spliced together by authors

However, in the case of Suzhou, problems of commuting and transportation do not matter that much. As mentioned above, the new city is positioned not least as a dwelling place, but as a comprehensive living area, which has its own industry, shopping and service districts, acting as a perfect complement to the old city. Hence, instead of living and working in different places and commuting every day, residents of Suzhou can enjoy the convenience of combinating two places into one and needn't travel distantly. If it is needed, they can visit their friends or relatives living in another city on weekends. In this way, pressure on the roads that connect the two cities can be mitigated to a large extent and congestions rarely happen.

45.4.3 Life style, Chinese Tradition and Others

In the former paper, we have discussed the industry division and transport between these two cities. Then, besides that, is there any other underlying connection between these two cities? This question leads us to further think the culture and lifestyles in both cities as well as Chinese tradition.

We start our discussion from the discrepancy of residents between the two cities.

Because of the well preserved culture relics, cultural atmosphere of ancient China is ubiquitous in the old city, which makes it appear peaceful and elegant. Aged people prefer to live in old downtown, partially because they have lived there for a long time and got used to the life patterns there. Furthermore, the circumstance in old city such as close neighborhood and tranquility is more attractive to elders. On the other hand, atmosphere in new city, as we have discussed earlier, is permeated with innovation and vigor and thus more likely to be accepted by young people. Besides, the constantly expanding industries in SIP are providing more and more challenging but desirable jobs to young immigrants. Therefore, besides industry division, we can see a distinct living division between the two cities.

Now, let's come back to the Chinese family tradition. Different from western countries, Chinese parents keep supporting their children from both aspects of material and spirit even after they are 18 years old. When young couples have a baby, they are used to getting help from their parents to take the care, so that they can be released to concentrate on their work. However, while the babies grow up and can take care of themselves, normally after primary school, they would leave their grandparents and come back to live with their parents.

The education resource distribution in Suzhou adapts to this Chinese family tradition pretty well. Primary schools in Suzhou are concentrated in the old city to meet the kids' need while Dushu Lake Sci-Edu Innovation Park offers adequate resources for youth's demand for advanced education in the new city. The latest statistics suggests that the Park has housed 18 colleges of domestic and international prestigious universities. Its strategic cooperation with high educational institutions is still stretching.

The two cities share the talent pool together. People living in different cities usually have a family union on weekends and knowledge spillover can be generated from that. It is partially because of the effect of knowledge spillover, development and innovation of both sides can be stimulated.

45.5 Conclusion

Though changing is the only immutable thing in the world today and there cannot be a pattern of development that can be applied in any context, we can still gain many inspirations from Suzhou's practice.

The relative independence of the two cities might be the most pivotal element of Suzhou's success. Firstly, for both cities have bred their own distinct lifestyles and set up complete systems of living and working, residents don't have to commute any more. As a result, the traffic pressure between two cities is greatly mitigated and the transport expenditure hugely reduced. Secondly, as the increasing complexity of innovation calls for more and more collaborations between individuals, the concentration of innovative talents in the new city enables individuals within the region to approach and communicate with each other much easier, and therefore boost their sense of cooperation. Thirdly, the unique living pattern in the old city can be preserved completely, which makes the ancient old town more fascinating to the tourists.

The case also shows that government, like what it always does in China, has played an important role in the process of promoting function positioning and smooth connection of the two cities.

In the end, traditions, culture and other covert factors could not be ignored. On the contrary, they should be carefully considered while we make a long-term plan for a city's sustainable development.

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Chapter 46
Construction of China's Monetary Condition Index Based on the STR Model

De-cai Zhou, Wen-ping Qi and Zheng-yi Jiang

Abstract Based on China's monthly data ranging from January 1996 to January 2012, using smooth transition regression model (STR), construct China's nonlinear monetary condition index. The conclusion shows that the constructed nonlinear MCI is highly in consistent with the tendency of inflation, thus it could be the indictor of the implement of China's monetary policy.

Keywords MCI · STR model · Monetary policy · China

46.1 Introduction

Since Charles. Freedman (1994) puts forward the concept of Monetary Condition Index (MCI), scholars from worldwide have been constructing different country and region's monetary condition index by various methods (Yamin 2010). Many scholars also have constructed similarly China's monetary condition index (CMCI) (Kun and Siwei 2011). Such as (Yulu and Weihong 2003) initially introduced and commented MCI in China. Yongxiang and Zhou (2004), Wensheng and Yaowei (2005), Zhicun (2008) estimated the CMCI by using single equation estimate methods. Jianbin and Cuihong (2006), Yongqing and Conglai (2009), Changsheng et al. (2010) constructed the CMCI by using VAR model. To sum up, the majority of current papers are based on linear method to construct MCI. Considering the nonlinear relationship between currency price, currency supply and demand and some economic variables, it is advisable to construct China's nonlinear monetary condition index by using STR model.

D. Zhou (✉) · W. Qi · Z. Jiang
School of Economics and Management,
Nanchang University, Nanchang, People's Republic of China
e-mail: decaizhou@163.com

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46.2 STR Model

The following is general format of STR model (Lütkepohl and Kratzig 2004):

$$Y_t = \Phi' z_t + \theta' z_t G(\gamma, c, s_t) + u_t \tag{46.1}$$

Amongst $z_t = (w_t', x_t')'$ is explanatory variable vector, $w_t' = (1, y_1, \cdots, y_p)$ and $x_t' = (1, x_{1t}, \cdots, x_{kt})$ are exogenesis explanatory variable's vectors; $\Phi^t = (\Phi_0, \Phi_1, \cdots, \Phi_m)'$ and $\theta^t = (\theta_0, \theta_1, \cdots, \theta_m)'$ are respective parameter vectors of $(m+1) \times 1$'s linear and nonlinear parts; $u_t \sim \text{i.i.d.N}(0, \sigma^2)$ is random error term; $G(\gamma, c, s_t)$ is the transition function, the bounded function about continuous transition variable s_t; γ is the smoothing parameter; s_t is the state variable (transition variable); $c = (c_1, \cdots, c_k)$ is location parameter; if the transition function's formation is as following:

$$G(\gamma, c, s_t) = \left(1 + \exp\{-\gamma \prod_{k=1}^{K} (s_t - c_k)\}\right)^{-1}, \gamma > 0 \tag{46.2}$$

The model is general Exponential Smooth Transition Regression (LSTR) model, in which when K = 1 it is called LSTR1 model and when K = 2 it is called LSTR2 model. There are generally 3 steps to estimate STR model: selection of model's format, estimation of parameters and diagnosis.

46.3 Empirical Results of STR Model

46.3.1 Variables' Selection and Data's Disposal

We select China's consumer price index (CPI), narrow money supply (M1), nominal effective exchange rate of Renminbi (NEER) and interbank interest rate (CR) to represent inflation, money supply, nominal exchange rate and short-term interest rate respectively. All are monthly data ranging from January 1996 to February 2012 which come from the national bureau of statistics of China, the people's bank of China, bank for international settlements web site and CEInet data. All the time series are seasonal adjusted and then taken natural logarithm to eliminate potential heteroscedasticity. Respectively, they are recorded as LCPI, LM1, LNEER, and LCR. Then we take the balance the above variables value minus the trend values of their HP filters as the gap values of them. They are recorded as LCPIH, LM1H, LNEERH and LCRH.

Table 46.1 Unit root test

Variable	ADF test				PP test			
	(C, t, n)	T-stat	Prob	Stationary	(C, t)	T-stat	Prob	Stationary
LCPIH	(0,0,1)	−11.1787	0.0000	Stationary	(0,0)	−11.5520	0.0000	Stationary
LM1H	(0,0,1)	−2.5732	0.0100	Stationary	(0,0)	−3.0036	0.0028	Stationary
LNEERH	(0,0,1)	−3.3340	0.0009	Stationary	(0,0)	−3.3798	0.0008	Stationary
LCRH	(0,0,1)	−4.8026	0.0000	Stationary	(0,0)	−4.4705	0.0000	Stationary

46.3.2 Stability Test

This paper uses unit root test to examine sequence stability. The outcome shows in Table 46.1. From it, we can find that LCPIH, LM1H, LNEERH and LCRH are stationary time series at the significance level of 1 % according to the ADF test and PP test.

46.3.3 Determine the Lag Orders and Concrete Forms of STR Model

1. *Determine the Lag Order of STR Model.* Firstly we test the length of lag. Though the standard test of lag length based on regression model, we determine the optimal lag orders of STR model. In order to determine the suitable orders, we choose the maximum lag orders 8 to test them. The test results are in Table 46.2. Seeing from Table 46.2, we find that according to the criteria of LOGL, AIC, SC and HQ, they all indicate that the optimal lag orders of the variables of STR model are 2 orders.
2. *Determine the Concrete Forms of STR Model.* On the basis of the framework model put forward by Lütkepohl and Krätzig (2004), Luukkonen et al. (1988) determine the concrete forms of it, namely the form of either LSTR1($K = 1$) or LSTR2($K = 2$). According to STR model's test methods, we make linear and nonlinear tests for the relationship between inflation and MCI's several variables. The outcomes show in Table 46.3. According to Table 46.3, we can find that when transition variable is LCPIH (-1), the P value corresponding to F3 is the minimum. Therefore the LSTR2 model is exogenous optimal form.

46.3.4 Estimation Outcome of LSTR2 and Its Analysis

After have determined the form of STR model's transition variable and transition function, we need to estimate the parameters of LSTR2 model. Firstly, we use the grid search to determine the initial value of smooth velocity and location function.

Table 46.2 The test of lag order

Lag	0	1	2	3	4	5	6	7	8
Log L	743.8	748.5	757.7*	754.9	753.2	752.2	750.2	747.0	744.6
AIC	−7.6771	−7.7234	−7.8188*	−7.7882	−7.7693	−7.7578	−7.7349	−7.6987	−7.6711
SC	−7.6263	−7.6047	−7.6315*	−7.5318	−7.4435	−7.3618	−7.2684	−7.1611	−7.0619
HQ	−7.6565	−7.6753	−7.7430*	−7.6843	−7.6373	−7.5973	−7.5459	−7.4808	−7.4242

Table 46.3 Outcome of nonlinear test

Transition variable	F	F4	F3	F2	F1
LCPIH(−1)*	1.90E-044	2.20E-011	1.75E-05	2.36E-01	LSTR2
LCPIH(−2)	3.21E-02	2.41E-01	1.59E-01	3.71E-02	LSTR1
LM1H	1.83E-02	5.07E-01	6.67E-01	2.42E-04	LSTR1
LNEERH	1.79E-06	1.97E-03	1.08E-03	1.10E-02	LSTR2
LCRH	1.04E-03	6.87E-02	2.28E-03	1.38E-01	LSTR2
LM1H(−1)	3.07E-03	3.07E-02	6.72E-02	5.11E-02	LSTR1
LNEERH(−1)	1.28E-06	2.53E-05	3.42E-03	1.48E-01	LSTR1
LCRH(−1)	8.05E-02	2.73E-01	2.16E-01	9.11E-02	Linear
LM1H(−2)	8.05E-02	2.73E-01	2.16E-01	9.11E-02	Linear
LNEERH(−2)	2.10E-05	8.10E-03	2.32E-03	1.81E-02	LSTR2
LCRH(−2)	2.02E-03	1.94E-01	2.75E-03	7.37E-02	LSTR2

At last we get the initial values 1.4048, −1.1376 and 1.9895 of the smooth velocity γ and location parameters *c1, c2*. Basing on the initial values of above grid search, we have estimated the equation (46.1) at first. Then according to the principle of generality to particularity, we have removed the insignificant variables step by step. Lastly, we get the estimated values of the parameters Φ, θ, γ, c in equation (46.1) (Terasvirta 1994). All results show in Table 46.4. Table 46.4 indicates that there are strong significances of estimated parameters and better fit. The 1 order lag of inflation, namely, LCPI (−1) in it appears the relation of significant smooth transition and the parameters of other variables are relative large and significant. It indicates that there isn't only stable linear relationship between China's money supply, nominal effective exchange rate of Renminbi (NEER), interest rate and inflation. There have structural changes and nonlinear relationship. Figure 46.1 shows that the dynamic characteristics of estimated Statistics of LSTR2 model are similar with those of raw statistics. This means that nonlinear model can better explain China's inflation.

46.4 Construct Nonlinear Monetary Condition Index of China

46.4.1 Determining Weight

Refer to (Hataiseree 1998), substitute the linear and nonlinear coefficients of LM1H, LNEERH, LCRH and their lag terms estimated by LSTR2 model into the following formulas to do their weights W_Φ and W_θ:

$$W_{\Phi i} = \frac{\sum_{t=0}^{n} \Phi_{it}}{\sum_i \left(\left| \sum_{t=0}^{n} \Phi_{it} \right| + M \left| \sum_{t=0}^{n} \theta_{it)} \right| \right)};$$

Table 46.4 Outcome of LSTR2 model's estimation

Linear part	LCPIH(−1)	LM1H	LCRH	LM1H	LNEERH(−1)	LNEERH(−2)	LCRH(−2)
Initial value	0.0989	0.0751	0.1799	0.0975	0.0729	0.0765	0.1731
Estimated value	0.1985	0.0604	0.1463	0.0879	0.0810	0.0753	0.1540
t-statistics	1.9521	2.1984	1.6900	3.0612	2.7753	2.6727	1.9429
P value	0.0525	0.0292	0.0928	0.0026	0.0061	0.0082	0.0536

Nonlinear part	Constant term	LCPIH(−1)	LM1H	LNEERH	LCRH	LCRH(−1)	LM1H(−2)	γ	c1	c2
Initial value	1.9583	1.4657	0.6481	0.6084	7.9711	5.8933	0.3552	1.4048	1.1376	1.9859
Estimated value	0.5971	0.7250	0.5004	0.4512	4.0661	2.1428	0.4852	1.0426	0.9637	1.5761
t-statistics	1.8026	2.9135	4.2711	3.6511	5.6026	2.5491	2.6696	1.9180	13.6487	3.6427
P value	0.0732	0.0040	0.0000	0.0003	0.0000	0.0117	0.0083	0.0568	0.0000	0.0004

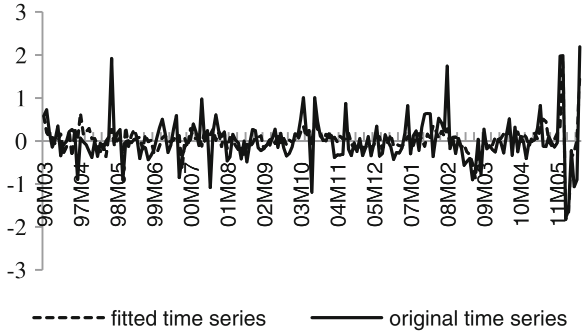

Fig. 46.1 The fitted and original time series

$$W_{\theta t} = \frac{\sum_{t=0}^{n} \theta_{it}}{\sum_{i}\left(\left|\sum_{t=0}^{n} \Phi_{it}\right| + M\left|\sum_{t=0}^{n} \theta_{it)}\right|\right)}; i = 1, 2, 3 \tag{46.3}$$

Amongst Φ_{it} and θ_{it} represent the coefficients of the variable*i*'s linear and nonlinear parts at time *t* respectively, *M* represents the mean of transition function's value.

46.4.2 Calculation of Index

Based on the definition of MCI and each variables' estimated weights in previous words, referring to Goodhart and Hofmann (2001)'s method, divide MCI into parts of linear and nonlinear and multiply the nonlinear part with transition function value. The formula is as follow:

$$MCI = 100 + \left[\sum_{i=1}^{n} W_{\Phi i}(XGAP_{it} - XGAP_{i0}) + \sum_{i=1}^{n} W_{\theta i}(XGAP_{it} - XGAP_{i0})G\right] \tag{46.4}$$

Among 0 and t represent base period and report period respectively, X is optional variable in constructing MCI, GAP is the corresponding gap value, G is the transition function value of nonlinear part.

Then according to formula (46.4), we construct China's nonlinear MCI We choose China's narrow money supply, nominal effective exchange rate of Renminbi and interbank interest rate as the exogenous variables of constructing the monetary condition index, set October 1998 as the base period in which the exogenous variables are relative balanced. We have calculated China's monthly nominal nonlinear monetary condition index ranging from March 1996 to January 2012 according to the linear and nonlinear parts' weights above. Its reference indicator is monthly Year-on-year CPI of China. The overall outcome is shown in Fig. 46.2, indicating that integrating factors of money supply, interest rate and

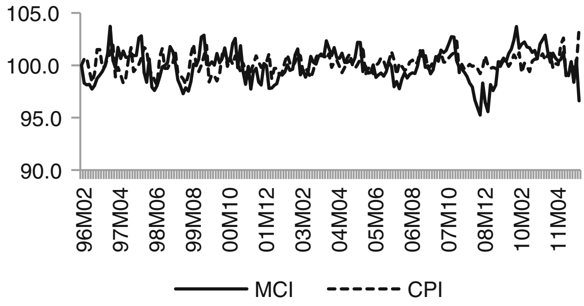

Fig. 46.2 China's nonlinear MCI and CPI

Table 46.5 Time varying cross correlation coefficient of MCI and CPI

L	0	1	2	3	4	5	6	7	8
CPI,MCI (−L)	0.254	0.3833	0.1437	0.0336	−0.0416	−0.1337	−0.134	0.0135	0.165
CPI,MCI (+L)	0.254	0.1892	0.1317	0.1119	0.2014	0.0221	−0.2153	−0.1921	−0.0887

exchange rate, MCI roundly reflects and measures the relationship between China's monetary policy and inflation. MCI has a resemble tendency with inflation rate, indicating the inherent consistency between MCI and inflation. MCI goes head of inflation, and what is more noticeable is the fact that the former's turning point leads the latter's 1–3 months.

Using the methods of the time-varying cross correlation coefficient, we have calculated the time varying cross-correlation coefficient of China's nonlinear monetary condition index with inflation, which is shown in Table 46.5. Table 46.5 shows that the correlation coefficient of MCI of lag 1 order with inflation is max, indicating that the former runs one month ahead of the latter.

46.5 Conclusion

This paper conducts nonlinear test to three variables: interest rate, exchange rate and money supply chosen to construct China's monetary condition index, and then finds significant nonlinear relationships between their effects to inflation. Accordingly, based on STR model, this paper estimates China's nonlinear monetary condition index. Through comparing its relation to inflation, we find that it can well reflect changes in inflation. And further research shows that MCI leads roughly 1 month ahead of inflation. Therefore, it is predictable to inflation and can be the indictor of monetary policy.

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Chapter 47
Growth Needs, Compensation Design, Intrinsic Motivation and R&D Creativity

Chao-ying Tang and Li-bin Liang

Abstract Intrinsic motivation is a well accepted antecedent of creativity. Based on experiment studies' results about the relationship between award and intrinsic motivation, this study aims to empirically analysis growth needs, payment design and intrinsic motivation. The data analysis result of R&D team members turns out that there is no significant correlation between payment design and intrinsic motivation. However, team member's intrinsic motivation mediates the relationship of growth needs and creativity. The result temporarily implies that to enhance R&D team members' intrinsic motivation, team members' growth needs might be more important rather than payment.

Keywords Growth needs · Intrinsic motivation · Payment · R&D creativity

47.1 Introduction

Scientific and technological innovation is important for national competitiveness. The first step of innovation begins with creative ideas. Hence, R&D creativity study has attracted attentions in the last ten years. Creativity is "the production of novel and useful ideas in any domain" (Amabile 1996). Previous studies of creativity point out there are two different kinds of factors that affect creativity. One is individual's factor, including personality, intrinsic motivation, needs, and abilities. Another is external environments, including leadership, culture, and organization support (Runco and Pritzker 1999). Researches in R&D management try to find how to enhance creativity through organizational environment management. But

C. Tang · L. Liang (✉)
School of Management, Graduate University of Chinese Academy of Sciences, Beijing, China
e-mail: llb@imech.ac.cn

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up to now, how payment design affects individual element and at last influence creativity still keeps as a white space to be exploited (Rogers 1954).

According to a number of experimental studies on creativity taken by psychologists, intrinsic motivation is commonly accepted can strongly enhance creativity (Amabile 1983; Zhou and Shalley 2003). People with high level intrinsic motivation will be more eager and contribute more effort to find a creative way to solve problems.

However how external factors especially rewards affect creativity is still in controversial. Some researches pointed reward can undermine creativity (e.g. Kruglanski et al. 1971; Amabile 1983, 1996; Deci and Ryan 1985). However, some (e.g. Amabile et al. 1986) got quite different conclusions that rewards may increase creative performance.

As payment is the most important reward for R&D team members. And almost previous studies are experimental. Where students and children are subjects and the creative activity is designed by researchers. Up to now, no studies focus on R&D real work. The effect of payment on R&D creativity is not clear. Hence this empirical study aims to analysis the relationship between payment in R&D context, R&D worker's intrinsic motivation and R&D creativity (Eisenberger and Rhoades 1999).

47.2 Literature Review

47.2.1 Growth Needs and Creativity

Abraham Maslow proposed a two-dimensional model of individual creativity. One dimension is recognized as creative productivity, the other one is regard as everyday creativity. A person performance well in the first dimension has achieved social recognition. This kind of creativity more depends on talent and special ability. Individual performances well in the second dimension will use creative method to solve life problems. Maslow calls this creativity "self-actualized creativity".

After synthesized lot researches about human motivation, Maslow put forwards a hierarchy of human needs based on two groupings: deficiency needs (including physiological needs, safety needs, belonging needs/love needs, and esteem needs) and growth needs (or being needs, including self-actualization needs, adding aesthetic and cognitive later). Individual turns to satisfy self-actualization needs if and only if deficiency needs has been satisfied. He points that creativity arises from nature human needs toward growth and self-actualization and the purpose of self-actualized is self-growth (Rigby et al. 1992).

Carl Rogers described that "the individual creates primarily because it is satisfying…because this behavior is felt to be self-actualization". According to this, it may be that innovation is driven by a fundamental need to progress and grow, to challenge and become self-actualized, to realize all one's potentialities (Maslow 2007).

Growth needs are defined as strong needs for personal challenge and accomplishment, for learning, and for professional development (Graen et al. 1986). According to the job characteristics model (Hackman and Oldham 1976), people who are high in "growth need strength" would be most likely to be motivated by jobs that have high skill variety, task identity, task significance, autonomy, and feedback (and would thus be more likely to experience intrinsic motivation). Houkes et al. (2003) found that growth need strength had a direct, synchronous, positive relationship with intrinsic motivation. And some studies only reported that growth needs strength moderates the relationship between task characteristics and intrinsic work motivation. Other researchers reported both additive and moderating effects.

Scholars also conducted several studies in relationship between growth needs and creativity. Regina Conti and Teresa Amabile discussed the impact of Maslow's approach to creativity: "Creativity emerges from the need for self-actualization" (pp. 2:255, *Encyclopedia of creativity*). Shalley et al. (2009) also found that growth need strength had a positive main effect on creativity.

47.2.2 Intrinsic/Extrinsic Motivation

Motivation is an internal state or condition (sometimes described as a need, desire or want) that activates, energizes and directs behavior (Kleinginna and Kleinginna 1981). Motivation can link human needs and human activity. Leontiev (1980) proposed that human needs was a kind of inner desire, which can only be satisfied through action. Needs can drive action only when it turns into motivation.

According to the orientations of motivation, it can be divided into two kinds: intrinsic motivation and extrinsic motivation. Intrinsic motivation means a person does something because it is inherently interesting or enjoyable. Deci & Ryan proposed interest and enjoyment are main factors of intrinsic motivation. Intrinsic motivation came from three kinds of needs: competence, autonomy, and relatedness (1985, 1992). Harter (1981) suggested intrinsic motivation contained three components: desire for challenge, curiosity and autonomy. Amabile (1993) summarized that intrinsic motivation was driven by enjoyment, interest, satisfaction of curiosity, self-expression, and challenge.

In Amabile's component model of creativity, intrinsic motivation is one of three factors of creativity (Amabile 1996): expertise, creative-thinking skills, and intrinsic motivation. She pointed that intrinsic motivation can lead to the acquisition of expertise and promote creativity-thinking skill. Hence among the three components, intrinsic motivation is the most important one. She also points that intrinsic motivation can most immediately and easily be influenced by the work environment.

The other is extrinsic motivation. Extrinsic motivation means the driver of doing something rests on its external reward. In their Organismic Integration Theory (OIT), Deci and Ryan (1985) proposed that extrinsic motivation can divided into four categories according to the degree of autonomy, which are: external regulation, introjection, identification and integration. Extrinsic motivation in some situation can also increase creativity. Amabile (1996) later found that external reward may be a positive rather than a negative influence on creative output when the feedback is constructive. But some studies regard that it has no significant influence on creativity (Gerrard et al. 1996).

47.2.3 Reward and Intrinsic Motivation

Reward and payment design is an important human resources management task. There are some studies about the interaction between reward and intrinsic motivation. Deci (1971), for example, found external reward (especially money) will affect intrinsic motivation. After that, a series of lab studies were conducted (e.g. Deci 1971; Lepper et al. 1973).

The main theoretical reason to explain the mechanisms of interaction among external reward, intrinsic and extrinsic motivation is called “over-justification”. It is based on Kelly’s Attribution theory (1967), Bern’s Self-perception theory (1972), cognitive evaluation theory (CET, Deci and Ryan 1985) and motivational synergy theory. Among them the most widely accepted explanation for the effect of reward on intrinsic motivation is CET. Deci and Ryan supposed that intrinsic motivation would be maintained or enhanced when competence and autonomy needs are satisfied. They classified the effect of external reward on intrinsic motivation into three kinds: informational, controlling, and demotivated. Informational reward can make individual perceived the ability to accomplish the task or to know how to finish the task. Thus it can enhance the competence, and then increase the level of intrinsic motivation. Controlling reward tried to control individual’s activity. When reward is designed not depend on performance and without a clear performance evaluation criterion. It will give individual a sense of out of control and lacking of necessary autonomy. This will decrease the level of intrinsic motivation.

The effects of intrinsic motivation and external reward on creativity are still in controversial. Some studies found external reward might decrease the level of intrinsic motivation and have a negative effect on creativity (Amabile 1983, 1996; Lepper et al. 1973). However, some found it has a positive effect on creativity under some contexts (e.g. in Heuristic task).

47.2.4 Payment and Intrinsic Motivation

The main award of R&D employee is payment given by organization. According to our interviews, there are three kinds of payment design in research institutes in China: firstly, the payment is based on employee’s experience and background (seniority payment); secondly, payment is based on the employee’s performance evaluated by organization (organization performance payment) or team performance evaluated by team (team performance payment). These three payment designs are mixed, that means for specific R&D employee, his/her payment is decided by the above three standards at the same time. However, which one dominates employee's payment design is not same in different R&D teams.

According to cognitive evaluation theory (Deci and Ryan 1985), payment in R&D groups, as a kind of external reward, may have effect on intrinsic motivation. If the payment is mainly decided by experience and background, that will lead to the un-autonomy perception and decrease employee's intrinsic motivation. If the payment is mainly decided by performance (either evaluated by organization or by group), that means employee can control it in some degree. Hence, it might increase intrinsic motivation.

47.2.5 Research Framework and Main hypothesis

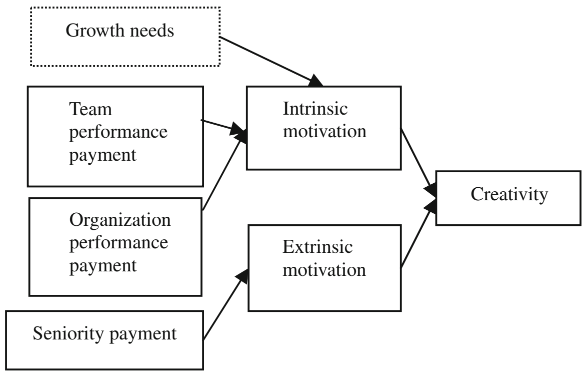
According to the above analysis, we present a conceptual model (See Fig. 47.1) and three main hypotheses.

Hypothesis 1 Intrinsic motivation mediates the relationship of growth needs and R&D creativity.

Hypothesis 2 Intrinsic motivation mediates the relationship of team performance payment/organization performance payment and R&D creativity.

Hypothesis 3 Extrinsic motivation mediates the relationship of seniority payment and R&D creativity.

Fig. 47.1 Payment, motivation, and creativity model



47.3 Data Analysis

47.3.1 Samples

Samples came from an institute of Chinese Academy of Sciences. The questionnaires were e-mailed to 120 R&D researchers. There were 91 responses with 17 incomplete responding. Effective responding size is 74. Which included 59 males (79.7 %) and 15 females (20.3 %). 13 samples (17.6 %) were group leaders and the others (82.4 %) were group members. The ages of samples vary from 27 to 74 years old.

47.3.2 Measurements

8-items intrinsic motivation and 8-items extrinsic motivation scales came from Amabile and her colleagues. In this study Cronbach alpha = 0.734 and 0.754 respectively.

4-items Growth need strength scales were adjusted from Hackman and Oldham (1980). Including following items: “Considering all the things that are personally important to you in a job, how important is it to you to have a job with”, “stimulating and challenging work,” “chances to exercise independent thought and action,” “opportunity to learn new things” and “opportunities for personal growth and development”. In this study Cronbach alpha = 0.724.

Creativity scales came from Farmer et al., which contains 3 items: “Tries new ideas or methods first”, “Seeks new ideas and ways to solve problems”, “Generates ground-breaking ideas related to the field”. In this study Cronbach alpha = 0.866.

Payment scales were designed by this study. Seniority payment includes: “My payment mainly affected by my seniority” and “Seniority decides my payment level in my organization”. In this study Cronbach alpha = 0.853.

Organization performance payment scales includes: “My payment mainly affected by my actual work performance by my organization”, “My personal work performance has been well evaluated”. In this study Cronbach alpha = 0.713.

Group performance payment scales contain: “My payment mainly affected by payment design of my team”, “Payment in my team is equal” (reverse scored). In this study Cronbach alpha = 0.605.

All are five-point Likert scales, 1 = “strongly disagree”, 5 = “strongly agree”.

Controlling variables contain gender, age, education background, research activity, team size and working experience. Statistical Package for Social Science (SPSS) version 15.0 is used to analysis data.

47.3.3 Mediating Effects

Table 47.1 presents the means, standard deviations, and correlations among above variables in study. According to the result, there is no significant correlation between payment design and intrinsic motivation, between payment design and creativity either. Creativity has significant correlations with growth needs and intrinsic motivation. We also find a significant correlation between growth needs and intrinsic motivation. Only seniority payment significantly correlates with extrinsic motivation. Extrinsic motivation has no significantly correlations with creativity. Based on correlation results, hypothesis 2 and 3 are rejected.

To test mediation, we followed the widely used procedure suggested by Baron and Kenny (1986). In model 1, we regress creativity on the control and independent variables as were entered in model 1 variables, gender, age, education, working experience, team size and positive mood. In model 2, and growth needs. In model 3, we regressed creativity on the controls and growth needs and intrinsic motivation. The results supported Hypotheses 1 as follows: (1) growth needs was significant in contributing to creativity. (2) Intrinsic motivation was statistically significant in contributing to creativity. (3) The regression coefficient for intrinsic motivation was significant in contributing to creativity when we controlled for the control variables and growth needs. The decreased, but still statistically significant, coefficient for positive mood in model 3 indicated that intrinsic motivation totally mediated the contribution of growth needs and creativity. The mediate model is as Fig. 47.2, and the statistic result is as Table 47.2. Hence, hypothesis 1 is accepted.

47.4 Discussion

During the past decade, research about creativity and motivation has attracted lot enthusiastic. Social psychologist scholars (such as Amabile) point that the "social environment influences creativity by influencing the individual components", especially through intrinsic motivation. By this way organizational management can impact creativity. But in which degree organizational invention influences individual's creative characteristic is not clear.

Unlike lots experimental studies on award and intrinsic motivation/extrinsic motivation, this study shows there is no significant relation between external payment and intrinsic motivation. Intrinsic motivation is predicted by individual's internal growth needs. This result suggests that intrinsic motivation might be decided by individual's property and not easy to be managed, while extrinsic motivation might be the goal of management.

However, it is too early to get this conclusion. There still needs further studies to exploit this relationship and which should overcome limitations of this study: the data came from single source and one organization, the sample size is not big enough.

Table 47.1 Mean, SD and correlations

	M	SD	SP	OPP	TPP	Growth needs	Intrinsic motivation	Extrinsic motivation	Creativity
SP	3.41	0.94							
OPP	3.27	0.89	−0.14						
TPP	3.18	0.79	−0.06	−0.02					
Growth needs	4.34	0.57	0.275*	0.05	0.15				
Intrinsic motivation	3.57	0.57	−0.15	0.02	−0.15	−0.09			
Extrinsic motivation	3.30	0.61	0.292*	0.17	0.01	0.18	0.20		
Creativity	4.10	0.62	0.19	−0.07	−0.09	0.381**	0.485**	0.09	

Note $n = 74$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (two-tailed test)
SP seniority payment, *OPP* organization performance payment, *TPP* team performance payment

Fig. 47.2 Mediating effect model

Table 47.2 Regression analysis of the mediating effect between growth needs, intrinsic motivation and creativity

	Intrinsic motivation	Creativity		
Step 1	(constant)	5.084**	2.783**	2.094**
	Gender	−0.158	−0.115	−0.099
	Age	−0.037	−0.028	−0.023
	Diploma	−0.012	0.033	0.077
	Nature of job	0.009	−0.009	0.001
	Size of group	−0.006	−0.005	−0.002
	Length of service	0.033	0.029	0.026
	Group role	0.262	0.232	0.092
Step 2	Growth needs		0.430**	0.241
Step 3	Intrinsic motivation			0.376**
Regulated R^2		−0.016	0.132	0.210
$\triangle R^2$		0.081	0.146***	0.080***
F		0.832	2.389***	3.160***
df		7.66	8.65	9.64

For the future studies, it might be necessary to include the perception of fairness as additional variables. Because perception of fairness may modulates the relationship between payment and intrinsic motivation.

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Chapter 48
The Establishment of New Accounting Standards System in China

Yan Wang

Abstract On February 15th, 2006, a statement was made at a ceremony in Beijing, the People's Republic of China, where the Chinese Ministry of Finance announced the adoption of new accounting standards system. It ushers a new era in Chinese accounting and shows the resolution of convergence towards International Financial Reporting Standards in China. Five aspects about the new accounting standards system are analyzed in this paper.

Keywords Accounting standards · Convergence · Market economy

48.1 Introduction

Chinese Ministry of Finance brought out 39 items of new accounting standards for business enterprises on February 15th 2006, and made a statement to affirm Chinese commitment to convergence towards *International Financial Reporting Standards* (IFRSs) at a ceremony in Beijing (Tweedie 2006). On January 1st, 2007, the new accounting standards were adopted in Chinese listed companies. This symbolizes the official establishment of new accounting standards system in China that adapts to the current market economy development of China.[1]

[1] http://www.examda.com, The Issues about The Establishment of Chinese New Accounting Standards (in Chinese), October 29 2006

Y. Wang (✉)
Department of Economic Management, Transport Management Institute, Ministry of Transport of the People's Republic of China, Beijing 101601, China
e-mail: wangyanyan1977@126.com

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48.2 Content of the New Accounting Standards System

In 1993, *Accounting Standards for Business Enterprises: Basic Standard* was promulgated in China. It was the beginning of the construction of Chinese accounting standards (Lou 2006). Four years later, the first specific standard—*Accounting Standards for Business Enterprises: Disclosure of Related Party Relationships and Transactions* was brought out. From then on, 15 items of specific standards appeared in succession. Those 17 standards formed the former accounting standards system which laid particular stress on enterprises in industry and commerce. The new accounting standards were increased to 39 items and extended to the industries of agriculture, finance and insurance. New accounting standards were added such as *Accounting Standards for Business Enterprises: Biological Assets, Accounting Standards for Business Enterprises: Transference of Financial Assets*. They fill up the blankness of accounting treatments in current market economy in China. On October, 30th, 2006, the practical manual of the standards was released. The basic standard, the specific standards and the manual are integrated into Chinese accounting standards system.

48.3 Construction Motivation of the New Accounting Standards System

As “a language of business” (Han and English 2007), accounting plays an important role in the economic development. Therefore, to satisfy the request of the economic development in China, the new accounting standards are constructed. In the 1980s, with the implementation of opening policy, *Accounting System for Chinese-foreign Joint Venture* was promulgated in China. It facilitated the absorption of foreign capital in China and prologued to Chinese accounting reform. In the 1990s, Chinese market economy was formed initially and series of accounting regulations were needed to reflect and order the economic activities. Consequently, a large-scale movement of accounting reform began in China and *Accounting Standards for Business Enterprises, Financial General Rules for Business Enterprises, Accounting System for Business Enterprises and Financial System for Business Enterprises* were promulgated. From the end of 1990s to the earlier in the 2000s, China made a great effort to join the World Trade Organization (Zhang and English 2006). One of the measures is to improve the consistent degree between the Chinese accounting regulations with the international ones. China started to execute new *Accounting System for Business Enterprises* from January 1st, 2001, which was more concrete, practical and suitable to the economic activities under Chinese economic conditions at that time besides its more consistency with international regulations. Promulgated in 2006, the new accounting standards system is to keep up with Chinese rapid economic development and to connect with international economy more easily. In a word, all

China has done with accounting is to accelerate economic development and perfect the order of Chinese market economy.

48.4 Construction Process of the New Accounting Standards System

Constructing accounting standards for business enterprises is not only highly technical but also strong influential on entire society (Harrison et al. 2009). Ministry of Finance invited many committee members of Chinese Accounting Standard Broad to take charge of more than 40 research projects on accounting standards separately which established the theoretical, technical and political foundations of the new accounting standards system. At the beginning of 2005, Ministry of Finance requested that members in charge of the research projects should know very well the IFRSs, the related standards of United States and the problems existing in current accounting practice in China and write out research reports as results. The request cleared the emphasis of the standards.

The construction of the new accounting standards system is based on a widespread opinion solicitation. On the basis of opinion solicitation of many committee members of Chinese Accounting Standard Broad, Ministry of Finance invited many accountants in international accounting firms and large-scale listed companies to discuss the standards and also solicited the opinions of the related ministries such as China's National Audit Office, State-owned Assets Supervision and Administration Commission of the State Council, China Securities Regulatory Commission, etc. At the same time, each questionnaire manuscript was issued through network, newspaper, magazines etc. to collect the ideas of the masses. The reclaimed opinions were treated earnestly as important basis of revision, which guaranteed the quality of the new standards.

Investigations, tests and studies are also important in constructing the new standards (Hurt et al. 2009). Ministry of Finance chose partial representative listed companies and more than 50 enterprises in large or middle scale to give simulative tests. Thus, the probable problems may appear in the tests. Furthermore, the countermeasures can be taken, and the consequence can be expected. These improved the feasibility of the new standards greatly.

In addition, the construction of Chinese accounting standards and auditing standards are synchronized (Graham Ward 2006). They are related closely and are promoted each other. Therefore, in the construction process of the accounting standards and auditing standards, whenever the content that influences both of them involved, the bilateral draft personnel negotiated and coordinated with each other, which guaranteed the communality, solemnity, authority of the standards' content and effective implementation of the standards.

48.5 Principles Held in Constructing New Accounting Standards System

The first principle is that new accounting standards should adapt to Chinese current national situation. Firstly, Chinese accounting standards must be subjected to legal circumstances of China. Secondly, the provisions of the standards should conform to the development level of Chinese economy. And at last, the coordination of the standards with Chinese culture is especially emphasized this time. The content should be easily understood by the readers. And the personnel having no related knowledge can also operate it well according to the standards. Because some provisions of the old standards are translated from overseas, they are obscurely difficult to understand and do not conform to Chinese custom. While in the formulation of the standards, Chinese language teachers were even invited to check whether the expression was clear, fluent and conformable to Chinese custom. The criterion was that the Chinese language teachers who had no accounting profession knowledge could understand the standards.

The second principle is to use the international regulations for reference (Choi and Meek 2007). There are three stages in Chinese accounting reform. The first stage—in the 1980s, China promulgated *Accounting Law*, and began to manage accounting work and accountants by the law. It was a great change of conviction from management by persons to management by law in accounting. Chinese accounting was linked line with international regulations from then on. In the second stage—from the 1990s to the earlier in the 2000s, a series of specific accounting systems and accounting standards were built up. Consequently, the frame of Chinese accounting regulations was set up by reference to the international regulations. Chinese accounting was coordinated with international accounting regulations. It is in the third stage at present, Chinese accounting is converging towards IFRSs. Convergence towards IFRSs is the direction of Chinese accounting's development and it is a process advancing step by step.

When applied to the Chinese specific economic activities, the international standards should be referred to but not be copied (Accounting School of Zhongnan University of Economics and Law 2010).

48.6 Convictions Persisted in the New Accounting Standards System

The first conviction is that more attention should be paid to the financial accounting reports. In the standards system, there are 8 items involving financial accounting reports. The status and function of financial accounting reports in the standards system are especially emphasized and the notes of the reports are giving rise to more attention in the new standards system.

The second conviction is that the revenue-expense view should be changed to the asset-liability view. The enterprises should reduce the useless property and avoid pursuing the profits one-sidedly. The key to evaluate the enterprise's achievement is to judge whether its net assets increase but not to judge from the amount of profit.

The third conviction is that the relationship between the historical cost and fair market value should be treated well. The historical cost should be used primarily, and the fair market value should be used under suitable prerequisites in order to avoid the false increase of profits.

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Chapter 49
Study on the Sustainable Growth of the Natural Resource Industry in China

Xiao-yong Wang

Abstract In order to sustain the development of natural environment, economy and society, it is necessary to make great effort to develop the Circular Economy. This goal needs to be accomplished by the sustainable capability of firms based on the natural resource. This paper investigates the relationship between the growth, fix-investment, cash-flow, and profitability of above discussed firms. Using the dynamic panel data from natural resource-based ninety-five listed-firms in China, the findings show that there exist close positive relationship between the growth and fix-investment, and the trends of cash-flow and fix-investment are tortuous upward, but the profitability declines in the corresponding years. The conclusions that the growth of firms is supported by the fix-investment and decline in profitability is caused by structure imbalance investment prove that policy-makers attach more importance on the short-term gains and neglect long-term planning development in natural resource industry.

Keywords Growth · Fix-investment · Profitability · Firms of Natural Resource

49.1 Introduction

With the development of the economy in the world today, resources consumption has increased dramatically. And a large number of mineral resources consumption has restricted the development of the economy by the population growth, which causes the ecological improvement and environmental protection are severe day by day. In this case, in order to make the economic development of our country and national security, we have to adhere to the scientific development view and

X. Wang (✉)
School of Economics, HuaZhong University of Science & Technology,
Wuhan, China
e-mail: think1993@126.com

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establish the resource-conserving, environment-friendly development and utilization of mineral resource system in mineral exploitation especially enhance the efficiency in the process of the mining, selection, exploitation and consumption. Therefore the national circulation economic working conference is held and the importance and urgency of the development of circular economy is analyzed and overall thought and main measures are put forward to speed up the development of circular economy, which make the air of saving resources, reducing the waste of resources and reducing emissions enveloped in whole society. These goals as discussed above need to be accomplished by the sustainable capability of firms in energy industry or the natural resource-based firms.

The natural resource-based firms which have right to possess the natural resource or exclusive possession rely on the consumption of resources by resources exploitation, primary processing as the basic mode of production and achieve firms' growth by the advantage of natural resources as the core competitiveness of the type of business. They play an important role in the development of national economy. But with the consumption of resources, the resource-based enterprises will be faced with a transformation and growth of difficulties. It is necessary to explore the characteristic of growth and the capability of the sustainable development in the energy industry. This paper focuses on the relationship between the sustainable growth and fix-investment by the way of empirically testing the development of the Circular Economy in the natural resource-based listed-firms in China.

The plan of this paper is as follows. In Sect. 49.2, the literature about the growth of the firms and investment are discussed. Variables and data statistics analysis are in Sect. 49.3, The VAR model about variables and estimations are in Sect. 49.4. In the last Section, we give the conclusion and policy suggestions.

49.2 Literature Review

The firm growth thought was born from the classical economists, they think the enterprise growth is the major cause of the division scale economy interest that is labor production in improving the efficiency of the production from the work division and specialization, which can expand the scale of enterprise production and further deepen the division of labor and cooperation in the enterprise. The above process recycles and enterprise growth is implemented through the enterprise scale economy (Smith 1904). The new classical economics enterprise growth theory, called enterprise scale adjustment theory, is argued that the reason of the enterprises growth is scale economy and the pursuit of scope economy. In the new classical economics the interior of complex arrangements in the enterprise are abstract away, which is seen as a production function. The functions can adjust the production to achieve optimal levels of scale process, in the other words; from the sub-prime scale to the optimal size of the process is called enterprise growth. The idea of Coase (1937) think the existence of the enterprise is that market transaction cost is higher than the enterprise internal management coordination costs. When the market transaction is equal to the marginal cost of enterprise internal management coordination of the marginal cost, it is considered to reach the enterprise scale expansion boundaries. Though the scholars are not agree with the definition of growth, the enterprise growth is generally considered to be the size of the enterprise increase gradually as time passes. There are some kinds of methods measured the size of the enterprise. Fordand and Slocum (1977) think that the scale of the enterprise organization and the organization of enterprise field can determine the growth of enterprise. Most of scholars think that the measurement method of the scale of the enterprise usually is according to different situation such as the number of employees, the annual sales or total assets. Lang et al. (1996) show that there is a negative relationship between the leverage and growth of firms, but leverage does not reduce growth of firms which are considered to have good investment opportunities, and it has negative relationship with the growth of firms whose growth opportunities are not recognized by the capital market. Damodaran (2009) thinks that the standard way of using the cash flow, growth rate is difficult to get young corporate value of realistic numbers because such characters as growth rate of firms can not be defined. Anderson and Garcia-feióo (2006) study the relationship among the capital investment, growth options and stock returns, they show that stock of firms whose low (high) book-to-market used by Fama and French (1992) significantly promote (reduce) the capital investment and increase (decrease) their market value. Dawson (1998) studies that institutions affect growth and empirical relationship between the institutions, investment and growth. His results show that free market institutions accelerate the growth. Fama et al. (2005) find that given the book-to-market equity ratio and expected profitability, higher rates of investment imply low expected returns. Carlin and Mayer (2003) find the strong relationship between the characteristic of industries, growth and investment of industries in different countries. Ramezani et al. (2002) use multivariate analysis and show that while there are more measures of earnings and sales growth, the firms exist optimal point beyond which further growth destroys the shareholder value and adversely impact profitability.

Circular Economy is short for the Material Cycle economy. Its meaning is that the process of investment, enterprise production, product consumption and waste production makes the traditional linear growth model relying on the consumption of resources change into the pattern of ecological resources circulation development in the system of the people, natural resource and science& technology. The traditional consumption of resources destructs the environment of the human life and production activities to the very serious degree. Pearce and Tumer (1990) formally adopt the word of Circular Economy, discuss the material circulation problems from the perspective of resource management. The conception of the Circular Economy prevails since then. German is the first country which deals with the waste by purring only at the end of process waste processing instead for prevents and reduces waste generation, at same time it regenerates the waste recycling and establishes the disposal programs of the waste. The procedure of waste disposal can be described followed, reduce the waste production at first, the next step is reusing the raw materials, the third step is recycling, and then heat recovery, harmless disposal at last.

According to Berk, Green, and Naik (Berk et al. 1999), the firm operating in discrete time invests the project when the project becomes available. At date t, $\{\varepsilon_j(t), t > j\}$ are the innovations that are serially independent standard normal, $\bar{C}$ is the mean of the cash flow, σ_j controls the variance, the cash flow from the project which was invested at date j < t is given by the following:

$$C_j(t) = I\exp[\bar{C} - \frac{1}{2}\sigma_j^2 + \sigma_j\varepsilon_j(t)] \tag{49.1}$$

So the valuing the firm takes two steps which involve the valuation of assets in place and the valuation of growth options.

First, the valuation of assets in place can be written as:

$$V_j(t) = I\exp[\bar{C} - \beta_j]D[r(t)] \tag{49.2}$$

$$\begin{aligned}\beta_j &= \sigma_j\sigma_z\text{cov}(\varepsilon_j(t), v(t)], D[r(t) \\ &= \sum_{s=t+1}^{\infty} \pi^{(s-t)}B[s-t, r(t)], B[s-t, r(t)] = \exp[-\alpha(s-t)r(t) - \varphi(s-t)]\end{aligned} \tag{49.3}$$

If the firm owns some projects, the value of firm's assets is given by its projects alive and we can define $\{\chi_j(t), t \geq j\}_{j=o}^{\infty}$ that equal 1 if the project is alive at time t, and zero otherwise:

$$\sum_{j=0}^{t} V_j(t)\chi_j(t) = b(t)e^{\bar{C} - \beta(t)}D[r(t)] \tag{49.4}$$

Second, the valuation of Growth options can be written as:

$$E_t\{\frac{z(s)}{z(t)}\max[V_s(s) - I, 0]\}, V_s(s) - I = I(\exp[\bar{C} - \beta_j]D[r(t)] - 1) \tag{49.5}$$

Combining 49.2–49.3 and 49.2–49.4, we can get the value of the firm:

$$b(t)e^{\bar{C} - \beta(t)}D[r(t)] + E_t\{\frac{z(s)}{z(t)}\max[V_s(s) - I, 0]\} \tag{49.6}$$

From the (49.6), we can learn that the value of the firm is governed by the investment and the growth of the firm. But there exists the relationship between the investment and the growth of the firm when the growth opportunities become the investment of alive project. As to the firms based on natural resource, the standard which evaluates whether the growth opportunities are feasible or realistic is principle of the Circular Economy. How to assess the degree or achievement of the development of the Circular Economy in the natural resource-based listed-firm of China? If the Circular Economy be developed, the natural resource-based firm must improve the production process and maximize the utilization rate of natural resources. It will be reflected on the reduction of production cost and efficient investment, especially, because the generation of the waste or take advantage of reusing the material can make a large number of other business income. In the next section, we empirical test the above phenomenon as discussed the growth of the firm and the fix-investment.

49.3 Variables and Data Statistics

In order to learn about the progress of the energy industry at present in China, we must investigate the natural resource-based listed-firms that own abundant capital and have large scale production. There ninety-five natural resource-based listed-firms in ShangHai and ShenZhen exchange. These firms studied for calendar t, 1998–2009, have excluded those ST-firms and firms with incomplete data. It is found that there are three types of ultimate shareholders: central government controller, local government controller, and nature person controller. According to the accounting standards, it is thought that the profit or net cash flow represents whether investment of natural resource-based firm is efficient or not. And it can also reflect utilization rate of natural resources.

We derive following variables: investment ratio, cash flow ratio, and profitability and growth opportunities database.
Fix-investment ratio = Fixed investment of Process equipment divided by book assets at end of year t.
Cash flow ratio = Net operating cash flow divided by book assets at end of year t.
Profitability = Net profit divided by book assets at end of year t.
The growth rate of main business net income (Growth) = (main business net income at year $t-$ main business net income at year $t-1) \div$ main business net income at year $t-1$.

Table 49.1 and Fig. 49.1 describe the statistic character which is Average variables of firms in every year mainly provided. From Fig. 49.1, it can be learned about that the trend of the fix-investment and profit is torturously rising. On the other hand the trend of the profit is torturous on the decline. In order to measure the impact of the fix-investment ratio on the level of Profitability or growth, we use four specifications. We use four vector auto-regressions that involve cash-flow, fix-investment, growth opportunities, and profitability.

Table 49.1 The growth of firms based on natural resource

Years	Growth
1998	0.3256
1999	0.2409
2000	0.3402
2001	0.1612
2002	0.2996
2003	0.329
2004	0.3833
2005	0.1032
2006	0.4136
2007	1.0703
2008	0.351
2009	1.3987

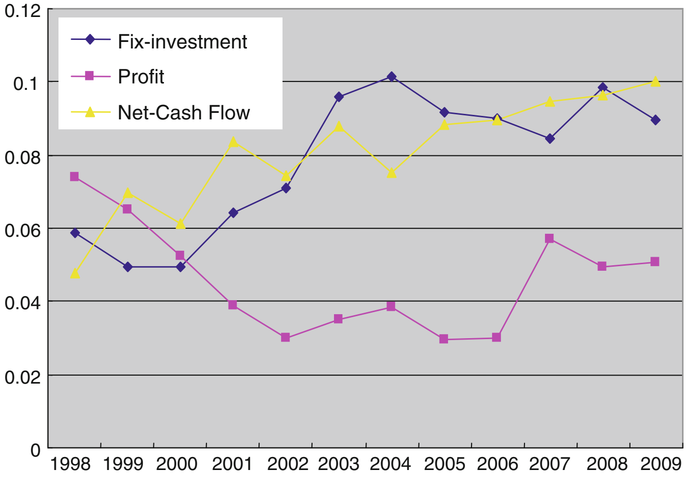

Fig. 49.1 Evaluation index of circular economy in the natural resource-based firms

49.4 Var-Models and Estimations

If using an Ordinary Least Squares (OLS) to estimate the each equations, the estimating result will likely suffer from biases due to unobserved firm-specific effect as well as possible endogenous repressors. For a dynamic and unbalanced panel, the more efficient methods were developed by Arellano and Bond (1998) and Blundell and Bond (1998). We apply Generalized Method of Moments in system (sysGMM) that can provide better estimators. For each estimation, in Table 49.2 we report *p*-value for the Sargan test, *p*-values for the parameter estimates basing on standard-errors asymptotically robust to heteroscedasticity and *p*-values for the test on first-order correlation (n1) and second-order correlation (n2) in the residuals (We only provide the impact of the key explanatory

Table 49.2 Regression results of model (7), (8), (9), (10)

Variables	Model (7)	Model (8)	Model (9)	Model (10)
Profitability (−1)	−0.25	−0.106	−0.08	−0.054
p-value	(0.000)	(0.000)	(0.048)	(0.000)
Cash-flow (−1)	0.45	−0.60	−0.11	0.03
p-value	(0.025)	(0.04)	(0.07)	(0.27)
Fix-investment (−1)	0.68	−0.40	−0.09	0.04
p-value	(0.057)	(0.038)	(0.018)	(0.25)
Growth (−1)	0.11	−0.49	0.25	0.04
p-value	(0.09)	(0.15)	(0.05)	(0.28)
p-value of n_1	(0.01)	(0.01)	(0.04)	(0.03)
p-value of n_2	(0.67)	(0.60)	(0.87)	(0.50)
p-value of Sargan test	0.42	0.43	0.77	0.84

variables). The result of the regression tells us that the growth has little impact on the profitability in the long run but is more associated with fix-investment. The same result is found in the regression of cash-flow. These mean that the industry of natural resource depends on investment to support its growth not on the efficient of production.

$$\begin{aligned} Growth_{it} = \gamma + \alpha_1 Growth_{it-1} + \alpha_2 cashflow_{it-1} + \alpha_3 Fix - investment_{it-1} \\ + \alpha_4 Profitability_{it-1} + \delta_{it} \end{aligned} \tag{49.7}$$

$$\begin{aligned} Profitability_{it} = \lambda + \beta_1\ Profitability_{it-1} + \beta_2 cashflow_{it-1} + \beta_3 Fix \\ - investment_{it-1} + \beta_4 Growth_{it-1} + \varepsilon_{it} \end{aligned} \tag{49.8}$$

$$\begin{aligned} Fix - investment_{it} =& \mu + \eta_1 Fix - investment_{it-1} + \eta_2 cashflow_{it-1} \\ & + \eta_3 Growth_{it-1} + \eta_4 Profitability_{it-1} + \zeta_{it} \end{aligned} \tag{49.9}$$

$$\begin{aligned} cashflow_{it} =& \omega + \phi_1 cashflow_{it-1} + \phi_2 Growth_{it-1} + \phi_3 Fix - investment_{it-1} \\ & + \phi_4 Profitability_{it-1} + \xi_{it} \end{aligned} \tag{49.10}$$

49.5 Conclusion

This paper explores the sustainable growth in the listed firms based on natural resource. We first construct the framework of the firm value involving the growth options and relationship between the investment and growth opportunities. In order to further disclose the factor controlling the growth opportunities of the firms, the vector auto-regressions of growth, fix-investment, cash-flow, and profitability are established. Using the dynamic panel data, we empirical test the relationship among the variables of Fix-investment, profitability, growth. It can be found that the growth of the firms based on natural resource depend excess on the fix-investment, though the increase of the cash-flow reflect the improvement of the investment efficiency is made, but the up-trend of profitability is lower than the fix-investment and net cash flow. This means that the growth of firms is supported by the fix-investment, which is not sustainable. The rising trend of cash-flow and decline on the profit prove that firms make fix-investment attach more importance on the short-term gains and neglect long-term planning development in natural resource industry. It is worth pointing out that the growth of natural resource-based listed-firms is not stable, which lead to overexploitation and structure imbalance in the investment. As advocated in the principle of development Circular Economy, the sustainable growth must be supported by the efficiency of production. At the same time, the above findings demonstrate that policy-makers must pay more attention to investment which enhance the profitability or the efficiency of production not duplication investments.

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Chapter 50
The Prediction Study on Output Value and Profit of China Mobile Tianjin Branch

Hong-li Wang, Lin-xi Song and Ya-tao Zhang

Abstract This paper predicted the future development of China Mobile Tianjin Branch, based on support vector machine, stochastic gradient boosting and artificial neural networks. By comparison, we known that stochastic gradient regression had higher precision for the prediction of output value, and that support vector machine regression had higher precision for the prediction of profit. By using the two regression methods, output value and profit in the next 4 years was predicted respectively, based on the company's past data. The study will provide creditable support for the formulation of the company's development strategy.

Keywords Prediction · China mobile · SVM · Stochastic gradient regression

Before 1994, the mobile communications market in China was monopolized by posts and telecommunications department. In 1994, the monopoly of China mobile communications market was break off, with China Unicom established. After the operation of posts and telecommunications department divided and china telecommunications reunion, China Mobile Communications Corporation was officially established on April 20th, 2000. Since then, the performance of China Mobile Communications Corporation increases rapidly, and the output value of Tianjin Branch has increased from 1.98 billion in 2000 to 7.40 billion in 2011.

In recent years, a number of scholars have carried out the prediction of business data in different industries. Fang et al. (2010) used the random forest method to predict the excess rate of return for China's fund, and proved the predictability of

H. Wang (✉) · L. Song
School of Management, Tianjin University, Tianjin, People's Republic of China
e-mail: wanghl@tju.edu.cn

L. Song
China Mobile Tianjin Branch, Tianjin, People's Republic of China

Y. Zhang
School of Mechanical Engineering, Tianjin University,
Tianjin, P.R.China

E. Qi et al. (eds.), *The 19th International Conference on Industrial Engineering and Engineering Management*, DOI: 10.1007/978-3-642-38433-2_50,

China's financial markets. Chen and Li (2009) predicted the output value of China's online game industry in the next few years based on gray prediction theory.

50.1 Method of the Support Vector Machine Regression

In 1995, based on statistical learning theory, Vapnik and Cortes proposed a new computer-based learning method: Support Vector Machine (Wang 2007; Chapelle and Vapnik 2000; Mangasarian and Musicant 2001). SVM has unique advantage in solving the small sample, nonlinear and high dimensional pattern recognition problem, and it can be extended to other computer-based learning problems such as function fitting.

For an unknown function: $y = f(x)$ where $x \in R^d, y \in R$, we can find a fitting function $\hat{f} : R^d \rightarrow R$, which makes the distance function.

$$R\left(f,\hat{f}\right) = \int L\left(f,\hat{f}\right) dx \tag{50.1}$$

smallest, where L is the Loss Function. Because f is unknown,we can only determine the fitting function $\hat{f}$ according to the samples, which have been obtained.

Using the regression function $f(x) = <w,x> + b$ to fit the sample data $(x_1, y_1), (x_2, y_2), \ldots, (x_r, y_r)$ where $x_i \in R^d, y_i \in R$, assume that all training data can be fitted without error by linear function at the accuracy ε

$$\begin{cases} y_i - <w,x> - b \leq \varepsilon \\ <w,x> + b - y_i \leq \varepsilon \end{cases} i = 1, 2, \ldots, k \tag{50.2}$$

Allowing the fitting error, we introduce the relaxation factors: $\xi_i \geq 0, \xi_i^* \geq 0$. Formula (2) is rewritten as follows

$$left\{ \begin{matrix} y_i - <w,x> - b \leq \varepsilon + \xi_i \\ <w,x> + b - y_i \leq \varepsilon + \xi_i^* \end{matrix} i = 1, 2, \ldots, k \tag{50.3}$$

The regression problem is transformed into how to minimize the distance function under the constraint functions (3). The rewritten distance function is as follows

$$R\left(\mathrm{w},\ \xi_i,\ \xi_i^*\right) = \frac{1}{2} \parallel \mathrm{w} \parallel^2 + \mathrm{C} \sum_{i=1}^{k} \left(\xi_i + \xi_i^*\right) \tag{50.4}$$

50.2 Method of the Stochastic Gradient Regression

Stochastic gradient regression (Xia et al. 2006; Hongchen 2009; Guo and Wang 2009) was put forward by Friedman in 2001, which was the linear combination of several regression trees.

$$F(x) = \sum\nolimits_{m=1}^{M} \alpha_m T_m(x) \tag{50.5}$$

α_m are combination coefficients, and $T_m(x)$ are regression trees. The trees are set up with fastest drop optimize idea, by using false residual which is generated by loss function negative gradient. Stochastic gradient boosting algorithm as shown in Fig. 50.1.

$\{y_i, x_i\}_1^N$ represents the original sample, and $\{y_{\pi(i)}, x_{\pi(i)}\}_1^{\hat{N}}$ is a random subsample, where $\hat{N} < N$, and $\{\pi(i)\}_1^N$ is a random sequence from $\{1, 2, \ldots, N\}$.

50.3 The Prediction Study on China Mobile Tianjin Branch

With the development of China's economy, especially the development of Tianjin's, the output value of China Mobile Tianjin branch increased from 1.98 billion in 2000 to 7.403 billion in 2011, and the profit of the company increased from 0.498 billion in 2000 to 1.573 billion in 2011. In order to provide better basis for formulating policies of the company, it is very necessary to predict the output value and profit in the future few years.

First of all, we needed to determine that which were the independent variables, and which was the dependent variable, in order to use regression methods to study the output value and profit of the company. Since we were using historical data to

Fig. 50.1 Stochastic gradient boosting arithmetic

$$F_0(x) = argmin_\gamma \sum\nolimits_{i=1}^{N} L(y_i, \gamma)$$

$$For\ (m = 1; m \leq M; m++)$$

$$\{$$

$$\tilde{y}_{\pi(i),m} = -[\frac{\partial L(y_{\pi(i)}, F(x_{\pi(i)}))}{\partial F(x_{\pi(i)})}]_{F(m)=F_{m-1}(x)} \quad i = 1, \ldots, \hat{N}$$

$$\{R_{jm}\}_{j=1}^{J} = J(num\ of\ leaf\ nodes)(\{\tilde{y}_{\pi(i)}, x_{\pi(i)}\}_1^{\hat{N}})$$

$$\gamma_{jm} = argmin_\gamma \sum\nolimits_{x_i \in R_{jm}} L(y_{\pi(i)}, F(x_{\pi(i)}))$$

$$F_m(x) = F_{m-1}(x) + \nu \cdot \gamma_{jm} I(x \in R_{jm})$$

$$\}$$

predict the future output value and profit, let the previous n years of data be the independent variables, and the (n +1) _(th) year data be the dependent variable (in the calculations below: n = 2). The data in 2011 wasn't used for fitting, but was left to verify the calculations were accurate or not. Secondly we analyzed the relationship between the independent variables and the relationship between the dependent variable and the independent variables. Based on three kinds of regression methods, the prediction of the output value and profit was obtained and selected by comparison with the left data.

The algorithm in this paper was completed by R software. In the process of calculation, the value of annual output value and profit was changed into annual growth rate. The final prediction value was obtained by predict the growth rates.

50.3.1 The Profit Prediction by SVM Regression

The profit of China Mobile Tianjin branch during 2010–2011 was shown in Fig. 50.2; and its growth rates were shown in Table 50.1.

Based on three regression methods [support vector machine (SVM), artificial neural networks (ANNs) (Zhang et al. 2010; Jianxin et al. 2000), stochastic gradient (SG)], the profit prediction of 2011 was calculated, and was compared with the true profit. The results were shown in Table 50.2.

By comparison, the SVM regression for the profit forecast was most effective. We used this method to obtain the predicted profit of 2012–2015. The results were shown in Table 50.3.

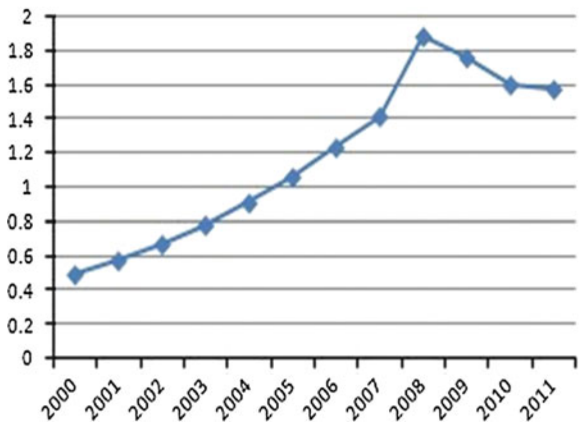


Fig. 50.2 The profit of Tianjin mobile in 2000–2011 (billion)

Table 50.1 Annual growth rates of the profit in 2000–2011

Years	2001	2002	2003	2004	2005	2006
Rate	0.163	0.164	0.163	0.163	0.163	0.163
Year	2007	2008	2009	2010	2011	
Rate	0.146	0.330	−0.065	−0.090	−0.016	

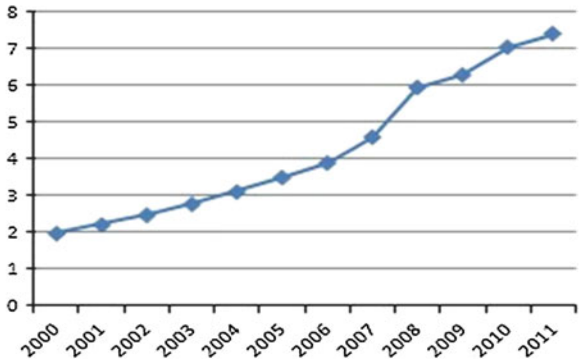
Table 50.2 The errors compared with the profit in 2011

Method	SVM	ANNs	SG
Prediction	1.629	2.2978	1.689
Error	3.58 %	46.07 %	7.37 %

Table 50.3 The forecasting results of profit based on svm regression (Billion)

Years	2012	2013	2014	2015
Prediction	1.584	1.645	1.688	1.716

Fig. 50.3 The output value of Tianjin mobile in 2000–2011 (billion)



50.3.2 *The Output Value Prediction by Stochastic Gradient Regression*

The output value of China Mobile Tianjin branch during 2010–2011 was shown in Fig. 50.3; and its growth rates were shown in Table 50.4.

Based on three regression methods [support vector machine (SVM), artificial neural networks (ANNs), stochastic gradient (SG)], the output value prediction of 2011 was calculated, and was compared with the true value. The results were shown in Table 50.5.

By comparison, the stochastic gradient regression for the output value forecast was most effective. We used this method to obtain the predicted output value of 2012–2015. The results were shown in Table 50.6.

Table 50.4 Annual growth rates of the output value in 2000–2011

Years	2001	2002	2003	2004	2005	2006
Rate	0.120	0.120	0.120	0.120	0.126	0.111
Year	2007	2008	2009	2010	2011	
Rate	0.181	0.293	0.056	0.121	0.052	

Table 50.5 The errors compared with the profit in 2011

Method	SVM	ANNs	SG
Prediction	8.007	7.999	7.783
Error	8.17 %	8.06 %	5.13 %

Table 50.6 The forecasting results of output value based on stochastic gradient regression (Billion)

Years	2012	2013	2014	2015
Prediction	8.379	9.108	9.716	10.879

50.4 Conclusion

Using three kinds of regression methods, the paper sets up output value and profit prediction models, and predicts output value and profit of China Mobile Tianjin branch in the future four years. The results indicate that the output value of the company will exceed 10 billion. The methods used in this paper can be applied to similar problems.

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Chapter 51
Study on the Mechanism of Value Increment During City Marketing

Jia-peng Dong and Yun-long Ding

Abstract In the process of urbanization and globalization, value oriented city marketing strategy plays a critical role in the city development. This research defines and classifies the concept of city value from the viewpoint of subject utility, involving three high homogeneity factors and six low homogeneity factors. In ideal conditions, city value increment is spontaneous. However in reality, an increment process requires active interventions of different marketing subjects and the adjustments of the dynamic model. Specifically speaking, the adjustments are described in this article as the customer requirements' identification, city marketing strategy making, value linkage together with integration, and the aim improvement. The case analysis of Paris verifies the dynamic model of value increment during city marketing.

Keywords City value · City marketing · Value increment

51.1 Introduction

Development in China is in the process of urbanization and globalization. The urbanization has brought large numbers of people into the city, with economic and social activities further aggregating to the city, while the limitation of the regional cooperation is broken by globalization which accelerate the integration of worldwide economic factors.

J. Dong (✉) · Y. Ding
Transportation Management College, Dalian Maritime University,
Dalian 116026 Liaoning, People's Republic of China
e-mail: niujw03@gmail.com

Y. Ding
School of Economy and Management, Harbin Institute of Technology,
Harbin 150006 Heilongjiang, People's Republic of China

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Globalization of industrial layout and the new construction of international division of labor show the importance of competition which is the dominant mechanism of the global economic development. The importance of regional and city development is increasingly obvious in this process. Global capital movement and commodity exchange have been promoted during globalization. In the circumstance, city marketing has become an important strategy to obtain the better position and more profits in the new international division of labor and industry layout (Liu 2005).

In order to maximize the benefit of city and achieve the sustainable development, we must stick to the value-oriented city marketing strategy and focus on the comprehensiveness and persistence. However many researches on city marketing lack the consideration about the complexity and sustainability of city marketing. How to achieve comprehensive and sustainable value enhancement is becoming the most important issue to solve.

This paper will analyze the composition of city marketing and the value increment mechanism, and come up with the dynamic model of city value increment which can promote the development of the city marketing theory.

51.2 Formation and Connotation of City Value

51.2.1 Formation of Systematic City Value

From the evolution of the theory of the urban developing, the understanding of the city development experience the process of ignorant-idealized-planning and rationalism-consideration of the public interests-globalization, finally becoming regional concept (Hall 1998).The city is a huge and complex system taking the human as the fundamental body and consisting many elements (such as material, culture, information etc.) and composition (such government, individual, enterprise etc.). The goal of the urban developing is diversification. The city is regarded as a concept of aggregation, therefore the sustain development of city, the happy life of citizens, the prosperous of culture, the increment of social welfare etc. should all be set as one objective of city development. Should all become the goals of the city development (Chen 2009). The criteria of international assessment about the city is becoming various, the city index system proposed by U.N. include economy and society development, environment, political activity, housing and traffic etc. (Wu and Ge 2001). The process of urban developing is due to comprehensive effect of many elements. The city is the platform of many elements aggregating which become the dynamic of the city urban formation and development (Hall 2003). While the open environment of city developing make it become a new form for world city (Friedmann 1982). New systematic urban view need take the relationship of the various parts of the city dominant elements as a whole and achieve the superiority accumulating and sustained development of urban competitiveness, which means sustained value increment of city value.

51.2.2 Definition of City Value

The introduction of the city values is the reflection of the essential problem "what city is, how it works" which emerged in the process of city development. City development strategy should depend on the customer needs, which means the customer request should be regarded as the starting point of a city development and the basic motive of the city marketing strategy. Consideration about city value, there are still diverse views among the academia domestic and abroad. Ni (2003) defined the city values from the concept of the city benefits. Xu (2004) put forward the view of Value Realization of the City Production Theory, which pointed that there were three perspectives of the city production values-Exchange Value, Production Value and Consumption Value. Liu Yanping thought that city values inherent in the relationship between city products and city customers, in the city development and competition, and in the relationship between the public values and personal values. Moreover, he believed that the essential of the city marketing is the process of delivering the customer value to obtain the customer's satisfaction and loyalty.

Even though there are dispute about the definition of city value in academia, but still, the essential elements of city value can be figured out through different voice. First is the utility subject of city value; Second is utility constitute and implementation of city value. Third is the measurement of city value. Fourth is the uniqueness of the city value compared with other product value.

51.2.3 Relationship Between City Values and City Marketing

As the direct embodiment of customer utility, city value fully reflects five valuable activities of city: the overall strength of a city in a specific period, the power of market in resource allocation, the ability and efficiency of the fully use of resources, the ability to gain advantages in the future and potential competition, and the influence to the outside world-including attraction and affinity (Editor's notes 2003). City value determines the ability of the further development of a city, so city value reflects a city's comprehensive competitiveness. Consequently, the essential purpose of city marketing is increasing the city value.

51.3 Composition and Mechanisms of Value Increment of Whole City Value

51.3.1 Elements of Whole City Value

The key to realize the city value is to make the recognition and management of all the possible opportunity and its nodes, to explore development in the value net of regional and global levels, which further introduced the concept of City Value

Chain (CVC). Porter (1998) raised the Value Chain (VC) model in the industry at the earliest, which consists of a series of closely linked economic activities including basic activities and support activities. In the VC model, the enterprise plays the main role. Analogized in the Porter's value chain model, domestic scholars put forward the city value chain model (Lian 2003). Other scholars form the view of local government role defined the city value chain as the enrichment activity of the strategy formulation, function analysis evaluation, development plan of the government in the process of city value enrichment (Yuan and Ge 2004). Liu YanPing modified the value chain model. He pointed the model should face the direction of creation of the city marginal values. The model expanded the value stream, added the urban infrastructure, the company cooperation management and defined it as value support activities. Furthermore, According to the characteristics of space, the value creating activities were separated as internal endogenous activity, exogenous endogenous activity, endogenous exogenous activity and external exogenous activity (Liu 2005).

It can be seen from the discussion of the above, the close connections between the various elements need to consider the overall value, the city value creation process requires the synergy of the various elements, and the government need play a significant role in this process (Zhou 2010).

51.3.2 Mechanisms of Value-Added of Whole City Value

In the process of city value appreciation presents two kinds of opposite mechanism. From the demands perspective, city value embodies in the optimization of urban customers delivery. From the supply perspective, city value embodies in the maximization of the public value. Therefore, the value of the whole city involves the public sphere, the private sector and public–private sector. The value increment by multiple factors can be regarded as the results of four elements: the internal incentives, the external environment, the competitive pressures, and the demands of the customers. The dynamic system of city marketing is as shown in Fig. 51.1.

Due to the difference on overall effect between the different subjects are imposed by the city value. The city value has diversity on the different components. So the whole city value is relative to the size of the main subjects. City value with its subject is a two-way choice relationship. The changing of demands of the subject will lead the changing of orientation and range of the city value increment. At the same time the diversity of the city value will lead the different preference choice. On the other hand, the present of city value will affect the diversity of element attraction. So, the city value enhancement is a continuing process of self-reinforcing and adjustment intervention. Overall, the growing power of the city value increment is an upward spiral. In order to reveal the mechanism, the following part will firstly analyze the spontaneous process of city value increment in ideal state, and then analyze the intervention-adjusted value increment process.

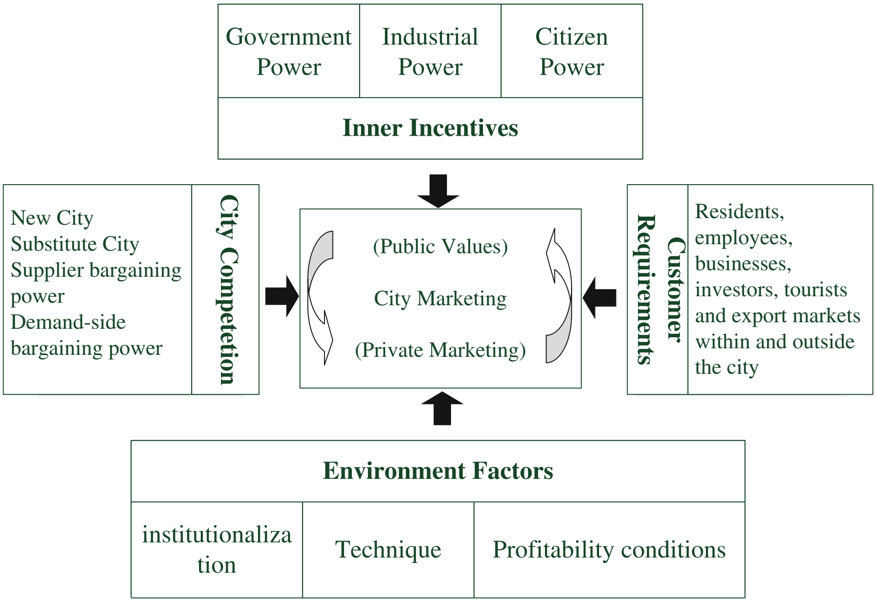

Fig. 51.1 Dynamic system of city marketing (Guo and Liu 2006)

In an ideal situation, city value will develop along an expected direction and autonomous complete value-added process in a long period. This process includes three basic steps: the first step is determining the orientation of city in areas like industrial development, facilities and image construction according to restricted conditions like environment and historical conditions, then forming a long-term strategy and plan. The city and the subjects form relatively stable city composition. The second step is building a frame of city value based on strategy and plan, developing and building all kinds of elements reasonably based on value orientation. The third step is following basic development order and making sure the development conform to the normal market mechanism, the order of natural and the social order, getting the scale growth of city value through subjects' normal value creation activities.

However, as previously mentioned, the city value is affected by the combination of internal incentives and external environment, competitive pressures, demand traction. This may lead to demand generation of new value, or generate a short board element which led to the development of lacking of incoordination and in-adaptation. The city marketing subject need to take the initiatively intervene to adjust in order to ensure the continuity of the city value increment; to make it back to the spontaneous increment process. This adjustment process usually consists of four basic components.

Firstly, identify the customer needs, determine the target value.

It must understand urban and rural customers' principal demands or significant restraints for public service and make clear the direction of city development.

Simultaneously, to realize contributing factors, this can improve present supplements. Following the gradient direction of merit function, it should finalize one or a couple of value factors as the targeted value.

Secondly, formulation and implementation of the target value-oriented city development strategy.

It takes the improving goal value as the major objective, combined with the long term strategy, making the short term city developing strategy. It needs to adjust the previous implementation of the project, resource allocation, and institutional settings. After formulate city development strategy, the government play a leading role in the process, using the policy supplying, legal drafting to develop system security platform. And use funding, resources tilting and financing to establish material security platform implementation of the strategy. According to the characteristics of the target value, to nurture, guidance, encourage the enterprises and non-profit organizations to participate in strategy implementation and to make the evaluation and feedback of the subjects' value in this process.

Thirdly, use other advantages and integration of value.

When the target value is under inferior position in the city competition, the city simply improvements target value from the internal is more difficult. At the same time the cities can formed attraction based on the external resources, gather the advantage of the target to achieve the value of integration.

Fourthly, increase the target value, and re-adjust the overall value.

After target value enhancing, it need to use the advantages and overcome the inherent disadvantages of the target value. It should overcome the short board effect in city development strategies. After the overall value adjustment, all value elements have achieved a relatively stable coordination state and back to the city value of the spontaneous process (Fig. 51.2).

Actually, the appreciation of city value mostly is under an adjusted condition, which will be affected by self-reinforcement and adjusted intervene. One significant difference between city marketing and city planning is dynamic in the marketing process. Depending on the clinical situation, the adjustment of marketing strategies needs to be taken in time. City marketer needs to make active responds to the changing situation, thereby committing to continuing added value of city value. The paragraph below uses Paris as a case study to demonstrate the ongoing adjustment process of the value increment in city marketing.

51.4 Case Study: Taking Paris as an Example

Paris is an area of 12,072 km^2, accounting for 2 % of the French territory, is the largest area of France's 22 regions and the level of economic development in a Europe fifth. Paris' population is 11 million (of which the urban population 9.5 million), accounting for 18.9 % of the population of France. The region's population density is 902 persons per square kilometer. It has the 22 % labor of

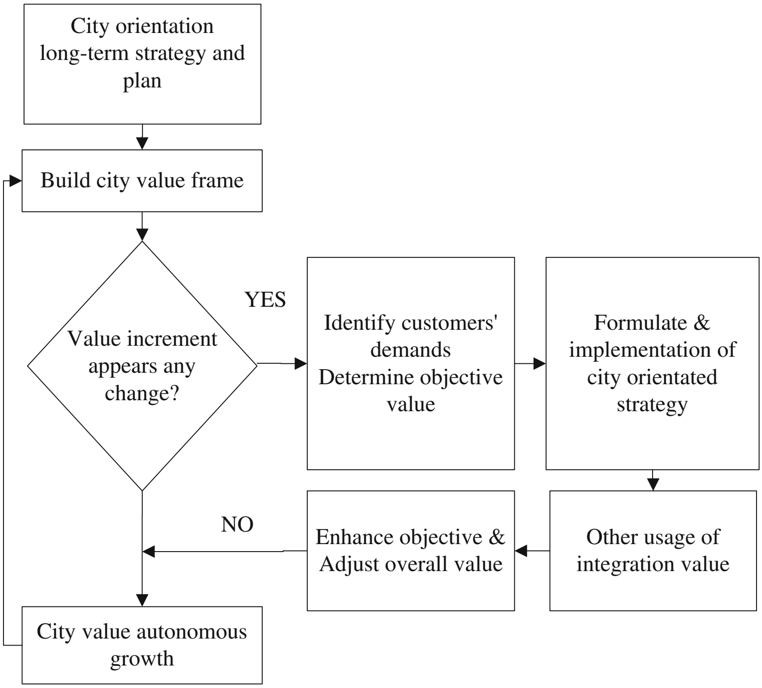

Fig. 51.2 Dynamic mechanism of city value increment

France (4,924.56 million), 27 % of the gross national product, 38 % of the enterprises, 50 % of scientific research efforts, 495 state colleges, and 171 vocational training centers (Qiao 2008).

51.4.1 Identify Customer Needs, Find Target Value

Paris industrialized development occurred in the 1960s, accompanied by a sharp influx of foreign population and the surge in urban population, population density and poor condition of human settlements become the characteristics of that time. On the one hand, the deterioration of living condition in the city center; on the other hand, the boom of purchasing power caused by the economic development and growth in demand, this principal contradiction led to the structural contradictions of urban space, mainly reflected in two issues. First, urban residents moving out to the suburbs which expand the city scale, the second, it is the decline of the inner city and cut of construction funding, the reduction of urban commercial reduce the convenience of central area's commercial and service level, further block the tourism industry, which cannot meet the needs of customers outside the city. As a result, the demand of living environment by the urban city residents and the demand of the central area of business facilitation by the outside residents became the major customer needs.

51.4.2 Formulation and Implementation of Target Value-Oriented Real-Time Strategy

Paris municipal government took city marketing strategy including city scale control and central area transform to meet the customer demands. Paris municipal government put forward the conception of Whole Paris Big Region in 1965 and aimed at expansion of city scale. The main idea is building eight satellite cities around Paris, each satellite city population of 500,000 people. Eight satellite cities distribute along the east–west axis of Seine. The city center connects satellite cities through ring road and subway. Aimed to the recovery and transformation of central area, Paris municipal government paid attention to the construction of new residential and commercial building in modern block, and promoted the updates of public service facilities. Besides, the government highlighted the traditional style of the block through large-scale repair, maintenance and renovation of historic buildings and blocks, enhanced the attractiveness of the traditional block through penetration of green space. The strict executing of the "local urban planning" makes the Paris planning carry out successfully.

Paris adopts flexible land development measures, so that maintain the vitality of the neighborhood of Paris. Paris makes some district of the neighborhood into a special development district, which bring the convenience to the owners.

51.4.3 Using Overall Value to Enhance Value Increment Capacity and Efficiency

Long history and culture, rich heritage, beautiful environment of the Seine constitute the unique advantages in the development of Paris. Paris municipal government pays high attention to those advantages and made strict protective measures. Over 5,000 buildings have been protected, and some are protected in group. The form of protection is not using them as a museum, but giving them new life and history, giving them multifunction such as living, business and entertainment, protecting them with dynamic form. Now, these buildings and blocks have become a part of Paris's modern life. They give Paris a new name—the charm city, they attracted the active participation of citizen and visitors, greatly accelerated the transformation of Paris's inner city and development of blocks, they promoted Paris's construction.

51.4.4 City Value of Linkage Proliferation Ability Enhanced

After new city construction and inner city transformation, the Paris area planning sub-city center and the new city has been successively built in a certain scale, economic structure and infrastructure layout of Paris reassembled, together with the mitigation of urban expansion and the construction of the inner pressure. Paris ultimately successful achieves the linkage value increment under continuous development and increase the attractiveness and competitiveness of the city.

From the Paris city marketing case, it is basically in line with the dynamic adjustment path presented in our previous model: the identification of customer requirements, determine the target value—the formulation and implementation of the target value-oriented strategy—the overall value of the integration—the overall value of value increment into a new cycle.

51.5 Conclusion

City values as the embodiment of customer demands and the effectiveness satisfaction, it reflects the return of the basis function of "city can give people a life". In this paper, the mechanism of its key areas of the city value increment was preliminary validated by the case study of Paris, France. Accordingly, some conclusions of value increment in the city marketing can be drawn as follows:

1. City value is consisted by multi-factor characterization of the city with non-homogeneity, self-effect, the differences between the subjects.
2. City value increment is the combination of a continuous process of self-reinforcing and adjustment of intervention, in which adjustment and intervention generally include identifying demands, determine the target value—the formulation and implementation of the target value-oriented strategy—the overall value of integration—the overall value of value increment.
3. City marketing process need to respond positively to the changes in the value increment, to achieve the continuity of the value increment by the intervention.

Because of the complexity of city systems, this paper just discusses the marketing process in the overall value increment mechanism and how to identify the target value, and the microscopic role of various elements of the city value in marketing process. The study is still open to further research and in order to better guidance to the marketing practices of city management.

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Chapter 52
An Empirical Research on Civilized Eco-Villages Sustainability in Hainan

Huan-jing Chen, Ruo-tuan Chen, Sheng-bai Jin, Yin Li and Ming-xuan Zhang

Abstract The combination of civilized eco-villages construction, socialism new rural construction, Hainan Ecological province construction and international tourism island construction provided a way of solving Three Rural Issues and fully realizing well-off society. This paper is dedicated to explore ways of new rural construction of Hainan in aspects like overall features, patterns, core motivations and endogenous capacity of sustainable development, and promote suggestions on sustainable development of Hainan civilized eco-villages construction.

Keywords Civilized eco-villages · Sustainability · Empirical · Research

52.1 Introduction

Since 2000, great achievement has been observed in the civilized eco-villages' construction in Hainan, but the construction remains in its elementary stages. From the regional point of view, this paper is to study the core driving forces and endogenous capacity that influence the civilized eco-villages sustainability, and

H. Chen
Hainan Trade Institute of TAFE, Haikou 571127, People's Republic of China
e-mail: chenhuanjing888@126.com

R. Chen (✉)
Hainan Foreign Language Institute of TAFE, Wenchang 571321, People's Republic of China
e-mail: lsycrt@163.com

S. Jin · Y. Li
Hainan Institute of TAFE, Haikou 570216, People's Republic of China

M. Zhang
College of Engineering, Peking University, Beijing 100871, People's Republic of China

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discuss the rural sustainable development of Hainan in the context of new rural construction, city and countryside integration and international tourism island construction, exemplifying the capability of developing civilized eco-villages in Hainan, and proposing the advice that international tourism island construction should be developed in the direction of benignity and mutual benefit with civilized eco-villages, the scientific foundation of development (People's Congress Standing Committee of Hainan Province 2005, Li 2008..

52.2 Intension Analysis of Sustainability

52.2.1 Develop Production and Ecological Economy

Civilized eco-villages can be activated by developing green ecological tourism economy and making changes in traditional rural economic increase. Major considerations are: net income per peasant, proportion of primary industry, proportion of rural ecological tourism economy, cyclic economy giving priority of methane, popularity of methane, pollution-free fruits and proportion of agricultural acreage, etc (Hainan reform & development research institute 2007, Hainan survey office of National Bureau of Statistics 2009).

52.2.2 Create Prosperous Life with Green Well-Off

Green well-off means the comprehensive well-off dominated by ecological optimization. Major considerations are: Average life expectancy, Engel coefficient, living quality index, water qualification rate, life informatization degree, etc (Hainan survey office of National Bureau of Statistics 2009, Wang 2006).

52.2.3 Promote Social Development in Eco-Culture

Eco-culture is the generalization of people's attitudes and activities towards nature, and corresponding belief, ideality, ideas and behaviors. Major considerations are: rural cooperative medical service coverage, rural endowment insurance coverage, average number of agricultural technician in 10,000, Gini coefficient of rural population, popularizing rate of ecological education in small or medium-sized kindergartens, average education year of rural population, culture and entertainment spending proportion of rural area, etc (Hainan survey office of National Bureau of Statistics 2009, Chang 2007).

52.2.4 Establish Scientific Management in Ecological Environment

Ecological environment is the lifeline of sustainable development of Hainan Civilized eco-villages in both natural and civil aspects. Major considerations are: rural satisfaction of making government affairs public, rural satisfaction of social security, farmland variation in common use, ecological forest coverage, total forest coverage, average water usage in 10,000 agricultural GDP (Hainan survey office of National Bureau of Statistics 2009, Chang 2007, Hainan civilization office 2011).

52.3 System Formulation on Sustainability

52.3.1 Evaluation Model of Hainan Civilized Eco-Villages Sustainability

Two key points of the model, as is shown in Fig. 52.1, are: the build-up of evaluation index system, and the choice of evaluation methods. Multiple-index Comprehensive Evaluating Method is a way of converting indicators with different dimensions which describe different aspects into dimensionless relative values, and combining those values into one overall evaluation (Huo 2005).

Quantification: Indicators can be divided into two categories, quantitative indicators and qualitative indicators by property.

Dimensionless disposal: This is also known as standardization or normalization, methods to eliminate dimensional effects via mathematical transformation. Suppose we have a linear relationship in dimensionless disposal, changes in actual value will cause proportional changes in standardized value. The formula is:

$$Z_i = (X_i - X)/S \tag{52.1}$$

Here X_i is the actual value, X is the standardized value and S is the standard deviation.

Adjusting the formula according to the characteristics, and we get the standardization formula of reverse indicators. Some indicators are qualitatively described based on subjective judgment, which cannot be denoted by numbers but levels instead, so they should be classified into specific levels according to subjective judgment, after which scores can be acquired and standardized (Bai 2006; Xu 1998).

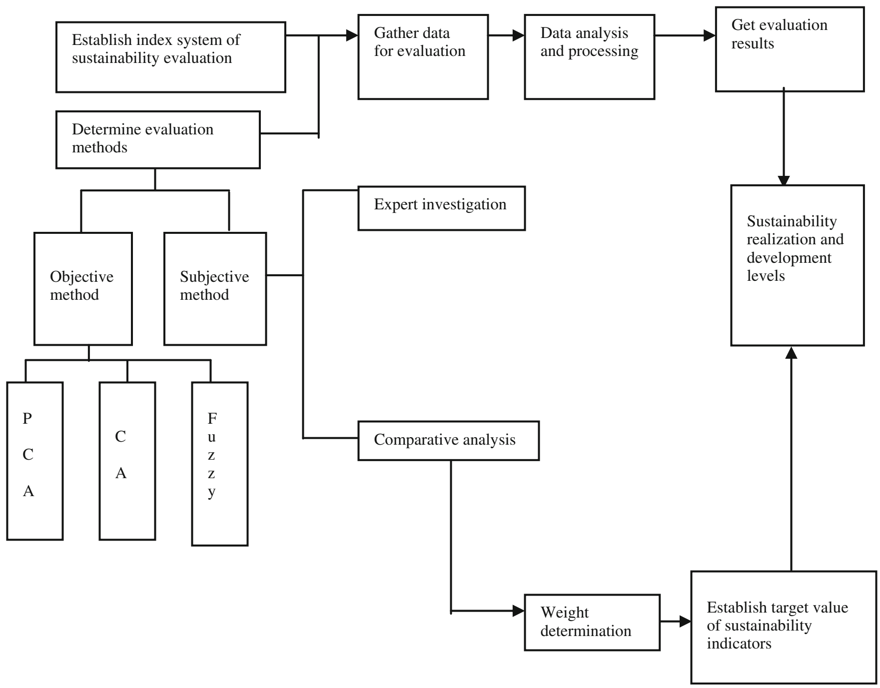

Fig. 52.1 Evaluation model of civilized eco-villages sustainability

52.3.2 Evaluation Model of Hainan Civilized Eco-Villages Sustainability

$S' = \left(Y'_1, Y'_2, \ldots Y'_N\right)$, S' is the actual value of indicator, Y'_N is indicator.

$S = (Y_1, Y_2, \ldots Y_N)$, S is the target value of indicator.

$$\Delta = S - S' = \left(Y_1 - Y'_1, Y_2 - Y'_2, \ldots Y_M - Y'_M\right), \Delta_1 = Y_1 - Y'_1, \Delta_2 = Y_2 - Y'_2, \Delta_M = Y_M - Y'_M.$$

$\Delta = (\Delta_1, \Delta_2, \ldots \Delta_M)$, qualified if $\Delta_I = 0$, unqualified if $\Delta_I > 0$

Two key points of the model, as is shown in Fig. 52.1, are: the build-up of evaluation index system, and the choice of evaluation methods. Multiple-index Comprehensive Evaluating Method is a way of converting indicators with different dimensions which describe different aspects into dimensionless relative values, and combining those values into one overall evaluation.

Index combination: an overall evaluation by combining different indicators in Multiple-index Comprehensive Evaluation. Linear Weighted Sum is a common combining technique in comparative analysis, and this paper is no exception (Jiang 2004).

Weight determination: weight determination methods are developed according to purpose and number of index. In the evaluation of civilized eco-villages' construction, we choose contrastive Analysis to determine weights, regarding the multi-hierarchical characteristics of index system.

52.3.3 Target Evaluation Index System of Hainan Civilized Eco-Villages Sustainability

Table 52.1

52.3.4 Evaluation of Hainan Civilized Eco-Villages Sustainability-Year 2009

Table 52.2 and Fig. 52.2.

52.4 Advice

1. Economic growth is the primary motivation of the sustainable development Civilized eco-villages. Long-effect mechanism should be established in developing rural ecological economy, to ensure the sustainable growth of farmers' income. Many industries can be planned surrounding the construction of international tourism island, such as village tour and agritourism, and with standards established and orderly growth, we can set up many successful examples.
2. Population quality is already a bottleneck for rural sustainability improvement, and civil ecological environment are not yet enough. Peasants should be encouraged and supported to be entrepreneurial personnel by increasing investment in rural education and training of migrant workers.
3. Large variance and pressure is observed in environmental protection level, and rural sustainable development can be ultimately ensured only by strictly prohibiting misuse of cultivated land and maintaining the dynamic balance of agricultural acreage.
4. Speed up ecological environment and renewable energy source construction, and promoting rural sustainable development. Emphasize household garbage collection and safety disposal, and improve economic, social and ecological benefits simultaneously by promoting recycling economy.
5. Promote eco-culture construction. Reinforce protection measures on ancient villages, buildings and other intangible cultural heritages by bringing up a batch

Table 52.1 Target evaluation index system of Hainan civilized eco-villages' sustainability

Core development	Index	Name of indicator	Unit	Target value for 2018	Weight
1. Develop production and eco-economy	1	Net income per peasant	¥	10,000	7
	2	Proportion of primary industry	%	35	3
	3	Proportion of rural eco-tourism economy	%	35	4
	4	Cyclic economy, and popularity of methane	10,000 homes	52.7	6
	5	Pollution-free fruits	%	90	6
2. Create prosperous life with green well-off	6	Rural cooperative medical service coverage	%	100	4
	7	Rural endowment insurance coverage	%	60	4
	8	Agricultural technician in 10,000 people	Person	4	4
	9	Gini coefficient of rural population	–	0.3–0.4	4
	10	Popularizing rate of ecological education in small or medium-sized kindergartens	%	99	5
	11	Average education year of rural population	Year	9	4
3. Promote social development in eco-culture	12	Rural culture and entertainment spending proportion	%	7	3
	13	Average life expectancy	Year	75	4
	14	Engel coefficient	%	40	4
	15	Living quality index	%	75	4
	16	Water qualification rate	%	90	5
	17	Life informatization rate	%	60	3
4. Establish scientific management in eco-environment	18	Rural satisfaction of gov-affairs publicity	%	85	4
	19	Rural satisfaction of social security	%	85	4
	20	Farmland variation	%	0	4
	21	Eco-forest coverage	%	26	4
	22	Forest coverage	%	23	4
	23	Water usage in 10,000 agricultural GDP	Stere	<=1,500	4

of influential cultural villages. Peasants should be guided to respect sciences and transform improper traditions by training and publicity, finally improving the literal and moral quality levels.

Table 52.2 Evaluation result of Hainan civilized eco-villages sustainability

Core development	Index	Name of indicator	Unit	2009		Target value for 2018	Weight
				Actual value	Level (%)		
1. Develop production and eco-economy	1	Net income per peasant	¥	4,570	45.7	10,000	7
	2	Proportion of primary industry	%	53.2	65.7	35	3
	3	Proportion of rural eco-tourism economy	%	0	0	35	4
	4	Cyclic economy, and popularity of methane	10 k homes	27.4	51.9	52.7	6
	5	Pollution-free fruits	%	53.02	58.9	90	6
2. Create prosperous life with green well-off	6	Rural cooperative medical service coverage	%	97.1	97.1	100	4
	7	Rural endowment insurance coverage	%	20.3	33.8	60	4
	8	Agricultural technician in 10,000 people	p	2.3	57.5	4	4
	9	Gini coefficient of rural population	–	0.34	100	0.3–0.4	4
	10	Popularizing rate of ecological education in small or medium-sized kindergartens	%	91.1	92	99	5
	11	Average education year of rural population	y	7.7	85.5	9	4
	12	Rural culture and entertainment spending proportion	%	6.4	91.4	7	3
3. Promote social development in eco-culture	13	Average life expectancy	y	71.6	95.4	75	4
	14	Engel coefficient	%	53.1	75.3	40	4
	15	Living quality index	%	62.5	83.3	75	4
	16	Water qualification rate	%	62	77.5	90	5
	17	Life informatization rate	%	97.3	100	60	3
4. Establish scientific management in eco-environment	18	Rural satisfaction of gov-affairs publicity	%	75	88.2	85	4
	19	Rural satisfaction of social security	%	62	72.9	85	4
	20	Farmland variation	%	0	100	0	4
	21	Eco-forest coverage	%	25.76	100	26	4
	22	Forest coverage	%	52	44.2	23	4
	23	Water usage in 10,000 agricultural GDP	Stere	784	100	<=1,500	4

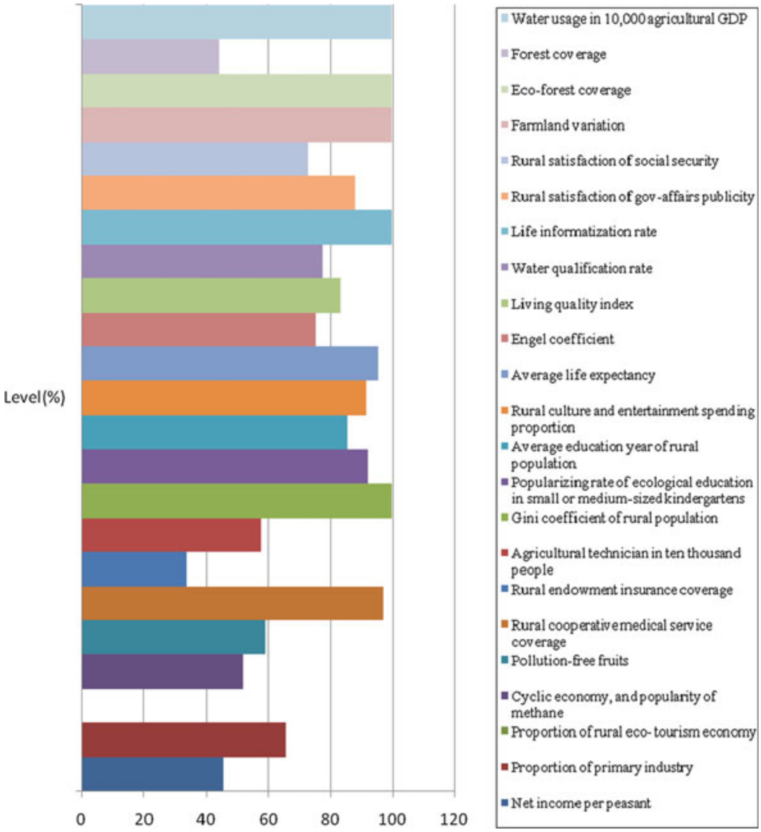

Fig. 52.2 Sustainability level of Hainan civilized eco-villages in 2009 (%)

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Chapter 53
Concept and Model Study for Reliability Engineering Capability of Equipment Development Units

Dong-yu Wang, Jia-duo Wu and Wei Wang

Abstract At present due to the lack of equipment development units' reliability engineering capability concept in equipment development project, it is not conducive to improve and measure reliability engineering capability. In order to solve this problem, this paper puts forward the concept of equipment development unit's reliability engineering capability. According to this concept, this paper builds up the model of equipment development unit's reliability engineering capability, including of constructing the hierarchical structure model and combining AHP with expert evaluation method to carry on quantitative analysis. It provides useful reference and contributes to the scientific evaluation of equipment development units' reliability engineering capability.

Keywords Analytic hierarchy process · Equipment development units · Model · Reliability engineering capability

53.1 Introduction

The characteristics of Equipment development project are high complexity and high level of technology. With equipment special commodity attribute, so it has traits as follows: possesses wide, a large size, process system with many links, long life cycle, cost much, complex internal structure and extensive external contact. The performance of the reliability requirements throughout the whole process of equipment development units will be able to directly affect the equipment readiness and mission success rate (Tiku and Pecht 2003a, b). However, it is lack of reliability engineering capability concept and model in home and aboard at

D. Wang (✉) · J. Wu · W. Wang
School of Reliability and Systems Engineering, Beihang University (BUAA), Beijing, China
e-mail: wwr1227@163.com

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moment. This is not conducive to measure and enhance the capability of reliability engineering. So this paper proposes equipment development units reliability engineering capability concept, and around this concept sets up equipment development units reliability engineering capability model, and on the basis of combining the AHP and expert evaluation method to carry on quantitative analysis. The equipment development units can be clearly and gradually carry out the reliability work and improve the reliability of equipment. It provides useful reference and contributes to the scientific evaluation of equipment development units' reliability engineering capability.

53.2 Reliability Engineering Capability of Equipment Development Units

53.2.1 Reliability Engineering

Reliability engineering is the study about engineering technology of fighting against failures in product life cycle process (GJB450A 2004). It is from view of dialectical relationship between the overall product and the external environment. With experimental studies, site investigation, fault and repair activity analysis method, study the product life and the relationship between reliability and environment, including the law of faults to occur, development, prevention and maintenance guarantee until restoration and a series of technical and management activities about improving reliability, prolong life and improve the performance (Tiku and Pecht 2003).

53.2.2 Reliability Engineering Capability of Development Equipment Units

Equipment reliability engineering research units is a measure about meeting the reliability requirement of practice activities to reach the final product reliability requirements (Jackson et al. 1999). Using existing mature or mature reliability technology through a series of reliability engineering process applied to the equipment and make equipment with specific reliability level (Oshana and Linger 1999; Shere et al. 1994).

Reliability work involves a series of technology and management activities associated with the fault characteristics (Neufelder 2000; Card 2002). From the point of technology, organization and process perspective, equipment development units' reliability engineering capability can be divided into four kinds of capability. They are reliability engineering support capability, reliability engineering

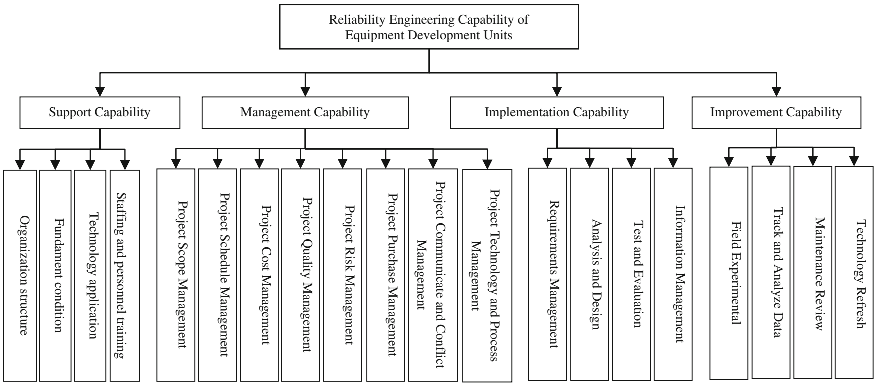

Fig. 53.1 Hierarchy diagram

management capability, reliability engineering implementation capability and reliability engineering improvement capability.

Equipment development units' reliability engineering is an integrated capability with a whole process, multi-subjects, multi-factor and multidiscipline (Schaffner 1999; Trienekens 2002). It describes the essential characteristics of reliability engineering process in an organizational unit. These characteristics are perfected reliability engineering's guarantee (Paulk et al. 1993).

The *comprehensive* above presents:

1. Covering the whole process including beforehand and afterwards (Fig. 53.1).
2. For the project, equipment and development units.
3. Comprehensive capability in the areas of project scope, time, coverage, quality, human resources, communication, risk, resource security, reliability and safety, integrated management functions.
4. Integrated model based on the organization, process, methods, personnel.
5. Multifunction integrated capability of data accumulation, capability evaluation, and continuous improvement.

53.3 Model for Reliability Engineering Capability of Equipment Development Units

53.3.1 Model Structure

Equipment development units reliability engineering capability can be built into a reliability engineering (level indicator) as the core, consisting of the reliability engineering support capability, reliability engineering management capability, reliability implementation capability and reliability engineering improvement capability, four kinds of capability (two grade target) composition model. The model reflects the development units in reliability engineering level, and can effectively measure the development units' reliability activities to meet the reliability capability that customer require.

1. Support Capability

Reliability engineering support capability is a measure about metric states on personnel, institutions and other factors which have a support influence on the project management (Cooke-Davies and Arzymanow 2003).

From the project management support capability definition, organization is an important function of project management. In project management, organizational status often determines the organizational behavior, also directly decided the project efficiency and performance. Good organization will combine management forces together and form an effective collaboration system in a unique way, promote to realize the goal of the project together. Organization structure from the angle of division and cooperation of labor set up the working relationship of equipment development units' members. Equipment development units' support capability includes not only the equipment development units of the member's capability, but also organizational survival and development capability. Therefore, according to the analysis the capability of project management is divided into organization structure established, fundament condition, technology application and staffing and personnel training, four aspects.

Based on GJB450A-2004 *equipment reliability general requirements of reliability program* and according to the connotation and the application timing of various work items, the specific targets of reliability engineering support capability include: organization structure established, staffing and personnel training, basic test environment, base device configuration, software applications, basic organization learning new technology (GJB450A 2004).

2. Management Capability

Reliability engineering management capability is a measurement on work activities in project process, such as planning, implementation, monitoring and improving. The project process management capability maturity level has direct influence on the project cost, schedule and performance target (Schleicher 2001).

China's defense project management knowledge system, referred as CB-PMBOK, defines 12 elements of national defense project management. Learning from the research achievement and theory basis and according to the reliability engineering work characteristics, we refine elements of equipment development units' reliability system management capability including: project scope management, project schedule management, project cost management, project quality management, project communicate and conflict management, project technology and process management, project risk management and project purchase management.

The specific targets of reliability engineering management capability include: determine the reliability requirements, determine the reliability of project requirements, develop reliability program, and make work plan, reliability failure reporting, analysis and corrective action system and establishing the fault review organization.

3. Implementation Capability

Reliability engineering implementation capability is a measurement of perfection degree on technical essentials which have important influence on project implementation and goals in project implementation process. Such as theory, production tools, equipment and other facilities of the technical element (Total equipment military training material edit committee Weapons and equipment procurement management 2003).

The process of organization fighting with product failure involves a series of technology and management activities related to fault characteristics. The development process mainly includes: requirements management, analysis and design, test evaluation and information management. Accordingly, the development process also can be divided into four categories: fault correlation properties of requirements management, analysis and design, test and evaluation, information management.

The specific targets of reliability engineering implementation capability include: establishing reliability model, reliability analysis, reliability prediction, FMECA, FTA, sneak circuit analysis, make the criteria of reliability design, components and raw materials selection, choose and control, determine the reliability key products, determine the functional testing, packaging, storage, handling, transport and repair influence to product reliability, finite element analysis, durability analysis, environmental stress screening, reliability development test, reliability growth test, reliability analysis and evaluation, life testing, supervision and control, the reliability information collection, reliability evaluation, reliability growth management, the use of reliability assessment, the use of reliability improvement, integrated design, design with the method of iteration, engineering test, comprehensive evaluation, test organization.

4. Improvement Capability

Reliability engineering improvement capability is a process measurement for setup improvement goal and finding improvement opportunities. The process comprises the reliability qualification test, fault data tracking and analysis, fault zero and feedback methods such as the correction measures and preventive measures.

Continuous improvement period is seen as a method of quality management on the basis of quantitative management in work process. And the relevant data are analyzed in order to find the root cause, and based on the work process itself correct and solve the problem, so as to achieve the purpose of continuous optimization. In this way, the organization can adapt and develop to the external environment.

The specific targets of reliability engineering improvement capability include: field experimental, track and analyze data, maintenance review and technology refresh.

53.3.2 Quantitative Analysis

As a result of various factors effects equipment development units' reliability engineering capability differently, we weighted it from two angles: one is to determine the weight of target system perspective which need to determine the level set of each index system. And the other one is considered from the appraisal angle which needs to determine each subject proportion coefficient and calculate the score according to the appraisal opinions of importance. To reflect this difference, we choose to combine analytic hierarchy process (AHP) with expert evaluation method (Delphi) together (Cooper GFA method for using belief networks as influence diagrams, UAI 96 Program Committee. Proceedings of the Twelfth Conference on Uncertainty in Artificial Intelligence. San Francisco: Morgan Kaufmann Publishers Inc 1996; Xiangqian 2004; Denghua and Jianshe 2002), AHP method is used to determine the target system weights set of equipment development units' reliability engineering capability mode, while Delphi method is used to determine the main views of the importance degree of expert.

1. Determine the weight of target system

Experts determine the relative important degree of target system. Relative importance degree is represented in $1 \sim 9$ scale. Questionnaire is designed as shown in Table 53.1, and the relative importance is represented as shown in Table 53.2.

According to Tables 53.1 and 53.2, we can get judgment matrix R as follows:

$$R = \begin{pmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{m1} & \cdots & b_{mn} \end{pmatrix}$$

Judgment matrix R has properties as follows:

1. $b_{ij} > 0$
2. $b_{ij} = (b_{ij})^{-1}$
3. $b_{ij} = 1$

Table 53.1 Questionnaire design table

Target	1	2	…	m
1	b_{11}	b_{12}	$b_{1\cdot}$	b_{1m}
2	b_{21}	b_{22}	$b_{2\cdot}$	b_{2m}
3	b_{31}	b_{32}	$b_{3\cdot}$	b_{3m}
…	$b_{.1}$	$b_{.2}$	$b_{..}$	$b_{.m}$
m	b_{m1}	b_{m2}	$b_{m.}$	b_{mm}

Table 53.2 Scales of relative importance

Target	meaning
1	Element i has the same importance with element j
3	Element i is slightly important than element j
5	Element i is obvious important than element j
7	Element i is very important than element j
9	Element i is extreme important than element j

Considering the complexity of the algorithm, here we use an algorithm of root method of analytic hierarchy process method to determine weight. And the weight formula is as follows:

$$w_i = \frac{\left(\prod_{i=1}^{n} b_{ij}\right)^{1/n}}{\sum_{k=1}^{n}\left(\prod_{j=1}^{n} b_{kj}\right)^{1/n}} \quad (i = 1, 2, \ldots, n) \tag{53.1}$$

$w_i > 0\ (i = 1,2,\ldots,n)$, $\sum_{i=1}^{n} w_i = 1$. Among them from this, $w = (w_1, w_2,\ldots,w_n)^T$ is the approximation value of characteristic vector, and n presents the number of targets, w_i presents the number i target of relative importance.

2. Level single sort and consistency check

Judgment matrix R is calculated according to experts' subjective judgment with estimation error. It may cause the eigenvalue and eigenvector with a quite deviation. So it needs the consistency check after calculated characteristic vector under the sheer level.

Calculating the maximum eigenvalue:

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(Aw)_i}{nw_i} \tag{53.2}$$

$(Aw)_i$ presents the number i element in Aw vector. Calculating the Consistency target C.I.:

$$C.I. = \frac{\lambda_{\max} - n}{n - 1} \tag{53.3}$$

Among them, n presents the order of judgment matrix, and λ_{max} presents the maximum eigenvalue of judgment matrix. The value of average consistency target R.I. as shown in Table 53.3.

Calculating consistency ratio C.R.:

$$C.R. = C.I. / R.I. \tag{53.4}$$

Table 53.3 Random consistency index

	1	2	3	4	5	6	7	8	9
R.I.	0.00	0.00	0.00	0.58	0.90	1.12	1.24	1.41	1.49

Calculation consistency ratio C.R.: when C.R. < 0.1, the consistency of the judgment matrix is acceptable, while when C.R. ≥ 0.1, the judgment matrix should be fixed appropriately

3. The hierarchy total ordering and consistency check

Hypothesis we have calculated each elements weight vector w^{k-1} of higher level ($k-1$) layer for the goals. The sorting weight of next layer (k) layer is which oriented by the number j element of upper layer $p_j^{(k)}$. So the synthesis sorting weight of each element in (k) layer to the total target elements is:

$$w^{(k)} = p_j^{(k)} w^{(k-1)} \tag{53.5}$$

Comprehensive importance calculation formula shows, calculation the comprehensive importance of a certain level must know the comprehensive importance of higher level. Comprehensive importance begins with the highest degree of level. And to the weight of the bottom element is got in down step by a recursive calculation. Combination consistency inspection question also must be calculated step by step. The combination consistency ratio of first layer (k) layer of is:

$$C.R.^{(k)} = C.R.^{(k-1)} + \frac{C.I.^{(k)}}{R.I.^{(k)}} \tag{53.6}$$

Theory explanations: when C.R. (k) < 0.1, presents hierarchical models all judgment at the K level above through the consistency check, otherwise the judgment matrix element value needs to be adjusted.

Considering the four major factors of equipment development units' reliability engineering capability with the quantitative and determine the target weight of the level in the model above, the equipment development units' reliability engineering capability evaluation function can be expressed as:

$$REC = B_1 \times w_1 + B_2 \times w_2 + B_3 \times w_3 + B_4 \times w_4 \tag{53.7}$$

Among them, the RSE presents equipment development units' reliability engineering capability, B1 presents support capability, B2 presents management capability, B3 presents implementation capabilities and B4 presents improvement capability where w_i ($i = 1,2,\ldots,n$) is the weight coefficient according to the analytical hierarchy process (AHP).

So far using analytic hierarchy process and expert evaluation method, we realize to quantitative analysis of equipment development units' reliability engineering capability model. It provides useful reference and contributes to the scientific evaluation of equipment development units' reliability engineering capability.

53.4 Conclusion

This paper presents the concept and connotation of equipment development units' reliability engineering capability, builds its model frame, and quantitatively analyzes the model. The model provides thoughts and guidance to assess and improve the reliability of system engineering for the military-industrial enterprise. In the future work, we should focus on how to evaluate the equipment development units' reliability engineering capability, so as to provide research units operable evaluation and improvement measures.

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Chapter 54
Importance of Strategic PMO Functions for PM Maturity

An Empirical Study in Japan Pharmaceutical Companies

Kaoru Nakamura and Hiroshi Osada

Abstract Recently, PMO (Project Management Office) is commonly understood as a key to the success of project management, especially with multiple project management in the organizations. PMOs are expected to improve PM maturity of organizations, as it is proved that PM maturity affects the organization performance. On the other hand, it is not yet clear what sort of PMO is most effective to achieve PM maturity of the organization. Many academics and practitioners describe that PMOs should obtain more strategic functions, although there is no clear definitions of these strategic functions. Therefore, this paper aims to find the important strategic functions which affect PM maturity. In this research, three strategic functions are extracted as important functions for PM maturity based on quantitative and qualitative analyses.

Keywords PMO · PM maturity · Strategic function

54.1 Introduction

The understanding that Project Management Office (PMO) is a key factor in successfully implementing project management in the organization (Kerzner 2004) is now widely accepted by many industries worldwide. Also PMO is recognized as one of the key drivers for improving organization performance after Kendall and Rollins explained that PMO's performance affects organization's return on investment in their literature in 2003 (Kendall and Rollins 2003). Furthermore, it

K. Nakamura (✉)
PRTM Management Consultants, Pricewaterhouse Coopers, Tokyo, Japan
e-mail: kaorunchan@gmail.com

H. Osada
Innovation Management, Tokyo Institute of Technology, Tokyo, Japan

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was explained that the Project Management Maturity (PM Maturity) level of an organization has a positive correlation with the organization's performance by the benchmarking study in pharmaceutical industry (Shibao 2008). On the other hand, some PMOs have failed or even have completely shut down, because they cannot justify their investment (Hobbs and Aubry 2007). In such circumstances, organizations established a great variety of different PMOs to deal with their reality (Hobbs and Aubry 2007). Many practitioners and academics have been trying to find what sort of PMO can contribute to the organization's performance, and have discussed in books and papers regarding what kind of roles or functions should be covered by PMO (Aubry et al. 2007). However, the contributions of PMOs are not easily measured and still remain as a continuous quest (Aubry and Hobbs 2011). It is also described that one important mission for PMOs is to improve PM Maturity of organization (Japan 2009). Accordingly, it is important for PMOs to have functions which improve PM Maturity level and put an effort on those functions so that PMOs contribute to organization's performance.

In 2002 the top ten project organization best practices were introduced (Toney 2002), and six functions were extracted as the program management level of PMO functions, which support strategic areas of project management. As project management evolved from merely tools and techniques used on standalone projects to an organizational capability, PMO are introduced as vital functions that support strategic alignment of projects (Crawford 2002). As such, PMO's role is not only to understand and apply modern project management practices, but also to adapt and integrate business interests into the organization's project management efforts (Hill 2004). PMO is deeply embedded in its host organization (Hobbs et al. 2006) and, conceived as an agent and a subject of change or renewal (Pellegrinelli and Garagna 2009). Recently PMO became a guardian for project management intellectual property (Kerzner 2009). Organizations choose among a number of possible roles or functions to entrust the PMO with. Some examples that are critical for PMOs that manage R&D projects are project selection and prioritization for the portfolio and intermediate project evaluation in order to decrease lead time (Tsujimoto 2004). In addition, Program and portfolio management are emerging themes in project management literature and they are associated with strategic alignment of projects and programs with organizational aims. Then, strategic functions are recognized critical for PMOs which manage multiple projects in organizations, as it is explained that strategic management is one of important PMO functions (Hobbs and Aubry 2005). Further, it was found that PMOs were more involved in strategic management functions such as 'Provide advice to upper management' or 'Participate in strategic planning' (Hobbs and Aubry 2007). Prior to those researches, linking projects to strategic goals is found as critical for PMO (Crawford 2004). Furthermore, it is reported that more matured organizations require more strategic PMO (Yamato 2007), and PMO is expected to cover more strategic areas (Japan 2009).

However, there is no clear definition of strategic PMO functions that is proposed to be effective for PM Maturity. Therefore this paper aims to find which strategic functions and execution are important for PM Maturity.

In the next section, methodology of this research is explained. In the third section strategic functions which are important to improve PM Maturity are proposed, based on both quantitative and qualitative analysis. The conclusions are described in the last section.

54.2 Methodology

This research is composed of both quantitative analysis with a specific focus on the relationship between strategic PMO functions and PM maturity and the qualitative case study based on semi-structured interviews. Fisher's exact test is applied to find the correlation between PM Maturity and each strategic function. Then effective PMO functions to improve PM Maturity are extracted by using the result of statistical analyses and discussion based on the interviews.

It is well known that Japan has a unique business culture (Vogel 1979) and different cultures require different management approaches (Cooke-Davies and Arzymanow 2003). Even within the same culture, a different country or project type might result in a different organizational culture inevitably affecting management approaches. In order to avoid disturbance factors that might be caused by cultural issues, the subjects for this research are limited to Japanese pharmaceutical companies. Further, the subjects are selected only for the companies executing new drug development projects; as companies that develop generic drugs are excluded due to the difference of project model. The new drug development projects have similar characteristics of having 3–7 years project period and simultaneously executing multiple projects with big uncertainties (Kuwashima 2006).

The research targets PMOs that have been operated for more than 3 years, as it is difficult for PMOs to give visible results in less than 3 years (Aubry et al. 2008). In addition, the size of organizations was limited, since the size difference between big pharmaceutical companies and small pharmaceutical companies may affect the outcome or scope of PMO activities (Cooke-Davies and Arzymanow 2003). Accordingly the size of targeted pharmaceutical companies is set to be bigger than $1 billion in revenue with more than 100 internal development staff. As a result, 13 organizations were selected, but three of them were not as relevant due to their recent restructuring of their PMO organizations. Accordingly, the subjects of this research resulted in ten PMOs. Interviews are made mainly for PMO staffs who are managing new drug development projects in clinical phases. There were a total of 38 interviewees including PMO managers (mandatory), PMO members (mandatory), Project managers (if possible) and R&D managers (if possible), and = 2–5 people per organization to gather fair data from people in various positions. In order to get the result as accurate as possible, interviews have been done twice in each company: once by phone and once face to face. The preliminary phone call lasted 30 min. After the preliminary call, the interviewee would confirm requested information with their organization and attend a 60 min face to face interview.

54.2.1 PM Maturity

The first PM Maturity model was defined in 2000 as five-level Project Management Maturity Model, and an organization's PM Maturity has positive correlation with actual project performance in this model (Ibbs and Kwak 2000). The first five-level process maturity model of an organization was developed in the particular field of Total Quality Management (Crosby 1979). Since then, a number of five-level PM Maturity models have been adopted in many studies (Kerzner 2001; OGM 2010; PMCC 2001; Nakamura et al. 2008) as shown in Table 54.1, shows the five-level PM Maturity model is well accepted (Shibao 2008). Each of them is very sophisticated as a process maturity model, however only the model developed by Nakamura et al. shown in Table 54.1 considers organization's performance. The model was defined considering organization's performance with specific criteria on project outcomes based on earlier works and practical problems found in real projects and organizations. Thus, this five-level project management maturity model is applied to assess PM Maturity in this paper. Interviewees select their own level by considering performance and project management process according to the descriptions in that model shown below.

54.2.2 Strategic PMO Functions

Six strategic PMO functions listed in Table 54.2 which were defined by Toney (Toney 2002) and well accepted by the industry are assessed in this research.

54.2.3 Execution Level

Each PMO function is mainly evaluated by its mere existence, though there is a research that evaluates PMO in relation to environmental factors and the type of PMO staffing based on the level of engagement (Dai and Wells 2004). Then there is a missing link between which PMO function is critical and how it should be implemented and executed. How PMO functions should be executed is quite important in a practical sense, as organizations which are acknowledge PMO's contribution to their performance, need to understand how to improve the PMO. It is introduced that there are some PMO functions, which don't work effectively (Hatfield 2008). This indicates that the existence of the PMO functions themselves does not guarantee their performance. This confirms that it is important for each PMO function to not just have specification, but perform properly. Some PMOs are not able to provide enough services as expected for many reasons, such as the level of engagement by PMO staffs (Dai and Wells 2004). It is found through the interviews that some functions are planned and performed once but those are never

Table 54.1 PM maturity models

Level	Project management maturity model				P3M3
	Ibbs and Kwak (process based)	Kerzner (process based)	Nakamura, Seki, Osada (processes and performance based)	PMCC (process based)	OGC (process based)
5	Sustained	Continuous Improvement	Optimised	Optimised	Optimised process
4	Integrated	Benchmarking	Sustained	Integrated	Managed process
3	Managed	Singular methodology	Integrated	Scientific	Defined process
2	Planned	Common process	Defined and managed	Planed	Repeatable process
1	Ad-hoc	Common language	Initial	Adhoc	Initial process

Table 54.2 Strategic PMO functions

Strategic PMO functions
Recruiting and developing project managers
Strategy alignment
Project selection and prioritaization
Resource assignment/management
Portfolio management
Program assessment

reviewed or followed, despite the fact that 50 % of PMOs express the importance of monitoring and controlling the performance of the PMO itself (Hobbs and Aubry 2007). This is a typical case of lacking an appropriate management process such as PDCA (Plan, Do, Check, Act) cycle defined by Deming (Walton 1986) that is widely accepted in the world as a methodology for improvement. This methodology has a track record of improving quality of Japanese products and proven to be effective in applying PDCA cycle on PMO function measurement in a recent empirical study (Nakamura et al. 2008). In this context, this paper newly defines the execution levels of PMO functions as below in consideration of PDCA cycle;

Execution Level of PMO Functions

Level 0: Did Not Exist/Executed without a well-considered plan resulting in a failure of performing its intended function

Level 1: Well-considered and executed based on the plan or Well-executed by continuously monitoring and optimizing.

These levels indicate how much each function is executed effectively based on the PDCA cycle.

54.3 Results and Discussions

The results of rating on PM Maturity and each function's execution level are shown in Table 54.3.

Authors applied Fisher's exact test to find the correlation between PM Maturity and each strategic function, because of the small sample size. As a result of statistical analysis, three functions with * on Table 54.4 (Strategy alignment, Project selection and prioritization, Resource assignment/management) have significant correlation with PM Maturity are extracted. Accordingly, these three functions are assumed as important strategic PMO functions to improve PM Maturity from quantitative point of view.

In order to provide a holistic view of the strategic PMO functions mentioned above, and validate the result of the above, this paper tries to analyze each function in detail through interviews from a qualitative point of view. The findings from interviews are as follows;

Table 54.3 PM maturity and execution levels of strategic PMO functions

Company	PM maturity	PM recruiting/ developing	Strategy alignment	Project ranking/ selection	Resource assignment/ management	Portfolio management	Program assessment
A	4	0	1	1	1	1	1
B	4	1	1	0	1	1	1
C	3	1	1	1	1	1	1
D	3	0	1	1	1	1	1
E	3	1	1	1	1	0	0
F	2	0	0	0	0	0	0
G	2	0	0	0	0	0	0
H	2	0	0	0	0	0	0
I	1	1	1	0	0	0	1
J	1	0	0	0	0	0	0
							n = 10

Table 54.4 Effective strategic PMO Functions for PM maturity

Strategic PMO functions	Significant difference
Recruiting and developing project managers	
Strategy alignment	*
Project selection and prioritization	*
Resource assignment/management	*
Portfolio management	
Program assessment	
	*p < 5 %

1. Recruiting and developing project managers

This function is measured by whether or not the PMO is directly involved in developing or recruiting project managers. A few PMOs have this function directly, on the other hand most PMOs coordinate project manager training which is provided by external consultants. In pharmaceutical companies, PMOs are expected to be a coordinator rather than a provider on this functionality, and the level of this function does not affect PM maturity. It is found through interviews that this function cannot be performed effectively because of the lack of direction. The organizations whose PM Maturity level is high maintain strategy alignment to help other functions work effectively such as company A-E. According to this fact, it is recognized that this function is not important for PM Maturity directly.

2. Strategy alignment

This function is evaluated based on whether the project execution is always aligned with the organization strategy. In the pharmaceutical industry, most PMOs are established with the expectation to run projects aligning to the organization's strategy which is formulated separately by a strategic planning section. All the companies that achieve high PM maturity understand the importance of having a clear alignment between the organization's strategy and projects' execution.

In order to achieve effective execution of PMO activities, it is essential to have these PMOs that have developed policy on how to execute projects according to the organization's strategy and maintain it with the support from the executives. Therefore, this function is recognized as very important for PM Maturity.

3. Project selection and prioritization

This function is evaluated based on whether or not the PMO supports the decision making of top management on project selection and prioritization according to the organization's strategy. Project selection and prioritization are key to manage resources which are not only human resources but also external costs, such as the CRO costs. This function should be based on capacity planning which should be done according to the organization's strategy. PMOs in highly mature companies manage cost in an aggressive manner and have easy access to the project's financial information. All the costs are typically controlled by line managers in Japanese pharmaceutical companies; therefore PMOs in some companies do not manage costs by projects. However it is crucial for the company to manage project costs since the project requires many kinds of costs across the organizations through multiple years. Accordingly, this function is important for PM maturity.

4. Resource assignment/management

This function is assessed based on whether or not the PMO plays a role in resource assignment or PM across the functional organizations. PMO's influence in resource assignment/management is independent from whether or not the PMO has a standardized process to exert authority: some companies are actively involved in resource assignment/management despite a lack of standardized process. Therefore, this is an important function for PM maturity.

5. Portfolio management

This function is evaluated based on whether or not PMOs can impact the portfolio management of the organization. All of the PMOs interviewed this time have the function to develop portfolio, although most of them just develop the charts and do not have any significant influences on the decision making or even support function for improvement of portfolio. PMOs of companies A-D actively participate in conjunction with the Strategy management and Resource assignment/management. Many of the portfolio management activities were done in functions such as strategy management and Resource assignment/management, while portfolio management merely acted as a provider of charts and other data. Thus, this function is recognized as a sort of sub-function rather than a core function to improve PM maturity.

6. Program assessment

Generally, in pharmaceutical companies, groups of therapeutic area are treated as programs. Therefore, this function is evaluated whether the PMO is involved in business assessment of each program or not. Four PMOs were taking a part to assess programs from project execution point of view, and it is very important for the top management to understand the current situation of projects to make right decisions, although it does not directly affect PM maturity as it is more like a support function for business decision making. Therefore, this function is not a key for PM maturity.

Based on the quantitative and qualitative analysis, the three functions which have significant differences are recognized to be important for PM Maturity. Accordingly, these four functions shown in Table 54.4 are extracted as effective PMO functions to improve PM Maturity in the Pharmaceutical industry.

54.4 Conclusion

This paper aims to find the important strategic PMO functions to improve PM Maturity and to contribute indirectly to organization performance. The research was performed with ten organizations in the pharmaceutical industry. In order to gather homogeneous data and detailed analysis on the situation, this paper applied statistical analysis and interviews using the PM Maturity model that considers organization's performance and the execution level, that was defined by considering the PDCA cycle, rather than mere specifications of PMO functions. In order to extract effective functions to improve PM Maturity, this paper applied Fisher's exact test to find significant correlation between PM Maturity and execution levels of strategic PMO functions. The small sample size remains a limitation of this research As a result, three strategic PMO functions in total are detected as important functions for PM Maturity with significant correlation shown in Table 54.4. The effectiveness of these three functions on PM Maturity was supported by detail analyses through interviews. Consequently, Strategy alignment, Project selection and prioritization, Resource assignment/management are extracted as important strategic PMO functions that affect to the PM Maturity. At the same time, this confirmed that strategic functions are important for PMO as many earlier work explained.

This research was limited by a small sample size consisting only of pharmaceutical companies; therefore further researches in other industries with larger samples are required to conclude the important strategic PMO functions to improve PM Maturity in multi-project environment. However, this research is expected to help organizations, especially managing multiple projects, which attempt to establish PMO or ensure the strategic function of PMO.

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Chapter 55
Quantitative Reliability Assessment of Safety Instrumented Systems with Diverse Redundancy

Kai Wang, Aidong Xu, Yan Song, Hong Wang and Jie Liu

Abstract Notions of redundancy and diversity are ubiquitous in the design of safety instrumented systems (SIS) which have demanding safety or reliability requirements. Whilst there is clear evidence that these approaches can bring benefits, these benefits can be difficult to quantify. Therefore, a novel method which can be used to quantify the effects of diverse redundancy on system reliability is proposed in this paper. The key idea is to model common cause failure (CCF) based on different categories of root causes and coupling factors. Further, the contribution of the CCF cause of each specific category to CCF probability in total has been considered. The novel method proposed can be applied to the practical SIS design process when related CCF data and component reliability data is available. Finally, an example is given to illustrate the usage of the novel method proposed in practical reliability analysis.

Keywords Common cause failure · Diverse redundancy · Reliability assessment · Safety instrumented systems

K. Wang (✉) · A. Xu · Y. Song · H. Wang · J. Liu
Key Laboratory of Industrial Informatics, Shenyang Institute of Automation, Chinese Academy of Sciences, Shenyang, China
e-mail: wangkai@sia.cn

A. Xu
e-mail: xad@sia.cn

Y. Song
e-mail: songyan@sia.cn

H. Wang
e-mail: wang@sia.cn

J. Liu
e-mail: jjiiee1970@163.com

Y. Song · J. Liu
The Graduate School of the Chinese Academy of Sciences, Beijing, China

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55.1 Introduction

Safety Instrumented systems (SIS) are used in the oil and gas industry to detect the onset of hazardous events and/or to mitigate their consequences to humans, material assets, and the environment (Lundteigen and Rausand 2007). The international standards IEC 61508 (International Electrotechnical Commission 2010) and IEC 61511 (International Electrotechnical Commission 2003) have provided guidelines for the design, installation, operation, maintenance and testing of SIS. Both standards are performance-based and safety integrity level (SIL) is used as a measure of SIS reliability. It is a trend in the future to assess SIS reliability quantitatively and calculate the SIL in the design process of SIS.

Redundancy is often introduced in the SIS architecture to enhance system reliability. However, Common Cause Failure (CCF) is a serious threat to SIS reliability and may lead to simultaneous failures of redundant components and safety barriers. IEC 61511 defines a CCF as a failure which is the result of one or more events, causing failures of two or more separate channels in a multiple channel system, leading to a system failure. A natural component of the study of CCF is the study of diversity. As early as 1970, diversity was identified as an effective antidote for CCF (Jacobs 1970). The rationale for diversity is that different designs will have different failure modes and will not be susceptible to the same common influences. While there is clear evidence that diversity can bring benefits in a redundant system, these benefits are extremely difficult to assess. The conventional notion of diversity relies on "independent" generation of "different" implementations. This concept is qualitative and does not provide a basis for comparing the reliabilities of two diverse systems. In Bukowski and Goble (2001), the validation of diversity to enhance system reliability has been verified based on a stress-strength failure model and Monte Carlo simulations. However, how to quantify the effects of diversity on system reliability was not proposed. A metric to quantify diversity among several designs is proposed in Mitra et al. (2002). However, the prerequisite to applying the metric to calculate diversity is that the distribution of fault pairs of redundant components has to be known in advance. Therefore, the metric proposed is difficult to be applied in the practical design process. In Torres-Echeverria et al. (2009), a diversity index was proposed to quantify diversity. The diversity index is mainly determined by the number of different technologies used per subsystems. Although the diversity index is simple enough to be applied in the practical design process, the actual coupling extent between redundant components can't be quantified accurately. Therefore, this diversity index can't describe diversity precisely. The process for using the Diversity Criterion Effectiveness (DCE) weights and the Diversity Attribute Effectiveness (DAE) weights to quantitatively evaluate the diversity strategies obtained from the sources of the nuclear power industry and non-nuclear industry is proposed in Wood and Belles(2010). However, the algorithm to determine the DCE and DAE weights was based on the engineering experience in nature and thus the method proposed also can't describe diversity accurately.

Many authors find it useful to split CCF causes into root causes and coupling factors. A root cause (RC) is the basic reason why components fail (e.g., a harsh environment), while a coupling factor (CF) is a characteristic of a group of components or piece-parts that identifies them as susceptible to the same causal mechanisms of failure (e.g., similarity in design, location, environment, mission, operation, maintenance, and test procedures). Much work (Rutledge and Mosleh 1995; Idaho National Laboratory 2007; Nuclear Energy Agency Committee on the Safety of Nuclear Installations 2004; Nuclear Energy Agency Committee on the Safety of Nuclear Installations 2008) has been done involving the RC classification and related data collection recently. As CCF event data collected increased, research of CCF based on RC and CF has prospective advantages. Therefore, a novel method which studies CCF from RC and CF point of view is proposed in this paper. The key idea of the novel method is to map diversity into CFs and then study the relationship between system CCF probability and diversity. The novel method classifies the RCs into categories and then assesses the corresponding CFs between redundant components respectively based characteristics of diversity. Weight factors are introduced to represent the contribution of the CCF cause of each specific category to CCF probability in total according to CCF event data collected. Finally, an example is given to illustrate the usage of the novel method proposed in practical reliability analysis.

This paper is structured as follows. In Sect. 55.2, CCF analysis is performed from the RC and CF point of view and then a novel method is proposed to assess reliability of SIS with diverse redundancy quantitatively. An example is given to illustrate the usage of the novel method in Sect. 55.3. Finally Sect. 55.4 concludes the paper.

55.2 A Novel Method for Reliability Assessment of Sis with Diverse Redundancy

55.2.1 CCF Analysis from RCs and CFs Point of View

As shown in Fig. 55.1, the main attributes of CCF causes can be summed up that a shared cause exists, which comprises two elements: a RC and a CF:

- RC: An event or mechanism to which the change in the state of a component can be attributed. The root cause is the basic reason why components fail.
- CF: A mechanism or factor that create the condition for multiple components to be affected by the same root cause.

CCF causes may be introduced at any stage of the SIS life cycle. We may distinguish between pre-operational causes and operational causes:

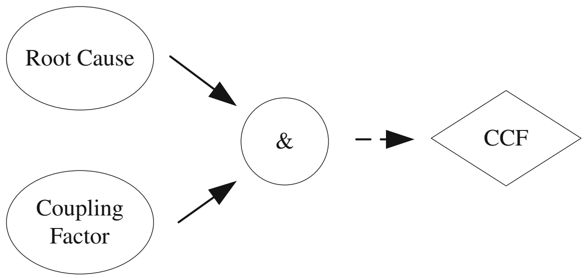

Fig. 55.1 CCF analysis from the viewpoint of RC and CF

- Pre-operational causes: design, manufacturing, construction, installation and commissioning errors.
- Operational causes:
  - operation and maintenance related: Inadequate maintenance and operation procedures, execution, competence and scheduling;
  - Environmental related: internal or external stress/exposure outside the design envelope.

As shown in Fig. 55.2, these CCF causes were split into RCs and CFs respectively and how they contribute to the occurring of a CCF event was illustrated. The explanations of each RC category, which lies inside the ring in Fig. 55.2, are as follows.

- Design/Construction/Manufacture Inadequacy: Encompasses actions and decisions taken during design, manufacture, or installation of components both before and after the plant is operational.
- External Environment: Represents causes related to a harsh external environment that is not within component design specifications. Specific mechanisms include electromagnetic interference, fire/smoke, impact loads, moisture (sprays, floods, etc.), radiation, abnormally high or low temperature, and acts of nature.
- Operations/Human Error (Plant Staff Error): Represents causes related to errors of omission and commission on the part of plant staff.

Each RC category corresponds to a specific CF category, which lies inside the edge of the ring, as shown in Fig. 55.2. The explanations of each CF category are as follows.

- Design/Construction/Manufacture based: Refers to the same design staff, manufacturing staff, quality control procedure, manufacturing method, construction/installation staff, and construction/installation procedure.
- External Environment based: Refers to all redundant systems/components exposed to the same external environmental stresses.
- Operations/Human based: Refers to the cases when operation of all (functionally or physically) identical components is governed by the same operating procedures.

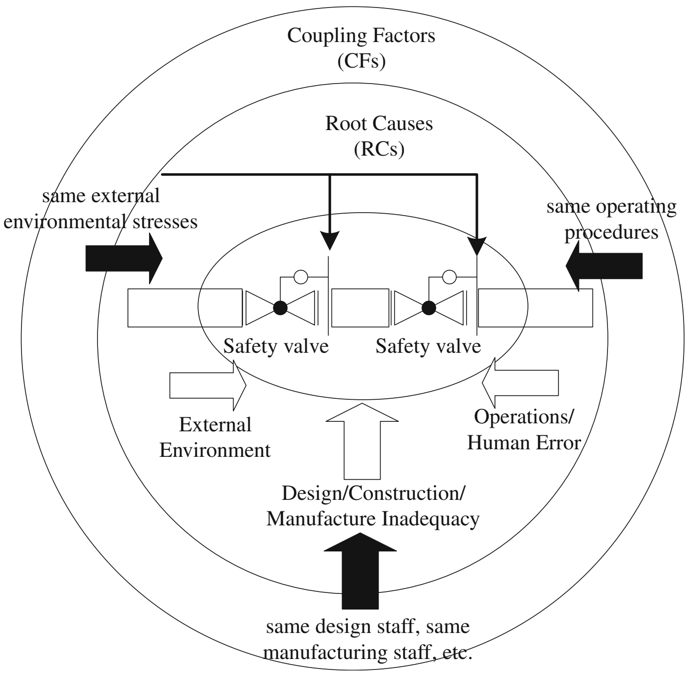

Fig. 55.2 Categories for RCs and CFs

In practice, CCFs usually result from more than one CCF cause (RC and CF). When diversity is applied in redundant systems, more than one CF changes simultaneously. For instance, chances of identical design errors may be minimized if two different groups of designers are asked to independently design a hardware block or a software module. At the same time, these different implementations will have different environmental performance parameters, for example, they will have different working range of temperature, humidity, and so on. Therefore, the CFs of the two categories, namely Design/Construction/Manufacture based and External Environment based, change simultaneously. It is the reason why diverse redundancy system reliability is difficult to assess.

55.2.2 A Novel Method to Assess Reliability of Sis with Diverse Redundancy

Since diversity affects more than one CFs simultaneously in practice, it is advisable to classify the RCs into categories and then assess the corresponding CFs between redundant components respectively based on the characteristics of diversity. In practice, RCs can be classified into categories, each of which can be further divided into sub categories, as long as failure reports can provide enough information. The relationship between CCF Probability and diversity can be researched through the related CFs. Consequently, a novel CCF model is proposed as follows.

$$prob.of\ \ CCF = \sum_{i=1}^{n} n \times w_i \times (prob.of\ \ RC_i) \times CF_i \tag{55.1}$$

Where,

n is the number of RC categories which are considered in CCF analysis
RC_i represents a specific category of RC, such as Design/Construction/Manufacture, External Environment, and so on
CF_i represents the corresponding CF of the RC_i
w_i represents the weight value of the RC_i which contributes to the CCF probability in total. The range of w_i is [0.0−1.0] and the following constraint has to be satisfied:

$$\sum_{i=1}^{n} \omega_i = 1 \tag{55.2}$$

55.3 An Example and Assessement

55.3.1 Assumptions

As shown in Fig. 55.3, assume that the system to be analyzed is composed of two independent channels. The success criterion requires one or more functioning trains. The top event is expressed by the following logic:

$$Top = (A \vee C) \wedge (B \vee D) \tag{55.3}$$

It should be noted that common causes are considered only for groups of valves in this paper. Common causes between controllers can be dealt with similarly. Therefore, we have Common Cause Component Group (CCCG) = {A, B}. To study the effects of diversity on system CCF probability, CCF analysis is performed respectively in 5 different cases in total, which are described in detail in

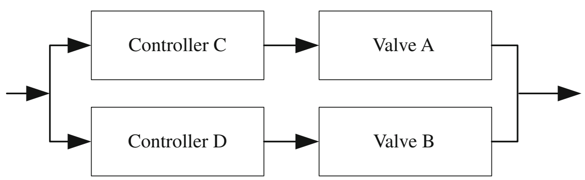

Fig. 55.3 The duplex system to be assessed

Table 55.1 Description of different redundancy types

Case	Type	Descriptions
1	Identical redundancy (IR)	Both of valve A and valve B are electric valves, and manufactured by the same company
2	Diverse redundancy (DR) (same technology, different manufacturer)	Both of valve A and valve B are electric valves, and manufactured by the different company
3	Diverse redundancy (DR) (same technology, different manufacturer)	Both of valve A and valve B are electric valves, and manufactured by the different company
4	Diverse redundancy (DR) (different technology)	Valve A is an electric valve, valve B is a pneumatic valve
5	Diverse redundancy (DR) (different technology)	Valve A is an electric valve, valve B is a pneumatic valve

Table 55.1. As far as CCF cause categories are concerned, "Design/Construction/Manufacture Inadequacy" category and "External Environment" category are considered here. Therefore, the Eq. (55.1) becomes,

$$prob.\ of\ CCF = 2 \times w_1 \times (prob.\ of\ RC_1) \times CF_1 + 2 \times w_2 \times (prob.\ of\ RC_2) \times CF_2 \tag{55.4}$$

where, RC_1 and CF_1 correspond to the "Design/Construction/Manufacture Inadequacy" category, while RC_2 and CF_2 correspond to "External Environment" category.

w_1 and w_2 represent the weight values of these two categories to the system CCF probability in total, respectively.

According to the distribution of CCF event by RC category in the related CCF event database (Idaho National Engineering and Environmental Laboratory 2003; Nuclear Energy Agency 2002), the percent of RC_1 category is much greater than RC_2 category. Therefore, it is reasonable to assume that w_1 equals to be 0.7 and w_2 equals to be 0.3.

As far as the RC_2 and CF_2 are concerned, probability values are determined based on the stress-strength failure model(Brombacher 1992). According to the stress-strength view of reliability, failures occur when stress is greater than strength. Further, assume that all the stochastic variables representing the environmental stress and component strength conform to Normal distribution. Obviously, not all stochastic variables of stress and strength will exhibit such statistical characteristics, but it is likely that many types of variables of stress and strength will. Further, note that the method proposed in this paper does not depend on variables of stress and strength being Normal distribution. Descriptions of names of stochastic variables are listed in Table 55.2 and their Mean and Variance parameters are shown in Table 55.3.

Table 55.2 Description of names of stochastic variables

Stochastic variable name	Description
X	Environmental stress
X_A	Valve A strength
X_B	Valve B strength

Table 55.3 Means and variables of stochastic variables

	X_A	X_B	X
Case (1)	+2.3, 2	2.3, 2	0, 1
Case (2)		3.3↑, 1.7	
Case (3)		1.1↓, 2.5	
Case (4)		3↑, 1.8	
Case (5)		1.2↓, 4	

55.3.2 Calculation of RC Probability

- Calculation of RC_1 probability

Only design errors are considered here. Therefore, to achieve a conservative result, RC_1 is defined as follows,

$$RC_1 = \text{Max}\ \{\text{Prob. of failure due to design errors of Valve A},\ \text{Prob. of failure due to design errors of Valve B}\} \tag{55.5}$$

Actual RC_1 probability can be determined by the related component reliability data base. Probability of Failure due to Design Errors (PFDE) of Valve A and Valve B in this paper and final RC_1 probability is shown in Table 55.4. Note that since this example is just to illustrate the RC probability calculation method, the probabilities in the second and third rows are hypothesized according to related reliability data base.

- Calculation of RC_2 probability

Firstly, assume the Harsh Environment Critical Point (HECP) to be 0.53. In practice the HECP can be determined by analyzing the related component reliability database. When the Environmental Stress value exceeds HECP, consider that a harsh environment happens. Consequently, RC_2 probability is defined as follows.

$$prob.\ of\ RC_2 = P(X > Xha) \tag{55.6}$$

Where,

X represents the stress random variable,

Xha represents the value of HECP

Table 55.4 Calculation of Rc_1 probability in different cases

	PFDE of valve A	PFDE of valve B	RC1 probability
Case (1)	0.025	0.025	0.025
Case (2)		0.018	0.025
Case (3)		0.043	0.043
Case (4)		0.021	0.025
Case (5)		0.035	0.035

Since the two redundant components are exposed to the same environment, it is reasonable to assume that of RC_2 probability is constant in all 5 Cases. According to the Standard Normal Distribution Function Table and Probability Theory, RC_2 probability can be achieved based on Eq. (55.6).

55.3.3 Calculation of the CF Value

- Calculation of CF_1 value

In Case (1), since the two redundant valves are identical, specify CF_1 to be unity. In Case (2) and Case (3), since both Valve A and Valve B are electric and the difference is only lies in that they are manufactured by different companies, specify CF_1 to be 0.8. In Case (4) and Case (5), since Valve A is an electric valve while Valve B is a pneumatic valve, there is off chance that they have the same design errors. Therefore, specify CF_1 to be zero.

- Calculation of CF_2 value

According to the stress-strength failure model, failures occur when environmental stress is greater than component strength. Further, a CCF occurs in redundant systems when the environmental stress is greater than the strength of two or more components. Therefore, define CF_i corresponding to RC_i as follows.

$$CF_i = \prod_{j=1}^{n} P(CS_j < CP_i) \tag{55.7}$$

Where,

CS_j refers to the jth Component strength,
CP_i refers to the Harsh Environment Critical Point which corresponds to RC_i
n refers to the number of the redundant components in the system

According to the Standard Normal Distribution Function Table and Probability Theory, the value of CF_2 can be achieved in all 5 cases based on Eq. (55.7).

Table 55.5 System CCF probability in different cases

Case (1) (IR)	0.0414
Case (2) (DR)	0.02975↓
Case (3) (DR)	0.06196↑
Case (4) (DR)	0.0023↓
Case (5) (DR)	0.01465↓

55.3.4 Calculation of System CCF Probability and Discussion

According to the related items calculated above, the system CCF probability can be calculated based on Eq. (55.4) and the final results are shown in Table 55.5. As shown in Table 55.5, the system CCF probability is not necessarily decreased when diversity is applied. For example, the CCF probability is actually increased in Case (3). The reasons can be illustrated as follows. According to Eq. (55.1), the CCF probability equals the sum of several items, each of which corresponds to one certain RC category. In particular, each item has different weighted value which contributes to the CCF probability in total. Therefore, the important thing is to determine which item is the dominated one. As far as the example in this paper is concerned, the dominated one is the item related to "Design/Construction/Manufacture Inadequacy" category due to w_1 is greater than w_2. As far as Cases (4) and (5) are concerned, since Valve B is designed based on the different technology from Valve A, which minimizes the contribution of CCF cause "Design/Construction/Manufacture Inadequacy" category to CCF probability in total, the system CCF probability is greatly decreased whether the strength of Valve B is greater than Valve A or not. While, in Case (3), since the diversity between Valve B and Valve A is "the same technology and the different manufacturers", which does not notably decreases the contribution of CCF cause "Design/Construction/Manufacture Inadequacy" category to CCF probability, the system CCF increased due to the strength of Valve B is less than the one of Valve A.

55.4 Conclusions and Prospects

Recently, RC and CF classification and related data collection have been performing in related domains, such as nuclear power industry, spacecraft, and so on. Therefore, the method proposed in this paper has good applying prospective in the future. As more CCF event information is collected, it is possible to quantify the effects of diversity in practical design process of SIS with diverse redundancy. Next work is to apply the reliability data available to the model proposed to study the relationship between CCF probability and diversity. In addition, as far as "external environment" CCF cause category is concerned, another work in the future is to develop mapping algorithms which can be used to determine the values of component strength, environmental stress, and HECP based on practical field reliability data collected.

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Chapter 56
Research on Influencing Factors Index System for Selecting a Project Delivery System

Fu-yan Zhou and Hong Ke

Abstract Whether a project can be successful or not, the selection of a proper Delivery System is one of the key factors. While the key of successfully selecting of a Delivery System is to build an influence factors index system for a specific Project Delivery System. This paper based on the definition of the range of Project Delivery Types, according to the project's specific features and characters of business, proposes a four-aspect system, including the project's own level, the project performance level, the owner and the contractor level and external environment level, which composed of the Project Delivery System Selected Influence factors index system. After the two rounds of index selection—frequency number statistic, expert scoring method, 4 level 19 influencing factors are finally selected to build the influencing factors index system, which can be a reference for selecting the Project Delivery System.

Keywords Expert scoring method · Frequency number statistic · Index system · The project delivery system

56.1 Introduction

In 2003, Ministry of Construction issued "On Fostering the Development of Engineering General Contract and Project Management Enterprises Guidance, This view from the viewpoint of contractors and construction market, prepares for the full application of multiple project Delivery Systems; in addition, in July 2004, the State

F. Zhou (✉) · H. Ke
School of Management, Tianjin University of Technology, Tianjin, China
e-mail: Zhou_fuyan@163.com

H. Ke
e-mail: 359191213@qq.com

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Council proposed in the “Decision on the Investment System Reform”, for non—commercial project invested by the Government to expedite the implementation agent system (Wang et al. 2008). That means through tendering and so on, selecting a professional project management unit to be responsible for construction and strictly controlling investment, quality and duration of the project, after completion certification is singed, it should be transferred to the used units. So multiple trading model of construction projects have been developing and applying in China.

Project transactions, internationally known as Project Delivery System, also known as Project Delivery Method or Project Delivery and Contract Strategy, China says it is the project management model (Wang and Jian 2006) or Project contracting model (Zhang and He 2003), Chen Yong-qiang Referred to as PDS (Chen et al. 2010), (This paper also referred to as PDS), it not only defines the roles and responsibilities of the parties, determines the payment for owners and allocation of risk between the parties, as well as provides a framework for the implementation of the project. To a large extent, it determines the project’s construction speed, cost, and quality and contract management approach. Construction projects have emerged in a variety of transactions in recent years, resulting in a mix of transactions, thereby for saving costs, improving project performance and how to properly select the appropriate item transactions have become a hot issue for the scholars concerning about; and it can be told from the success or failure of a growing number of project transactions, the transactions selected appropriate is one of the key factors determining the success or failure of a project (Oyetunji and Stuart 2006). Therefore, according to characteristics of the project itself, construction conditions, environmental factors and so on, how to establish a set of applied project delivery system and selection index system is the solution of the problem. First of all, this article reviews the existing literature at home and abroad and for carding, and points out the defects of the existing research; secondly, proposed the constructing framework for project delivery system selection index system; last but not least, to use frequency number statistic and to expert scoring method conducted the two rounds of index selection, on the basis of existing research to establish a simple, systematic, scientific project delivery system selection index system.

56.2 Related Literature Review

Considering the important impact of the PDS for the performance of the project, many domestic and foreign scholars have used the multi-case analysis and comparison of different project transactions method and so on to analyze the factors affecting the choice of PDS, which would provide a basis for it. The results are shown in Table 56.1.

From the table above, defects of current research mainly in the following two points: (1) different perspectives and differences in research methods make the different conclusion on the factors affecting the PDS, so the selected factors have limitations and can not be contained all project transactions. (2) Current study

Table 56.1 Related literature review

Author	Selection method	Influencing factors
Mafakheri et al. (2007).	Case analysis	Project scope, project cost, uniqueness, cultural, financial assurance, scope change, risk management, external license, etc
Luu et al. (2005)	Case analysis	Completed on time, the experience of the owners, engineering capabilities, market competition degree, material availability, technical performance, etc
Ling et al. (2004)	Comparison of different PDS	Unit cost, cost growth, the construction speed, delivery speed, quality of equipment, system quality, satisfaction of owners, management burden of owners, etc
Al Khalil et al. (2002)	Case analysis	Construction scale, value engineering, project duration, project complexity, the allocation of responsibilities, project price, the participation of owners, etc
Ng et al. (2002)	Case analysis	Project cost, project quality level, complexity, market competitiveness, the allocation of risks, responsibilities and political environment, etc
Chen et al. (2010)	Literature research	Cost, duration, quality, size, complexity, the owners 'participation, the owners' experience, etc
Chen et al. (2009)	Comparison of different PDS	Initial budget to complete the project is critical, project design is very complex, project construction is complex, owners' small financial risks, etc
Yang et al. (2007)	Induction	Project scale, project design depth, the ability of owners management, the owners of quality requirements, construction conditions, etc

makes those indicators so general and lack of systematic induction and summarized that would not form a more complete selection of impact factors indicator system for PDS, make people doubt the results of some indicators. In view of this, to establish a comprehensive and scientific index system for PDS is particularly important, and the current research provide a solid theoretical foundation for establishing the index system, which can be used as a source of the index selection.

56.3 Construction Framework of Index System for the PDS Select

56.3.1 Principles of Construction

To construct the indicator system should follow the following principles: (1) Comprehensiveness and representativeness. The indicator selection should reflect the whole properties of the object being evaluated, and the indicators should represent the different characteristics of the research object. This article through domestic and foreign related literature review analyzes the index to build a more comprehensive index system. (2) Avoid indicators being covered by each other; the interpretation of different indicators in the selection of PDS is prone to similarity or overlap. (3) Operability. If the constructed index is difficult to obtain relevant data in practice, then it will lose the meaning of build. Therefore, it is necessary to consider the operability of the indicators, when the index is built. And it should be expressed by quantitative approach. (4) Combination of qualitative and quantitative indicators. Qualitative and quantitative indicators should be combined in the design of index system, as complete as possible to serve for selecting a PDS.

56.3.2 Framework of Construction

In theory, an index system should accurately reflect the characteristics and the actual level of the object which it pointed, the contents of indicators should be able to fully include all the factors that could affect the pointed one. Because of the diversity of the PDS type, all kinds of factors should be considered when it affects the PDS select in variety of transaction mode, such as project their own characteristics, the characteristics of owners and contractors and the impact of the external environment, and from the paper of Hong et al. (2007) and Yang and Chen (2010) can be seen different projects transactions impact the performance of the project are different, and therefore can be used as one of the factors selected by the PDS. In view of this, for construction of a comprehensive, systematic, scientific index system for PDS select, this article defines the index system including the following levels: project's own level, project performance level, the owner and the contractor level and external environment level. Based on this the framework of the construction of PDS select index system, it is shown in Fig. 56.1.

Index composition of the Project performance level

Project performance level index is mainly from duration, quality and cost, security, contract business and so on, but due to security, contract business etc., it is not easy to do quantitative calculation. Based on this, this paper mainly considers indicators of duration class, cost class and quality class. (1) Duration class index: refers to the requirements to project duration, including requirements for controlling duration extension rate and shorten duration, duration certainty, etc. (2) Cost class index: refers to the requirements to project cost, including cost control rate, cost certainty requirements, etc. (3) Quality class index: refers to the requirements to project quality, including quality assurance and quality level requirements, etc.

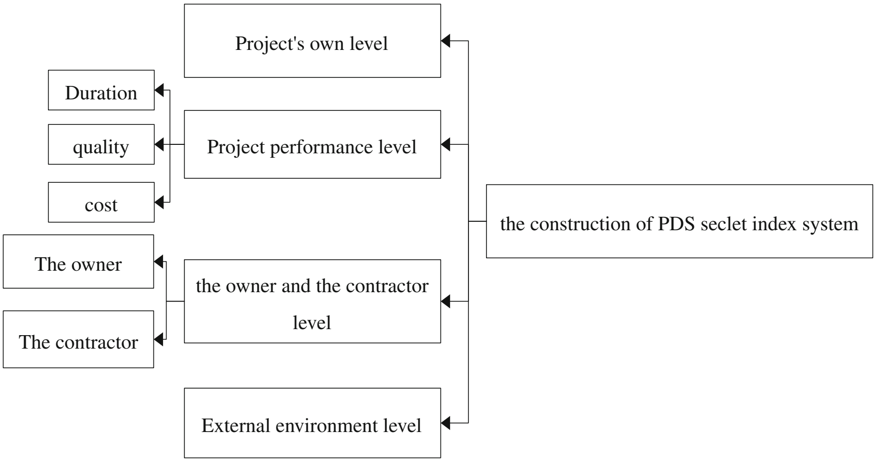

Fig. 56.1 Index system building framework diagram

Index composition of the owner and the contractor level

Due to the contractual relationship between the owner and contractor, this article will put them together as PDS select level of impact factor indicators. This indicator mainly comes from the experience of the owners, owners of the composition, participation and management capabilities of the owners, the experience of the contractor, the contractor's management and professional technical capacity, both sides are willing to take risks and the degree of confidence between the parties. For example, if the contractor has better management and technical expertise (e.g., design ability), project experienced, the owners may consider the entire project implementation by the contractor in EPC, etc. Or, the owners may commission design units involved in the project.

Index composition of the External environment level

On the process of selection PDS, there are various external factors of uncertainty. It is the main objective reason resulted in the selection of accuracy. The greater uncertainty, the higher the transaction costs. Therefore, during choosing PDS, the influence of external environment has become one of the factors that must be taken into account. The source of this level indicators include the three aspects: (1) the market. Including price competition, the choice of contractors, material availability, etc. (2) Government issued a series of related policies. Including legal implications, political influence, etc. (3) From the construction site conditions. Including site conditions may lead to changes in design or construction, the terms of the contract and claims, etc.

56.4 Construction of Index System for the PDS Select

56.4.1 The Methodology of Construction

In order to make the construction of index system simple and clear, author intends to make the index system divided into three levels, from the highest to the lowest are: comprehensive index, synthesis index and individual index. Among them, comprehensive index reflects PDS select type, synthesis index reflect the above classification four levels of indicators of the impact of PDS selected, individual index reflects under all levels affect the PDS selected specific targets, by these indicators constitute a synthesis index. Therefore, the establishment of index system firstly from the individual indicators, step by step improve the index system.

On the basis of explicitly constructing the index system, with comprehensiveness, representative, scientific and operational as principles, with determined four levels of influence factors as direction, source of individual index include the following three main areas: (1) Main sources: selected from the existing literature of PDS select frequently used indexes; (2) Important sources: from the main impact objective performance indicators; (3) Reference source: some relevant indicators used by scholars and experts or institutions in PDS select. Then to use frequency statistic method (Chen et al. 2004) do theory primary to PDS select index from the three sources of the indicators, to choose the higher frequency index as a primary design indicators, and on the basis of this use expert scoring method to filter out the consensus of experts, high evaluation of PDS selected indicators.

56.4.2 Primary Election of Individual Indicators

Through the present recourses and PDS selection practice to get the original indicators, and similar or related indicators are classified based on indicators of the impact factor range and frequency statistics principle, and in accordance with the above PDS Index System principles, do frequency statistics on three sources indicators, get primary indicators, as shown in Table 56.2.

56.4.3 Screening Index by Expert Scoring Method

In order to make each indicator bring as much information as possible, according to the index is representative and the quantity is more streamlined, in the primaries of the indicators, a second expert scoring method screening. Author used Likert five—level scale for questionnaire design.

Table 56.2 Primary indicator collection

Level indicators	Specific indicators(58)
The project's own level (15)	Project size, project type, project function, appearance of the building, project scope, project complexity, the price of the contract, project financial assurance, completion time deterministic, project profiles, project amount, project location, allows to change degree, engineering disputes, the depth of the project design
The project performance level (23)	Cost changes rate, duration of the programme completed, completed on time, completed within the budget, unit cost, growth and strength of cost, speed of construction, the cost of each stage, schedule delays, turnover quality, system quality, equipment quality, construction speed, duration certainty, cost certainty, duration of the work, all stages of the duration, speed of delivery, duration extension rate, design quality, process quality, quality of materials, engineering quality level
The owner and the contractor level (14)	Contractor responsibility on its own, similar project experience of contractor, experience of owners, the allocation of responsibilities, available staff of owners, the risk of the owners, owners' participation after contract awarded, trust, owner participation, the owners satisfaction, the burden of owners to manage, design control, risk allocation, the contractor's ability
The external environment level (6)	Laws and regulations affecting, choice of contractors, external licenses, market competitiveness, economic environment, the construction site conditions

Questionnaire design

It requires every expert make choice that which degree the index selection effects on PDS, according their own theoretical research and practical experience. To make questionnaire designed by Five—point scale distributed to relevant experts, let them score under every property index according to the given criteria. (5) shows the indicator have great impact on PDS select; (4) shows impact general; (3) shows impact small; (2) shows impact minimal; (1) shows no impact.

Expert selection

In order to make effective research on the PDS selected, through releasing to three types of expert questionnaire for scoring. Firstly, 15 questionnaires to theory experts on the PDS select. Their selection is mainly based on the published literature search sort determines the number of 15 experts, the actual resumption of 9, the recovery rate is 60 %. Secondly,25 questionnaires were issued to the staff of the project management consulting firms, actual resumption of 12, the recovery rate is 48 %. Thirdly, 20 questionnaires were issued to the cost engineers who work experience more than 5 years, actual resumption of 10, the recovery rate is 50 %. The author issued a total of 60 questionnaires to recover 31, 31 valid

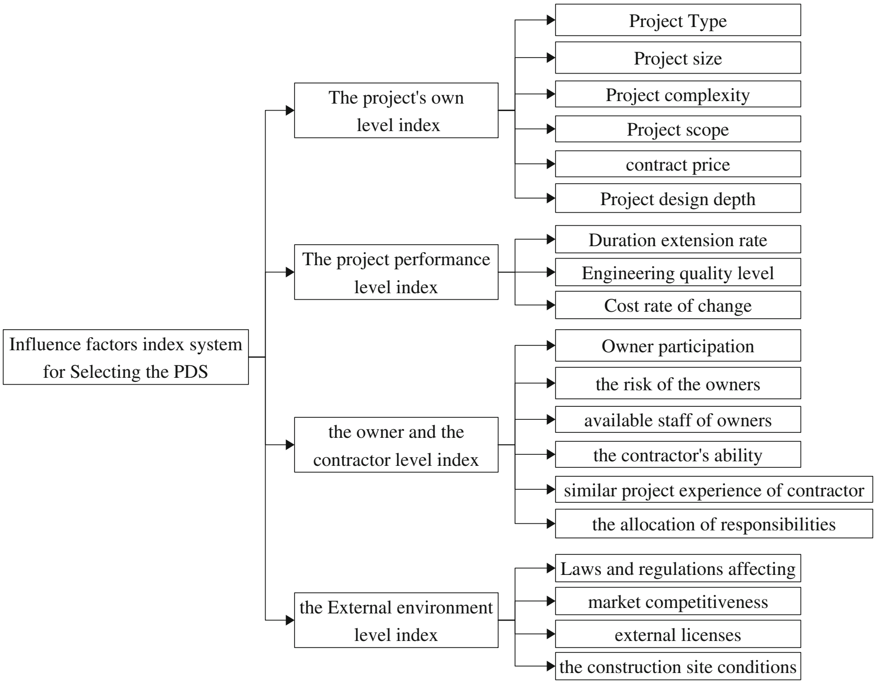

Fig. 56.2 Index system for the PDS select

questionnaires, the recovery rate is 51.67 %, the questionnaire 100 % efficient. To the questionnaires recovered, in the context of each index properties, related expert judgment scoring summary, we should calculate the average score for each indicator, and then do theory and practice analysis of index score, selecting higher score value and widest coverage index is provided, get filtered indexes.

56.4.4 The Construction of Index System

From the primaries index to the screened index, finally determines the set of individual indicators, according to the division level of the indicators to build the PDS selection index system shown in Fig. 56.2.

56.5 Conclusion

As project management spreads widely in China, there are also a wide variety PDS, and the PDS has a great impact on project final performance, so as to get more and more attention. This paper is mainly to analyze the PDS choose influence factors, built a simplified and practical index system for the PDS select. However, how to combine the index system to use the scientific selection method to choose the PDS is also worthy of further study. In addition, the PDS index system is still at the exploratory stage. It is uncommon to be found the reference research results at home and abroad, so the index system built in this paper is just a theoretical exploration, the applicability of it needs to be tested by the empirical data in the application process and continue to be improved.

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Chapter 57
Research on Synergy Management Thought-Based Engineering Project Management Model

Jing-wen An, Xiao-chuan Wang and Zhi-qiang Zhang

Abstract Application of synergy management thought to engineering project management is increasingly paid much attention to. For this, a engineering project management model is proposed with synergy optimization of multiple goals as orientation and synergy management of whole process of project as carrier based on synergy management of information, in which parties, as main body of synergy act upon the whole process integrating increasingly complex development trend of modern engineering project based on analysis on drawbacks of traditional project engineering management model and adaption of engineering project with external environment is emphasized.

Keywords Engineering project · Management model · Synergy management

57.1 Introduction

Research on engineering project management model, in fact, is exploration on adopted management principles, methods or means in the process of entire-life cycle of engineering project and the only way of improving engineering project management level and promoting development of modern project management theory. With the constant expanding of modern engineering project scale, increasing increase of complexibility of required technology and more and more uncertainties of external environment, drawbacks of traditional engineering project management model appear gradually. Therefore, a new management model and technical means is needed urgently to meet and adapt the need of increasing complexibility of modern engineering project. Synergy management thought

J. An · X. Wang (✉) · Z. Zhang
School of Management, China University of Mining and Technology (Beijing), Beijing, China
e-mail: wangxiaochuan5852@163.com

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provides some new theory for this and combination of synergy management thought with project management theory contributes to solving the problems arising out of modern engineering project management, improving efficiency of engineering project management and achieves overall goals of project.

Synergy concept was first proposed by famous strategic management expert, Ansoff, in his book Corporate Strategy in 1965. He pointed out that effect that overall benefits of company are far beyond sum of independent elements is called "synergy" and often described as "$1 + 1 > 2$" (Cheng et al. 2003), and then, a German physicist, Herman hawking, systematically explained synergy theory and published works including Introduction to Synergetics, etc. in 1976 (Eddie et al. 2002). Synergy management thought emphasizes to make a new structure of time, space and function by synergy recombination of time, space and function structure on intra-system elements and sub-systems (Wu 2006). What's more, the size of synergy effect made by system mainly depends on properties of elements and sub-systems, mode of action among them and environment of system. Therefore, the paper will discuss research on synergy thought-based engineering project management model. Firstly we think of engineering project as a complex system and promote the synergy management of elements of engineering project system including information, goals, parties, whole process, etc. by research on existing synergy phenomenon and characteristics in the process of entire-life cycle of engineering project, strengthen and guide interrelation and mode of action among elements, pay attention to synergetic adaption of engineering project system with external environment and finally make engineering project from unordered to ordered one and project implemented successfully.

57.2 Analysis for Drawbacks of Traditional Engineering Project Management Model

Traditional engineering project management model exposes more and more drawbacks mainly including the following, facing increasing complex development trend of modern engineering project.

1. *Backward information management is easy to make "information isolated island"*. Traditional engineering project management model is lack of overall consideration and unified standard on information management under which the same information is collected and managed multiply. Parties usually communicate incomplete information mutually starting with their interests, which is easy to make "information isolated island" and cause demanders to spend a large amount of time and expenses to collect, analyze and process information, which reduces efficiency and also increases costs. According to the statistics, 10–33 % costs increase of engineering project is in connection with information communication, while engineering change and mistakes caused by information communication accounts for total costs of engineering around 3–5 % in the large and medium engineering project (Beasley et al. 1993).

2. *Excessive pursuit of some goal of engineering project impairs other goals*. Increasing complex modern engineering project decides that goal system also consists of multiple integrated sub-goals mainly including construction period, costs, quality, resources, satisfaction of parties, etc. Traditional engineering project management model usually emphasizes some sub-goal but neglect synergy optimization among them, which will impair other goals and lower synergy degree of goal system. Although its research and development are pretty mature in the aspect of progress control, budget, quality control, contract management, etc., traditional engineering project management model can't make overall efficiency and effect of engineering project improved because of lacking synergy thought of overall optimization and dynamic management of goal system. In the meantime, with the change of environment, goals of engineering project will also change.
3. *Inconsistent interests of parties are easy to make opposite attitude*. That traditional engineering project management model divide project task into different phases and its responsibility is assumed by different enterprises cause inconsistent goal and discrete responsibility. Inconsistent interests of project parties are easy to make opposite attitude. Especially, opposite attitude between contractor and owner will cause delay of construction period and expenses increase directly and is easier to cause a claim when engineering project changes. Industrial crisis including unguaranteed construction period, cost overrun, owner's un-satisfaction on project, etc. experienced by construction industry in the developed country at the beginning of 1990s is just because opposite attitude among parties cause dispute increase in the process of developing project and finally cause delay of construction period and costs increase (Chang 2002).
4. *Phase division and division of labor based on specification of whole process of engineering project*. Whole process of traditional engineering project has the obvious characteristics of phase, and is implemented by different contractors in accordance with division of labor based on specification, which makes lack of synergy between upstream and downstream phase and management lack of continuity. In the meantime, the characteristics of phase make final benefit link reduced, discourage enthusiasm of each aspect and make owner assume more project risks. According to the statistics, 30 % of project cost loss can be attributive to dis-synergized whole process of project management. Phases and sub-processes of entire-life cycle of project must break through the boundary of activity time and content and combine into a whole organically.
5. *Neglecting synergy of engineering project with environment and lacking sustainable development*. Consideration of traditional engineering project management model on environmental factors is insufficient. No consideration on whether engineering project will pollute ecological environment and how degree of pollution is, whether engineering project will integrate with local social culture and manners and customs and whether engineering project is consistent with social and economic development further intensifies environmental uncertainties and risk of project. According to the statistics, more than 95 % of large-scale dam and hydropower project participated by global 68 countries in

China suffer huge controversy and is demonstrated and protested by local residents and faced with the crisis of shelving and loss because of neglecting environmental responsibilities.

Above all, modern engineering project has sufficient domestic demand for synergy, whose demand for information synergy management, synergy management of multiple goals, parties' synergy management, synergy management of whole process and external environmental synergy is more and more large. Therefore, ability of synergy management will become the key factor of successful modern engineering project.

57.3 Conceptual Model of Synergy Management Thought-Based Engineering Project Management Model

The paper points out that any engineering project can be regarded as a compound system which consists of information, multiple goals, parties, whole process integrating main drawbacks of aforesaid traditional engineering project management model based on synergy management thought. Interrelation and mode of action among elements is as shown Fig. 57.1. Therefore, synergy management thought-based engineering project management model should be established based on information synergy management with results of synergy optimization of multiple goals as orientation and synergy of whole process of engineering project as carrier where parties is regarded as main body of synergy to act upon whole process and four elements cooperate with each other synergistically and also pay much attention to synergetic adaption of it with external environment, make synergy of it with environment constantly, lower outside restraint gradually, utilize resources reasonably and then enhance the overall function and efficiency of engineering project. Above all, establishment of conceptual model of synergy management thought-based engineering project management model is as shown Fig. 57.2.

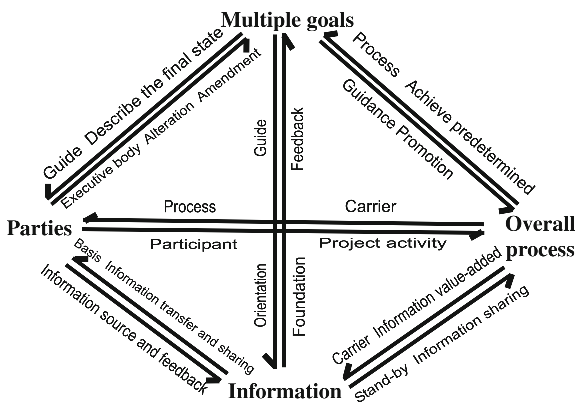

Fig. 57.1 The interrelation among elements of engineering project system

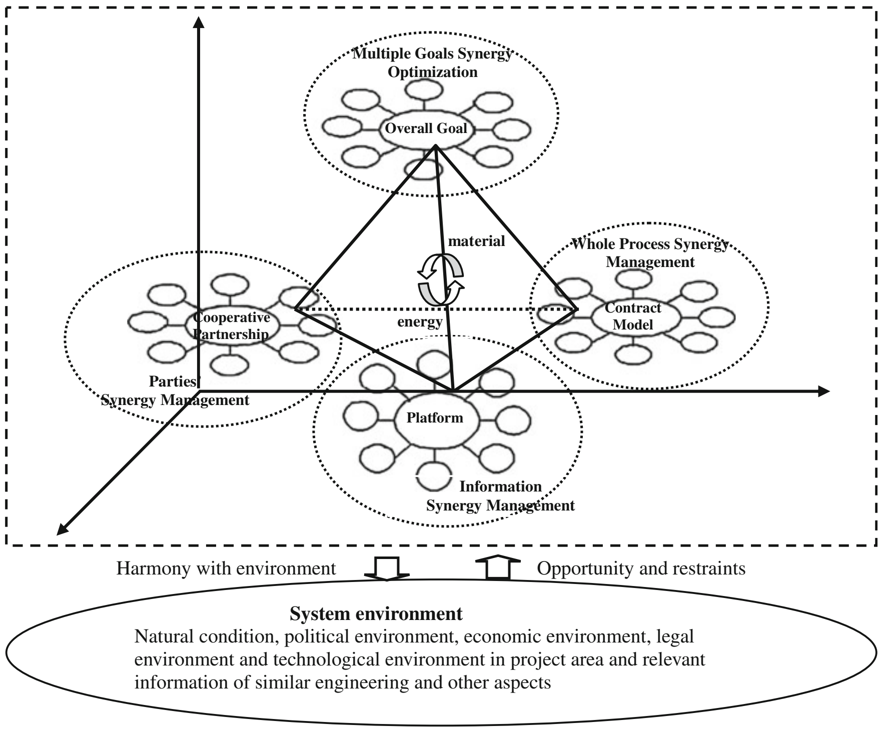

Fig. 57.2 Conceptual model of synergy management thought-based engineering project manage model

57.3.1 Synergy Management of Engineering Project Information

Information standardization is the fundamental way of achieving information synergy management. Owner of engineering project as maker and requester of information standardization code of project overall project management more contributes to promotion and implementation of information standard. Owner can also request parties to use the same project management software or the same information management platform to be convenient for information synergy management in according to the specific circumstances of project. Information synergy management platform relies on mature domestic and foreign information platform technology to make whole process of engineering project unified in an information management platform for development by setting reasonable organization structure and working process. Data and information of project management is collected, classified and centralized to information synergy management platform so that relevant personnel can have access to authorized project information anytime and anywhere.

Synergy of is the basis of multiple goals, whole process and parties synergy management and root of overall synergy effect of engineering system and that utilizing information synergy management platform technology conducts information synergy management based on information standardization can improve efficiency and quality of information communication of engineering project within entire-life cycle, lower the costs of information communication and better meet requirements of synergy management of multiple goals, whole process and parties on information condition.

57.3.2 Synergy Optimization of Multiple Goals of Engineering Project

Goal system of modern engineering project mainly includes time, cost, quality, resource, satisfaction of parties, harmony with environment, which influence and restrict each other. Lesson from many failures tells us that optimization of single goal can only make part of project optimized and excessive and blindly pursuit of one goal will make synergy of sub-goals lower. Synergy optimization of multiple goals means to balance among sub-goals to make them synergistically develop and strive to achieve the overall optimization of goal system. Here synergy of sub-goals within goal system is measured by synergy degree S. Higher synergy degree means more orderly overall structure of goal system and to be easier to achieve overall optimization. Overall synergy degree of goal system is as shown Formula (57.1).

$$S = \sum_{i=1}^{n} w_i f_i \quad s.t. \quad \sum_{i=1}^{n} w_i = 1 \tag{57.1}$$

f_i is the overall and orderly contribution degree of sub-goal i to goal system while w_i is owner or project itself of preference weight on sub-goal i. Weight coefficient is generally determined by management personnel in accordance with specific circumstances and characteristics and by relevant management experience and historical data or by experts' graded approach. Synergy optimization of multiple goals can be solved by GA and PSO which is more widely applied because of easy, precise and deep intelligent background (Yang et al. 2004).

57.3.3 Parties' Synergy Management of Engineering Project

Engineering project supply chain system means to integrate project parties including owner, design manufacturer, contractor, supplier, etc. into a whole construction network by control of information flow, material flow and capital flow within entire-life cycle of engineering project and is main body of implementation and management of engineering project. Parties' synergy management of engineering project emphasizes establishing a supply chain with good performance and efficient operation, which firstly need to select appropriate members of supply chain and then set out to establish cooperative partnership. Cooperative partnership devotes to establishing long-term cooperation but not only confined to some engineering project, is strategic synergy cooperation, emphasizes mutually confiding and respecting other's interests and value and constantly strengthen parties' communication and exchange and promote mutual synergistic benefits and make an effort for achieving greater joint benefits and overall goals of project by creating good cooperation atmosphere. In addition, selection of partners is pretty important. Firstly, partner should have the same strategic goals and values. Secondly, partner should have cooperative and synergistic organizational culture. Finally, we should fully measure technical indicator, management indicator, and business indicator of parties. In the meantime, we also should make higher standard to measure cooperative performance in the process of synergy cooperation.

57.3.4 Synergy Management of Whole Process of Engineering Project

Entire-life cycle process of modern engineering project has extended forward to conception phrase of project and backward to removal of project (ISO Technical Report 1994). Whole process is generally divided into decision-making, design and planning, construction and operation, which includes their sub-processes. Synergy management of whole process is the carrier for achieving overall goal of engineering project, which emphasizes that engineering project needs to consider comprehensively all factors within entire-life cycle of project at the beginning to recombine and optimize whole process of project integrally, break through the time and space limit of phrases and sub-processes, enhance interface overlapping and synergy degree and achieve cross-parallel work as soon as possible.

Synergy management of whole process needs corresponding contract model to give support. Project contracting model, to a certain degree, embodies synergy of process thought, in which only few, even just one contractor takes the whole process of project and finally provides project with perfect use functions. Contracting scope of contractor expands constantly, even including feasibility research of project, financing, design and operation and management, which contributes to guarantying implementation of project and continuity of management within overall process of project and strengthening organic penetration among phrases or sub-processes and avoiding short-term behavior, making rights and obligations become clear and eliminating blind zone of responsibility because of combining final benefits of project with contractor.

57.4 Research on Synergetic Adaption of Engineering Project with External Environment

All influential external factors constitute the external environment of engineering project system in the process of developing engineering project, which generally includes natural condition, political environment, economic environment, legal environment and technological environment in project area and relevant information of similar engineering and other aspects (Cheng 2001). External environment has an important influence on development of engineering project system. Engineering project has a close relation with external environment for exchanging information, material and energy. Environment provides resources required for engineering project and also decides implementation program and technical means. In the meantime, implementation and development of engineering project will have an important effect on external environment. Therefore, whether engineering project is adapted to external environment, to a certain degree, decides success and failure of engineering project.

Process of interaction of entire-life cycle of engineering project with external environment is just the achievement process of overall goals of engineering project system. External environment not only provides opportunities and resources but also restraint and interference. If the relationship between engineering project activity and external environment is handled properly, engineering project system will make emergent phenomena constantly in the process of steady development and approach to expected goal of project. If the relationship between engineering project activity and external environment is handled improperly, structure and function of engineering project system will degrade and hinder the achievements of project goal (see Fig. 57.3). Synergy management on external environment and whole process of engineering project can promote adjustment of overall structure of engineering project system to make synergy of engineering project with environment. In the meantime, environment also will make positive feedback to system to stimulate and strengthen such synergy and further promote engineering

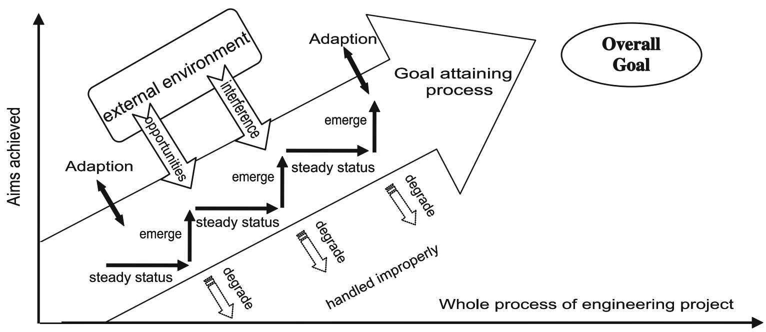

Fig. 57.3 Shematic plot of interaction of engineering project with external environment

project system to emerge from one to another steady status, which can reduce and avoid degradation, stimulate engineering project system to form huge overall synergy effect and promote the achievement of overall goal of project.

57.5 Conclusion

Problems arising out in the process of implementation and management of engineering project are largely as a result of imperfect management model. Traditional management mode of engineering project can't well adapt to new presented characteristics and solve corresponding problems properly. Introducing synergy management thought into research on engineering management has an important revealing influence and provides new thinking model and theoretical perspective on and for development of collaborative management theory, solution to practical problems arising out in the whole process of engineering project management and improvement of engineering project management level. Synergy management thought-based engineering project management model aims at promoting engineering project to form the function and structure far beyond sum of elements, make huge synergy effect and achieve more and larger successes by synergy management on elements information, goals, parties and the whole process, synergy consistence and close cooperation among elements and synergetic adaption of engineering project with external environment.

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Chapter 58
Research on the Reliability Growth Management Techniques of High-Speed Train for Whole Life Cycle

Wen-Jin Zhang and Nan Lan

Abstract How to ensure the high reliability of high-speed train is also facing the new challenges. The traditional reliability growth only focuses on the early development phase of high-speed trains, resulting in missing the growth information that is collecting form the whole life. This article gives an eye to the whole life cycle of high-speed train, and introduces a scientific and reasonable reliability growth management method. Furthermore, take the traction system of a high-speed train for example, this paper make a detailed description for steps of implementation reliability growth. Firstly, reliability growth planning is laid down. And then fault tree analysis (FTA) and failure mode effect analysis (FMEA) technology is used to formulate a growth scenario. Finally, we verify the effect of reliability growth management by means of the train's actual operation. Results show that, comparing with the original reliability index value Mean Distance between Failures (MDBF), it has raised after take the first batch reliability growth measures for traction system.

Keywords FTA · FMEA · High-speed trains · Management techniques · Reliability growth · Whole life cycle

58.1 Introduction

With the rapid development of high-speed rail transport, high-speed train tends to be multi-functional, integrated and complicated. And contradiction between system complexity and high reliability exists in the high-speed train. How to ensure the high reliability of high-speed train is also facing the new challenges (Guo 2011).

W.-J. Zhang · N. Lan (✉)
School of Reliability and Systems Engineering, Beihang University,
Beijing, China
e-mail: buaa.lannan@gmail.com

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As long as the high-speed train exposes defects in all stages of the life cycle, the corrective measures are taken. Therefore, the reliability growth is not only occurring in the development phase of the high-speed train, but also occurring in each stage of the whole life cycle. The traditional reliability growth techniques are based on the plain engineering ideas, and just focus on the early development phase, resulting in missing the growth information that is collected form the whole life cycle. Therefore, the reliability growth process of high-speed train should be extended from the development phase to the whole life cycle (Cassanelli 2006, He and Dai 1995, Sun 2008).

Research the reliability growth management techniques in whole life cycle, which can exclude all unreliable elements and hidden faults. This paper keeps the whole life cycle in view, studying the reliability growth management techniques of the high-speed train.

58.2 Reliability Growth Management for the Whole Cycle

For the management of reliability growth, we divided the whole life cycle of high-speed train into two stages, one is called the early stage, and the other is called production and application stage (Chang 2000, Ho et al. 2006, Madshus and Kaynia 2000, Seo et al. 2010, Tan et al. 2011).

58.2.1 Reliability Growth Planning

Reliability Growth planning is an important part of development planning. In order to allocate the resources coordinately, it must be completed before the program validation. Reliability growth planning and management should be set about two aspects, one is the overall management, and the other is the sectional management. The overall management mainly by means of developing the ideal growth curve, and reach the goals of management through adjusting plan factors such as the starting point of the curve, growth rate, funding, schedule and so on. The sectional management reflects in the planning growth curve. On the basis of ideal growth curve, Sectional management making arrangements according to allocate the resources and work schedule.

58.2.2 Reliability Growth Management in the Early Stage

The early stage of reliability growth for the whole life cycle includes two phases, which are plan demonstration, design and development. In this stage, design change is easily and timely, and the cost of reliability growth is low. However, the early stage information has many unknown factors, such as working conditions, the interaction between devices and so on.

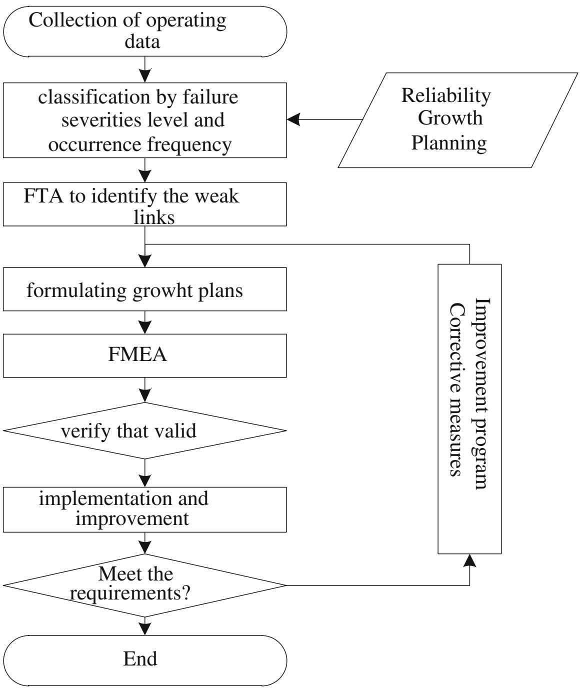
In the early stages, we improve product reliability mainly through the Test, Analyze and Fix (TAAF). TAAF process management not only relies on project management, but also tracking, assessment and prediction the product by the data obtained in the experiment. Through quantitative analysis, we can timely judge and make decision for the progress of the planning.

58.2.3 Reliability Growth Management in the Early Stage

The reliability growth in the production and application stages has good certainty. Because of hardware design become mature and information is less unknown, controlling the design changes are more easily.

However, the reliability growth has to pay higher price. The Collection, Analysis and Fix (CAAF) process, which is showed in Fig. 58.1, is the primary means to achieve reliability growth in this stage. The processes of CAAF can exposure the product failure that will be occurred in actual use environment, and make up the deficiencies of the TAAF.

Fig. 58.1 Flow chart of CAAF process



58.3 Engineering Examples

Since a high-speed train operation, a large number of failures were accumulated. We selected traction system, which failure occurred more frequently, as a research object, and implement the theory of the reliability growth management for the whole life cycle on it.

Firstly, we do the growth planning for traction system, and formulate a growth strategy, the ideal growth curve and the planned growth curve. Secondly, identify system weaknesses and develop improvement plans according fault tree analysis (FTA). Thirdly, apply the failure mode effect analysis (FMEA) to verify the effectiveness of improvement measures. Finally, implement the improving measures on the traction system, and then verify the effect of reliability growth in the actual train running again.

58.3.1 Traction System Reliability Growth Planning

1. *Growth target*

According to project needs and practical feasibility, we set the traction system Mean Distance between Failures (MDBF) target at 500,000 km on a comprehensive weight.

2. *Growth strategy*

In the process of traction system reliability growth, we will eliminate the failure modes gradually. We would put the failure, which have serious consequences, good economy, effective cost and clear expected correct consequences, on the first batch to concentrate correction. And then the principal contradiction in the remaining fault will be correct in a second batch. By analogy, the traction system failure will be decreased gradually with the work of reliability growth, and ultimately achieve our expected reliability growth target.

3. *The overall management: formulate the ideal growth curve*

At present, Duane model is widespread use in the reliability growth test of repairable product. Considering the actual situation of a high-speed train, we will use the Duane model in this reliability growth. Formulating the ideal growth curve is a process that we must weigh and balance again and again. And the parameters must meet the constraints of the following formula.

$$M_{obj} = \frac{M_I}{1-m}\left(\frac{T}{t_I}\right)^m \qquad (58.1)$$

$$M_I = (1 - m)(\frac{T}{t_I})^m M_{obj} \tag{58.2}$$

$$t_I = T\left[\frac{M_I}{(1 - m)M_{obj}}\right]^{1/m} \tag{58.3}$$

$$m \approx -1 - \ln\left(\frac{T}{t_I}\right) + \left\{\left[1 + \ln\left(\frac{T}{t_I}\right)\right]^2 + 2\ln\left(\frac{M_{obj}}{M_I}\right)\right\}^{1/2} \tag{58.4}$$

$$D = t_I\left[\frac{(1 - m)M_{obj}}{M_I}\right]^{1/m} \tag{58.5}$$

$$M_{Gp} = \frac{M_{I_0}}{1 - dK_\lambda} \geq M_{obj} \tag{58.6}$$

After repeated deliberations, the reliability growth parameters for this high-speed train's traction system is: the reliability target M_{obj} is 500,000 km, Duane growth rate m is 0.5, the total test mileage D is 2,500,000 km, the correct ratio $K\lambda$ is 0.95, the validity average correct coefficient d is 0.85, reliability level of the curve starting point M_I is 100,000 km, and the curve starting point mileage D_I is 400,000 km. When step into the reliability growth test, a high-speed train traction system must have reliability level M_{I0} is 96,250 km. According to the above parameters, we derived ideal reliability growth plans curve such as Fig. 58.2 Shown.

4. *Sectional management: formulate the ideal growth curve*

Base on the ideal growth curve shown in Fig. 58.2, combined with the failure data shown in Table 58.1, considering the resources and time, we get the plan reliability curve as in Fig. 58.3 shown. Each batch has one or more correct target components. In the beginning of each corrective batch, the concentrated correcting way is taken for the batch target component. Therefore, reliability growth curve will jump. And in other time periods, we will take the timely rectification measures

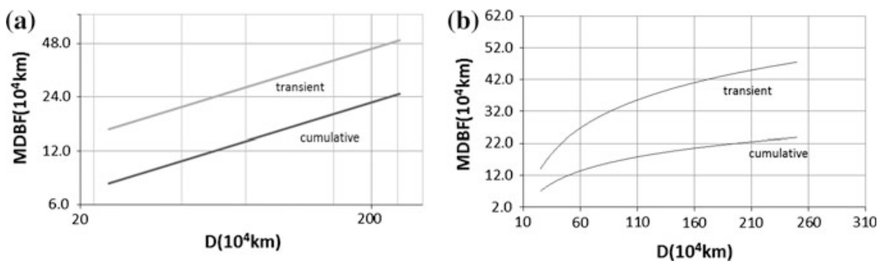


Fig. 58.2 The ideal reliability growth curve of high-speed train's traction system. **a** In bilateral logarithmic coordinates. **b** In linear coordinates

Table 58.1 Correct the order of subsystem failure

The corrected batch	Failure information			
	Respective subsystems	Number of failure	The main failure mode	The proportion of occurrence
1	TCU	81	Grounding fault of TCU	25%
2	IGBT	72	IGBT control module A12 monitoring work	23%
			IGBT control module A11 monitoring work	
3	Traction motor	65	Traction motor allowed to run stable overrun	20%
			Traction motor: reaches the overheating limit	
4	Cooling system	48	Cooling cycle was exceeded the maximum allowable operating temperature	15%
			Cooling cycle: coolant differential pressure > minimum pressure	
5	Transformer	38	The transformer output decreased, resulting in a high-pressure unit failure	12%
	Traction converter	9	Bilge board grid of Equipment crack	3%
Temporarily not corrected	Cooling unit	<5	Traction cooling unit coolant level is too low	<1%
Temporarily not corrected	Central control unit	<5	Communication failure	<1%

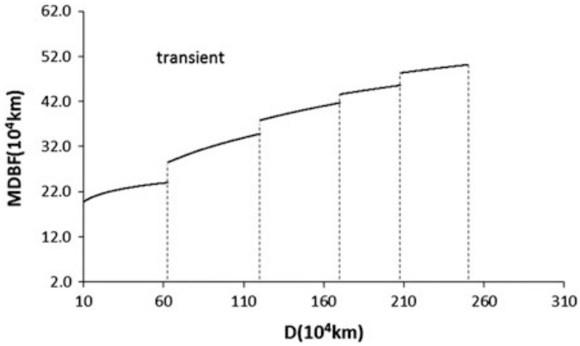


Fig. 58.3 The planning reliability growth curve of high-speed train's traction system

when the other failures occur in the batch target component. Therefore, we can consider the reliability growth curve is smooth growth.

58.3.2 The CAAF Process of Traction System

1. *Failure data collection and collation*

Figure 58.4 shows the failure data collection and collation process. There are three major data sources in the operation of traction system, existing information management system, running test and supply-side management platform. This example selects high-speed train operational information from 2010 to 2011 to analysis.

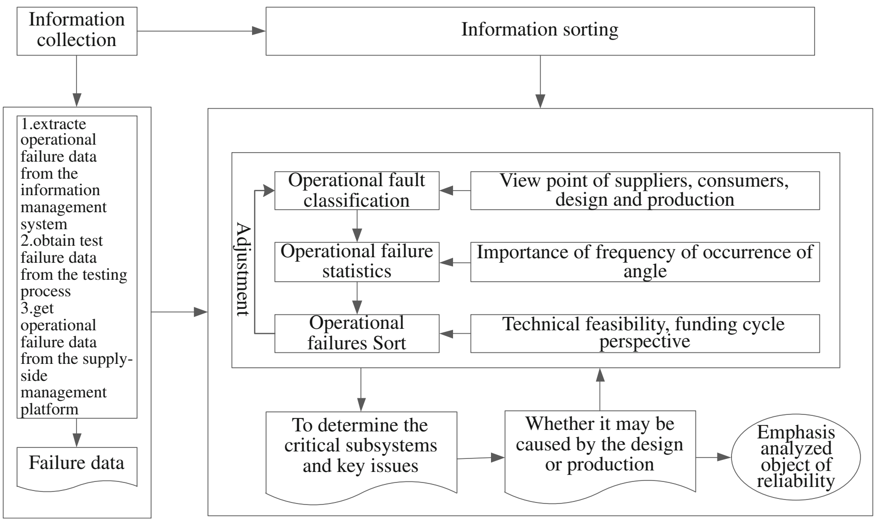


Fig. 58.4 Analysis and processing flow chart of operational failures

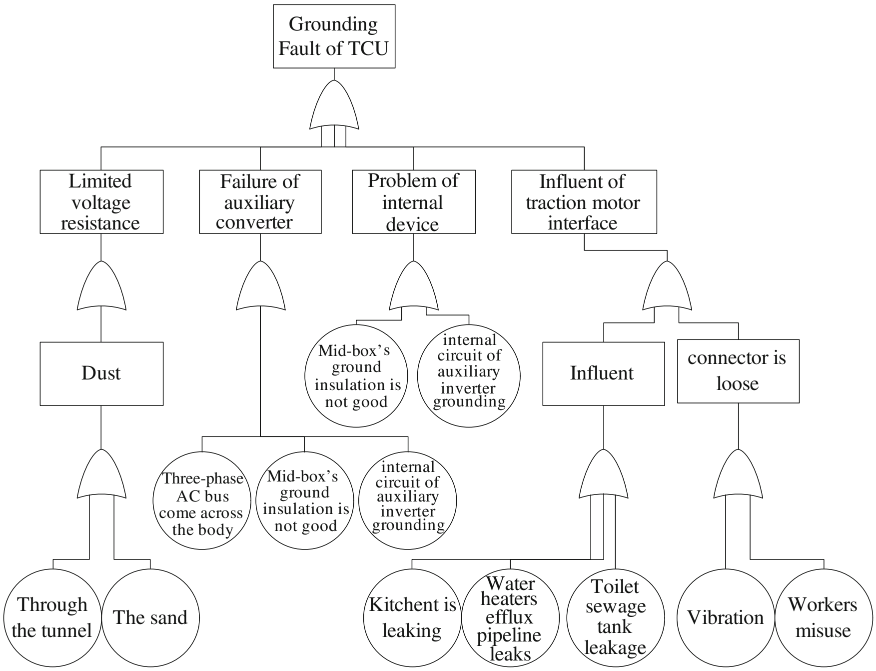


Fig. 58.5 Fault tree analysis of TCU grounding fault

As shown in Table 58.1, statistics and sorting the collected failure data one by one, and determine the critical subsystems which is impact safety and mission is traction control unit (hereinafter referred to TCU). TCU is an important structural component of the high-speed train's traction system.

According to the failure record of development unit, TCU fails 81 times, which have 31 times records of the TCU grounding fault. Because of this failure mode occurs in a higher frequency and has serious consequence, we put it as first batch of failure to correct. And then sort them from high to low in accordance with the proportion of each failure mode occurrence, and determine that the failure mode will be corrected by the batch sequence such as Table 58.1 Shown.

2. *Use FTA to analyze the failure mode*

We put the TCU grounding fault as a top event to analyze using FTA technology, aim at identifying all the reasons and reason combination that lead to this top event happen and find out the weak link of the system, in order to take corrective measures to improve the high-speed train reliability. The results of FTA analysis are shown in Fig. 58.5.

The total number of bottom events that may cause the top event occur is 10. Among them, 4 bottom events belong to the device itself quality problem areas, 5 bottom events belong to the environmental factors, and 1 bottom event belong to

Table 58.2 Minimal cut set list

No	Order	Cut set	No	Order	Cut set
1	1	{Through the tunnel}	7	2	{Workers misuse, Toilet sewage tank leakage}
2	1	{The sand}	8	2	{Workers misuse, Water heaters efflux pipeline leaks}
3	2	{Vibration, Kitchen is leaking}	9	1	{Mid-box's ground insulation is not good}
4	2	{Vibration, Water heaters efflux pipeline leaks}	10	1	{internal circuit of auxiliary inverter grounding}
5	2	{Vibration, Toilet sewage tank leakage}	11	1	{Three-phase AC bus come across the body}
6	2	{Workers misuse, Kitchent is leaking}			

misuse of workers. In addition, the number of minimal cut sets is 11, 5 minimal cut sets is in one order, 6 minimal cut sets is in two order, as shown in Table 58.2.

3. *Formulating growth plan*

According to the FTA analysis, we work out a reliability growth scheme as following:

- Improved Design of devices to enhance its insulating properties;
- Do the finite element analysis and design for the devices, and do the strict environmental vibration test to ensure the reliability of the devices;
- The components used make the 100 % screening;
- Training the operation workers to prevent misuse;
- According to the preventive maintenance requirements of bathroom, kitchen and water heaters, appropriate preventive maintenance will be taken on them with strict scheduled maintenance interval.

4. *FMEA to confirm*

Assume that TCU has taken the above measures to improve, and then do the FMEA to check whether it can remove the TCU grounding fault. After careful analysis with designers, we believe that this failure mode would not appear.

5. *Implementation of improvement and confirm by the actual operation*

Take the measures for the TCU in accordance with the above improvement measures. And in the next train actual operation, we confirmed that the original TCU grounding fault was eliminated. The other TCU failures occurred in the actual operation was timely corrected too.

58.3.3 The CAAF Process of Traction System

Now, the first phase of the reliability growth declared a success after the train 625,000 km run. According to the reliability assessment results, overall reliability of the high-speed train has been a definite increase. And MDBF value was increased by 15.91 %, reaching the first phase target value of the reliability growth.

58.4 Conclusions

1. In this paper, the reliability growth technology for the whole life cycle is implemented in the operational phase of high-speed train. In the first stage of reliability growth, reliability index MDBF of high-speed train's traction system has increased by 15.91 %. It shows that the reliability growth technology for the whole life cycle can be successfully applied in engineering practice.
2. If we really want to implement the reliability growth for the whole life cycle, we must track, collect, excavate various types of reliability data start form the development stage, and use data mining and information fusion technology to carry out a reliable growth analysis and prediction. This proposition is the development trend of the future reliability growth, there are still to be studied.
3. The purpose of this paper is not to offer up a solution to this problem, but to stimulate public discussion on a topic that is close to the hearts of aircraft development workers.

Acknowledgments Take this opportunity to extend my sincere thanks to the CNR Tangshan vehicle technicians. They provide a large number of high-speed train's detailed data for the study of reliability growth, and offer selfless technical support to the completion of this paper.

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Chapter 59
Step-Stress Accelerated Degradation Test Model of Storage Life Based on Lagged Effect for Electronic Products

Jin-yong Yao and Rui-meng Luo

Abstract Step-stress accelerated degradation test (SSADT), plays an important role in evaluating the storage life and reliability of the equipment products with high reliability and long life. Traditional models for step-stress tests have largely relied on the cumulative exposure model (CEM) where the hazard function has discontinuities at the points at which the stress levels are changed. Based on lagged effect a new step-stress model where the hazard function is continuous is introduced. The hazard function is assumed to be constant at the two stress levels, and linear in the intermediate period. The lagged step-stress model with the cumulative risk model (CRM) is deduced and obtained by the maximum likelihood estimation of the unknown parameters in terms of the hazard function. The new model shows its excellent fit and obtained reliability function at last.

Keywords Cumulative risk model (CRM) · Degradation model · Storage life and reliability · SSADT

59.1 Introduction

More and more attention has been paid to storage performance in mission systems in recent years. The estimation of storage life and reliability of electronic products is an important index in the product life cycle (Zhu et al. 2009). Determining the storage life of the products quickly and accurately can avoid premature destruction

J. Yao (✉) · R. Luo
School of Reliability and Systems Engineering, Beihang University,
Beijing, China
e-mail: jinyongyao@buaa.edu.cn

R. Luo
e-mail: ruimeng20062166@126.com

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or enormous waste caused by replacement, and serious consequences resulted from late replacement.

At present, there are four main types of storage test: site storage tests, laboratory simulations, storage tests and accelerated storage life tests. With the technological development, the storage life of high reliability products is improved (Meeker et al. 2009).˙ The products, however, must endure rigorous tests to determine the effect of different stress factors. Traditional test methods for simulating the real environment, reliability and storage life cannot meet the technical requirements of the development. Therefore, by means of the step-stress test method, the test technology of stimulating the weak link in the product and potential failure has been developed (Lin and Li 2006).

Step-stress tests are a particular type of accelerated test routinely used in life-tests. The items or units are subject to higher stress levels than normal stress levels and increased stress induces shorter failure time. Using a model of relating stress levels and failure distributions is often possible to determine the properties of the product failure distribution under normal operating conditions.

In a standard step-stress test, all individuals or items are subject to an initial stress level (Meeker et al. 2009). The stress is gradually increased at pre-specified times during the exposure. The stress factor refers to the rise of the temperature, voltage, and pressure. Traditional models for step-stress tests have largely relied on the cumulative exposure model (CEM) in which the hazard function has discontinuities at points at which the stress levels are changed. There are few applications of the step-stress test in existing references. We introduce a new step-stress model with lagged effect where the hazard function is continuous. The hazard function is assumed to be constant at the two stress levels and linear in the intermediate period. This new model will not show immediate effects of the stress change due to the consideration of possibility units. We model this "lag" effect using a piecewise continuous hazard function.

59.2 SSADT Assessment Method

SSADT is a test which, by means of observing degradation trend of the product in different accelerated stress-levels of performance parameters, infers the product storage life. The test result evaluation of the accelerated degradation test usually includes a performance degradation model and a life extrapolation (Mao and Wang 1986).

59.2.1 Test Principle of SSADT

To do SSADT (Mao and Wang 1986), a set of stress levels $\sigma_1, \sigma_2, \ldots, \sigma_n$ should be determined which are higher than normal storage stress level σ_0. At the start, the

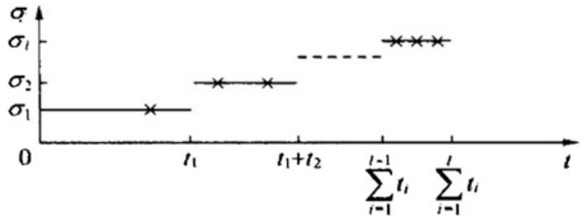

Fig. 59.1 SSADT principle

test sample is in stress level σ_1. After t_1 puts the stress level up to σ_2 and until a certain sample fails. The test principle is shown in Fig. 59.1.

Assuming that the test uses the four stress levels s_1, s_2, s_3, s_4, and the corresponding censored times are t_1, t_2, t_3, t_4, the relationship between the stress and time can often be expressed as

$$s = \begin{cases} s_1, & 0 \le t < t_1; \\ s_2, & t_1 \le t < t_2; \\ s_3, & t_2 \le t < t_3; \\ s_4, & t_3 \le t < t_4. \end{cases} \tag{59.1}$$

After the test implementation phase, the tests are conducted on the product in accordance with pre-designed experimental conditions and then observation values of the product performance parameter in different stress levels are obtained.

59.2.2 Performance Degradation Model

To the products whose weak link is clear and degradation mechanism is specific, one or more performance parameters in a given acceleration stress s_i will be monotonic change irreversible. Related studies have shown that the degradation process of product performance parameters is a stochastic one, and typically, Wiener random stochastic process can be used to describe this trend (Li and Jiang 2007; Li and Jiang 2008). This degradation process can be mathematically expressed as

$$W_i(\tau) = d(s_i) \cdot \tau + \sigma B(\tau) \quad (i = 1, 2, 3, 4) \tag{59.2}$$

Here $W_i(\tau)$ is the degradation of the product performance at time τ under the stress level $i; d(s_i)$ is the drift coefficient and reflects the relationship among the performance changes with the stress; σ is the diffusion coefficient and constant; $B(\tau) \sim N(0, \tau)$ is standard Wiener process, known as the standard Brownian motion (where τ is a time scale, and when the performance degradation process of the product is a linear process, τ is the actual time t; for the nonlinear degradation process, τ is the function of time.) When the stress of the accelerated degradation test is temperature, according to the engineering judgment and analysis of the similar product, we can assume that the relationship between drift coefficient $d(s_i)$ and s_i meet Arrhenius equation:

$$d(s_i) = \exp(a+b/s_i), \quad (i = 1, 2, 3, 4) \tag{59.3}$$

Under the stress s_1, when $0 \le \tau < \tau_1$,

$$W_{ss}(\tau) = W_1(\tau) = d(s_1)\tau + \sigma B(\tau) \tag{59.4}$$

Under the stress s_2, when $\tau_1 \le \tau < \tau_2$,

$$\begin{aligned} W_{ss}(\tau) &= W_1(\tau_1) + W_2(\tau - \tau_1) \\ &= d(s_1)\tau_1 + \sigma B(\tau_1) + d(s_2)(\tau - \tau_1) + \sigma B(\tau - \tau_1) \\ &= d(s_1)\tau_1 + d(s_2)(\tau - \tau_1) + \sigma B(\tau) \end{aligned} \tag{59.5}$$

Under the stress s_3, when $\tau_2 \le \tau < \tau_3$,

$$\begin{aligned} W_{ss}(\tau) &= W_1(\tau_1) + W_2(\tau_2 - \tau_1) + W_3(\tau - \tau_2) \\ &= d(s_1)t_1 + \sigma B(\tau_1) + d(s_2)(\tau_2 - \tau_1) + \sigma B(\tau_2 - \tau_1) \\ &\quad + d(s_3)(\tau - \tau_2) + \sigma B(\tau - \tau_2) \\ &= d(s_1)\tau_1 + d(s_2)(\tau_2 - \tau_1) + d(s_3)(\tau - \tau_2) + \sigma B(\tau) \end{aligned} \tag{59.6}$$

Under the stress s_4, when $\tau_3 \le \tau < \tau_4$,

$$\begin{aligned} W_{ss}(\tau) &= W_1(\tau_1) + W_2(\tau_2 - \tau_1) \\ &\quad + W_3(\tau_3 - \tau_2) + W_4(\tau - \tau_3) \\ &= d(s_1)\tau_1 + d(s_2)(\tau_2 - \tau_1) \\ &\quad + d(s_3)(\tau_3 - \tau_2) + d(s_4)(\tau - \tau_3) + \sigma B(\tau) \end{aligned} \tag{59.7}$$

59.2.3 Failure Time Distribution Function and Probability Density Function

Given the failure threshold L, the product degradation failure time t can be expressed as

$$T = \inf\{t : t > 0, Y(t) = L\} \tag{59.8}$$

Here $Y(t)$ is the performance degradation according to W. At a normal temperature, the performance degradation process of the products is a Wiener process, and the probability distribution function can be expressed as the inverse Gauss distribution:

$$F(t) = \Phi\left[\frac{1}{\sigma\sqrt{t}}(d(s_i)t - L)\right] + \exp\left[\frac{2d(s_0)L}{\sigma^2}\right] \cdot \Phi\left[-\frac{d(s_0)t + L}{\sigma\sqrt{t}}\right] \tag{59.9}$$

Here Φ is the probability density function of the standard normal distribution. Let x be increment, then the probability density function in the dependent time increment Δt is

$$f(x) = \frac{1}{\sigma\sqrt{2\pi\Delta t}} \exp\left\{-\frac{[x - d(s)\Delta t]^2}{2\sigma^2\Delta t}\right\} \tag{59.10}$$

where $x = W_{ijk} - W_{ij(k-1)},\ x \sim N(d(s_i)\Delta t, \sigma^2\Delta t)$.

59.2.4 Life Extrapolation Method

From the probability density function of the performance increment x in the independent time increment Δt, we can obtain the maximum likelihood function

$$L(a, b, \sigma) = \prod_{i=1}^{K}\prod_{j=1}^{n}\prod_{k=1}^{M_i}\frac{1}{\sigma\sqrt{2\pi\Delta t}} \cdot \exp\left\{-\frac{\left[(W_{ijk} - W_{ij(k-1)}) - d(s_i) \cdot \Delta t\right]^2}{2\sigma^2\Delta t}\right\} \tag{59.11}$$

Then

$$\ln L = -\frac{1}{2} \cdot \sum_{i=1}^{K}\sum_{j=1}^{n}\sum_{k=1}^{M_i}\left\{\begin{array}{l}\ln(2\pi\Delta t) + \ln(\sigma^2 \\ + \frac{\left[(W_{ijk} - W_{ij(k-1)}) - d(s_i)\cdot\Delta t\right]^2}{\sigma^2\Delta t}\end{array}\right\} \tag{59.12}$$

The expression of $\hat{\sigma}^2$ can be drawn by solving the derivation of a ; b are unknown parameters in $d(s_i)$ and has not yet been estimated value of a, b. If you are still using the maximum likelihood estimation method to estimate a, b, only obtain one estimate value. Firstly, the maximum likelihood estimation method is adopted to obtain the estimation of σ^2 and $d(s_i)$, that is, $\hat{\sigma}^2$ and $\hat{d}(s_i)$ which are

$$\hat{\sigma}^2 = \frac{1}{\Delta t \cdot \sum_{i=1}^{K}\sum_{j=1}^{n}\sum_{k=1}^{M_i} M_j} \cdot \sum_{i=1}^{K}\sum_{j=1}^{n}\sum_{k=1}^{M_i}\left[(W_{ijk} - W_{ij(k-1)}) - d(s_i) \cdot \Delta t\right]^2 \tag{59.13}$$

$$\hat{d}(s_i) = \frac{\sum_{i=1}^{K}\sum_{j=1}^{n}\sum_{k=1}^{M_i}(W_{ijk} - W_{ij(k-1)})}{nM_i\Delta t} \tag{59.14}$$

Secondly, the least squares method is used to obtain the estimate of a, b. In the Arrhenius model, the logarithmic of the performance degradation rate is

$$\ln d(\hat{s}_i) = a + b/s_i \tag{59.15}$$

Thus the estimation of a, b namely $\hat{a}, \hat{b}$, are substituting $\hat{a}, \hat{b}, \hat{\sigma}^2$ into $Y(t)$, yields the performance degradation equation. When the normal stress is determined, the estimation values of the three parameters are substituted into the previous formula to obtain the corresponding storage life.

59.3 Step-Stress Models with Lagged

59.3.1 The CRM

Assuming that the hazard function associated with the initial and elevated stress levels is constant. Then n individuals or items are exposed to the same initial stress level x_1. Subjects are continuously monitored, and at some prespecified time point τ_1, the stress level is increased to x_2. The effect of the stress increase is not seen immediately: a known latency period δ is assumed to exist before the effects are completely observed. In the interval $[\tau_1, \tau_2]$, here $\tau_2 = \tau_1 + \delta$, the hazard slowly increases. The piecewise hazard function is assumed to have the following form:

$$h(t) = \begin{cases} \theta_1, & 0 < t < \tau_1; \\ a + bt, & \tau_1 \le t < \tau_2; \\ \theta_2, & t \ge \tau_2, \end{cases} \tag{59.16}$$

here $\tau_2 > \tau_1$. The parameters a and b in the model are chosen to ensure that the hazard function $h(t)$ is continuous. Therefore, a and b satisfy

$$a + b\tau_1 = \theta_1, \; a + b\tau_2 = \theta_2. \tag{59.17}$$

The hazard is constant in the intervals $[0, \tau_1]$ and $[\tau_2, \infty)$. In the interval (τ_1, τ_2), the hazard changes linearly. The parameter b measures how quickly the effects of the increased stress are observable. Both τ_1 and τ_2 are assumed to be known in this model, which can be extended to the case where neither of these constants are known. It is called the cumulative risk model (CRM) in order to emphasize the accumulated effects of the stress on the lifetime. By using the definition of the hazard in (59.16), the survival function (SF), $S(t)$ may be written as

$$S(t) = \begin{cases} e^{-(a+b\tau_1)t}, & 0 < t < \tau_1; \\ e^{-at - \frac{b(t^2+\tau_1^2)}{2}}, & \tau_1 \le t < \tau_2; \\ e^{-(a+b\tau_2)t - \frac{b}{2}(\tau_1^2 - \tau_2^2)}, & t \ge \tau_2. \end{cases} \tag{59.18}$$

The cumulative hazard (CH) function is

$$H(t) = \begin{cases} (a + b\tau_1)t, & 0 < t < \tau_1; \\ (a + b\tau_1)\tau_1 + \frac{1}{2}(t - \tau_1)^2 b, & \tau_1 \le t < \tau_2; \\ (a + b\tau_1)\tau_1 + \frac{1}{2}(\tau_2 - \tau_1)^2 b + (t - \tau_2)(a + b\tau_2), & t \ge \tau_2. \end{cases} \tag{59.19}$$

59.3.2 Maximum Likelihood Estimation for the CRM

Let

$$t_1 < \ldots < t_{n1} < \tau_1 < t_{n1+1} < \ldots < t_{n1+n2} < \tau_2 < t_{n1+n2+1} < \ldots < t_n \tag{59.20}$$

where n_1, n_2 and $n_3 = n - (n_1 + n_2)$ express the number of failures that occur before τ_1, between τ_1 and τ_2, and beyond τ_2, respectively. The maximum likelihood functions of a and b is given by

$$\begin{aligned} l(a,b) =& (a + b\tau_1)^{n1} e^{-(a+b\tau_1)\sum_{i \in I_1} t_i} \\ & \times \prod_{i \in I_2} (a + bt_i) e^{-\sum_{i \in I_2}(at_i + \frac{bt_i^2}{2})} e^{-\frac{n_2 b\tau_1^2}{2}} \\ & \times (a + b\tau_2)^{n_3} e^{-(a+b\tau_2)\sum_{i_3} t_i} \times e^{-\frac{n_3 b}{2}(\tau_1^2 - \tau_2^2)} \end{aligned} \tag{59.21}$$

$$I_1 = \{1, \ldots, n_1\}, I_2 = \{n_1 + 1, \ldots, n_1 + n_2\}, I_3 = \{n_1 + n_2 + 1, \ldots, n\}.$$

The derivation of the maximum likelihood estimators is provided in the appendix, along with the expressions for the observed Fisher information. It is noted that the MLE of b can be obtained as the solution of the nonlinear equation

$$-1 + \frac{n_1}{n - bK + bT\tau_1} + \frac{n_3}{n - bK + bT\tau_2} + \sum_{i \in I_2} \frac{1}{n - bK + bTt_i} = 0 \tag{59.22}$$

where $T = \sum_{i=1}^{n} t_i$ and

$$K = \tau_1 \sum_{i \in I_1} t_i + \frac{1}{2} \sum_{i \in I_2} t_i^2 + \frac{1}{2} n_2 \tau_1^2 + \tau_2 \sum_{i \in I_3} t_i - \frac{1}{2} n_3 (\tau_2^2 - \tau_1^2). \tag{59.23}$$

Once the MLE of $b, \hat{b}$, is obtained as the solution of (59.21), the MLE of a, namely $\hat{a}$, is simply

$$\hat{a} = \frac{n - \hat{b}K}{T} \tag{59.24}$$

59.4 Data Analysis and Result

The three sets of electronic products are chosen to perform the SSADT and the test parameters are shown in Table 59.1.

The test results are shown in Fig. 59.2.

If the product performance degradation of less than 29 is taken as the criterion of failure, the estimated values obtained for each parameter are separately:

$$\hat{a}=2.254,\ \hat{b}=5904.75,\ \hat{\sigma}=0.0573.$$

Supposed the two degradation variables of the products satisfy the normal distribution; the sensitive stress is temperature and satisfies the Arrhenius acceleration model (Zhou et al. 2011); failure thresholds are 8 and 10; normal design temperature is 25 °C; the accelerated temperature is set to 45 and 60 °C. Firstly, four normal random numbers s_{11},s_{11},s_{21}, and s_{22}.are produced, and then data is calculated at 45 °C.

$$\begin{cases} y_{11}(t) = \mu_{11}(t) + c_{11} \cdot s_{11}, \\ y_{12}(t) = \mu_{12}(t) + c_{21} \cdot s_{11} + c_{22} \cdot s_{12}. \end{cases} \tag{59.25}$$

The calculating method of c_{ij} is as follows:

$$\begin{bmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix} = \begin{bmatrix} 0.9 + 0.1t & 0.8 + 0.15t \\ 0.8 + 0.15t & 1.7 + 0.2t \end{bmatrix} \tag{59.26}$$

Then calculate data at 60 °C with the same method and obtain the values of c_{11}, c_{21}, and c_{22}. Finally, repeating the above steps, we can obtain the simulation value $y_{ij}(t),\ t = 1, 2, \cdots, 10$ at every time point and the data of mean and variance–covariance of the degradation so that we get the mean and covariance matrix equations under different stress.

Supposed the parameter coefficient and temperature satisfy the Arrhenius acceleration model. We can obtain the relationship of the parameters, temperature and time by means of MLE fitting as follows

Table 59.1 Ssadt test parameters

Test parameters	Parameter value	Test parameters	Parameter value
T_1	45 °C	M_1	247
T_2	50 °C	M_2	174
T_3	55 °C	M_3	155
T_4	60 °C	M_4	144
Δt	2 h		

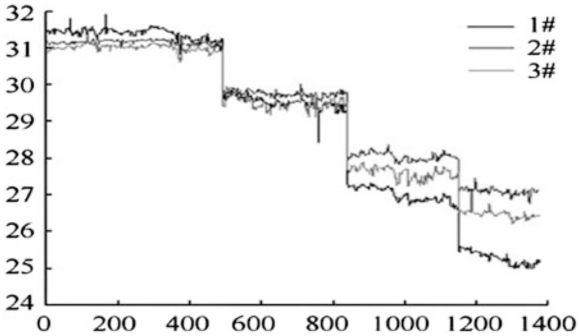

Fig. 59.2 Test data of an electronic product performance SSADT

$$\begin{cases} \mu_1 = \exp(1.746 - \dfrac{51}{T+273}) + \exp(17.79 - \dfrac{6488}{T+273})t \\ \mu_2 = \exp(2.266 - \dfrac{71}{T+273}) + \exp(11.47 - \dfrac{3912}{T+273})t \\ a = \exp(19.45 - \dfrac{7011}{T+273})t + \exp(18.44 - \dfrac{5955}{T+273}) \\ b = c = \exp(17.51 - \dfrac{6512}{T+273})t + \exp(21.12 - \dfrac{7012}{T+273}) \\ d = \exp(22.46 - \dfrac{7469}{T+273})t + \exp(22.43 - \dfrac{7009}{T+273}) \end{cases} \tag{59.27}$$

Thus we can obtain the relationship of mean and covariance with time under normal design conditions ($T = 25$ °C). If the two degradation variables are independent, the reliability function is

$$\begin{aligned} R =& \Phi(\frac{L_1 - \mu_1(t)}{\sigma_1(t)}) \cdot \Phi(\frac{L_2 - \mu_2(t)}{\sigma_2(t)}) \\ =& \left[\Phi(\frac{8 - 4.922 - 0.0201t}{\sqrt{0.0164t + 0.11911}}) - \Phi(\frac{0 - 4.922 - 0.0201t}{\sqrt{0.0164t + 0.11911}})\right] \\ & \cdot \left[\Phi(\frac{10 - 7.8461 - 0.077t}{\sqrt{0.0269t + 0.2451}}) - \Phi(\frac{0 - 7.8461 - 0.077t}{\sqrt{0.0269t + 0.2451}})\right] \end{aligned} \tag{59.28}$$

59.5 Conclusion

This new model for SSADT was motivated by the limitation of Nelson's CEM. Our formulation in terms of a piecewise hazard function provides a more realistic model for biomedical applications. The performance has been evaluated using a simulation study. In addition to the simulation results, we have used a real data set to fit the new model which is extremely flexible and provides an excellent fit to the fatigue data.

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Chapter 60
The Realization of Web Service Description of Project Procurement Management Based on Semantic

Zhi-bing Wang and Zhu-mei Sun

Abstract In order to achieve the efficiency and effectiveness, providing accurate information to support the project management has become an inevitable trend. We realize the fast and accurate information transfer between the procurement department and other departments and improve the information communication and data sharing efficiency in the procurement process through building the informatization of project procurement management and building the flow and the standards of information transfer. Web service is an emerging web distributed technology. Its purpose is to solve the structure of data on the platform and problems in the application of integrating and sharing. To apply the semantic web services effectively in the construction of informatization of procurement management will be a good solution to the informatization problems it is facing now. The article takes the contract management of project procurement management for example to describe the contribution of the service and give the OWL-S description of it.

Keywords Fonts · Formatting · Margins

Project procurement management is the process which the organization gets goods and services from the outsides in order to achieve its task. It has a great impact on the realization of the ultimate benefit of the organization. With the rapid development of the information and internet technology, the procurement of the organization has become electronization and cyberization. The traditional methods which rely on artificial or stand-alone management can no more satisfy the requirement of the project procurement management (Tao and Wang 2007; Li and Zhang 2005;

Z. Wang (✉)
School of Civil Engineering and Architecture, Jiangsu University of Science and Technology, ZhenJiang, Jiangsu, China
e-mail: justwzb@qq.com

Z. Sun
Library, Jiangsu University of Science and Technology, Zhenjiang, Jiangsu, China

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Chen 2002; Luo 2008). In order to achieve the efficiency and effectiveness, providing accurate information to support the project management has become an inevitable trend. We realize the fast and accurate information transfer between the procurement department and other departments and improve the information communication and data sharing efficiency in the procurement process through building the informatization of project procurement management and building the flow and the standards of information transfer. Web service is an emerging web distributed technology. Its purpose is to solve the structure of data on the platform and problems in the application of integrating and sharing. The arising of vast web services required to be discovered and matched automatically and intellectually. In order to solve the problem, it generates the semantic web services (Roman et al. 2005; Kopecky and Roman 2006; Jaeger and Engel 2005; Scicluna et al. 2004; Gannod and Brodie 2005). To apply the semantic web services effectively in the construction of informatization of procurement management will be a good solution to the informatization problems it is facing now.

60.1 Overview of Ontology Web Language for Services

Ontology web language for services (OWL-S) is based on OWL used in the web services. It's the extension of OWL. The existing web services language WSDL is based on the XML. It is short of semantic description. The appearing of ontology web language for services solves the problem (OWL-S 2012; Shen et al. 2005; Wen 2002). It's the predecessor of DAML-S and is a high-level ontology language used to describe web services specifically.

OWL-S includes a set of ontology. It provides the vocabulary for web services description, describes the semanteme of the services. It can infer according to the requirement and effects of the services. It makes the web services be understood by the computer and easy for use. So it can make the services be discovered, executed, assembled and interoperated automatically and dynamically by humanization intellective subject.

Web services process includes atomic process, simple process and composite process. One service has three object properties as presents, described-by and supports ordinarily. The corresponding range of the properties is service-profile, service-model and service-grounding.

Service-profile sets the purpose of the services. It is expressed by service-profile Class in OWL. In order to help the subject who searching for service to determine whether the service meets their needs, it provides the information and service description ability needed by the subject. It describes the function information of service. There are a series of properties using for service profile description in OWL-S. The greatest feature of service-profile is bidirectional. While the services providers can use it to describe the function of services, the services demanders can use it to describe the services they need. The services matcher can use the bidirectional information to match when the services are found. In addition, service-profile is registry-model-neutral. In other words, profile supports variety registration patterns, such as the UDDI registration pattern which based on the centralization.

Service-model describes how services work. It is expressed by service-model Class in OWL. It describes the input, the output, the precondition and the result of the implement for simple services. In addition to the previous, it also describes process model for complex services which are seen as a process. The process model is composed of process ontology and process-control ontology. Atomic process, simple process and composite process constitute the Process Ontology.

Service-profile and service-model are abstract description of services while service-grounding is of specific norms of services. It explains the detail of accessing the service, includes communication protocols, message format and so on. Its core function is to achieve message mapping from abstract input and output of an atomic process and the message will carry the related information by transmissible format (OWL-S 2004; Chai 2005; Neches et al. 1991).

60.2 Creation of Project Procurement Management Service

The work flow of project procurement is consist of six aspects, including purchase planning, inquiry planning, inquiry, supplier choosing, contract management and contract closure. Due to space limitations, the article will only take contract management for example to explain the creation process of service.

60.2.1 Service Definition

Contract management is the process which to ensure the contract parties can fulfill their respective obligations conscientiously according to the contract requirements and protect their interests. It includes contract implementation management, contract change management and contract payment management (Li and Zhang 2005; Chen 2002; Luo 2008).

(1) Service Process Definition
(a) Atomic Process Creation

- Contract Implementation Management

The management activity will export correspondences and change requests through performance reports based on the input of contracts and work results. Figure 60.1 gives the detail description of the activity.

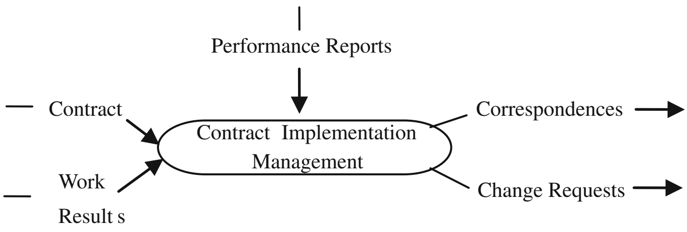

Fig. 60.1 Contract implementation management

- Contract Change Management

The management activity will export contract changes through contract change control system based on the input of change requests. Figure 60.2 gives the detail description of the activity.

- Contract Payment Management

The management activity will export payment application through payment system based on the input of correspondence and vendor invoice. Figure 60.3 gives the detail description of the activity.

The input and output parameters of the atomic process in the figures has been defined in the domain ontology. Each of the parameters is one instance of certain class. All the parameters are gathered in Table 60.1.

(b) Composite Process Creation

The composite process is named Compositeprocess_Htgl. And the control construction is defined as sequence. The article uses protégé to realize the process based on the setting of input and output parameters as Fig. 60.4 shows.

Fig. 60.2 Contract change management

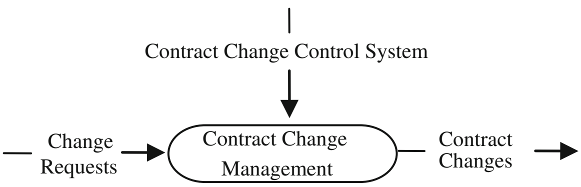

Fig. 60.3 Contract payment management

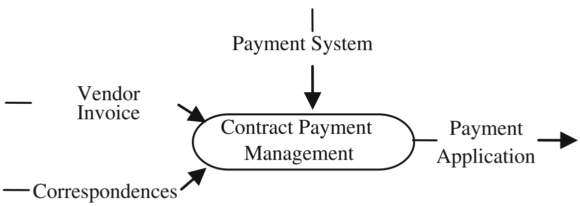

Table 60.1 Collection of contract management parameters

Atomic process name	Management activity	Input	Output
htssgl	Contract implementation management	Ht_2 Gzjg_1	Lwhj_1 Bgsq_1
htbggl	Contract change management	Bgsq_2	Htbg_1
htzfgl	Contract payment management	Lwhj_2 Mffp_1	Zfsq_1

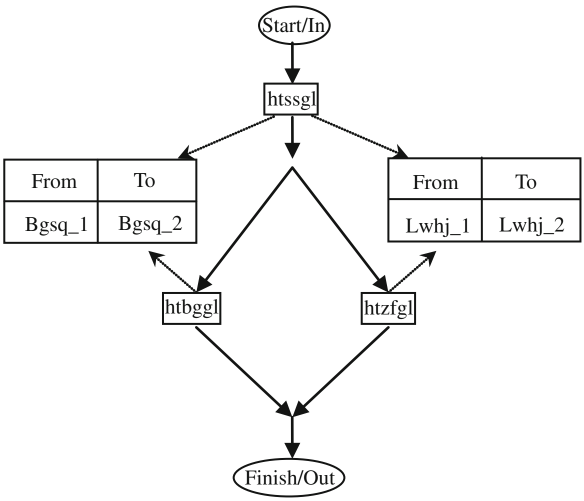

Fig. 60.4 Composite process of contract management service

(2) Service Profile Definition

The Service Profile is named Htgl_Profile and the service is named Htgl_Service. The value of has_process is Compositeprocess_Htgl. The input and output parameters is managed by the IOPR manager.

(3) Service Grounding Definition

The Service Grounding is named Wsdlgrounding_Htgl. Each atomic process is defined as HtssglGrounding, HtbgglGrounding and HtzfglGrounding.

Figure 60.5 gives the service ontology of contract management.

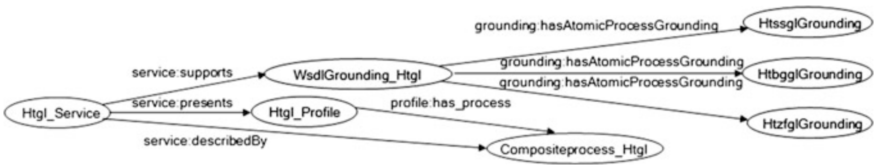

Fig. 60.5 Service ontology of contract management

Table 60.2 Description of contract management service by OWL

OWL description	Notes
<service:Service rdf:ID = “Htgl_Service”>	Define the service “Htgl_Service”
<service:presents>	Define the service profile
<profile:Profile rdf:ID = “Htgl_Profile”>	Input parameters
<profile:hasInput rdf:resource = “#Ht_2”/>	Output parameters
<profile:hasInput rdf:resource = “#Gzjg_1”/>	
<profile:hasInput rdf:resource = “#Bgsq_2”/>	
<profile:hasInput rdf:resource = “#Mffp_1”/>	
<profile:textDescription rdf:datatype = “http://www.w3.org/2001/XMLSchema#string”	
>an online service to get a purchase plan </profile:textDescription>	
<profile:serviceName rdf:datatype = “http://www.w3.org/2001/XMLSchema#string”	
>Htgl_Service </profile:serviceName>	
<profile:hasOutput rdf:resource = “#Lwhj_1”/>	
<profile:hasOutput rdf:resource = “#Htbg_1”/>	
<profile:hasOutput rdf:resource = “#Zfsq_1”/>	
<service:presentedBy rdf:resource = “#Htgl_Service”/>	
</profile:Profile>	
</service:presents>	
<service:described-By>	Define the composite process “Compositeprocess_Htgl”
<process:CompositeProcess rdf:ID = “Compositeprocess_Htgl”>	
<service:describes rdf:resource = “#Htgl_Service”/>	
<process:invocable rdf:datatype = “http://www.w3.org/2001/XMLSchema#boolean”	
>true </process:invocable>	

60.2.2 *Service Description by OWL*

Table 60.2 gives the detail description of contract management service by OWL.

60.3 Conclusion

By abstract defining various management activities of project procurement management as atomic process and its composite process as a service model, the tools and data files used in the process have been normalized and standardized. And it lays the theoretical and technical basis for the future integration and reuse of the project management information system.

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Chapter 61
The Research of RAMS Management in China's High-Speed Railway Construction Project

Jin-hui Cao

Abstract By the engineering theory of safety system, this paper researches RAMS management in Zheng-Xi high-speed railway project with the reference of European standard EN50126, to establish RAMS management system which suits Chinese high-speed railway construction, and to improve the reliability, availability, maintainability and safety of the project.

Keywords High-speed railway · Reliability · Maintainability · Availability · Safety · RAMS management

61.1 Introduction

Chinese high-speed railway was built in 1999 on Qinhuangdao-Shenyang Passenger Special line. After 10 years' construction of high-speed railway and the transformation of railway speed, China has the world's largest scale and highest operation speed of high-speed railway now. There are some differences between high-speed railway and ordinary railway on the technology, construction and so on. Therefore, the domestic construction methods can not totally meet the needs of high-speed railway construction. RAMS management is the management of the system about reliability, availability, maintainability and safety. RAMS represents the long-term work performance which is established through the engineering concepts, tools, methods and techniques in the system of working cycle. In this case, Zheng-Xi PDL engineering consultants decide to apply the RAMS management to the project, especially to fulfill specific construction process for completing the system guarantee.

J. Cao (✉)
Department of Industrial Engineering,
Tianjin University, Tianjin, China
e-mail: cao_jh@163.com

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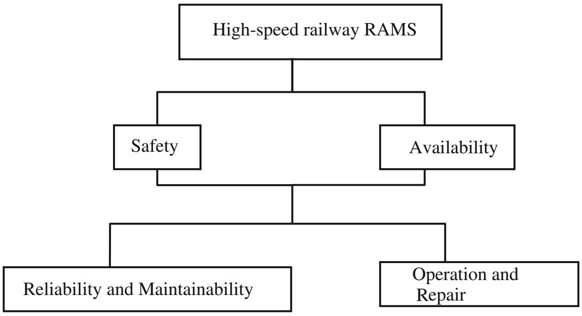

Fig. 61.1 Relationship of high-speed railway RAMS elements

61.2 Theory of High-Speed Railway Rams Management

RAMS of the system can be expressed as qualitative and quantitative indexes which are related to the system, subsystem or the grade of component parts of the system. In the high-speed railway project, managers should construct the suitable RAMS management system and influence factors of identification system, through the criteria establishment for the assessment of risk level and relationship. The appropriate measures should be taken to solve the problem, in order to avoid or reduce the adverse factors on the high-speed railway project construction and operation. The relationship of the four elements of RAMS is shown in Fig. 61.1.

In the foreign study, Diamantidis, F. Zuccarelli and A. Westhäuser focused on the safety management of rail traffic tunnel project (Høj and Kröger 2002). Tore Markeset, Uday Kumar studied how to control the risk in RAMS management (Markeset and Kumar 2003). In the domestic study, Zhang Yang and Liu Sining applied the RAMS to metro construction of Chengdu (Zhang and Liu 2008). Zhang Shuguang put forward the framework of life cycle safety assessment system of high-speed railway construction in China (Shuguang 2007).

61.3 The Rams Management Requirements of High-Speed Railway Construction

61.3.1 The RAMS Influence Factors of High-Speed Railway Construction

1. Human factors

Human factors can be defined as the influence on the system such as staff characteristics, expectation and behavior. These factors include the structure, physical and psychological aspects (Jiayu and Chunxin 2001). Human factors (attributed to the needs of staff on the health, safety and job satisfaction) can make the workers work efficiently and effectively. In the project construction stage, staff includes not only the first line construction workers and supervisors, but also the owner, contractor and project manager of consultant Staff have the ability to do some positive contributions to railway system RAMS. In order to achieve this goal, the manner of human factors impact on the railway RAMS should be determined and managed throughout the life cycle. During the construction, enthusiasm should be fully mobilized and the human's leading role should be played to make the workers devote themselves to the project construction, to reduce or even avoid producing harm and fully play the "human factors first" leading role.

2. Materials, equipment, machinery and other factors

Engineering materials (including raw materials, (semi-products and fittings) are material conditions to construction. If there is no engineering material, the construction cannot be done well (Yellow Book-Engineering Safety Management Issue 3 and London: Rail track 2000). The quality of material affects performance of system RAMS directly, only if the material could meet the demand of RAMS; RAMS target could be finished through a standard construction process. Because of that, the material control of the project has great significance on RAMS management of the project.

Machinery and equipment of construction are important material foundations to construction mechanization of the project during construction. The construction site conditions, building structure, mechanical equipment, construction organization and management and other factors must be considered systematically. Construction machinery type and performance parameters should be selected together, so that they can be used to support organic connection.

3. Factors of construction method

The construction method comprises the construction scheme, construction technology, construction method and technical measures. Specifically, it mainly contains the control of construction organization design, measures, technical scheme, process flow and ways of detection etc. in project construction period. Construction scheme is the source of all projects. Whether the scheme is correct or not, it will directly affect the realization of project goal. Moreover, the RAMS target is related with construction scheme directly (Wengong and Liyun 2008).

4. Environmental factors

Environmental factors include the factors of natural environment, construction quality management, construction work environmental factors and so on. Environmental factors are important factors that can affect the engineering construction, so there are complicated and uncertain features in the construction. Environmental factors in the construction process of the system mainly include the physical environment, advanced integration of the railway system in the environment, the defined probability in the test system of railway environment.

61.3.2 The Requirements of RAMS Management in Construction Project

1. Establish the assurance program of system

The RAMS management of construction project must establish system assurance programs firstly, which need to discuss related tasks about reliability, availability, maintainability and safety including assessment, management and verification. These tasks will be completed in various stages of construction project. Specifically, the assurance program of the system should determine all RAMS activities during the delivery period of the contract, in order to achieve the related goal (Chan and Ming 2009). System assurance programs elaborate the assurance standards of the system among the project participants to assure activities and RAMS method systematically. In the specific implementation process, consultants of construction project are often responsible for the coordination and management.

2. Establish the risk management program

Consultants of construction project should establish the risk management program based on experience and improvement in international relevant projects, summarize problems during the implementation process of the project, and adjust hazard management program.

3. The implementation of system assurance program and risk management program

The participants of project shall implement the system assurance program strictly, so it should be done before arranging personnel training, establishing performance appraisal system and devising responsibility. Under the coordination with the consultant, three parts should work with united strength to ensure the implementation of the plan system. The contractor should identify hazard, record, assessment, management and the arrangement of personnel who are responsible for undertaking the relevant work in accordance with the risk management procedures strictly. When encountering problems, they can communicate with the owners and consultants actively to solve problems.

61.4 Problem Existed in Rams Management of Constructions Project in High-Speed Railway System

61.4.1 Problem Existed in the Proprietor

Problem existed in the proprietor is mainly caused by anthropic factor, as well as partly related with environmental factor. Proprietor is the actual investor of engineering project, while the proprietor of domestic high-speed railway project is railway ministry of People's Republic of China. Due to the feature of railway system in China, government and enterprise are hard to distinguish, and varies of problems occurred in engineering project. Once in a while, proprietor cannot fulfill the contact earnestly and force the contactor to construct without the payment. All these factors result in defaults on salary of workers and cost of materials and equipments. Both of them directly affect the quality of engineering. During the building engineering of railway program in China, the unreasonable requirements proposed by proprietor become various obstacles for contractor and further affect the achievement of RAMS target (Dongliang 2009).

61.4.2 Problems Existed in the Advisor

Problem existed in the advisor involve anthropic factor, material factor and so on. Advisor assists every department to set up RAMS management system, to measure and supervise the materials, to offer reasonable constructing program and so forth. Because of the short history of high-speed railway building in China, both proprietor and contractor lack enough experience. It is always difficult to obtain the ideal effect during the understanding and executing of technique-advise program. Interior management of supervising departments always appears to be numerous and disorderly in the program, system and technique. On the other side, the right of supervising department is not parallel with responsibilities. The limitation of right and weighty responsibility frequently affect the effective process of supervision.

61.4.3 Problem Existed in the Contractor

Problems existed in the contractor involve anthropic factor, material factor and so on. It is not long since RAMS was introduced into China. The example is few on the RAMS application in railway program. The contractor is required to have related experience with practical situation. Affected by management concept of traditional contracting model, many overall contractors and sub-contractors still do not clarify the status and the relationship in law with other main parts participating in the building process, let alone the responsibility which should be borne and the role it should played. During the concrete building process of program, problems are embodied in the buck-passing of related responsibility of RAMS between overall contractor and sub-contractor, which cannot guarantee the fulfillment of RAMS target.

61.5 Countermeasure to Problems of Rams Management System in High-Speed Railway System

61.5.1 Countermeasure to Problems Existed in the Proprietor

Due to excessive gap of market status, proprietor often makes use of its advantageous status to go against the contract, which is especially embodied in the payment of engineering expense. Under this condition, RAMS target of program cannot be guaranteed; moreover the benefit of proprietor will be violated. Therefore, proprietor should set up correct conscious of contract, control the RAMS index of program by intimate cooperation with advisor and entrust advisor with technique support and supervision (Barabady et al. 2010). To improve the understanding toward RAMS management of railway employee by means of train and setting up regulations, and found the conscious of RAMS management, acknowledge the method and strategy of system assurance, support the advisor to manage RAMS index and offer help when needed.

61.5.2 Countermeasure to Problems Existed in the Advisor

To set up a perfect program of system assurance, advisor should organize professional employee in enterprise to make up RAMS team at first, which is especially in charge of drawing up program of system assurance. Furthermore, advisor should refer to international management experience, study and analyze EN50126 and some other RAMS management systems broadly applied in the world. RAMS team should set up the program of system assurance initially and pass it to the proprietor and contractor, sum up and improve after receive the feedback, and then draw up the formal program of system assurance.

61.5.3 Countermeasure to Problems Existed in the Contractor

Contractor should perfect the RAMS management system in program department, clarify the responsibility of quality position, and assign the responsibility of every person, perfect the regulation of position responsibility and methods of RAMS management test, enhance the self-checking, mutual checking and connecting checking. Furthermore, Contractor should positively make the RAMS management view and suggestion offered by advisor practicable, appoint specially-assigned person to take charge of work with high risk, and the person is directly responsible for person who is in charge of program. Set up the regulation concerning the report of RAMS troubles, analyze the problems affecting the quality of RAMS target during construction and adopt some measure to remedy, meanwhile strengthen the measure to prevent in advance. Carry out principle of "Never let the three off" when dealing with accidents, namely: Never let off until reason of accident is clarified, Never let off until person in charge of accident and related person received correspondent education, and never let off until measures of rectification and prevention are set up.

61.6 Case Studies of Rams Management Application in High-Speed Railway System

61.6.1 Problems Coping with RAMS Management in the Zhengzhou-Xi'an High-Speed Railway Construction Projects

Work tasks related to reliability, availability, maintainability, and security are discussed in detail in system assurance programs of Zhengzhou-Xi'an high-speed railway construction project including the assessment, management and verification. With reference to the European standard EN50126, work processes are developed in accordance with the actual situation of the project (British Standard Institution 1999; IEC 2278).

Hazard management program provides contractors/subcontractors with a systematic and consistent approach, which can identify, document, evaluate, and manage hazards in the Zhengzhou-Xi'an Passenger Dedicated Line. These hazards may cause potential harm to the passengers, crew, or other public. Hazard management action is summarized in the following five steps, risk identification, mitigation measures identified, mitigation measures implanted, owner audit and endangering close (Hassan and Gibreel 2002).

The hazard log contains all the hazards in the project implementation process. To meet the requirements of Zheng-Xi Company, the format of the international

Table 61.1 Main points of project hazards

Project name	Project definition
Project hazard coding	Each hazard has a definite coding, ensuring that the hazard can be clearly identified. The system is charged by the hazard management executor.
Hazard category	Hazard classification function can achieve the same kind of hazard classification, comparison and report described in detail below.
Hazard sub-category	In each hazard category, sub-categories are divided to further improve the classification process, described in detail below.
Hazard description	Description for the potential hazards or equipment loss.
Hazard reason	Description of events, conditions, environments that lead to the occurrence of such hazards. Each hazard has one or more reasons.
Existing solution	Measures that have been taken to mitigate safety hazards.
Preliminary rating	Before taking any measures, we can rate the hazards, based on the frequency and level.
Recommended solution	Recommend solutions to further reduce the hazard frequency, or the level of seriousness.
Final hazard frequency	The occurrence frequency of potential hazards, before taking relevant measures.
Final hazard seriousness	Assess the seriousness of the hazard, before taking measures.
Final hazard rating	Before taking any measures, we can rate the hazards, based on the frequency and level.
Hazard situation	Hazard situation within the final revision date, including the hazard identification, mitigation identification, mitigation measures, and customer audits.
Hazard owner	The project participants are able to take actions to relief/control the identifiable hazards. Recognized by the crowd: the owner, project consultancy team, designer, contractors and site supervisors.
Professional type	This is the more detailed classification of the hazard log. Some recognized directories: roadbed, bridges, tunnels, Sidian, stations/motor car office, rail and others.

standard will be suitably modified in the hazard classification and report (Yihong and Xiaoxia 2007; Pan and Chan 2005). Main points of project hazards log are shown in Table 61.1.

61.6.2 The RAMS Management Works Actually Carried out in the Zhengzhou-Xi'an High-Speed Railway Construction Project

1. Describe the system assurance and project risk management to the company directors, design units, construction units and resident supervisors, through a large number of conferences and lectures.
2. With reference to the international advanced experience and the actual situation in China, we can submit various versions of the system assurance and project

risk management programs, which should be timely, adjusted to make it more efficient in a changing environment.
3. Project risk log sheet is made to collect record and manage risks.
4. Identify the risks faced in this project, on the basis of review documents, construction site inspection and the different types of expert conferences in the past projects.
5. Communicate timely with Zheng-Xi Company through various channels, including oral communication, letters, and monthly risk management reports.

61.6.3 The RAMS Management Result and Evaluation

Thanks to the cooperation of owner, consultants and contractors, Zhengzhou-Xi'an high-speed railway project establish an effective RAMS management system, making the reliability, availability, maintainability and security meet the requirements of project, relevant government and owner. The owner and contractors actively accept consults' suggestions. They establish and improve the RAMS management system through good communication mechanisms. Consultant of the project is a tripartite commonwealth. Domestic partners and foreign partners make a clear division that foreign parties offer international work experience and domestic parties are responsible for specific integration.

As the relatively new kind of management style, RAMS management is recognized by owners, consultants, contractors and other stakeholders. Specifically, the RAMS management results of the project are as follows:

1. It can enhance the cognition of project risks and management, and increase the overall level of security.
2. Enhance the level of awareness of system guarantee works and increase the possibility of using the international system guarantee workflow in the China projects.
3. Make the Ministry of Railways learn more about a formal certification system of high-speed railway.

In the management process, there are other outcomes that can provide a reference to the future high-speed railway construction, and even other areas of the building project. In addition, further analysis and summary will be needed to establish a more perfect RAMS management system which can meet the requirements of the interests of all parties in the process of project management in the future.

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Chapter 62
The Research on Integration Methodology for Maintenance Support Resource

Jian Huang, Zhong-hua Cheng and Ya-bin Wang

Abstract Maintenance resource integration is a way to reduce the complexity in using and managing resource, improve maintenance efficiency, and reduce maintenance costs. In this paper, the basic idea of resource integration is studied, and a method of maintenance facilities integration is put forward. By this method, the maintenance facilities can be integrated reasonably and economically. It has universal applicability in resource integration, and can also integrate other maintenance resources. The scientific and practicality of the method are validated through application of examples.

Keywords Fuzzy clustering · Multi-attribute decision making · Resource integration · Similarity analysis

62.1 Introduction

Maintenance resource integration is an efficient way to optimize maintenance costs and improve support ability in equipments' life cycle, which is also beneficial to maintain operational readiness and enhance battle effectiveness of equipments. Along with the development of new technology and increasingly complex of

J. Huang · Z. Cheng · Y. Wang
Department of Equipment Command and Administration,
Ordnance Engineering College, Shijiazhuang, China

J. Huang (✉)
Department of Grassroots Service, Xiangyang Sergeant School
of Military Economy College, Xiangyang, China
e-mail: Huangjian1981_0521@163.com

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equipments, the requirements of maintenance resource become higher (Mao-zhi et al. 2009). As a result, how to allocate and integrate maintenance resource rationally in order to make maintenance more economic and higher quality turns into imminent need of equipment support departments.

But in actual maintenance work, resource programming is often determined by experts' experience or by reference to the known requirements of some similar equipment. It is just a simple list of resource requirements that would be probably used in maintenance, which maybe lead to redundancy of maintenance resources. This not only causes waste of resources, increases maintenance costs, but also makes the management of maintenance resources more difficult, reduce maintenance efficiency. Therefore, it is necessary to integrate maintenance resource to make full use of resource, reduce maintenance costs, and improve maintenance efficiency.

At present, the domestic and international research on the integration of maintenance resource is mostly in macroscopic view that is how to use new technologies and support methodologies to ameliorate the architecture of support system, optimize the allocation of support forces, and how to improve the resource utilization. Reference (Xue-yan et al. 2010) definitudes the connotation of civil-military integration equipment maintenance, and puts forward the elements integration from personnel, information, technology and material. In this paper, we focus on the redundancy of maintenance resource in microcosmic view, and put forward an approach to integrate varieties and amounts of maintenance resource. At last, an example is given to prove the approach available.

62.2 Integration Study

Maintenance resource includes many elements, such as personnel, spare parts, facilities, technology manuals and computers, etc. In this paper, we take maintenance facilities for example to introduce the method to resource integration. In actually, there are many similar facilities in equipment maintenance. These facilities have high similarity both in performance and in using condition, which could be possible to replace each other in maintenance. If all of them are set in equipment maintenance, some of them will be idle and maintenance costs will be higher. Therefore, we should simplify and optimize the varieties and amounts of facilities as possible as we can. Facilities integration should obey the principles as follows: (1) Facilities should be 'consolidated' and 'merged' in the case of not affecting equipment maintenance in order to simplify the varieties settings of them. (2) To optimize the using of facilities, such facilities, which are high comprehensive performance, simple to use, low cost, and easy to get, should replace other facilities, which are complex to repair, high cost, and difficult to get. (3) The varieties and amounts of facilities should be set as minimization as possible. Such integration can reduce complexity in use and management of facilities, improve maintenance efficiency, and reduce maintenance costs.

The approach of integration is as follows: (1) Similarity analysis. The basic idea of similarity analysis is to find out the facilities, which are quite similar in shape, size, function, performance and use requirement, by means of clustering analysis. We analyze the similarity of different facilities in performance shape, size and use requirement based on clustering to find out which ones could be used in the same condition. According to the clustering, the facilities which need to integrate will be found. (2) Integration. The facilities which are similar in both performance and using condition can be integrated. The best comprehensive performance ones should be selected as general facilities to replace all of them.

62.3 A Method of Facilities Integration

In this paper, an approach for facilities integration based on fuzzy clustering and multi-attribution decision making (MADM) is presented.

62.3.1 Similarity Analysis of Facilities

As we all known, there are many facilities using in equipment maintenance. Therefore, the facilities which can be 'consolidated' and 'merged' must be found out. A fuzzy clustering method is adopted to realize this purpose.

To integrate facilities, it needs to analyze their similarity in performance, shape, size and use requirement by clustering. That is whether these facilities can use in each other's environment, whether these facilities can meet the requirements of maintenance after replacement of each other. After the above clustering analysis, we will get a set of facilities which are most similar.

Assumptions: there are m kinds of requirement characteristics in performance, shape, size and use requirements. $A_k(i,j)$ is the fuzzy similarity between facility i and facility j in k requirement. The value of A_k is scored by the expert. Scoring rules are as follows:

$$A_k(i,j) = \begin{cases} 1 & \text{can replace each other} \\ 0.8 & \text{can replace in some conditions} \\ 0.2 & \text{have possibilit y to replace} \\ 0 & \text{cannot replace} \end{cases}$$

Construct the fuzzy similar matrix $R = (r_{ij})_{n\times n}$. r_{ij} is correlation degree of facilities, and equals to weighted average of fuzzy similarity between facilities under above requirements. As follows:

$$r_{ij} = \begin{cases} \sum_{k=1}^{m} \omega_k A_k(i,j) & i \neq j \\ 1 & i = j \end{cases} \tag{62.1}$$

In formula: ω_i is the weight of i requirement.

Establish fuzzy equivalence matrix $\hat{R}$. The fuzzy similar matrix is symmetry and its all diagonal elements are 1. Therefore, it has symmetry and reflexivity, but it maybe has not transitivity. We use transitive closure method (Dong-sheng and Ying 2011) to transform it into the fuzzy equivalence matrix $\hat{R}$.

Choose different threshold values $\lambda(\lambda \in [0, 1])$ for the fuzzy equivalent matrix and cluster facilities dynamically according to λ. The result of cluster analysis is dynamic. To get a more distinct classification, we need to determine an optimal threshold λ. Through comprehensive analysis, select the proper threshold to get the most similar facilities.

62.3.2 Facilities Integration

From the above analysis, a set of similar facilities will be gotten. Then, we should choose a best facility in comprehensive performance as general facility to replace others. To solve the problem, we use an extended VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) method, which is combined with interval fuzzy set concept and grey correlation analysis technique.

The steps as follows:

Step1: Organize a group of experts as decision-making team, and determine every attributes of each alternative.

Step2: Supposed there are n alternatives, m attributes in each alternative. Establish the decision matrix of triangular fuzzy interval number $\tilde{Z} = (\tilde{z}_{ij})_{m\times n}$ and the weight vector of attributes $\tilde{\omega} = [\tilde{\omega}_1\ \tilde{\omega}_2\ \mathrm{L}\ \tilde{\omega}_n]$.

$\tilde{z}_{ij}$ and $\tilde{\omega}_j$ represent as triangular fuzzy interval number, as follows:

$$\tilde{z}_{ij} = \left[\tilde{z}_{ij}^L, \tilde{z}_{ij}^U\right] = \left[\left(a_{ij}^U, a_{ij}^L\right), b_{ij}^{l,U}, \left(c_{ij}^L, c_{ij}^U\right)\right]$$
$$\tilde{\omega}_j = \left[\tilde{\omega}_j^L, \tilde{\omega}_j^U\right] = \left[\left(\omega_{ij}^U, \omega_{ij}^{L'}\right), \omega_{ij}^{L,U}, \left(\omega_j^L, \omega_j^U\right)\right]$$

$\tilde{z}_{ij}^L, \tilde{z}_{ij}^U$ and $\tilde{\omega}_j^L, \tilde{\omega}_j^U$ represent as the lower bound and upper bound of triangular fuzzy interval number. According to Tables 62.1 and 62.2, experts give the value of each attribute C_j and weight of each alternative A_i.

Step3: Determine the positive ideal point $\tilde{z}^+$ and negative ideal point $\tilde{z}^-$.

Step4: Calculate the weighted fuzzy grey relational coefficient γ_{ij}^+ between each alternative and the positive ideal, and γ_{ij}^- as negative ideal point.

Table 62.1 Linguistic description of attribute weights

Weight	Triangular fuzzy interval number
Very low	[(0, 0), 0, (0.1, 0.15)]
Fairly low	[(0, 0.05), 0.1, (0.25, 0.35)]
Low	[(0, 0.15), 0.3, (0.45,0.55)]
Medium	[(0.25, 0.35), 0.5, (0.65, 0.75)]
Important	[(0.45, 0.55), 0.7, (0.8, 0.95)]
Fairly important	[(0.55, 0.75), 0.9, (0.95, 1)]
Very important	[(0.85, 0.95), 1, (1, 1)]

Table 62.2 Linguistic description of attribute

Attribute	Triangular fuzzy interval number
Very poor	[(0, 0), 0, (1, 1.5)]
Fairly poor	[(0, 0.5), 1, (2.5, 3.5)]
Poor	[(0, 1. 5), 3, (4.5, 5.5)]
Medium	[(2.5, 3.5), 5, (6.5, 7.5)]
Good	[(4.5, 5.5), 7, (8, 9.5)]
Fairly good	[(5.5, 7.5), 9, (9.5, 10)]
Very good	[(8.5, 9.5), 10, (10, 10)]

$$\gamma_{ij}^{+} = \frac{\min\limits_{i} \min\limits_{j} d\left(\tilde{\omega}_j \tilde{z}_{ij}, \tilde{\omega}_j \tilde{z}_j^{+}\right) + \zeta \max\limits_{i} \max\limits_{j} d\left(\tilde{\omega}_j \tilde{z}_{ij}, \tilde{\omega}_j \tilde{z}_j^{+}\right)}{d\left(\tilde{z}_{ij}, \tilde{z}_j^{+}\right) + \lambda \max\limits_{i} \max\limits_{j} d\left(\tilde{z}_{ij}, \tilde{z}_j^{+}\right)} \tag{62.2}$$

$$\gamma_{ij}^{-} = \frac{\min\limits_{i} \min\limits_{j} d\left(\tilde{\omega}_j \tilde{z}_{ij}, \tilde{\omega}_j \tilde{z}_j^{-}\right) + \zeta \max\limits_{i} \max\limits_{j} d\left(\tilde{\omega}_j \tilde{z}_{ij}, \tilde{\omega}_j \tilde{z}_j^{-}\right)}{d\left(\tilde{z}_{ij}, \tilde{z}_j^{-}\right) + \lambda \max\limits_{i} \max\limits_{j} d\left(\tilde{z}_{ij}, \tilde{z}_j^{-}\right)} \tag{62.3}$$

ζ as distinguishing coefficient, we take $\zeta = 0.5$, and $\zeta \in [0.1]$.

Setp5: Calculate S_j, R_j, and Q_j of each alternative.

$$S_i = \sum_{j=1}^{n} \gamma_{ij}^{+} \tag{62.4}$$

$$R_i = \max_{j} \gamma_{ij}^{-}. \tag{62.5}$$

In formula: $i = 1,2,\ldots,m$; $j = 1,2,\ldots,n$.

$$Q_i = v \frac{(S^* - S_i)}{(S^* - S^-)} + (1 - v) \frac{(R_i - R^*)}{(R^- - R^*)} \tag{62.6}$$

In formula: $S^{*} = \max_{i} S_i$, $S^{-} = \min_{i} S_i$, $R^{*} = \min_{i} R_i$, $R^{-} = \max_{i} R_i$, v represent **. When $v > 0.5$, it represent decision by opinion of most people. When $v = 0.5$, it represent decision by consensus of decision maker. When $v < 0.5$, it represent decision by refuse. Usually, let $v = 0.5$.

Step6: According to the value of Q_i, rank the alternatives.

62.4 Case Study

A certain type of anti-aircraft artillery system is the most advanced next-generation short-range air defense systems. There are 5 kinds of DC regulated power supply used in the system. We take these powers for example to explain the method of facilities integration.

62.4.1 Similarity Analysis in Utilization Interchangeability

Select 4 factors which affect DC power using: input and output, weight, size, reliability. Give each one appropriate weight {0.6, 0.1, 0.1, 0.2}. According to the scoring rules, value the fuzzy similarity between powers by experts. According to the formula 62.4, calculate correlation degree and establish fuzzy similar matrix R. Then transform matrix R into fuzzy equivalence matrix $\hat{R}$, as Table 62.3:

According to the results in Table 62.4, cluster by threshold λ. The dynamic clustering diagram is as Fig. 62.1. After comprehensive analysis, we can conclude: $\lambda = 0.86$, classification is {1, 2, 4, 5}, {3}

Table 62.3 Fuzzy equivalence matrix

	1	2	3	4	5
1	1	0.86	0.94	0.94	0.44
2		1	0.86	0.86	0.44
3			1	0.94	0.44
4				1	0.44
5					1

Table 62.4 Weight of each alternative

Attribute	Triangular fuzzy interval number of weight
C_1	[(0.665, 0.798), 0.902, (0.940, 0.989)]
C_2	[(0.810, 0.924), 0.987, (0.993, 1)]
C_3	[(0.301, 0.447), 0.597, (0.712, 0.794)]
C_4	[(0.702, 0.829), 0.923, (0.953, 0.992)]
C_5	[(0.141, 0.246), 0.443, (0.529, 0.629)]
C_6	[(0.194, 0.299), 0.443, (0.593, 0.693)]

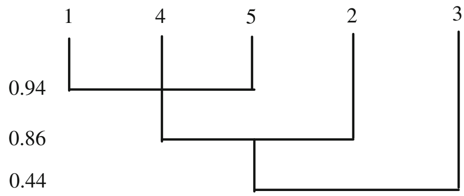

Fig. 62.1 Dynamic fuzzy clustering diagram

Table 62.5 Attribute value of each alternative

	A_1	A_2
C_1	[(7.177, 8.486), 9.377, (9.630, 9.891)]	[(7.384,8.638), 9.481, (9.696, 9.956)]
C_2	[(7.501, 8.834), 9.667, (9.834, 10)]	[(7.365, 8.671), 9.532, (9.739, 9.973)]
C_3	[(7.704, 8.969), 9.735, (9.867, 10)]	[(7.281, 8.547), 9.418, (9.656, 9.947)]
C_4	[(7.641, 8.927), 9.714, (9.857, 10)]	[(6.958, 7.138), 8.819, (9.110, 9.511)]
C_5	[(7.752, 8.940), 9.751, (9.875,10)]	[(8.021, 9.181), 9.840, (9.920, 10)]9
C_6	[(7.660, 8.940), 9.720, (9.860,10)]	[(7.710, 8.974), 9.737, (9.868, 10)]
	A_3	A_4
C_1	[(7.011, 8.011), 8.853, (9.226, 9.710)]	[(6.153, 7.492), 8.552, (9.054, 9.445)]
C_2	[(6.375, 7.766),8.816, (9.249, 9.604)]	[(7.333, 8.650), 9.521, (9.734, 9.973)]
C_3	[(7.387, 8.758), 9.629, (9.814, 10)]	[(4.792, 6.572), 8.072, (8.798, 9.411)]
C_4	[(7.641,8.927),9.714,(9.857,10)]	[(5.919, 7.187), 8.252, (8.830, 9.260)]
C_5	[(6.737, 8.325), 9.412, (9.706, 10)]	[(6.236, 7.610), 8.674, (9.147, 9.524)]
C_6	[(7.586, 8.830), 9.619, (9.787, 9.977)]	[(3.648, 5.094), 6.404, (7.363, 8.092)]

62.4.2 Facilities Integration

From the conclusion of similarity analysis, we know power 1, 2, 4, 5 can integrate. We choose one kind of power to replace others, which have high comprehensive performance, and are simple to repair, low cost, easy to get.

Supposed each power as an alternative, remarked A_1–A_4. Comprehensively consider power's reliability C_1, using amount in maintenance C_2, easy to get C_3, operational complexity C_4, purchase cost C_5, and management costs C_6, use VIKOR method to choose the best one.

According to the decision of experts, the value of each attribute C_j and weight of each alternative A_i are given in the Tables 62.4 and 62.5.

Determine the positive ideal point $\tilde{z}^+$ and negative ideal point $\tilde{z}^-$. For calculation simply, regard them as limit:

$$\tilde{z}^+ = \left\{ \begin{array}{l} [(10,10),10,(10,10)],[(10,10),10,(10,10)],[(10,10),10,(10,10)], \\ [(10,10),10,(10,10)],[(10,10),10,(10,10)],[(10,10),10,(10,10)] \end{array} \right\}$$

$$\tilde{z}^- = \left\{ \begin{array}{l} [(0,0),0,(0,0)],[(0,0),0,(0,0)],[(0,0),0,(0,0)], \\ [(0,0),0,(0,0)],[(0,0),0,(0,0)],[(0,0),0,(0,0)] \end{array} \right\}$$

Table 62.6 Weighted grey relational coefficient of each alternative

	C_1		C_2		C_3		C_4		C_5		C_6	
	γ_{ij}^{+}	γ_{ij}^{-}	γ_{ij}^{+}	γ_{ij}^{-}	γ_{ij}^{+}	γ_{ij}^{-}	γ_{ij}^{+}	γ_{ij}^{-}	γ_{ij}^{+}	γ_{ij}^{-}	γ_{ij}^{+}	γ_{ij}^{-}
A_1	0.661	0.536	0.692	0.528	0.709	0.525	0.703	0.526	0.713	0.524	0.705	0.526
A_2	0.679	0.532	0.676	0.532	0.665	0.536	0.589	0.562	0.738	0.521	0.710	0.525
A_3	0.622	0.551	0.587	0.559	0.682	0.530	0.703	0.526	0.632	0.539	0.695	0.529
A_4	0.564	0.569	0.674	0.533	0.494	0.592	0.540	0.580	0.573	0.564	0.407	0.668

Table 62.7 Rank and result

	S_i	R_i	$Q_i(v = 0.5)$	Rank
A_1	4.183	0.536	0	1
A_2	4.057	0.562	0.166	2
A_3	3.921	0.559	0.228	3
A_4	3.252	0.668	1	4

According to formula 62.2 and 62.3, calculate the grey relational coefficient γ_{ij}^{+} and γ_{ij}^{-}, let $\zeta = 0.5$. Result in Table 62.6:

According to formula 62.4 and 62.5, calculate value of S_i and value of R_i., result in Table 62.7:

Finally, we know power 1 is the best one and choose power 1 as the final general facility.

62.5 Conclusion

To sum up, reasonable integration can economize maintenance resource, improve support efficiency. The approach purposed in this paper can effectively integrate facilities, and reduce maintenance costs. It is a universal method, and can also integrate other maintenance resource.

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Chapter 63
The Research on Trust Mechanism Between Client and Contractor in Construction

Yao Wang and Yi-lin Yin

Abstract Trust between client and contractor in construction has been widely accepted as the contributor to improve project performance. Therefore, revealing the black box of trust mechanism has theoretical value and practical demand. According to previous research, this paper seeks to construct a dynamic framework of trust so as to analyze the process of trust building and changing. As a study consequence, the critical factors of initial trust building and the disturbance factors of dynamic changing are identified through literature review and theoretical analysis. These findings will be used to do the empirical study of the future research.

Keywords Client and contractor · Construction projects · Dynamic changing · Initial trust · Trust mechanism

63.1 Introduction

Trust is a fundamental ingredient of social interaction or an essential part of business transaction that demands contributions from the parties involved (Williamson 1993). In recent years, a considerable literatures have emerged on the relationship between trust and project management, the trust has been widely accepted to be the critical factor to improve project management performance (Pinto et al. 2009; Wong et al. 2008). Previous studies on trust between client and

Y. Wang (✉) · Y. Yin
Department of Management and Economics, Tianjin University,
Tianjin, People's Republic of China
e-mail: elitewy@163.com

Y. Yin
School of Management, Tianjin University of Technology,
Tianjin, People's Republic of China

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contractor in construction projects suggest that the trust will effectively drive project success through project partnering (Black et al. 2000), information sharing based on knowledge management (Teerajergul et al. 2009), efficient risk allocation (Jin and Ling 2005), construction contract terms design (Zaghloul and Hartman 2003). Meanwhile, in the practical field, if client and contractor in the construction contracting do not trust each other, it will certainly result in inefficiency of projects management, cooperative dilemma, even project failure (Wong et al. 2008). Therefore, in order to performance improvement, it is of significant importance for client and contractor to understand the trust mechanism of construction project. This article is aim to propose a fundamental analytical framework of trust mechanism, preliminarily reveals how trust can be fostered and dynamically changes during the construction project duration.

63.2 Literature Review

63.2.1 The Nature and Forms of Trust

Trust is a multi-disciplinary, multi-dimensional concept, so there are different definitions and types about trust. From perspective of psychological, Rousseau et al. (1998) pointed that trust is a psychological state comprising the intention to accept vulnerability based upon positive expectation of the intentions or behaviors of another. In view of transaction cost economics, trust is the behavior about economic expectation, it means that trading parties have relevant abilities to do the business and have common will to avoid opportunism behavior (Luo 2005). Now, in construction, several alternative models of the trust have been proposed. In the research of construction projects, two kinds of trust model are the basic forms and widely agreed. In an attempt to advance the conceptual understanding of the trust, Hartman (2000) developed a model of trust which includes the trust based on ability and competence, trust based on integrity and the trust based on intuition. The trust concept of Lewicki and Bunke includes three basic forms, that is,at its lowest form, trust takes form of deterrence-based trust, the second level of trust is termed knowledge-based that relies on information, the highest level of trust is identification-based trust (Lewicki and Bunker 1996).

63.2.2 The Trust and Context of Construction Project

In some papers, many researchers have suggested that realistic situation of construction projects is beneficial to build trust between client and contractor. Bhattacharya et al. has pointed that trust will exists in an uncertain and risky environment (Luo 2005), Rousseau et al. (1998) also agreed that parties in contracts need trust each other to reduce risk, promote exchange, especially for complex construction projects that are exposed to uncertainty and high risk, and coupled with the problems of imperfect information.

Although many insights have been given into the richness of the trust research, there is still considerable confusion about the complex and slippery concept, for example, (1) the determinants of trust at the beginning of the project, and (2) the dynamic evolution of trust during the implementation of project.

63.3 The Analytical Framework of Trust Mechanism

From the perspective of project governance theory, project is the temporary contract organization, due to divergent interests of the client and contractor, in limited time span, building trust is very difficult. Hence, trust relationship between client and contractor need relies on trust signaling at the beginning of the project. The relevant research result shows that at bidding stage, the antecedents of the trust have important influence on trust building, such as reputation, competency (Jiang et al. 2011). And, at the contract negotiation of project, the gain/pain share agreement is also known as a good risk allocation scheme, which is beneficial to trust building (Kadefors 2004). Based on these literatures, it is possible to identify the critical factors of initial trust literature review and theoretical analysis.

As a psychological state, the level of trust during the implementation of project is either growing or diminishing (Walke et al. 2008), it is a dynamic process because of some factors, such as different views of project management between client and contractor, engineering changes, operational efficiency of communication system.

And then, at the end of project, the level of trust will be fixed, the project performance and client/contractor management ability will be transformed into the market signaling through market mechanism.

In sum, the framework of trust mechanism is shown in Fig. 63.1. This paper reports a two-stage study for this purpose, the main research contents include:

1. Review the trust dimensions of the construction projects, identity the critical factors of initial trust.
2. Propose the dynamic disturbance factors of trust which will appear at the implementation phrase.

63.4 The Establishment of Initial Trust

Client and contractor do interaction of project management through bidding and contract negotiation at the beginning of project, with the environment of imperfect information, they need show more trust signal at the beginning so as to build the

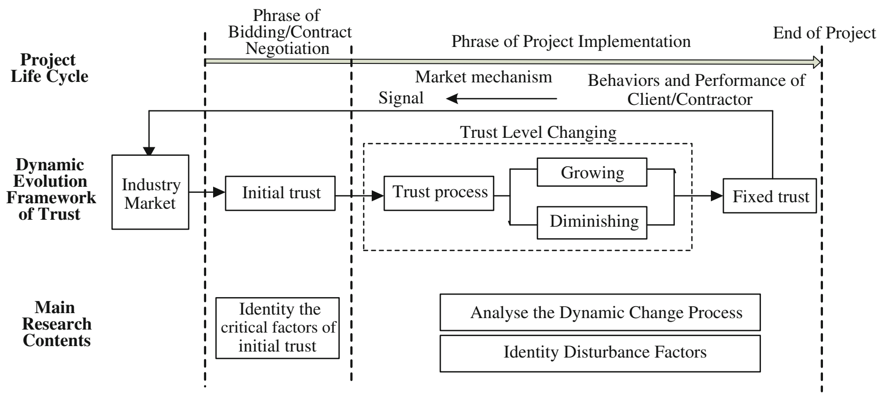

Fig. 63.1 Basic research framework of trust mechanism

trust relationship, what are the factors that have an effect on initial trust building? In construction, the initial trust is often affiliated with the contract clause design, reputation of client/contractor, competence of project management, and so on. Table 63.1 gives a statistic summary of factors that would affect the initial trust building. From this table, the reputation, contract term design and the competence are widely analyzed. In addition, some researchers also put forward other facets, such as the long-term cooperation, compatibility.

Following are the main critical factors of initial trust, and the descriptions for these attributes:

63.4.1 Trust Based on Reputation and Competence

Reputation of market: the reputation is the valuable asset, especially for the contractor. Because the contractor with better reputations are more trustworthy, it means the constructed projects that the contractor have done have high performance. Of course, the reputation of client in the market, such as settlement of progress payment, is also the attentive focus of contractor.

Competence of management: the competence primarily involves financial, risk management. They are the important elements in building trust. For example, the contractor or client with healthy financial status is trustworthy in views of the other party, because the risk to make a profit by unreasonable claims is lowered. In construction industry, no project is risk-free, the special technology ability to cope with substantial risks is a significant contributor to the project success. The contractor who has the high level technology is the competitive advantage.

Table 63.1 Statistic Summary Of Initial Trust Building Attributes

Literatures	Factors						
	Reputation	Contract terms	Competence	Organization policy	Long- term cooperation	Common objective	Compatibility
(Wong et al. 2005)	√	√	√		√		
(Jin and Ling 2005)	√	√		√		√	√
Cheung et al. (2011)	√	√	√	√			
Pinto et al. (2009)			√				√
Laan (2008)	√	√		√			√
Girmscheid et al.(2010)	√						
Lau and Rowlinson (2011)	√	√	√		√	√	
Jiang et al. (2011)	√	√	√				
Aubert and Kelsey (2000)	√	√	√				
Eriksson and Westerberg (2011)	√		√				
Frequency (L/N)	9/10	7/10	7/10	3/10	2/10	2/10	3/10

63.4.2 Trust Based on Contract Terms

Risk allocation: equitable agreements of risk during the negotiation can help the client and contractor to establish trust, because the equitable agreements are the signal of no opportunism behavior. Benefits should be fair and match with the efforts of client/contractor, otherwise mistrust will be formed.

Adopt ADR: the contract term of ADR states that the contract parties will seek a win/win resolution sincerely without destroying the cooperation harmony.

63.5 The Dynamic Evolution of the Trust

Despite the trust has been established at the beginning of the project, the initial trust is only the kind of general trust without verification, it is the expectation based on signaling. In fact, trust level is much more sensitive to the behavior/outcomes of project management, it is often associated with the different disturbance factors (Wong and Cheung 2004).

During the construction of project, the client and contractor have already worked together over a period of time, so the communication system between the partners has become a platform to enhance the face-to-face trust. On the other hand, the process performance will make the client or contractor to reconsider the competence, unity and actions of the partner, this will inevitably affect the dynamic changing of trust level.

Based on the analysis above, this research categorizes the disturbance factors into two types, performance factors and interaction factors are shown in Fig. 63.2.

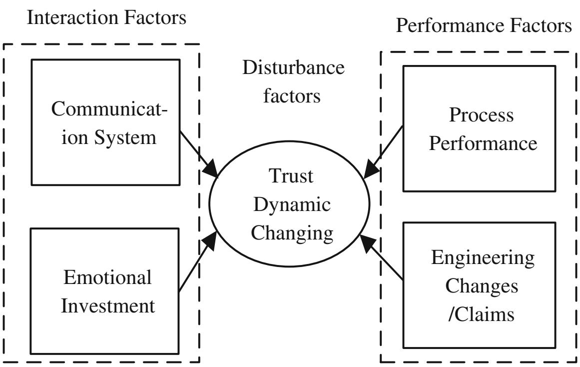

Fig. 63.2 The disturbance factors of trust

63.5.1 *Performance Factors*

Process performance: during the phased assessment of project, process performance is the focus. If the construction quality does not meet the contract requirements or quality standard, the trust based on reputation and ability will reduce.

Engineering changes/Claims: engineering changes are very common in construction projects. When the client and contractor have different views about the construction conditions, such as geological conditions and force majeure, the claims will appear. Whether or not the dispute is friendly resolved will directly affect the trust relationship between the partners.

63.5.2 *Interaction Factors*

Communication system: communication system defines the channels for interactions of the temporary project organization; trust will be enhanced through the effective system of workshops, project meetings. Information flow will reduce the uncertainty of the risk and claims. Through the system, client and contractor who provide unbiased and useful information will avoid the misunderstanding of project, increase their mutual trust.

Emotional investment: trust is the state of psychological, so it does not develop instantaneously. From the Emotional Quotient management (EQ), emotional investment during the implementation of project is the better way to understand the feelings of the other parties. Spending more time and efforts to listen the impression of the other parties, especially when facing to the project conflict, will eliminate the frictions between them, and it is the positive signal to trust growing.

63.6 Conclusion

In construction, trust between client and contractor has initial formation and dynamic evolution characteristics. The trust level will change with project cycle, project activities and project environment. Therefore, this study reveals the black box of trust in project relationships. Firstly, a trust framework has established based on project life cycle. Secondly, the study identified two types of the initial trust: trust based on trust based on reputation and competence, trust based on contract terms; analyzes two types of the disturbance factors: interaction factors, performance factors.

A series of project management experts will be interviewed, and the scale development of trust in construction cultural context will be done. The constructs of the framework and the relevant factors will be tested empirically through technique of structural equation modeling in future research.

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Chapter 64
Reliability Analysis on Shell Design of Large Oil Storage Tanks

Wang He, Li-chuan Liu and Jin-lin Yang

Abstract The paper studies the procedures of the shell design and reliability analysis of large oil tanks and presents the results of calculation and analysis on the strength-stress model of tanks' wall reliability by checking point's method. Taking a 100,000 m^3 tank for example, shown is the analysis and calculation on the reliability of the wall design with different numbers of shell courses, and also resulted is the numbers of shell courses based on the reliability of the holistic tank wall.

Keywords Large oil tank · Tank-wall design · Shell thickness · Shell course · Structural reliability

64.1 Introduction

Usually, the amount of steel used in a tank wall would be 50 % of the whole used. So the design of a tank wall doesn't only affect its function and reliability, but also does its cost. According to the requirement for a tank's strength, its wall thickness should increase linearly along with static hydraulic pressure from top to bottom. However, in engineering practice, the wall of tanks is made of the steel-plates with different thickness. On the premise of optimal radius and height, here more important is what steel-plate width of the shell courses could keep higher reliability of the holistic tank-wall. Therefore, based on the design of tank-wall, analyzed is reliability of a tank-wall structure.

W. He (✉) · L. Liu · J. Yang
Department of Petroleum Supplying Engineering, Logistical Engineering University, Chongqing 401311, China
e-mail: hewang326@163.com

L. Liu
e-mail: licliu@sina.com

J. Yang
e-mail: yangjinlin9075@163.com

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64.2 Methodology

64.2.1 Wall Design

On the basis of design capacity and least amount of material used, the formula of calculating the tank-wall-height with different thickness of shell plates can be described as Eq. (64.1)

$$H = \sqrt{\alpha\lambda} \tag{64.1}$$

where H is tank-wall-height (m);α is a coefficient, related to tank design parameter; λ is thickness summation of tank-bottom and tank-roof. With the above equation, the tank diameter and height could be defined as the basic structure parameters of a designed tank.

The wall design of oil steel tank (Huang 1999; Wu et al. 2009) can be divided into two groups, with the same and different shell wall thickness. The capacity below 1,000 m^3 is more economic with the former, while the tanks with a larger capacity should be designed of the variable shell thickness. So the thickness of every course decreases along with the wall from bottom to top. A floating-roof tank should keep the all courses with the same diameter, inside for the floating tray available to move up and down. The maximum stress of every course is at the point a little higher than the bottom of shell course end because of the below course's hoop stress. The one-foot method (Pan et al. 1986; Shuai et al. 2006), usually, is applied in the tanks with a diameter less than 60 m. However, it is not irrational for the tanks with diameter more than 60 m, so the variable point method (Pan et al. 1986; Shuai et al. 2006; Zhang 2001) is applied to reduce the required shell thickness with the same allowable stresses. In order to determine the position of the maximal stress of every course-plate, the impact between the shell wall's courses is considered in the wall-thickness calculation called as the variable point method. The variable point calculation of the wall-thickness of oil tanks is shown as followed.

The bottom shell course thickness of tanks can be obtained from the following expression (Myers 1997):

$$t_{01} = \frac{\gamma(H - 0.3)D}{2[\sigma]\eta} \text{ or } t_{01} = \left[1.06 - \frac{0.0696D}{H}\sqrt{\frac{H}{[\sigma]\eta}}\right]\frac{9.8HD}{2[\sigma]\eta} \tag{64.2}$$

where t_{01} is the design thickness of the wall bottom course, mm; H is the uprightness height from bottom of shell to top angle or to bottom of overflow, m; D is the nominal tank diameter, m; γ is the per- weight of the liquid, t/m^3; η is joint efficiency; $[\sigma]$ is the steels allowable design stress for calculating plate thickness, and taken by minimum between $0.75\sigma_s$ and $\frac{3}{7}\sigma_b$ (MPa).

The thickness of the second shell course of tank wall is calculated by the following procedures. When the bottom shell course of the wall-thickness t_{01} has been calculated, the width of the course-plate should be judged first by the following three governing conditions and then the thickness of the second shell course given by the respective expressions (Myers 1997):

$$\begin{aligned} &\frac{h_{i-1}}{\sqrt{Rt_{0(i-1)}}} \leq 1.375, \quad t_{0i} = t_{0(i-1)}. \\ &\frac{h_{i-1}}{\sqrt{Rt_{0(i-1)}}} \geq 2.625, \quad t_{0i} = t_{ai}. \\ &1.375 < \frac{h_{i-1}}{\sqrt{Rt_{0(i-1)}}} \leq 2.625, \end{aligned} \tag{64.3}$$

$t_{0i} = t_{ai} + (t_{0(i-1)} - t_{ai})(2.1 - \frac{h_{i-1}}{1.25\sqrt{Rt_{0(i-1)}}})$ where h_{i-1} is the height of bottom shell course, m; R is the tank radius, m; t_{0i} is the final thickness of the ith shell course, mm; t_{ai} is the thickness of the ith shell course by the variable point method, mm. t_{ai} can be obtained by resolving the following equations (Myers 1997).

$$t_{ai} = \frac{\gamma(H_i - X_i)D}{2[\sigma]\eta} \tag{64.4}$$

$$\begin{aligned} X_{i1} &= 0.61\sqrt{Rt_{ai}} + 0.32\, C_i H_i \\ X_{i2} &= C_i H_i \\ X_{i3} &= 1.22\sqrt{Rt_{ai}} \\ X_i &= \min(X_{i1}, X_{i2}, X_{i3}) \end{aligned} \tag{64.5}$$

where H_i is the hydraulic height of the ith shell course's bottom, m; K_i is the distance above the lower end of the ith shell course; $C_i = \frac{(K_i-1)\sqrt{K_i}}{1+K_i\sqrt{K_i}}$; K_i is thickness lower course at joint/thickness upper course at joint, equated with ${}^{t_{0(i-1)}}/_{t_{ai}}$; others are the same as the meaning shown above.

The thickness of the upper shell courses is related with the thickness of lower shell courses. The thickness of each course is determined by a common stress, and the theoretical location of the design point is at a variable distance above the bottom of the course. The distance is lowest value obtained from the above expressions (64.4) and (64.5).

64.2.2 Reliability Analysis of Tank Wall

Every engineering design should be provided with certain of its reliability, and so does the wall design of oil tanks. The reliability of structures is defined as the probability that the structure performances its function during a certain period of time and in the designed condition (Zhao et al. 2000).

In the cases of static loading, stress-strength interference model is usually followed as the invalidation physical model in the reliability design of static structures.

Then limit state equation (Zhao et al. 2000) can be expressed by:

$$y(r,\, s) = r - s \tag{64.6}$$

where r is the strength; s is the hoop stress.

When the distributing for the random variables is known, the reliability can be calculated by the following equation (Shuai et al. 2006):

$$\mathrm{R(t) = P(y\ > 0)} = \iint\limits_{r>s} f_r(r) f_s(s) drds. \tag{64.7}$$

where R(t), P, $f_r(r), f_s(s)$ are reliability degree, probability, density function about strength, density function about stress.

In engineering practice, it is complex even almost impossible to calculate the above integral with an explicit result, even if the simplest functional function (Zhao et al. 2000). According to the engineering statistical investigation, random variables about stress and strength would follow the normal distribution or logarithm normal distribution model. When random variables are assumed as normal distribution and independent one another, the reliability could be expressed as (Zhang 2001)

$$R(t) = 1 - \Phi\left(-\frac{\mu_r - \mu_s}{\sqrt{\sigma_r^2 + \sigma_s^2}}\right) = \Phi\left(\frac{\mu_r - \mu_s}{\sqrt{\sigma_r^2 + \sigma_s^2}}\right) \tag{64.8}$$

where $\mu_r,\ \mu_s$ are the average of strength and stress and $\sigma_r,\ \sigma_s$ are the standard deviation of strength and stress.

Let

$$\beta = \frac{\mu_r - \mu_s}{\sqrt{\sigma_r^2 + \sigma_s^2}}, \tag{64.9}$$

And then,

$$R(t) = \Phi(\beta) \tag{64.10}$$

If can be shown that the parameter β indicate the reliability of tank shell.

The reliability model about tank wall is a weakest-chain or series model as the following (Dai and Wang 1986).

$$R(t) = \prod_{i=1}^{n} R_i(t) = \prod_{i=1}^{n} \Phi(\beta_i) \tag{64.11}$$

There are several methods to calculate β, such as central point, checking points, mapped transform, practicality analysis, etc. Here, checking points is applied to calculate the reliability index of tank wall and analyze its effect on shell courses on tank wall to be analyzed.

According to membrane theory, the stress in the wall of vertical cylindrical tank (Myers 1997) is given by:

$$s = \frac{PD}{2t} \tag{64.12}$$

where s is the hoop stress; P is the liquid pressure; t is the uniform thickness of shell, equated with t_{0i}.

So, the limit state equation becomes

$$\begin{aligned} y(r,s) &= g(X_1, X_2, \ldots, X_n) = r - s = r - \frac{PD}{2t_{0i}} \\ &= r - \frac{\rho g[20-(i-1)h_i]D}{2t_{0i}} = r - \frac{\omega D}{t_{0i}} = 0 \end{aligned} \tag{64.13}$$

where ω is a coefficient and constant to every course with the designed shell width. By the above limit state equation, there are three random variables. In order to decide the design-check points for the reliability, the values of these random variables at the design-check point need to be calculated as the following.

$$\begin{aligned} r^* &= \mu_r + \beta\sigma_r \cos\theta_1 \\ D^* &= \mu_D + \beta\sigma_D \cos\theta_2 \\ t_{0i}^* &= \mu_{t_{0i}} + \beta\sigma_{t_{0i}} \cos\theta_3 \end{aligned} \tag{64.14}$$

where $\cos\theta_{X_i}$ is sensitivity coefficient, which can be given by:

$$\cos\theta_{X_i} = \frac{-\frac{\partial y}{\partial X_i}\Big|_{p^*}\sigma_{X_i}}{\sqrt{\sum_{i=1}^{n}\left(\frac{\partial y}{\partial X_i}\Big|_{p^*}\sigma_{X_i}\right)^2}}$$

$$\begin{aligned} \cos\theta_1 &= \frac{-\sigma_r}{\sqrt{(-\sigma_r)^2 + \left(\sigma_D\frac{\omega}{t^*}\right)^2 + \left(-\sigma_{t_{0i}}\frac{\omega D^*}{t_{0i}^{*2}}\right)^2}} \\ \cos\theta_2 &= \frac{\sigma_D\frac{\omega}{t^*}}{\sqrt{(-\sigma_r)^2 + \left(\sigma_D\frac{\omega}{t^*}\right)^2 + \left(-\sigma_{t_{0i}}\frac{\omega D^*}{t_{0i}^{*2}}\right)^2}} \\ \cos\theta_3 &= \frac{-\sigma_{t_{0i}}\frac{\omega D^*}{t_{0i}^{*2}}}{\sqrt{(-\sigma_r)^2 + \left(\sigma_D\frac{\omega}{t^*}\right)^2 + \left(-\sigma_{t_{0i}}\frac{\omega D^*}{t_{0i}^{*2}}\right)^2}} \end{aligned} \tag{6.15}$$

Put the average of every random variable as test checking point $P_0(\mu_r, \mu_D, \mu_{t_{0i}})$, and make the following equation balanced.

$$\begin{aligned} & A\beta^2 + B\beta + C = 0 \\ & \quad A = \sigma_r \sigma_{t0i} \cos\theta_1 \cos\theta_3 \\ & \quad B = \sigma_r\, \mu_{t_{0i}} \cos\theta_1 + \mu_r \sigma_{t_{0i}} \cos\theta_3 - \omega\sigma_D \cos\theta_2 \\ & \quad C = \mu_r\, \mu_{t_{oi}} - \mu_D \omega \end{aligned} \tag{64.16}$$

where, μ_r, μ_D, $\mu_{t_{oi}}$ are the average of strength, diameter and t_{0i}; σ_r, σ_D, $\sigma_{t_{0i}}$ are the standard deviation of strength, diameter and t_{0i}. Cyclic iterative method can be used to calculate the checking points and β for different courses and different thickness.

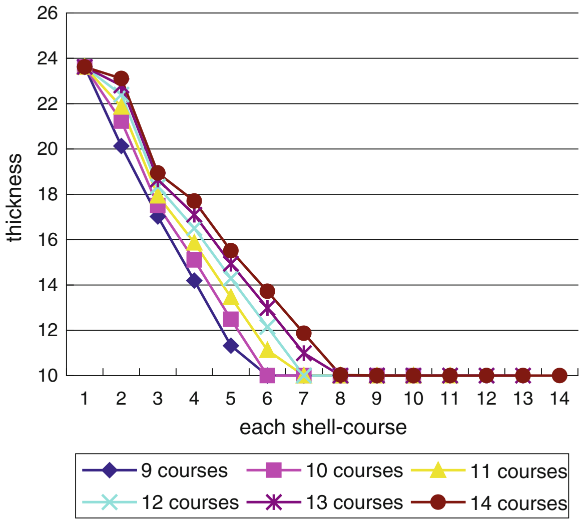
64.2.3 Example Case

Taken consideration of is the case: the volume capacity of the tank is: 100,000 cbm, steel material: thickness range: 10–34 mm, strength: 610–730 MPa, yield stress r: 490 MPa, allowable stress $[\sigma]: 327\,\text{MPa}$, shell width: 1,000–3,000 mm, store liquid density $\rho: 1,000\,\text{kg/cm}^3$, variation coefficient of strength limitation : 0.05–0.1, variation coefficient of steel-size : 0.03–0.05.

First, according to (64.1), H is 21.8 m, set it into 22 m, For the 100,000 cbm of volume capacity, the diameter is about 80 m.

Then, suppose tank made of the same width shell-course, number of shell-course is from 7 to 14 for a tank-wall. The wall thickness is calculated by compiling the program of Microsoft Visual Basic 2005. If the steel width h_{i-1} is known, the wall thickness can be obtained. As shown in Fig. 64.1 is the wall thickness with different course-number.

Fig. 64.1 Thickness of every shell-course with different numbers of shell-course



And then, in order to calculate the reliability index, the average and standard deviation of three random variables must be known.

The variation coefficient of strength limitation gets 0.05–0.1 and that average gets the geometry size and criterion deviation gets 1/3 deviation for its statistical meaning (Dai and Wang 1986). 0.1 is used as the variation coefficient of strength, namely $\mu_\sigma = 490, \sigma_\sigma = 49\,\text{MPa}$. Literature (Tan 2004) points out that $D \geq 76\,\text{m}$, $\sigma_D = 0.021$, namely $\mu_D = 80, \sigma_D = 0.021\,\text{m}$. Given the courses, thickness can get a fixed value, which can act as average of wall thickness. 0.04 is used as the variation coefficient of the thickness of tank-wall.

In order to calculate reliability indices, a program is compiled and calculated checking points and reliability indices β for different shell-course number and different thickness. The results of the calculation are shown in the following (Sun et al. 2002).

64.3 Results and Discussions

Wall thickness is not variable with different numbers of shell-course at bottom course in Fig. 64.1. The steel consumption amount in volume about the whole tank-wall becomes fewer with numbers' increasing as a whole in Fig. 64.2. Reliability is relatively higher when the thickness calculated less than the maximum that design-code requires in Figs. 64.3 and 64.4. Reliability of the second shell-course is increasing with shell-course number increasing, that is to say, the

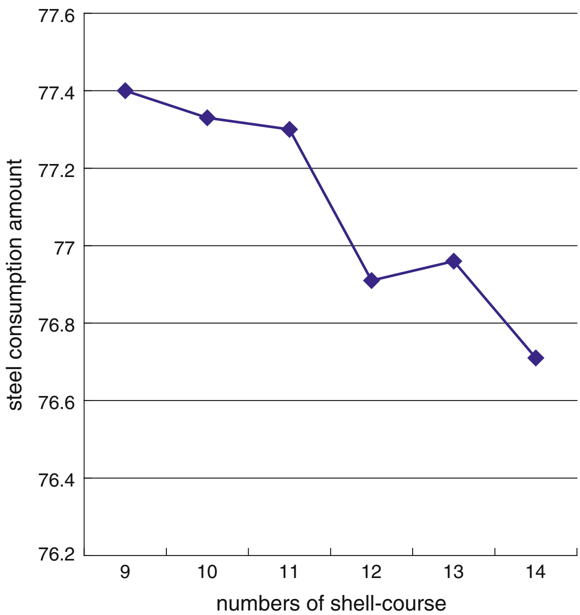
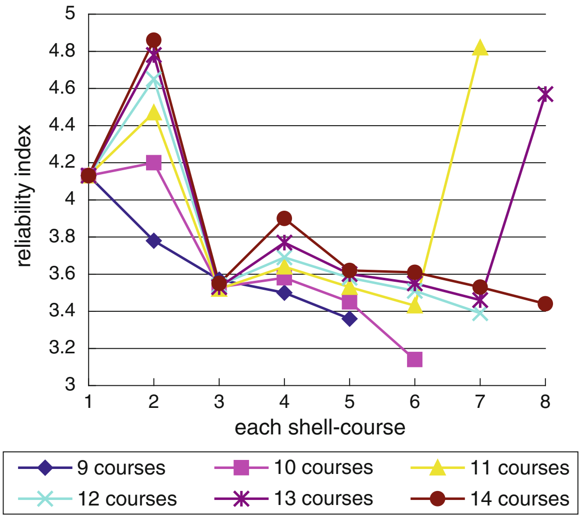


Fig. 64.2 Steel consumption amount in volume about tank wall with different numbers of shell-course

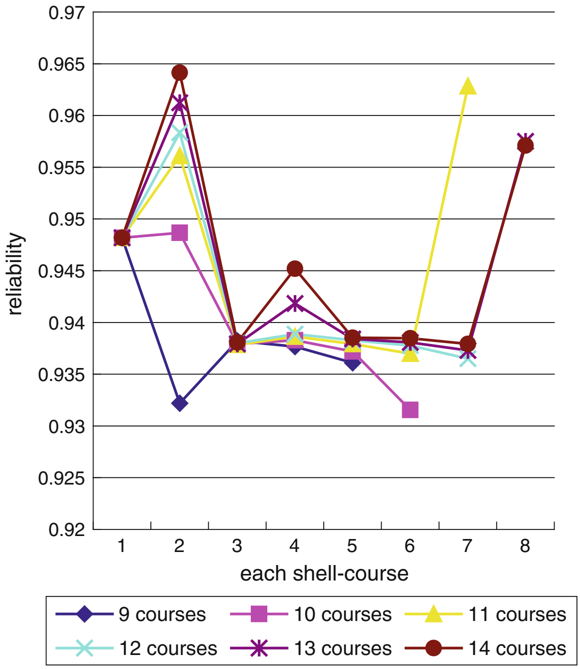
Fig. 64.3 Reliability index of every shell-course with different numbers of shell-course



lower are numbers of shell-course, the more obvious is the influence from the restraint of the tank bottom in the shell-course design.

The heights of minimum thickness and numbers of shell-course have several impacts on tank-wall's whole reliability and steel consumption amount for large tanks in Figs. 64.5 and 64.6. There is one shell-course number to make whole

Fig. 64.4 Reliability of every shell-course with different numbers of shell-course



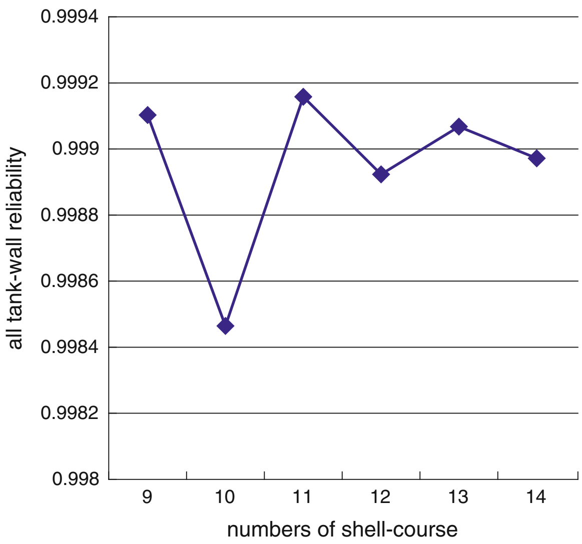


Fig. 64.5 Reliability of the whole tank-wall with different numbers of shell-course

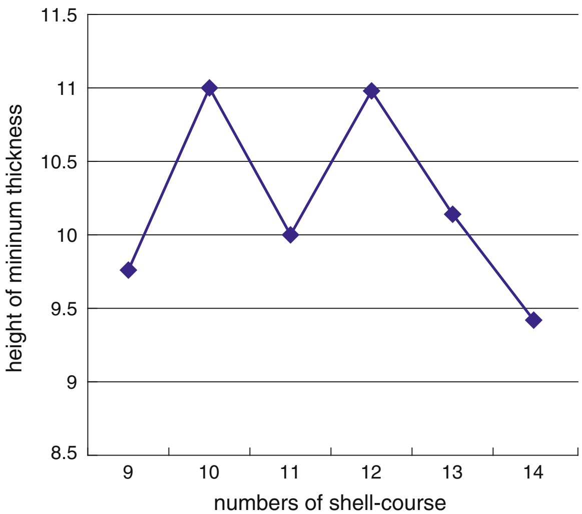


Fig. 64.6 Height of minimum thickness with different numbers of shell-course

reliability of tank-wall maximum when taking no account of influence on reliability of weld number in progress of reliability calculation. But if weld is considered in reliability, the optimal number of shell-course will change and number of shell-course will become fewer. The upper part of the tank-wall can be taken place by other steel material that strength is lower because it requires lower respectively.

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Chapter 65
The Interval Estimation of MTBF Based on Markov Chain Monte Carlo Method

Yi Dai and Bin-quan Li

Abstract The distribution of time between failures of numerical control (NC) system follows the Weibull distribution, thus it's estimation of Mean Time Between Failures (MTBF) in reliability engineering is of significance. But there are great difficulties in interval estimation of MTBF using traditional method for Weibull distribution. After the introduction of the approximate estimation, the Markov chain Monte Carlo (MCMC) method is proposed. Combined with the specific characteristics of two-parameter Weibull distribution, Markov chain is established to calculate the interval estimation of MTBF, which solves the problems effectively. And MCMC is more accurate than that of engineering approximation. By analyzing various results in different conditions of MCMC transition kernel, the paper proves that MCMC is a good method for solving interval estimation of Weibull distribution parameters, which has systematic solution process and good adaptability. It greatly enhanced the robustness, effectiveness and accuracy of the calculation.

Keywords Markov chain · Monte Carlo · Weibull · Interval estimation · Reliability evaluation

Y. Dai (✉) · B. Li
Mechanical Engineering School, Tianjin University of Technology and Education, Tianjin 300222, China
e-mail: dai1845@qq.com

B. Li
e-mail: jz05022300@sina.com

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65.1 Introduction

In the previous research of the NC system reliability (Yi et al. 2004; Haibo et al. 2005), we obtained the conclusions that the failure probability of NC system obeyed Weibull distribution after two years of data collection. It was an important object in Reliability engineering to calculate the mean time between failures (MTBF) of the product. However, the point estimate of MTBF was easy to obtain, but it had encountered great difficulties in the solution of interval estimation.

MCMC sampling method (Albert 2009; Hamada et al. 2008), fundamentally changes the ideas in computing the point estimates and interval estimates in statistics. Through dynamic simulation, implemented by MCMC method, the expected form of random variables with specific distribution is directly constructed. The point estimates and interval estimation of parameters, MTBF values included, can be properly calculated, which avoids indirect, cumbersome and difficult search of asymptotic distribution and pivotal quantity. MCMC method (Shisong et al. 1998; Andrieu et al. 2004; Hamada et al. 2008; Pate-Cornell M E 1996), increasing the robustness and accuracy of computing, greatly improves the adaptability of implementation and systemic calculation, In this paper, MCMC method is proposed to structure the transition kernel and Markov chain which is suitable for Weibull distribution and it solves the problems of interval estimation of MTBF (Erto P 1994; Athreya et al. 1996) value effectively. Compared with results by different MCMC transition kernel, it proves that MCMC method which has systematic solution process and good adaptability is appropriate for computing various interval estimates. It greatly increases the flexibility and precision of the calculation.

65.2 Interval Estimation of MTBF Values Based on MCMC Method

As can be seen from the description above, the direct simulation of distribution has a huge advantage compared to indirect search of pivotal quantity in the statistical inference. The following is focuses on how to directly construct the distribution of MTBF.

65.2.1 Establishing Markov Chain of Stationary Distribution $L(m, \eta)$

In the life test of numerical control system under fixed time censoring with replacement (Coolen 1996; Arturo 2000; Coolen 1994), it obtains censored samples $T = (t_1, t_2, \ldots t_r, L_1, L_2, \ldots L_s)$. Where, $t_1, t_2, \ldots t_r$ are failure data and $L_1, L_2, \ldots L_s$ are censored data. The two-parameter Weibull probability density function $f(t)$ and Survival function $\mathrm{S}(t)$ are given by:

$$f(t) = (mt^{m-1}/\eta^m)\exp[-(t/\eta)^m] \tag{65.1}$$

$$S(t) = \exp[-(t/\eta)^m] \tag{65.2}$$

where, $t > 0$, m is the shape parameter and η is the scale parameter.

The censored samples likelihood function can now be expressed as follows:

$$\begin{aligned} L(m,\eta) &= \prod_{i=1}^{r} f(t_i) \prod_{j=1}^{s} \mathrm{S}(L_j) \\ &= \frac{m^r}{\eta^{rm}} \prod_{i=1}^{r} t_i^{m-1} \exp\left(-\sum_{i=1}^{r} (\frac{t_i}{\eta})^m\right) \exp\left(-\sum_{j=1}^{s} (\frac{L_i}{\eta})^m\right) \end{aligned} \tag{65.3}$$

By MCMC method, it obtains the Markov chain which takes $L(m,\eta)$ as stationary distribution. The sample obtained by Markov chain can be used for statistical inference. For example, it obtains the samples $X^{(1)},\ldots,X^{(n)}$ through sampling from $L(m,\eta)$. If $X^{(1)},\ldots,X^{(n)}$ are the samples of Markov chain which takes $L(m,\eta)$ as stationary distribution, the Monte-Carlo integral is still valid.

Then the problem is converted into how to construct stationary distribution of Markov chain.

Set $p(x,y) = q(x,y)\,\alpha(x,y)$. Taking $L(m,\eta)$ as objective distribution, after choosing the proposal distribution, $q(*|x)$, $\alpha(x,y)$ is written as follows:

$$\min\left\{1, \frac{L(m_y,\eta_y)\,q(y,x)}{L(m_x,\eta_x)\,q(x,y)}\right\} \tag{65.4}$$

where, m_y and η_y are proposal values, m_x and η_x are initial values.

So, $p(x,y)$ is the transition kernel of Markov chain which is determined by stationary distribution $L(m,\eta)$.

65.2.2 Optimization of distribution parameters

Because the ratio η/m of Weibull distribution is large, to ensure the iterative synchronization of two parameters, the Jacobi's transformation (Ntzoufras 2009; Givens et al. 2009) is used to solve the two parameters first and it obtains m and η with inverse transform.

Set $u = \log(\theta) = \log(m,\eta)$. Considering the Jacobian J as follows:

$$\begin{aligned} J &= \frac{\partial(m,\eta)}{\partial(u_1,u_2)} = \begin{vmatrix} \frac{\partial m}{\partial u_1} & \frac{\partial \eta}{\partial u_1} \\ \frac{\partial m}{\partial u_2} & \frac{\partial \eta}{\partial u_2} \end{vmatrix} \\ &= \left(\frac{\partial(u_1,u_2)}{\partial(m,\eta)}\right)^{-1} = \left(\begin{vmatrix} \frac{\partial u_1}{\partial m} & \frac{\partial u_1}{\partial \eta} \\ \frac{\partial u_2}{\partial m} & \frac{\partial u_2}{\partial \eta} \end{vmatrix}\right)^{-1} \end{aligned} \tag{65.5}$$

If it establishes the Markov chain in the $u-$ space, the objective distribution $L(m,\eta)$ is transformed another distribution in $\theta-$ space. The Metropolis–Hastings ratio $\alpha(x,y)$ is given by:

$$\frac{L(\log^{-1}(m_y,\eta_y))q(x,y)|J(y)|}{L(\log^{-1}(m_x,\eta_x))q(y,x)|J(x)|} \tag{65.6}$$

By the process above, the Markov chain which takes $L(m,\eta)$ as stationary distribution is established. Then it obtains m and η with inverse transform. The sample obtained by Markov chain can be used for statistical inference.

65.2.3 Structure and Implementation

Normal distribution is selected as proposal distribution. The iterative step of MCMC method can be summarized as follows:

For $t = 1,\ldots,N$:

1. Set $\theta = (m,\eta) = (\theta_0^{(t-1)},\theta_1^{(t-1)})$
2. Propose new values θ' from U$nif(-0.5,0.5)$
3. Calculate $\theta'' = \theta + \theta'$
4. Calculate $\alpha(\theta,\theta'')$ given by (65.6)
5. Update $\theta^{(t)} = \theta''$with probability $\alpha(\theta,\theta'')$ or keep the same values with the remaining probability.

Normal distribution is selected as proposal distribution. The iterative step of MCMC method can be summarized by the following steps:

For $t = 1,\ldots,N$:

1. Set $\theta = (m,\eta) = (\theta_0^{(t-1)},\ \theta_1^{(t-1)})$, $\sigma^2 = (0.1,0.1)$
2. Generate θ' from $Norm(\theta,\sigma^2)$
3. Calculate $\alpha(\theta,\theta')$ given by (65.6)
4. Update $\theta^{(t)} = \theta'$ with probability $\alpha(\theta,\theta')$ or keep the same values with the remaining probability.

65.3 Simulation Analysis

The censored samples of numerical control system are obtained by the life test under fixed time censoring with replacement. The data are given by Table 65.1.

Table 65.1 Censored samples (in hours) of numerical control system

Failure Data	37	4,627	4,871	848	1,673
	226	864	571	74	857
	1,758	3,877	864	752	3,458
	3,363	916	1,714	1,580	3,769
	820	2,074	415	1,789	813
	2,797	1,381	606	853	4,701
	229	1,130	93	931	2,048
	451	2,107	356	2,063	2,451
	999	500	4,781	3,329	1,634
	351	832	80	489	477
	3,042	1,060	1,246	3,629	615
	549	228	2,949	65	1,301
	2,361	1,741			
Censored Data	46	339	4,429	1,182	1,743
	36	4,273	1,743	2,101	495
	1,947	297	256	1,301	2,354
	2,915	400	25	1,415	3,551
	2,011	130	744	3,794	3,641
	5,048	5,275	2,642	46	3,696
	1,545				

Hollander and Proschan method (Lee 1998) is selected for goodness of fit test of the data in Table 65.1. It is proved that the data obey the Weibull distribution. According to the data in Table 65.1, the estimation obtained by MLE and MCMC method is shown in Table 65.2.

The iteration of m, η and MTBF value are shown in Fig. 65.1. The histogram and distribution of m, η and MTBF value are shown in Fig. 65.2.

Table 65.2 Results of point estimation and interval estimation

		Interval estimation (90 %)	m	η	MTBF value
MLE		Lower confidence limit	0.89	2,071	1,925.4
		Point estimation	1.06	2,520	2,463.0
		Upper confidence limit	1.26	3,066	3,246
MCMC method	Proposal distribution (uniform distribution)	Lower confidence limit	0.89	2,120.0	2,073.6
		Point estimation	1.06	2,592.9	2,548.8
		Upper confidence limit	1.26	3,141.6	3,143.8
	Proposal distribution (normal distribution)	Lower confidence limit	0.89	2,121.1	2,074.0
		Point estimation	1.06	2,600.4	2,559.6
		Upper confidence limit	1.25	3,169.7	3,190.5

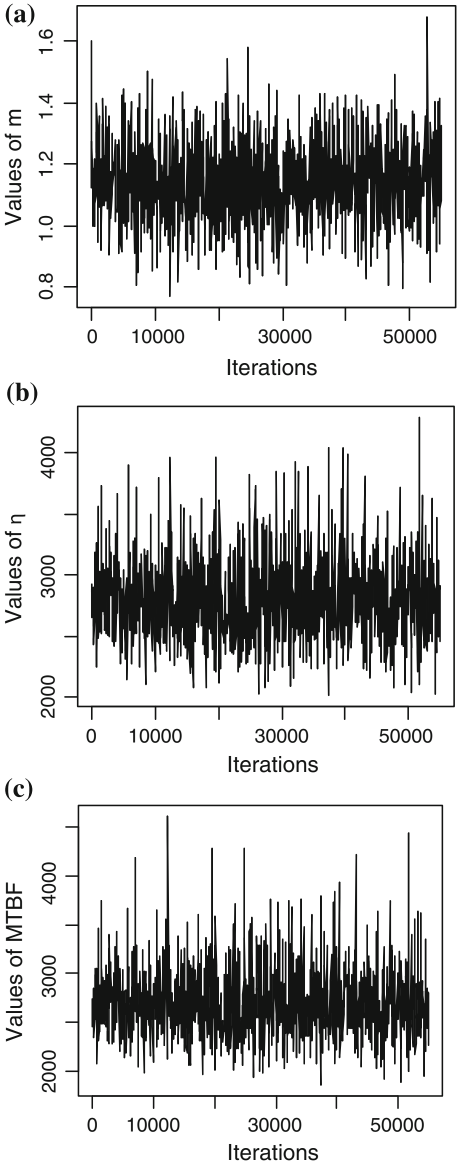
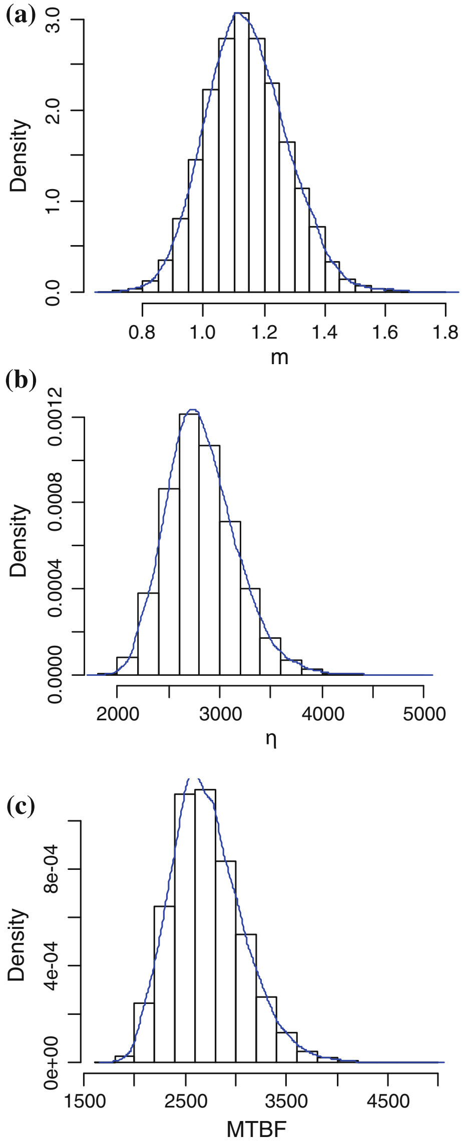


Fig. 65.1 Iterations of the Weibull distribution parameters for censored samples of numerical control system: **a** shape m and **b** scale η.and **c** MTBF value

Fig. 65.2 The histogram and r distribution of the Weibull distribution parameters: **a** shape m, **b** scale η and **c** MTBF value



65.4 Conclusion

1. Markov chain was established to calculate the interval estimation of MTBF value, which solved the difficult problem effectively. It proves that it's more accurate than the approximation by MLE and it ensures the smooth implementation of reliability assessment.
2. Compared with results in the different conditions of MCMC transition kernel, it proves that MCMC method is appropriate for computing various interval estimates of characteristics in reliability engineering, which has systematic solution process and good adaptability. MCMC method has unparalleled advantage in calculating interval estimates and it may basically replace the traditional methods.
3. MCMC method solves the interval estimation of MTBF in the reliability assessment of numerical control system effectively.

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Chapter 66
A CA-SVM Based Monte Carlo Approach for Evaluating Complex Network Reliability

Yuan-peng Ruan and Zhen He

Abstract Many real-world complex systems can be modeled as networks. Evaluation of network reliability plays an important role in engineering applications. When evaluating the *S-T* complex network reliability, the traditional approaches may bring about the problems of increasing computational complexity or decreasing the calculation accuracy. This paper proposes a CA-SVM based Monte Carlo approach based on the drawbacks of traditional approaches. Support Vector Machine (SVM) is a fast and efficient algorithm to ascertain the network connectivity in simulation process. Cellular automata (CA) is used for creating training data points, which speeds up the computing process. Particle swam optimization (PSO) is used for parameters selection of SVM, which increases the accuracy of the result. An example is shown to illustrate the proposed approach.

Keywords Complex network reliability · Support vector machine · Cellular automata · Particle swarm optimization

66.1 Introduction

Many real-world complex systems such as communication systems (Aggarwall 1975), power transmission and distribution systems (Yeh 1998) and transportation systems (Aven 1987) can be modeled as networks. The traditional approaches (Billinton and Allan 1992) to evaluate the reliability of network are based on the minimal cut sets or minimal path sets. Nevertheless these approaches will lead to NP-hard problems due to the increasing complexity of the network (Billinton and Allan 1992). As a result, some works put forth Monte Carlo Simulation (MCS)

Y. Ruan (✉) · Z. He
School of Management, Tianjin University, Tianjin, China
e-mail: ruanyuanpeng@sina.com

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based approaches, which are now recognized as playing an important role in the evaluation of network reliability (Billinton and Allan 1992; Fishman 1986).

Ascertaining the connectivity of *S*-*T* network is an important problem under the above mentioned MCS based approaches. The approaches frequently used before are based on depth-first procedure or breadth-first procedure (Fishman 1986). With the increasing complexity of the network, the above mentioned approaches will be time consuming. Cellular automata (CA) based approach, which can overcome the above difficulty, is proposed to the application in network reliability evaluation (Rocco and Moreno 2002a; Yeh et al. 2010). Recently, some works extend the use of CA to problems of computing the availability of the renewable network (Enrico et al. 2006), evaluating the *K*-terminal reliability of the network (Rocco and Enrico 2005) and computing the maximum unsplittable flow of the network (Rocco and Enrico 2005).

Since MCS based approaches require a large number of connectivity evaluations of *S*-*T* network, it may be convenient to replace this evaluation by an approximated but fast algorithm. Because the *S*-*T* network has two states (operating or failed), it's a two-category classification problem to ascertain the connectivity of the network. Support Vector Machine (SVM), as a artificial intelligence technique, was developed by Vapnik (1998). Because of the superiority of structural risk minimization principle (SRM) over empirical risk minimization principle (ERM), SVM has been widely used for network reliability evaluation (Rocco and Moreno 2002b; Yuan et al. 2010).

The quality of SVM classification models depends on a proper setting of the parameters (SVM hyper-parameters and SVM kernel parameters), so the main issue to apply SVM is how to set these parameters. The works published before chose grid search method to set parameters (Rocco and Moreno 2002b; Yuan et al. 2010). However, when using this method, one should increase the search range or decrease the step size to make the optimal solution accurate, which may result in a highly time-consuming search process (Ren and Bai 2010). To overcome this problem, we substitute the grid search method with particle swarm optimization (PSO).

In this work, we proposed a CA-SVM based Monte Carlo approach to evaluate the complex network reliability. Firstly, establish the training data with CA; secondly, train the SVM with PSO and cross-validation; lastly, ascertain the connectivity of each simulation with the SVM trained and compute the *S*-*T* network reliability.

Section 66.2 briefly describes CA algorithm. Section III briefly describes SVM and parameters selection using PSO, then proposes a CA-SVM based Monte Carlo approach for evaluating complex network reliability. An example is presented in Sect. 66.4 to illustrate the proposed approach.

66.2 Ascertainment of the Connectivity of S-T Network using CA

66.2.1 Description of CA

Cellular automata (CA), a kind of approach to simulate the behavior of dynamic discrete systems, was originally conceived by Ulam and Von Neumann in the 1950s. CA consists of some cells, usually assumed to be homogeneous and with limited discrete states. Each cell's action at a given time t relies on its state at the time $t - 1$, those of its neighborhood at the time $t - 1$ and a transition rule. As shown in Fig. 66.1, CA can be mainly classified into one-dimensional CA and two-dimensional CA based on its cells' dimensions. Two-dimensional CA also can be classified into two categories: Von Neumann neighborhood and Moore neighborhood (Tomassini and Perrenoud 2001).

66.2.2 CA Algorithm of Ascertaining the Connectivity

Let $G = (N, A)$ be a network graph, where N is the set of n nodes, A is the set of directed arcs. The *S-T* network connectivity evaluation refers to finding if there is a path from a source node S to a terminal node T. It's assumed that E_i is the neighborhood of the node i, defined as $E_i = \{j \in N \text{ s.t. } (j, i) \in A\}$ and $w\,(i, t)$ is the state of node i at the time t. The state $w\,(i, t)$ of each node is binary, assuming the value of 1 when node i is active and of 0 when passive.

Each node i follows an OR Boolean transition function

$$w(i, t + 1) = \mathrm{OR}(w(j,\ t), \ldots, w(k,\ t), w(i,\ t)),\ j, \ldots, k \in E_i \tag{66.1}$$

As some works have shown, *S-T* connectivity can be computed in O(n) time using CA, which is an advantage over the traditional approaches (Rocco and Moreno 2002a; Rocco and Enrico 2005).

The basic algorithm proceeds as follows:

1. $t = 0$
2. Set all the cells state values to 0

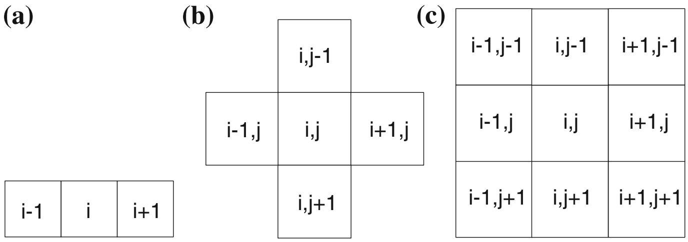


Fig. 66.1 Types of CA. **a** One-dimensional type. **b** Von Neumann type. **c** Moore type

3. Set $w(S, 0) = 1$
4. $t = t + 1$
5. Update all cells states by function (1)
6. If $w\ (T, t) = 1$, then stop: $c = 1$ and there is a path between S and T
7. If $t < n - 1$ go to step 4. Else
8. $c = 0$ and there is no path between S and T

66.3 Reliability Evaluation of Complex Network Using CA-SVM Based Monte Carlo Approach

66.3.1 Description of SVM Classifier

Support vector machine (SVM), which is desired to find a separator to partition data-set as far as possible, provides a novel approach to the two-category classification problem.

Suppose a set of N training data points $\{(X_1, y_1), (X_2, y_2), \ldots, (X_N, y_N)\}$, where $y_i = \{1, -1\}$. For linear SVM, as shown in Fig. 66.2, consider the separating hyperplane

$$H : y = w \cdot X + b = 0 \tag{66.2}$$

where w is normal to the hyperplane H. The two hyperplanes

$$\begin{aligned} H_1 &: y = w \cdot X + b = +1 \text{ and} \\ H_2 &: y = w \cdot X + b = -1 \end{aligned} \tag{66.3}$$

is parallel to H and the data points closest to the two parallel are called support vectors.

To partition the two groups completely, the optimal separator can be obtained by a constrained optimization formulation (Scholkopf and Smola 2000):

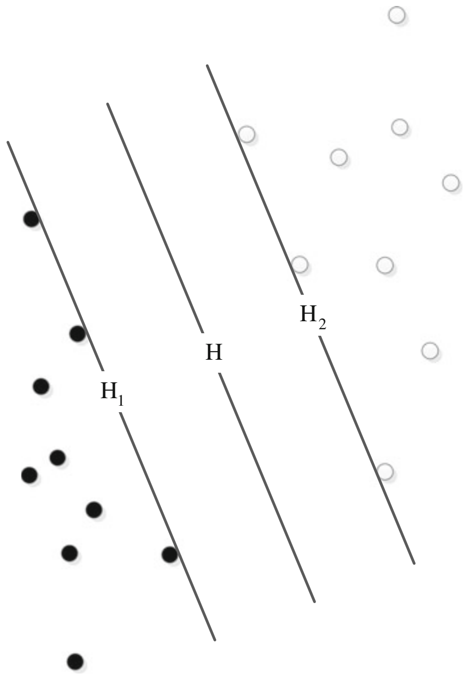
$$\underset{w,b}{Min} \frac{1}{2} \|w\|^2 \tag{66.4}$$

$$\text{s.t. } y_i(w \cdot X_i + b) \geq 1, \quad i = 1, 2, \ldots, N.$$

However, sometimes it is impossible to separate the training data points linearly. To solve this problem, imperfect separation should be considered and the formulation (66.4) will be transformed as follows:

$$\underset{w,b}{Min} \frac{1}{2} \|w\|^2 + C \sum_{i=1}^{N} \xi_i \tag{66.5}$$

Fig. 66.2 Linear SVM



$$\text{s.t. } y_i(w \cdot X_i + b) \geq 1 - \xi_i,$$
$$\xi_i \geq 0, \quad i = 1, 2, \ldots, N.$$

The Lagrangian formulation for the dual problem of formulation (66.5) is as follows:

$$Max - \frac{1}{2}\sum_{i=1}^{N}\sum_{i=1}^{N}\alpha_i\alpha_j y_i y_j X_i \cdot X_j + \sum_{k=1}^{N}\alpha_k \tag{66.6}$$

$$\text{s.t. } 0 \leq \alpha_i \leq C, \quad i = 1, 2, \ldots, N$$
$$\sum_{i=0}^{m}\alpha_i y_i = 0$$

where α_i represents the Lagrangian multiplier of X_i and C is the penalty parameter.

After the solution has been obtained, the decision function for new X_i is as follows:

$$f(X_i) = \text{sgn}(\sum_{j=1}^{N}\alpha_j y_j X_i \cdot X_j + b) \tag{66.7}$$

For non-linear SVM, the decision function for new X_i can be obtained through replacing $X_i \cdot X_j$ with kernel function. There are many kernel functions which can be used (Scholkopf and Smola 2000). Among them, the commonest are Gaussian radial basis function and polynomial function, which is as follows:

$$k(X_i, X_j) = e^{-\|X_i - X_j\|^2/2\sigma^2}, \tag{66.8}$$

$$k(X_i, X_j) = (X_i \cdot X_j + 1)^d. \tag{66.9}$$

Because the reliability evaluation is a non-linear problem and the parameter of Gaussian radial basis function is continuous, which is easy to be tuned (Ren and Bai 2010), this paper selects Gaussian radial basis function to train SVM.

66.3.2 Parameter Optimization Using PSO

Since the SVM generalization performance heavily depends on the setting of C and σ, these parameters should be set properly. Particle swarm optimization (PSO), a population based optimization algorithm, was first introduced by Kennedy and Eberhart (Kennedy and Eberhart 1948). In PSO, each particle represents a potential solution to the optimization problem. The performance of each particle depends on the pre-defined fitness function. Each particle flies according to its own experience and the experience of its neighboring particles with a certain velocity.

The flying velocity of each particle can be updated during each iteration with the equation

$$v_{ij}^t = wv_{ij}^{t-1} + c_1 r_1 (p_{ij}^{t-1} - x_{ij}^{t-1}) + c_2 r_2 (g_{ij}^{t-1} - x_{ij}^{t-1}) \tag{66.10}$$

and each particle will position with the equation

$$x_{ij}^t = x_{ij}^{t-1} + v_{ij}^{t-1}. \tag{66.11}$$

The p_{ij}^t and g_{ij}^t respectively represent the best previous position of each particle and the best particle in the whole swarm within the iteration t. $c_1 \cdot r_1$ and $c_2 \cdot r_2$ determine the weights of two parts. c_1 and c_2 are learning rates which are non-negative constants. r_1 and r_2 are generated random numbers in the interval [0, 1]. w is the inertia coefficient which is a constant in the interval [0, 1].

66.3.3 Proposed Approach

The proposed approach for reliability evaluation of complex network is illustrated in Fig. 66.3. CA and PSO are fast and efficient alternatives for DFS and grid search approach. MCS, as a kind of simulation technology, has a big advantage over the tradition approaches, which can result in NP-hard problems, for complex network reliability evaluation.

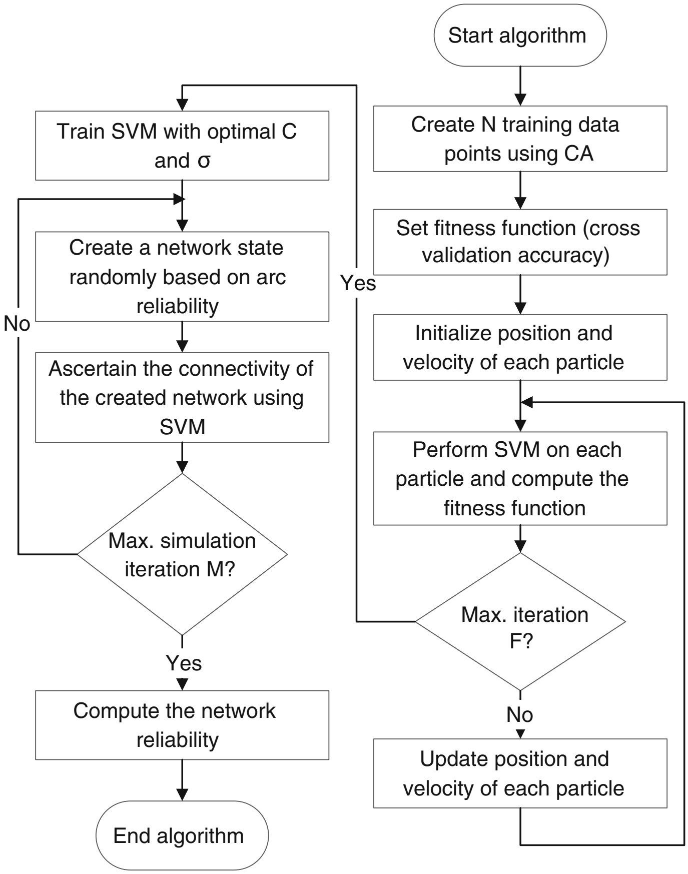


Fig. 66.3 Proposed algorithm flow diagram

66.4 Example Discussion

The complex network shown in Fig. 66.4 was proposed by Yoo and Deo (1988). It consists of 21 arcs which have the following reliabilities: $r_7 = 0.81$, $r_4 = r_{12} = r_{13} = r_{19} = 0.981$, and other $r_i = 0.9$.

After 100,000 simulation iterations, the results shown in Table 66.1 illustrate that proposed approach gives a result which is not better than CA-MCS based approach but accurate enough for engineering applications. Because proposed approach substitutes SVM for CA when ascertaining network connectivity during each simulation iteration, it will be a fast and efficient substitute for CA-MCS based approach when a large number of simulation iterations are needed.

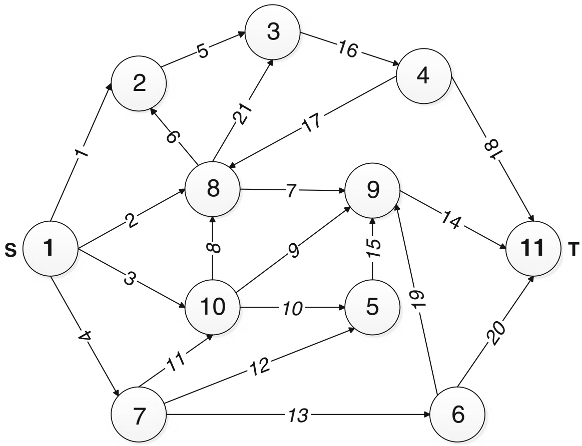


Fig. 66.4 A complex network

Table 66.1 Comparison of algorithms

	Proposed approach	CA-MCS based approach (Rocco and Moreno 2002a; Yeh et al. 2010)	The exact result
Reliability	0.9968	0.9973	0.997186
Relative error rate	−0.039 %	0.01 %	/

66.5 Conclusion

Complex network reliability has become a hot research topic recently. *S-T* network reliability evaluation, as the basis of this research topic, should be focused on. Some traditional approaches can not solve complex network reliability evaluation well due to inconvenience or inaccuracy. This paper proposes a CA-SVM based Monte Carlo approach for reliability evaluation of complex network, which is a fast and efficient substitute for some CA-MCS and DFS-SVM based approaches. This paper combines CA algorithm, which can create training data points instead of DFS, and PSO, which can be substituted for grid search algorithm to select the parameters of SVM, into the proposed approach. The proposed approach also can be extended to other areas such as evaluations of network availability and *K*-terminal network reliability.

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Chapter 67
Determination of Two Change Points of a Bathtub Failure Rate Curve

Ren-yan Jiang

Abstract This paper gives main characteristics of the failure-rate-based bathtub curve, defines two change points of the bathtub curve and develops nonparametric and parametric methods to estimate the change points. Simple relations for estimating the interval failure rate in the infant mortality and random failure phases are derived. The proposed methods are useful for model selection and can be used to evaluate the appropriateness of any bathtub curve model. These are illustrated through a real-world example.

Keywords Failure rate · Bathtub curve · Change point · Nonparametric method · Parametric method

67.1 Introduction

The bathtub curve has been widely used to explain the failure behavior of the population of non-repairable components. It is characterized by three phases (i.e., early use phase, normal use phase and wear-out phase) and associated with different failure mechanisms (i.e., infant mortality, random failure and wear-out failure).

For repairable systems, the failure is characterized by rate of occurrence of failure (or intensity function) rather than the failure rate. The plot of the intensity function versus time can be bathtub-shaped (e.g., see Pulcini 2001, Dijoux et al. 2009) and in this case it is also called the bathtub curve. Two kinds of the bathtub curve have different engineering significance. To differentiate, Jiang and Murthy (2008) call them the component-level and system-level bathtub curves,

R. Jiang (✉)
Faculty of Automotive and Mechanical Engineering,
Changsha University of Science and Technology, Changsha, Hunan 410114, China
e-mail: jiang@csust.edu.cn

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respectively. In this paper, we focus the attention on the component-level bathtub curve and let $r(t)$ denote the failure rate function.

There are many approaches to specify the partition points (termed as the change points) between two adjacent phases. For example, Bebbington et al. (Rajarshi and Rajarshi 1988) define the change points based on the curvature of the bathtub curve. The basic idea is that at the change points the curvature has maximal changes. When the estimation is based on the fitted model, the estimated change points depend on the model, which itself needs to be validated; when the estimation is based on a nonparametric approach, this curvature-based approach is probably not robust since it needs to evaluate the curvature, which is a function of $r'(t)$ and $r''(t)$.

In this paper we develop the methods to specify the change points from an engineering-oriented viewpoint. The paper is organized as follows. We present some the bathtub curve models in Sect. 67.2. The methods to specify the change points are presented in Sect. 67.3, and illustrated in Sect. 67.4. The paper is concluded with a brief summary in Sect. 67.5.

67.2 Bathtub Curve Models

The bathtub curve models are developed for modeling data that display the bathtub-shaped failure rate. There are many such models in the literature, e.g., see Lai et al. (1993), Jiang and Murthy (2003). According to the support, the bathtub curve models roughly fall into the following two broad categories:

- Models with infinite support, and
- Models with finite support.

67.2.1 Models with Infinite Support

This category of models is defined in $(0, \infty)$ and given in the form of distribution (or reliability) function, failure rate or cumulative hazard function. Two typical models defined in terms of the distribution (or reliability) function are the Weibull competing risk model, e.g., given by (see Mudholkar and Srivastava (1993):

$$R(t) = \exp[-(\frac{t}{\eta_1})^{\beta_1} - \frac{t}{\eta_2} - (\frac{t-\gamma}{\eta_2})^{\beta_3}], \tag{67.1}$$

with $0 < \beta_1 < 1 < \beta_2, \gamma \geq 0$ and the exponential Weibull distribution given by (e.g., see Hjorth 1980)

$$F(t) = \{1 - \exp[-(t/\eta)^{\beta}]\}^{\gamma}, \beta\gamma < 1 < \beta. \tag{67.2}$$

A typical example defined in terms of failure rate function is the model given by (see Crevecoeur 1993):

$$r(t) = at^{\beta-1}e^{\alpha t},\ \beta \in (0, 1). \tag{67.3}$$

Two typical models defined in terms of cumulative hazard rate function are given by (see Xie et al. 2002):

$$H(t) = at^{\beta}e^{\alpha t},\ 0<\beta<1, \alpha > 0, \tag{67.4}$$

and given by (see Mudholkar et al. 2009):

$$H(t) = a\{\exp[(t/\eta)^{\beta}] - 1\}, a, \beta, \eta > 0. \tag{67.5}$$

67.2.2 Models with Finite Support

A decreasing function defined in $(0, \infty)$ can become bathtub shaped when making a variable transformation to change the support to a finite range. The following (see Bebbington et al. 2008) is such an example:

$$H(x) = \left(\frac{x/\eta}{1 - \theta x}\right)^{\beta}, \beta \in (0, 1),\ x \in (0, 1/\theta). \tag{67.6}$$

Here, random variable $Y = X/(1 - \theta X)$ follows the Weibull distribution with the support $(0, \infty)$, and random variable X has a finite support $(0, 1/\theta)$. The failure rate is given by:

$$r(x) = \beta H(x)\left(\frac{1}{x} + \frac{\theta}{1 - \theta x}\right). \tag{67.7}$$

67.3 Specification of Change Points

67.3.1 Definition of Bathtub Curve

Usually, the bathtub curve is ambiguously defined as "first decreasing and then increasing". A stricter definition is as follows:

(a) There exists a point t_1 before which the dominant failure mode is infant failure and the failure rate is roughly decreasing; t_1 is relatively small and $r(0)$ is usually finite.
(b) There exists a point t_2 after which the dominant failure mode is wear-out and the failure rate is increasing; and t_2 is relatively large.

(c) Between t_1 and t_2, the dominant failure mode is random failure, the failure rate is roughly constant and $t_2 - t_1$ is relatively large.

67.3.2 Change Points of a Bathtub Curve

Let $r_1(t)$, $r_2(t)$ and $r_3(t)$ denote the failure rate functions associated with the infant, random and wear-out failure modes and, t_1 and t_2 denote the change points, respectively. The total failure rate is their superposition and given by:

$$r(t) = r_1(t) + r_2(t) + r_3(t). \tag{67.8}$$

Let t_0 denote the time where $r(t)$ achieves its minimum. At t_0 we have:

$$r_1(t_0) \approx r_3(t_0) \approx 0. \tag{67.9}$$

Let λ denote $r(t_0)$, i.e., the minimal failure rate. We call t_0 the minimum point.

In the interval $(0, t_0)$, the total failure rate can be characterized by a decreasing function given by $r^{(1)}(t)$, which can be viewed as superposition of $r_1(t)$ and $r_2(t)$ without the effect of $r_3(t)$.

In the interval (t_0, ∞), the total failure rate can be characterized by an increasing function given by $r^{(3)}(t)$, which can be viewed as superposition of $r_2(t)$ and $r_3(t)$ without the effect of $r_1(t)$.

The interval (t_1, t_2) can be divided into two sub-intervals: (t_1, t_0) and (t_0, t_2). In the former subinterval $r_1(t)$ has a weak effect and hence the failure rate can be mildly decreasing; in the latter subinterval $r_3(t)$ has a weak effect and hence the failure rate can be mildly increasing. As a result, a two-order polynomial can be appropriate for approximating their superposition, which is denoted as $r^{(2)}(t)$.

As such, the left change point is defined as

$$r^{(1)}(t_1) = r^{(2)}(t_1), \tag{67.10}$$

and the right change point is defined as

$$r^{(2)}(t_2) = r^{(3)}(t_2). \tag{67.11}$$

67.3.3 Characteristics and Significance of the Bathtub Curve

In the literature the bathtub curve is usually characterized by two characteristic points. The first characteristic point is actually or somehow similar to t_0 defined above and given different terms such as critical point (e.g., see Bebbington et al. 2008) or turning point (e.g., see Bebbington et al. 2006); and the second characteristic point is somehow similar to t_2 defined above and termed the instability point by (Xie et al. 2002).

Here we characterize the bathtub curve by four parameters: t_1, t_0, λ and t_2. The magnitude of t_1 represents the manufacturing quality and provides the information about burn-in.

The magnitude of t_0 reflects the type of manufacturing defects. According to Jiang and Murthy (2009), there are two types of basic manufacturing defects: assembly defects and nonconforming components. t_0 can be relatively small for the former and relatively large for the latter. Also, it can reflect the beginning time of ageing. A large [small] t_0 implies that the aging begins lately [early]. λ reflects the reliability associated with the random failure mode.

Finally, t_2 provides the information about the intervention time of preventive maintenance and $t_2 - t_1$ reflects the useful life.

67.3.4 Non-Parametric Estimation of Failure Rate

Suppose that a dataset is given by

$$x_1(n_1) < x_2(n_2) < \ldots < x_m(n_m), \tag{67.12}$$

where x_i, $1 \le i \le m$, is a failure time (i.e., it is not a censored observation) and n_i is the number of failures at that time. We view x_i as a representative point of interval $\left(\frac{x_{i-1}+x_i}{2}, \frac{x_i+x_{i+1}}{2}\right)$. At the beginning of this interval, the number of surviving items is given by N_i. For example, for a complete dataset it is given by:

$$N_i = \sum_{j=i}^{m} n_j. \tag{67.13}$$

As such, a nonparametric estimate of the failure rate at x_i is given by

$$r_i = \frac{2n_i}{N_i(x_{i+1} - x_{i-1})}, 1 \le i \le m, \tag{14}$$

where $x_0 = 0$ and x_{m+1} is defined as $2x_m - x_{m-1}$.

67.3.5 Discussion

(1) For the first failure observation x_1, we may view it as the representative point of interval $\left(0, \frac{x_1+x_2}{2}\right)$ rather than $\left(\frac{x_1}{2}, \frac{x_1+x_2}{2}\right)$. As such, (67.14) is revised as

$$r_1 = \frac{2n_1}{N_1(x_1 + x_2)}. \tag{67.15}$$

(2) For group data, let $n(x_{i-1}, x_i)$ denote the number of failures in the interval (x_{i-1}, x_i) and N_i denote the number of surviving items at x_{i-1}. The interval representative point is $\bar{x}_i = (x_{i-1} + x_i)/2$, and the failure rate is estimated as:

$$r(\bar{x}_i) = \frac{n(x_{i-1}, x_i)}{(x_i - x_{i-1})N_i}, 1 \le i \le m. \tag{16}$$

(3) The empirical intensity function can be defined in a similar way (e.g., see Pulcini 2001). Here, N_i usually or almost is unchanged.

67.3.6 Nonparametric Approach to Specify the Change Points

If the plot of r_i versus x_i is bathtub shaped, we propose the following multi-step procedure to specify the characteristic points of a bathtub curve.

The first step is to get the initial estimates of the change points through examining the empirical failure rate curve obtained from the above approach. Let τ_1 and τ_2 denote the initial estimates of t_1 and t_2, respectively.

The second step is to estimate the minimum point. This is done by fitting the data points in (τ_1, τ_2) to the following two-order polynomial given by

$$r^{(2)}(t) = \lambda + b_2(t - t_0)^2. \tag{67.17}$$

The third step is to estimate the left change point. This is done by fitting the data points in $(0, \tau_1)$ to the following negative exponential function given by

$$r^{(1)}(t) = e^{a_1 - b_1 t}. \tag{67.18}$$

As such, t_1 is given by

$$e^{a_1 - b_1 t_1} = \lambda + b_2(t_1 - t_0)^2. \tag{67.19}$$

If the data in $(0, t_1)$ are different from the data in $(0, \tau_1)$, this step is repeated until the data in these two intervals are the same or $t_1 \approx \tau_1$.

The fourth step is to estimate the right change point. This is done by fitting the data points in (τ_2, ∞) to the following exponential function given by

$$r^{(3)}(t) = e^{a_3 + b_3(t - t_0)}. \tag{67.20}$$

As such, t_2 is given by

$$e^{a_3+b_3(t_2-t_0)} = \lambda + b_2(t_2 - t_0)^2. \tag{67.21}$$

If the data in (t_2, ∞) are different from the data in (τ_2, ∞), this step is repeated until the data in these two intervals are the same or $t_2 \approx \tau_2$.

The interval mean failure rate in the early use period is given by

$$\lambda_1 = \frac{1}{t_1}\int_0^{t_1} r_1(t)\mathrm{d}t = \frac{e^{a_1}(1-e^{-b_1 t_1})}{b_1 t_1}. \tag{67.22}$$

The interval mean failure rate in the normal use phase is given by

$$\begin{aligned}\lambda_2 &= \frac{1}{t_2 - t_1}\int_{t_1}^{t_2} r_2(t)\mathrm{d}t \\ &= \lambda + b_2\frac{(t_2-t_0)^2 + (t_2-t_0)(t_1-t_0) + (t_1-t_0)^2}{3}.\end{aligned} \tag{67.23}$$

67.3.7 Parametric Approach

The change points need to be differently defined when a parametric model is fitted to the data with bathtub shaped failure rate. This is because the three parts of the failure rate in three phases are superposed together and the total failure rate is given by a single function.

We start with the minimum point, which can be obtained from the fitted model. According to (67.9), we have

$$r(t_0) \approx r_2(t) \approx \lambda. \tag{67.24}$$

When $t < t_1$, the dominant failure mode is the infant failure so that we have $r_1(t) > r_2(t)$; when $t > t_1$, the dominant failure mode is the random failure so that we have $r_1(t) < r_2(t)$. When $t = t_1$, the effects of the two modes are indifferent so that we have

$$r_1(t_1) = r_2(t_1) = \lambda \text{ or } r(t_1) = 2\lambda. \tag{67.25}$$

As such, the left change point is defined by (67.25). In a similar argument, the right change point is defined by

$$r(t_2) = 2\lambda. \tag{67.26}$$

Table 67.1 Life time of 50 devices

0.1	0.2	1	1	1	1	1	2	3	6
7	11	12	18	18	18	18	18	21	32
36	40	45	46	47	50	55	60	63	63
67	67	67	67	72	75	79	82	82	83
84	84	84	85	85	85	85	85	86	86

67.4 Illustration

We illustrate the method using the data shown in Table 67.1, which come from (Aarset et al. 1987).

67.4.1 Non-Parametric Estimates

Using the non-parametric approach outlined in Part D of Sect. 67.3, we obtained the empirical failure rate shown in Fig. 67.1 As seen, the data have a bathtub-shaped failure rate and the initial estimates of change points are about $(\tau_1, \tau_2) = (2, 80)$.

Fitting the empirical failure rate to (67.17) yields the estimate of the minimum point, which is shown in the second row of Table 67.2.

Fitting the empirical failure rate with $t \le \tau_1$ to (67.18) yields the estimate of the left change point, from which we have $t_1 = 3.36 > \tau_1$. This implies that the observation $x = 3$ should be included when fitting (67.18). In this case, we have $t_1 = 2.94$, which is close to the previous estimate and hence the iterative process terminates.

Fitting the empirical failure rate with $t \ge \tau_2$ to (67.20) yields the estimate of the right change point, from which we have $t_2 = 79.65 \approx \tau_2$ and hence a new iteration is not needed.

The final estimates are shown in the second row of Table 67.2 and Fig. 67.1. As seen from the figure, the estimates look reasonable.

Using the estimated parameters to (67.23) we have $\lambda_2 = 0.01597$. On the other hand, the average of the empirical failure rates over (t_1, t_2) equals 0.01569, which is very close to the estimate of λ_2 from (67.23). This confirms the appropriateness of the nonparametric method.

67.4.2 Estimates Derived from a Fitted Parametric Model

Consider the models given by (67.1), (67.4) and (67.6). They are fitted to the data using the maximum likelihood method. The characteristic points derived from the

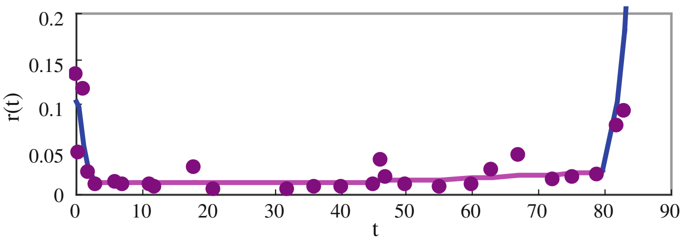

Fig. 67.1 Non-parametric estimates of failure rate

Table 67.2 Empirical and fitted failure rates

Model	$\ln(L)$	t_1	t_0	t_2	$\lambda, \times 0^2$
Non-parametric		2.94	21.54	79.65	1.2532
(67.1)	−205.391	6.74	74.41	80.03	1.2360
(67.4)	−227.155	1.29	10.33	44.09	1.0484
(67.6)	−205.146	4.84	28.10	62.60	0.7783

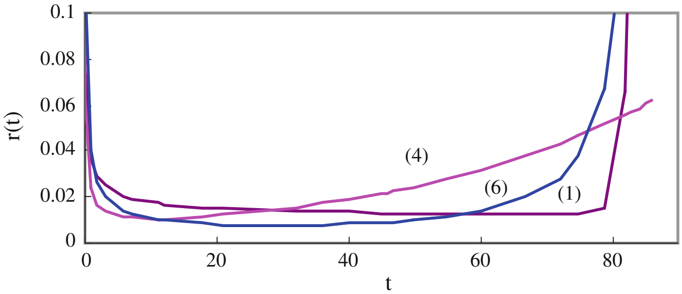

Fig. 67.2 Parametric estimates of characteristic points

fitted models are shown in Table 67.2, along with the log-likelihood values. Figure 67.2 shows the failure rate functions of the fitted models.

In terms of the log-likelihood, the best model is the model given by (67.6). However, compared with the empirical failure rate curve, the best model is the model given by (67.1). The characteristics obtained from (67.4) are considerably different from those obtained from the non-parametric method, implying that it is inappropriate for modeling the data.

The above analysis shows that the non-parametric method can provide plausible estimation for the characteristics of the bathtub curve. However, a bathtub curve model may give misleading results.

67.5 Conclusions

In this paper, we have strictly defined the failure-rate-based bathtub curve and characterized the bathtub curve using three characteristic points. We have proposed a non-parametric method to estimate the empirical failure rate and its characteristic points. The interval failure rates associated with the early and normal use phases have been derived. These have been illustrated by an example. Two main findings have been:

- In the normal use phase, the failure rate can be mildly impacted by both infant failure and wear-out modes so that it can be convex, decreasing or increasing as shown in Fig. 67.2, and
- A bathtub curve model may give misleading results unless it is appropriately validated.

The proposed nonparametric estimates for the failure rate and its characteristic points can be used to evaluate the appropriateness of a bathtub curve model and to select an adequate model for modeling a given dataset. The results presented in this paper can be easily extended to the case of intensity-function-based bathtub curve.

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Chapter 68
Weighted Linear Response Surface Method for Structural Reliability Analysis

Qing-hui Dai and Jun-yuan Fang

Abstract Response face method is a common method to do reliability analysis for uncertain expressed complex structures of limit state function. This thesis introduces a weighing linear response surface method on the base of traditional response surface method. This method mainly chooses good sample points, and gives up bad sample points by the way of giving the point rational weight number in order to raise the fit precision. Then the thesis presents the calculation steps and flow chart of the weighing linear response surface method. Finally, it inspects and verifies the superiority of the new method through a count case on fit precision.

Keywords Response face method · Weighing · Failure probability

68.1 Introduction

First Order Second moment Method (FOSM) and Advanced First Order Second moment Method (AFOSM) are the relatively simple method in structural reliability analysis (Lv et al. 2009). There are some reality can not satisfy the prerequisite with regard of FOSM and AFOSM, such as, it can only solve the known problem of the limit state function. Monte Carlo (Li et al. 2007) simulation method can fill the lack of FOSM and AFOSM, but it's low efficiency and very time-consuming, and in some cases there are convergence problems. The response surface method (Lv et al. 2009; Li et al. 2007; Zhang et al. 2008; Bucher and

Q. Dai (✉) · J. Fang
Department of Mechanical Engineering, North China Electric Power University, Baoding, China
e-mail: dqh6789@126.com

J. Fang
e-mail: fangjunyuan@126.com

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Bourgund 1990; Kang and Song 2004) overcomes the deficiencies of these methods. In addition, the response surface method can be directly combined with the finite element which wears a structural reliability analysis.

The traditional response surface method (Zhao 1996; Faravelli 1989; Yang and Zhang 1999) rechooses the new sample points each times of iteration, which makes the nice sample points be ignored and logging in the bad sample points when fitting the response surface. At last, it makes the result of decreasing the fitting precision. This article describes a weighted linear response surface method, whose principle is giving the sample a reasonable weight number, choosing the good sample points closed to the real response surface, eliminating the bad sample points which is far away from the real response surface. In this way, the good sample points can be reused, and the reliability analysis fitting precision can be put up.

68.2 The Response Surface Method

68.2.1 Reliability and Reliability Index

Expression of the structure of the limit state function can be expressed as follows:

$$G(\overline{X}) = G(x_1, x_2, \cdots, x_n) \tag{68.1}$$

where, $x_1, x_2, \cdots, x_n$ are basic variables, such as material properties, load parameters, geometric dimensions, etc. When $G(\overline{X}) \leq 0$, F is the corresponding failure domain. When $G(\overline{X}) \geq 0$, S is the corresponding failure domain. The probability of failure represented by P_f:

$$P_f = P\{F\} = P\{G(\overline{X}) \leq 0\} = \int\limits_{G(\overline{X}) \leq 0} f_x(\overline{X}) \mathrm{d}x \tag{68.2}$$

where, $f_x(\overline{X})$ is the joint probability density function of the vector of basic variables $\overline{X} = (x_1, x_2, \cdots, x_n)$.

There follows the relationship between the failure probability P_f and reliability P_r:

$$P_f + P_r = 1 \tag{68.3}$$

When the basic variables follow a normal distribution, there comes the following relationship:

$$\begin{cases} P_f = \Phi(-\beta) \\ P_r = \Phi(\beta) \end{cases} \tag{68.4}$$

where, β is reliability index, the higher the reliability index β is, the higher reliability P_r is.

68.2.2 Response Surface Methods for Reliability Analysis

The basic idea of response surface method is to select the polynomial containing parameters to be determined instead of the real limit state function, and select the appropriate sample point to obtain the unknown parameters. Finally, after times of iterations, it ensures the selection of the polynomial function approximation to the real limit state function on the probability of failure.

The core issue of response surface method is as follows:

(1) *Choosing the form of polynomial function*

The real limit state function $G(\overline{X})$ mainly uses the tests-fitting $\overline{G}(\overline{X})$ which can specifically express the function relation. The selection ways of $\overline{G}(\overline{X})$ are mostly divided into two ways: linear polynomial:

$$\overline{G}(\overline{X}) = b_0 + \sum_{i=1}^{n} b_i x_i \tag{68.5}$$

where, x_i is the i basic variable; $b_i(i = 0, 1, 2, \cdots, n)$ is the undetermined coefficient of the polynomial function. n is the number of the basic variable.

The quadratic polynomial without cross terms shows as follows:

$$\overline{G}(\overline{X}) = b_0 + \sum_{i=1}^{n} b_i x_i + \sum_{j=1}^{n} b_{n+j} x_j^2 \tag{68.6}$$

where, b_0 is the constant coefficient; $b_i(i = 0, 1, 2, \cdots, n)$ is one-time items coefficient; $b_{n+j}(j = 1, 2, \cdots, n)$ is the quadratic term coefficient; n is the number of the basic variable.

On the circumstance of many based variables, choosing $\overline{G}(\overline{X})$ contains quadratic polynomial with cross terms makes amount of calculation very huge, so it is not be adopted.

(2) *The choice of sample points*

There are many ways to select the sample points as usual, such as Bucher design (matrix design), central composite design, random sampling, two-level factorial design, etc. Now the finite element soft has added the function of selecting samples as well. For example, ANSYS has the three ways to confirm the position of the sample point: central composite design, matrix design and custom-design.

(3) *The method of the polynomial function fitting*

Presently, the most common usage of the fitting method is least squares method. Then there expands some weighted least square method, in order to fix the weak point of not distinguishing the good and bad sample points.

68.3 Weighted Linear Response Surface Method

Linear response surface method is the method that linear polynomial is fitted by limit sate function, confirming the $n + 1$ undetermined coefficients of linear polynomial through deterministic test. Finally, it will choose an iteration method to meet require of precision of fitting expression failure probability and real failure probability.

Linear response surface method is only used on the circumstance that nonlinearity degree of the structure real limit state equation is not big. However, most time on practical engineering applications, the nonlinearity degree of the real limit state equation is big and coefficient of variation of the basic variable is small, which can also get the high precision by using linear response surface method. As the excellent feature of using less approximate function of undetermined coefficients and demanding less sample points, linear response surface method is wildly used in engineering.

68.3.1 The form of Polynomial Function

$$\overline{G}(\overline{X}) = b_0 + \sum_{i=1}^{n} b_i x_i \tag{68.7}$$

where, $b_i(i = 0, 1, 2, \cdots, n)$ is undetermined coefficient, the number of coefficients to be determined is $(n + 1)$.

68.3.2 The Determination of the Undetermined Coefficients in Polynomial

The vector of undetermined coefficients $b = (b_0, b_1, b_2, \cdots, b_n)$ can be obtained from weighted least squares method, the number of sample points m has to be higher than or equal to the number of coefficients of the response surface $n + 1$, Usually, $m = 2(n + 1)$. And calculate the corresponding value $G(X_i)(i = 1, 2, \cdots, m)$ of the sample point X_i. A is the sample matrix of $m \times (n + 1)$ order of m sample points, which shows bellow:

$$A = \begin{bmatrix} 1 & \cdots & x_{1j} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ 1 & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ 1 & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix}$$

$$\overline{b} = \left(A^T WA\right)^{-1} A^T W\overline{y} \tag{68.8}$$

where, $\overline{y} = (G(X_1), G(X_2), \cdots, G(X_m))$, x_{ij} is the j basic variable value of the i row, W is weight matrix.

68.3.3 Selecting the Sample Points

Linear response surface method usually uses the design method which Bucher came up with in 1990 to select the sample points. Basically, it selects a center point first, and then gets the sample points through the distance deviated along the direction of coordinate axes. This distance usually is the f times of the standard deviation σ_{x_i} of the basic variable x_i, f is interpolated coefficient, and most time choosing the value between 1 and 3, generally, 2 or 3 is chosen when the first iterated, then comes to the value 1. Figure 68.1 shows the selecting sample points principle designed by Bucher in two dimensional spaces.

68.3.4 The Confirmation of the Weight Matrix W

W is the $n \times n$ diagonal matrix of weights, w_i is weight factor. Then here comes the constructor method of diagonal matrix of weights (Kaymaz and McMahon 2004; Zhong et al. 2010).

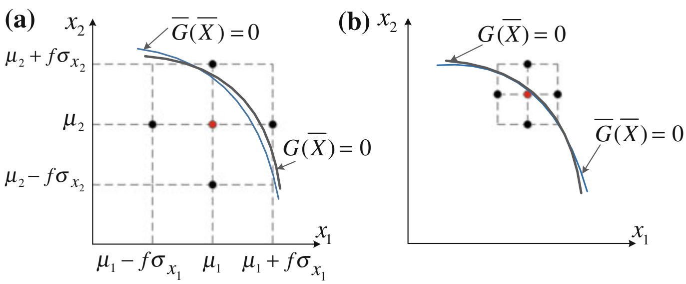

Fig. 68.1 The selecting sample points principle designed by Bucher in two dimensional spaces. **a** The first iteration. **b** Meet the accuracy requirements

$$\begin{cases} y_{best} = \min|G(X_i)|, (i = 1, 2, \cdots, m) \\ w_i = \dfrac{y_{best}}{|G(X_i)|} \\ \\ W = \begin{bmatrix} w_1 & & \\ & \ddots & \\ & & w_m \end{bmatrix} \end{cases} \tag{68.9}$$

68.3.5 The Calculation Procedure of Weighted Linear Response Surface Method

(1) Using $\overline{G}(X) = b_0 + \sum_{i=1}^{n} b_i x_i$ to fit the limited state function $G(\overline{X})$.
(2) Using Rackwize-Fiessler method to normalize the un-normalized basic variable.

The physical dimension, strength and deadweight of general components conforms normal distribution. Also there are many distributions such as normal distribution, logarithmic distribution and weibull distribution in ANSYS.

If the distillation function and density function of basic variable x_i on limit state function is $F_i(x_i)$ and $f_i(x_i)(i = 1, 2, \cdots, n)$, the mean value and standard deviation of the basic variable x_i' which equivalents of x_i and follows a normal distribution can be got from formula 68.10 and formula 68.11.

$$\mu'_{x_i} = X_i^* - \sigma'_{x_i} \cdot \Phi^{-1}\left(F_i\left(X_i^*\right)\right) \tag{68.10}$$

$$\sigma'_{x_i} = \phi\left(\Phi^{-1}\left(F_i\left(X_i^*\right)\right)\right)/f_i\left(X_i^*\right) \tag{68.11}$$

where, Φ and ϕ are the distillation function and density function which follow the standard normal distribution, X_i^* is the pre-choose point which is supposed to be mean value as usual.

(3) Choosing a way for taking the sample point, and the procedure comes to the follows:

- The first iteration of the sampling center point is denoted by $X^{*(1)}$, Computing the mean value of the basic variables $\mu = (\mu_1, \mu_2, \cdots, \mu_n)$, give as

$$X^{*(1)} = \mu = (\mu_1, \mu_2, \cdots, \mu_n) \tag{68.12}$$

- Select $n + 1$ sample points: compare the absolute value of the i sample point's limit state function $G(X_i)$ and j's $G(X_j)$, $j = n + 2$, Then select the sample point with small absolute value, and get rid of the sample point with large absolute value.

(4) Determine the diagonal matrix of weights W from Eq. (68.9).

(5) The obtained Coefficient matrix $\overline{b}^{(k)}$ is used in Eq. (68.8), then gets $\overline{G}(\overline{X})^{(k)}$ from Eq. (68.7), where, k is the k times iteration.

(6) Apply the FOSM/AFOSM method to obtain the design point $X_D^{(k)}$ of the k times iteration, then obtain the reliability index $\beta^{(k)}$ or failure probability $P_f^{(k)}$ of $\overline{G}(\overline{X})^{(k)}$.

(7) Compute the value of the limit state function $G\left(X_D^{(k)}\right)$ at the point $X_D^{(k)}$. Determine the new central point $X^{*(k+1)}$ of the $k+1$ times iteration from Eq. (68.13)

$$X_i^{*(k+1)} = X_i^{*(k)} + \left(X_{Di}^{(k)} + X_i^{*(k)}\right)\frac{G\left(X^{*(k)}\right)}{G(X^{*(k)}) - G\left(X_D^{(k)}\right)} \tag{68.13}$$

where, $X_i^{*(k+1)}$ is the i coordinate value. This strategy is in order to ensure that the new center point close to the true limit state equation.

(8) Repeat the previous step until $\left|\beta^{(k)} - \beta^{(k-1)}\right| < \varepsilon$, then stop, where ε is a given reference accuracy.

Calculation of weighted linear response surface method given below flowchart: (Fig. 68.2).

68.4 Example

Here comes the limit state function:

$$G(\overline{X}) = \exp(0.2x_1 + 1.4) - x_2$$

where,the basic variables $x_i (i = 1, 2)$ follow a standard normal distribution, $x_i \sim N(0, 1)$, We regard the result of AFOSM as the exact solution. Compare the result of traditional linear response surface method and the weighted linear response surface method with the result of AFOSM. The results show in Table 68.1.

We can be seen from the Table 68.1 of results. The calculated results of traditional linear response surface method produce large errors,the calculated results of weighted linear response surface method produce very small errors.

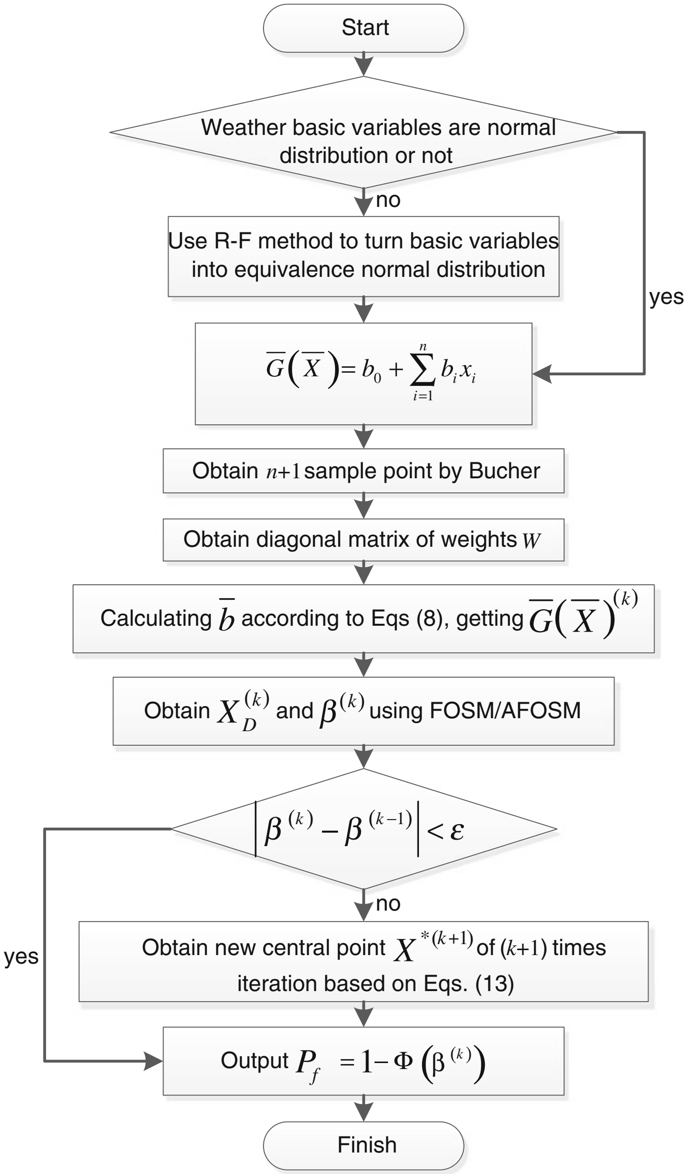

Fig. 68.2 Weighted linear response surface method for computing flow chart

Besides, when the interpolation coefficient f changes, the variation range of the calculated results is smaller than the results of the traditional linear response surface method.

Table 68.1 Calculated result

Method	f	The number of sampling	β	P_f ($\times 10^{-4}$)	Errors (%)
AFOSM			3.350	4.045	0
Traditional linear	1	24	3.430	3.015	25.464
response	2	24	3.430	3.015	25.464
surface method	3	24	3.532	2.061	49.048
weighted linear response	1	24	3.3450	4.046	0.025
surface method	2	24	3.3450	4.046	0.025
	3	18	3.350	4.037	0.198

68.5 Conclusion

The traditional response surface method re-choose the new sample points in each iteration, which makes the nice sample points be ignored and login the bad sample points when fitting the response surface. At last, it makes the result of decreasing the fitting precision. After introduce weight matrix ,the calculated results of weighted linear response surface method produce very small errors,and more stable.

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Chapter 69
The Latest Development of Objective Bayesian Analysis

Ning Ji and Yi Dai

Abstract The 2011 International Workshop on Objective Bayes Methodology has been held in East China Normal University last year. This paper selects three experts' reports to introduce the latest development of Objective Bayesian Analysis. Professor James Berge applied the reference prior in estimating the parameters of Gaussian random field and is shown to yield a proper posterior distribution. Professor Ferreira used the theory of Objective Bayesian to solve the parameters of Exponential Power Regression Models and recommended the Jeffreys prior in three cases. Professor Lai-sheng Wei introduced the loss function for Empirical Bayes test problem for variance components in random effects models and the recommended noninformative prior distribution is given, obtained very good result. Those three experts' arguments will be introduced in detail in this paper.

Keywords Gaussian random field · Jeffreys prior · Noninformative prior · Objective Bayesian analysis · Random effects models · Reference prior

69.1 Introduction

Bayesian method is developed based on Bayes theorem for solving statistical problems systematically (Wu 2000). Bayesian analysis as a subjective theory is a kind of general view, but it is not very accurate either in history or in reality. In fact the first Bayesian experts, Thomas Bayes and Laplace, use a constant prior distribution for the unknown parameters based on the Bayesian analysis. How to make the prior probability generates the subjective and objective Bayesian School.

N. Ji (✉) · Y. Dai
School of Mechanical Engineering, Tianjin University of Technology and Education, Tianjin 300222, China
e-mail: jining5225015@163.com

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Objective Bayesian School's main content is the use of noninformative prior distribution. Most of them are using Jeffreys prior distribution (Berger 1985). Maximum entropy prior is another commonly used noninformative prior distribution in practice (Berger 1985). Details will be discussed in this paper.

69.2 Reference Prior Application to Gauss Random Field

Professor James Berge comes from the University of Duke introduced the development history of Objective Bayesian Analysis and pointed out that the objective Bayesian analysis has been applied to many fields of Bayesian analysis. It is characterized by use of the following prior.

Non-informative prior. The largest frequency that we use in practice is constant prior, Jeffreys prior and the maximum entropy prior. The reference prior is often emphasized in the latest statistics literature. The basic thought of the reference prior is that: firstly, extraction the test data $z_k = (x_1, x_2, \cdots, x_k)$ from the population distribution $p(x|\theta)$; then introduce a kind of measure $I\{z_k; p(\theta)\}$ which expressed that under the prior distribution of $p(\theta)$, the amount of information that sample data z_k can provided. The sample data z_k defined by $I\{z_k; p(\theta)\}$ can provide the prior $\pi_k(\theta)$ which contains the maximum amount of information and obtained the corresponding posterior distribution $\pi_k(\theta|x)$. And then in limit significance (use Kullback–Leibler distance) to define the limit $\pi(\theta|x) = \lim_{k\to\infty} \pi_k(\theta|x)$, we call $\pi(\theta|x)$ is reference posterior distribution. Finally we define $\pi(\theta)$ which satisfying $\pi(\theta|x) \propto p(x|\theta)\pi(\theta)$ as reference prior distribution (Li 2006).

Objective Bayesian analysis method can successfully, which has been confirmed, but it will also appear some problems in practice.

Constant prior can yield improper posteriors (Berger et al. 2000). For instance, we use the Objective Bayesian analysis method to estimate the mean and the variance for the Gaussian random field $\{Z(s), s \in D\}$, $D \subseteq R^l$; we usually select the constant prior or Jeffreys prior. At the same time parameter v will be introduced through the process of estimation to control the smoothness and roughness of the random field. Unknown regression parameter β will be also introduced. Professor James Berge gives the likelihood function for parameters (β, σ^2, v) as following:

$$L(\beta, \sigma^2, v; Z) = \left(2\pi\sigma^2\right)^{-\frac{n}{2}} |\Sigma_v|^{-\frac{1}{2}} \exp\left\{ -\frac{1}{2\sigma^2} (Z - X\beta)' \Sigma_v^{-1} (Z - X\beta) \right\} \tag{69.1}$$

In which the symbol Z is the observed data. And the prior density form:

$$\pi\left(\beta, \sigma^2, v\right) = \frac{\pi(v)}{\left(\sigma^2\right)^a} \quad a \in R \tag{69.2}$$

Professor James Berge demonstrated that for the prior (69.2) with $\pi(v) = \frac{1}{v}$ and any a, the posterior distribution of (β, σ^2, v) is improper. For the model described above with sampling distribution (69.1) and prior distribution (69.2), the posterior distribution of (β, σ^2, v) is proper if and only if (Berger et al. 2000):

$$0 < \int_{\Theta} L^I(v)\pi(v)dv < \infty \tag{69.3}$$

This follows immediately from (69.3), since $L^I(v) \to c_0$ as $v \to 0$ and $\frac{1}{v}$ is not integrable at 0.

For the above mentioned problems, James Berge proposed the use of a reference prior. The ultimate prior form is derived:

$$a{=}1,\ \pi(v) \propto \left\{ tr\left[W_v^2\right] - \frac{1}{(n-p)}(tr[W_v])^2 \right\}^{\frac{1}{2}} \tag{69.4}$$

In which,

$$W_v = \left(\frac{\partial}{\partial v}\Sigma_v\right)\Sigma_v^{-1}P_v^{\Sigma} \quad P_v^{\Sigma} = I - X\left(X'\Sigma_v^{-1}X\right)^{-1}X'\Sigma_v^{-1}$$

Σ_v is the $n \times n$ matrix, $\Sigma_{v,ij} = K_v\left(\|s_i - s_j\|\right)$, $K_v\left(\|s_i - s_j\|\right) = corr\{Z(s), Z(u)\}$.

Prior (69.4) yields a proper posterior distribution.

69.3 Objective Bayesian Analysis for Exponential Power Regression Models

Professor Ferreira form University of Missouri, applied the Objective Bayesian Analysis method to parameter solution for Exponential Power Regression Models and recommended the Jeffreys prior in three cases.

Exponential Power distribution (Ferreira 2011):

$$f(y|\mu, \sigma, p) = \frac{1}{2\sigma}\exp\left[-\left(\frac{\Gamma\left(1 + {}^{1}\!/_{p}\right)|y-\mu|}{\sigma}\right)^{p}\right] \tag{69.5}$$

In which:

$$-\infty < y < \infty,\ -\infty < \mu < \infty,\ \sigma > 0,\ p \geq 1$$

Model:

$$y_i = X_i'\beta + \varepsilon_i,\ \varepsilon_i \sim EP(0, \sigma, p)$$

Based on the Fisher information, three default priors for the parameter (β, σ, p) are derived.

Jeffreys prior is:

$$array*20l\pi^{J}(\beta,\sigma,p) \propto \frac{\left[\Gamma\left(\frac{1}{p}\right)\Gamma\left(2-\frac{1}{p}\right)\right]^{\frac{k}{2}}\left[\left(1+\frac{1}{p}\right)\psi'\left(1+\frac{1}{p}\right)-1\right]^{\frac{1}{2}}}{\sigma^{(k+1)}p} \tag{69.6}$$

Independent Jeffreys prior associated with the grouping $\{(\beta),(\sigma,p)\}$:

$$\pi^{l_1}(\beta,\sigma,p) \propto \frac{\left[\left(1+\frac{1}{p}\right)\psi'\left(1+\frac{1}{p}\right)-1\right]^{\frac{1}{2}}}{\sigma p} \tag{69.7}$$

Independent Jeffreys prior associated with the grouping $\{(\beta),(\sigma),(p)\}$:

$$\pi^{l_2}(\beta,\sigma,p) \propto \frac{1}{\sigma p^{\frac{3}{2}}}(1+p)^{\frac{1}{2}}\left[\psi'\left(1+\frac{1}{p}\right)\right]^{\frac{1}{2}} \tag{69.8}$$

Professor Ferreira demonstrated that π^{l_2} can yield a proper posterior. Both prior π^{J} and π^{l_1}lead to improper posteriors because of their relatively heavy tail in term of p when $p \to \infty$.

In practice, if the heavy tail behavior of the data observed, to reduce the influence of outliers and increases the robustness of analysis, we may directly fix $1 \le p < 2$. Then π^{J} and π^{l_1} priors may also lead to proper posteriors.

69.4 Empirical Bayes Estimation of Variance Components in Random Effects Model

Professor Lai-sheng Wei from University of Science and Technology of China introduced the loss function for Empirical Bayes test problem for variance components in random effects models and the recommended noninformative prior distribution is given, obtained very good result.

The random effects model is as following (Wei 2011):

$$Y_{ij} = \mu + \alpha_i + e_{ij}; \quad i = 1, \cdots, a; j = 1, \cdots, b$$

In which $\alpha_i \sim N\left(0, \sigma_2^2\right), \quad e_{ij} \sim N\left(0, \sigma_1^2\right)$

There are many methods on estimating the variance components σ_1^1 and σ_2^2 such as ANOVA (Hu et al. 2007), Maximum likelihood (Mao et al. 1998), Restrict Maximum likelihood and Bayesian method (Mao 2005).

Professor Wei demonstrated that if under the non informative prior:

$$\pi\left(\sigma^2\right) \propto \sigma^{-2} \tag{69.9}$$

And under the loss function

$$L\left(\sigma^2, d\right) = w\left(\sigma^2\right)\left[\left(d_1 - \sigma_1^2\right)^2 + \left(d_2 - \sigma_2^2\right)^2\right] \tag{69.10}$$

It can obtain very good result.

69.5 Conclusion

According to the questionnaire investigation results distributed to famous scholars from international statisticians field, Jordan, chairman of international Bayesian statistical society (ISBA), announced five important unanswered questions in the Bayesian theory method, the sorting of which is (Jordan 2011): (1) model selection and hypothesis testing; (2) Calculation and statistics; (3) the relationship between Bayesian and frequency; (4) prior; (5) Nonparametric and semiparametric; How to make the prior probability generates the subjective and objective Bayesian School. Choosing prior in subjective way is the focus of the study for Objective Bayesian School. Use the noninformative prior is the main content for Objective Bayesian School and has been made great achievement. The Jeffreys prior, the maximum entropy prior and the reference prior are the largest frequency prior that we used in practice. Now many scholars are still committed to the study of the noninformative, believing that through joint efforts, Objective Bayesian School certainly could have greater achievements.

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Chapter 70
Study on Fault Classification of Power-Shift Steering Transmission Based on v-Support Vector Machine

Yuan Zhu, Ying-feng Zhang and Ai-yong Du

Abstract This paper focused on the condition monitoring problem of the Power-Shift Steering Transmission (PSST). Spectrometric oil analysis is an important way to study the running state of PSST. Because of complicated nonlinear relationship in oil analysis data, a model of PSST' fault classification based on v- Support Vector Machine (v-SVM) is proposed. The fundamental of v-SVM is researched. The influence of model parameters for performance of v-SVM is analyzed. Experimental results show that, comparing with C-support vector machine and BP neural network, the v-support vector machine has good properties in research of fault classification of PSST.

Keywords Fault classification · v-support vector machine · Power-shift steering transmission

70.1 Introduction

As the rapid development of mechanical technology, the equipments become more sophisticated. The real-time status of equipment is important problem in condition monitoring. Spectrometric analysis of oil liquid model is a valid method in condition monitoring (Zheng et al. 2009; Li et al. 2009; Hongbo et al. 2006; Bing et al. 2006).

PSST is sophisticated equipment which is often used in hostile environment. The configuration of PSST is shown in Fig. 70.1. The failure of any part may leads to very serious consequences. Therefore, people want timely to know the status of PSST. From the lubrication system of the equipment regularly to obtain oil

Y. Zhu (✉) · Y. Zhang · A. Du
Department of Auto Engineering, Academy Military Transportation, Tianjin 300161, China
e-mail: prizhyle0223@sina.com

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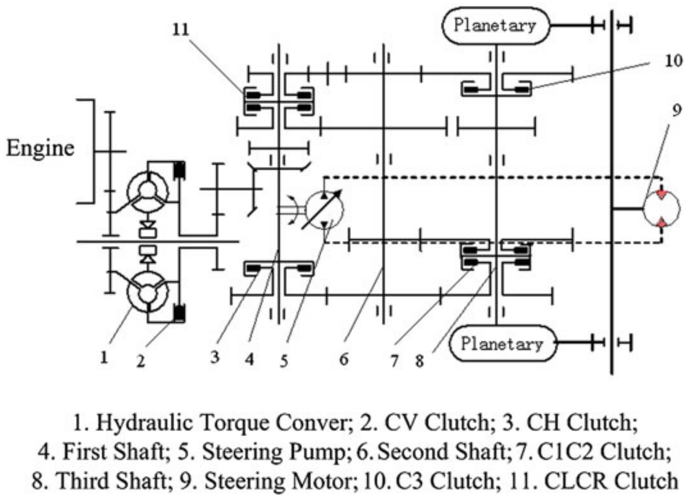

Fig. 70.1 The configuration of PSST

samples and spectral analysis, we can get the quantitative information of component wear without dismantling and identify the potential failures and timely maintenance. Therefore, we want to build a fault classification model using the samples that have been obtained during the running of PSST.

In this paper, a fault classification model of power-shift steering transmission based on v-Support Vector Machine is proposed. The correct rate of the model has been proved to be very high with limited fault samples.

70.2 v-Support Vector Machine

Basic classification approach of SVM is an issue of dichotomies (Boser et al. 1992; Vapnik 1998). For nonlinear problems, *C,* a penalty factor is introduced in order to obtain relatively good classification performance. In SVM training process, *C,* the penalty factor plays two roles: maximize classification interval and minimize training errors (Li et al. 2003; Zhai et al. 2003). The aforementioned roles are competing in the way that maximizing classification interval will inevitably lead to the increased training errors while minimizing training mistakes will result in the declined classification interval. In the training process, *C* mainly plays a compromised function (Hu et al. 2007). As a result, difficulty is in existence for selection of *C*. Hence, Schölkoph et.al. (2000) propose an improved approach, namely, substituting parameter v for *C*.

Assume that sample set X = {xi} ∈ Rd is composed of two types of points. In case of xi belongs to the type 1, it can be concluded that yi = 1. In case of xi belongs to the type 2, it can be concluded that yi = −1. Therefore, the training sample set {xi, yi} can be obtained, among which i = 1,2,3…n. Map x from original space to F, a high-dimensional feature space through applying a nonlinear mapping function:

$$\phi : x \to \phi(x),\ R^d \to F \tag{70.1}$$

Thus, corresponded optimization problem of dichotomies issue is:

$$\min J(\omega, \xi, \rho) = \frac{1}{2}\omega^T \cdot \omega - v\rho + \frac{1}{n}\sum_{i=1}^{n} \xi_i \tag{70.2}$$

$$\text{s.t. } y_i\left[\left(\omega^T \cdot \phi(x_i)\right) + b\right] \geq \rho - \xi_i \tag{70.3}$$

$$\xi_i \geq 0,\ i = 1,\ 2,\ \ldots,\ n,\ \rho \geq 0 \tag{70.4}$$

where ξ_i reflects distance between y_i, actually indicates value and SVM output. Compared with C-SVM, there contains no parameter C, which is replaced by parameter v. In addition, the parameter of ρ is also added in. In case that $\xi_i = 0$, condition (70.3) means that the two types of points are separated by the interval of $2\rho/\|\omega\|$ (Boser et al. 1992; Naiyang and Yingjie 2004).

The following function of formula (70.2) is obtained through introducing Lagrange function:

$$\begin{aligned} L(\omega, \xi, b, \rho, \alpha, \beta, \delta) = {} & \frac{1}{2}\|\omega\|^2 - v\rho + \frac{1}{n}\sum_{i=1}^{n} \xi_i \\ & - \sum_{i=1}^{n} \left\{\alpha_i\left[y_i\left[\left(\omega^T \cdot \phi(x_i)\right) + b\right] - \rho + \xi_i\right] + \beta_i\xi_i\right\} - \delta\rho \end{aligned} \tag{70.5}$$

Partial derivative of formula (70.5) is solved and the result is introduced into the function. Maximum value of α is worked out, and then dual problem of optimization issue (70.2) is obtained as follows:

$$\max\ -\frac{1}{2}\sum_{i}^{n}\sum_{j}^{n} \alpha_i\alpha_j y_i y_j \left(\phi(x_i)^T \cdot \phi\left(x_j\right)\right) \tag{70.6}$$

In other words, the minimum value of the following dual problem needs to be solved:

$$\min \frac{1}{2}\sum_{i}^{n}\sum_{j}^{n} \alpha_i\alpha_j y_i y_j \left(\phi(x_i)^T \cdot \phi\left(x_j\right)\right) \tag{70.7}$$

Calculating problem with similar shape of $\frac{1}{2}\sum_{i,j=1}^{n} \alpha_i\alpha_j y_i y_j \varphi(x_i)^T \varphi\left(x_j\right)$ will be encountered when solving optimization issue (70.7) with SVM. Direct calculation will be quite complicated due to the fact that φ function is nonlinear. In order to avoid the problem, Vapnik (Boser et al. 1992) puts forward kernel function method, namely, replace $\varphi(x_i)^T\varphi(x_j)$ calculation with $K(x_i, x_j) = \varphi(x_i)^T\varphi(x_j)$. RBF kernel function, which currently enjoys the most extensive application, is employed in the research with the following form:

$$K(x_i, x_j) = \exp\left(-\frac{|x_i - x_j|^2}{\sigma^2}\right) \tag{70.8}$$

After introducing kernel function, dual problem of dichotomies issue can be demonstrated as follows:

$$\min \frac{1}{2}\sum_{i}^{n}\sum_{j}^{n}\alpha_i\alpha_j y_i y_j K(x_i, x_j) \tag{70.9}$$

$$\text{s.t.} \sum_{i=1}^{n}\alpha_i y_i = 0 \tag{70.10}$$

$$0 \le \alpha_i \le \frac{1}{n},\ i = 1, 2, \ldots, n \tag{70.11}$$

$$\sum_{i=1}^{n}\alpha_i \ge v \tag{70.12}$$

70.3 Experimentation Research

Spectrometric oil analysis technology mainly detects the type and content of elements of oil. Different components may contain the same elements. According to Spectrometric analysis method, the same component elements are classified as the same type. The fault classification model of PSST is shown in Table 70.1.

The spectrometric analysis of oil liquid data shows in Table 70.2. We obtain these data in the vehicle road test and optimize these samples. Each group contains 8 elements such as Fe, Cr, etc.

Table 70.1 The fault classification model of PSST

Fault class	Component	Main elements
Clutch fault	Friction, Steel	Fe, Mn, Cu, Pb
Gear fault	Transmission gear, planetary	Fe, Cr, Ni
Sealing element fault	Sealing ring, Oil set	Fe, Si, Mn, Mo, Cr

Table 70.2 Spectrometric analysis of oil liquid data (unit: μg/mL)

Number	Cr	Cu	Si	Pb	Fe	Mn	Al	Mo
1	0.3	19.4	3.8	9.4	7.8	0.0	2.9	8.8
2	0.3	28.5	5.2	13.2	10.8	0.7	3.3	2.6
3	0.3	34.1	3.4	13.8	11.9	0.7	3.0	2.3
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
33	0.9	65.2	15.4	39.5	36.4	0.6	12.9	9.7

70.3.1 Selection of Parameters

Parameter selection occupies a significant status in SVM model training. RBF kernel function is put into application in the process of model training. Therefore, two parameters: σ and v need to be confirmed in the process. Related researches indicate that numeric area of v is supposed to be (0, 1) (Li and Xu 2005; Pawlak 1997; Swiniarski and Skowron 2003).

Figure 70.2 indicates variation trend of classification accuracy rate with parameters of σ and v. According to the figure, when σ enjoys certain numeric area, no significant variation of classification accuracy rate is witnessed with the increasing of v; when v enjoys certain numeric area, classification accuracy rate decreases in a gradual manner with the increasing of σ. It can be seen from calculation that when $\sigma = 0.003$ and numeric area of v is 0.36–0.5, the accuracy rate is 0.9, which also applies in case of $\sigma = 0.045$ and numeric area of v is 0.42–0.55. However, another problem needs to be noticed, namely, number of support vector, for numeric area of v is influenced by number of support vector.

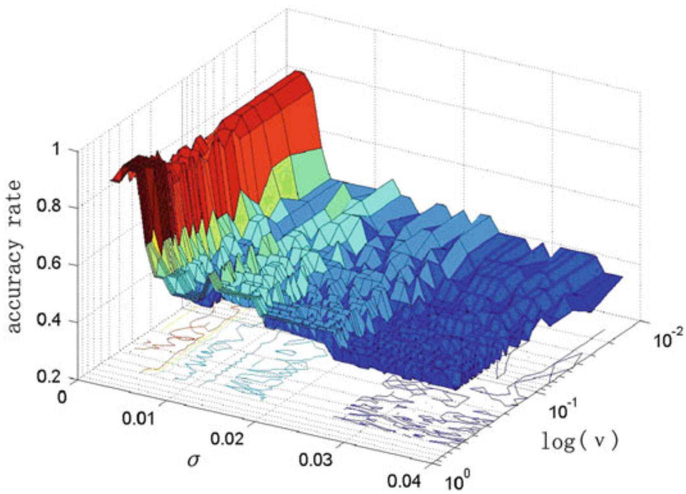

Fig. 70.2 Relationship of accuracy rate and parameters

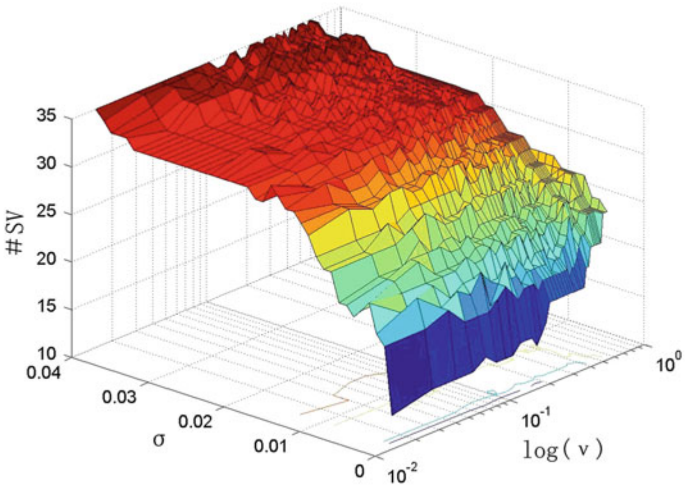

Fig. 70.3 Relationship of support vector number and parameters

Figure 70.3 indicates variation trend of support vector number with parameters of σ and v. #SV represents number of support vector. The figure shows that parameter σ can pose significant influence on the number of support vector. No matter what the numeric area of v is, number of support vector always increases sharply with the increasing of σ; no significant variation of support vector number is witnessed when σ enjoys certain values, no matter how v changes. With the increasing of σ, number of support vector also increases, while accuracy rate of the model declines, thus making popularization capacity of the model decrease. Therefore, selection of the parameter of σ is of great significance. Selection of the parameter of v is supposed to be affected by the number of support vector; otherwise, it will pose influence on popularization capacity of the model.

Taking into comprehensive consideration influence of model parameters on accuracy rate and number of support vectors, the paper ultimately selects $(\sigma, v) = (0.045, 0.42)$ as the parameter for SVM model.

70.3.2 Experimentation

Through selecting, we pick out 33 group data for training and 10 group data as testing samples. During the training, the model makes only one error of judgment in test samples. The correct rate of judgment for the test group data is 90 %. Table 70.3 show that, comparing with C-support vector machine and BP neural network, the v-support vector machine has good properties in research of fault classification of PSST.

Table 70.3 Correct rate of different classifiers

Classifiers	Parameters of model	Correct rate (%)
v-support vector machine	$\sigma = 0.045$, $v = 0.42$	90
C-support vector machine	$\sigma = 0.05$, $C = 0.2$	70
BP neural network	net.lr = 0.01, net.show = 500;	80

In most cases, the oil samples of the lubrication system of the equipment are normal. But, the components of the PSST may have a potential fault that could not be detected. The model of PSST' fault classification based on v-SVM can judge the status of PSST. The correct rate of the model has been proved to be very high with small samples.

70.4 Conclusion

In this paper, a model of PSST' fault classification based on v-SVM is proposed. The fundamental of v-SVM is researched. The influence of model parameters for performance of v-SVM is analyzed. The correct rate of the model has been proved to be very high with limited fault samples.

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Chapter 71
A Group Technology Based Methodology for Maintenance Scheduling

Ji-hong Yan and Xin Li

Abstract A novel Group Technology (GT) based methodology for maintenance scheduling of complex series–parallel production system is proposed. Hierarchical Clustering (HC) method is employed to group facilities according to their similarities in location, facility type, maintenance type, structural position and maintenance time. And weight allocation of these considered factors is optimized using Tabu Search (TS). Simulation results validate the methodology's effectiveness in reducing maintenance cost.

Keywords Group Technology · Maintenance scheduling · Hierarchical Clustering · Similarity · Weight allocation

71.1 Introduction

Proper maintenance scheduling not only reduces maintenance cost, but also increases the availability, reliability, and life span of facilities. Current research on maintenance scheduling mainly concerns with Preventive Maintenance (PM) scheduling (Khanlari et al. 2008), including Periodical Maintenance (Ángel-Bello et al. 2011; Park et al. 2000), Condition Based Maintenance (Tian and Liao 2002; Tian et al. 2011), etc., due to its effectiveness to avoid or mitigate the consequences of failure of facilities.

Particularly, for multiunit systems, research on PM focuses on Opportunistic Maintenance (OM) (Radner and Jorgenson 1963; Wang 2002) and Group

J. Yan (✉) · X. Li
Department of Industrial Engineering, Harbin Institute of Technology, Harbin, China
e-mail: jyan@hit.edu.cn

X. Li
e-mail: 23joe@163.com

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Maintenance (GM) (Ritchken and Wilson 1990; Sheu and Jhang 1997; Gertsbakh 1984; Abdelhadi 2010). Under OM, the failure of a subsystem results in possible opportunity of other subsystems to undertake maintenance. And under GM, facilities are maintained in groups under certain conditions, so that more reasonable logistics of spare parts and smaller scale of scheduling problem can be achieved (Abdelhadi 2010). However, for either OM or GM, little research is conducted on complex systems, and method for grouping facilities is scarcely studied.

In this paper, we proposed a novel methodology for maintenance scheduling of complex system based on GT, in which OM and Clustering-based Group Maintenance (CGM) are combined. Facilities' structural dependence are studied and described with a structure model. HC (Abdelhadi 2010; Vakharia and Wemmerlöv 1995) is employed to group facilities according to factors such as their similarities and interrelationships. And TS is applied to optimize the weight allocation of the considered factors in clustering. A case study of a complex series–parallel production system is presented to verify the methodology.

71.2 Production System Modeling

71.2.1 Facility Performance & Maintenance Effect Modeling

We've studied the modeling of the performance of facilities and the effect of four types of maintenance actions, i.e. minor maintenance, medium maintenance, overhaul and replacement in previous work (Yan et al. 2011), which are also applied in this paper. As shown in Fig. 71.1, minor maintenance, medium maintenance, overhaul and replacement are carried out at t_1, t_2, t_3 and t_4 respectively. No improvement of reliability is obtained after minor maintenance, whereas reliability degradation is slowed down; after medium maintenance and overhaul, the reliability is improved, and overhaul has more significant effect; after replacement, the facility is as good as new. The first three types of maintenance are

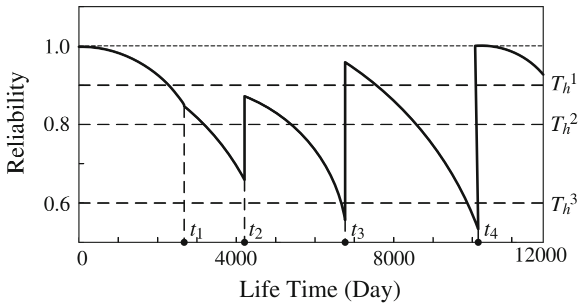

Fig. 71.1 Reliability evolution of a facility with maintenance

triggered by referring to three thresholds of reliability, T_h^1, T_h^2, and T_h^3. When improvement of reliability is below a certain level denoted as L_R, the reuse of facility is no more economic, and replacement should be carried out.

71.2.2 Production System Structure Modeling

To describe the structural dependence between facilities, the structure of the system is modeled, in which each facilities is assigned with a facility number and a 3-digit code [s_1, s_2, s_3] recording its structural position in the system. s_1 stands for the production line; s_2 for work stage (each work stage carries out a certain process); and s_3 stands for the label of the facility in the corresponding work stage. For instance, facility 3 in the system shown in Fig. 71.2 is the 2nd paralleled facility in Work Stage 2 of Production Line 1, whose structural code is [1, 2, 2], etc. The input and the output of the system are regard as facilities and assigned with facility numbers.

71.2.3 Maintenance Cost Modeling

The maintenance cost of the kth maintenance activity consists of direct maintenance cost C_m^k and indirect production loss L_p^k. Direct maintenance cost, including cost of maintenance actions for maintenance units C_u^k and set-up cost C_s^k, can be calculated by (71.1) and (71.2).

$$C_m^k = C_u^k + C_s^k \tag{71.1}$$

$$C_u^k = \sum_{i=1}^{M} (C_p^{k,i} + C_t^{k,i} + C_h^{k,i} + C_c^{k,i}) \tag{71.2}$$

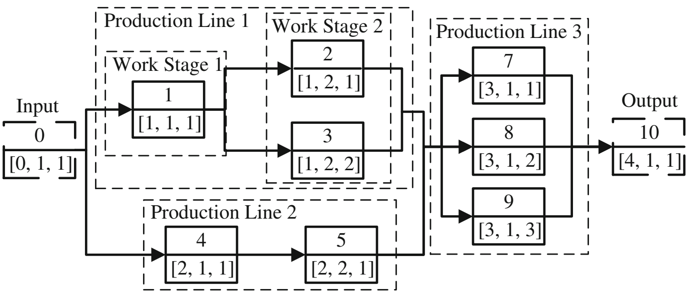

Fig. 71.2 Structure model of a series–parallel system

where $C_p^{k,i}$, $C_t^{k,i}$, $C_h^{k,i}$, and $C_c^{k,i}$ are cost of spare parts, maintenance tools, maintainers, and consumables for maintenance unit i.

Commonly, the productivity of a production system $P(t)$ at time t depends on its bottle neck then. In this paper, it is assumed that there's no buffer between any two connected work stages, production of the system has been balanced, facilities in the same work stage has same productivity. Hence, the L_p^k can be calculated by (71.3).

$$L_p^k = P_0 \times (t_k - t_{k+1}) - \int_{t_k}^{t_{k+1}} P(t)\mathrm{d}t \tag{71.3}$$

where P_0 is the normal productivity of the system; t_k is the time when kth maintenance activity starts and t_{k+1} is when the maintenance activity ends. And $P(t)$ equals to the lowest productivity of all work stages at time t.

71.3 Clustering Based Grouping Method

Based on Group Technology, products or processes with high similarity can be grouped together to achieve higher efficiency (Ünler and Güngör 2009). In this paper, according to OM, a maintenance activity is triggered once any facility calls for overhaul or replacement, and then HC is employed to group facilities that need maintenance according to their similarities. Particularly, similarities in facilities' location, type, maintenance type, structural position and maintenance time are considered in this paper.

To measure the similarity of facilities in location, the distance between any two facilities is calculated according to a relative coordinate system on shop floor. Facility i is assigned with two coordinate values, i.e. x_i and y_i. Thus the similarity in location $S_l^{i,j}$ between facilities i and j can be calculated by (71.4) and (71.5).

$$D_{dis}^{i,j} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \tag{71.4}$$

$$S_l^{i,j} = (D_{dis}^{\max} - D_{dis}^{i,j})/(D_{dis}^{\max} - D_{dis}^{\min}) \tag{71.5}$$

where $D_{dis}^{i,j}$ is the distance between facilities i and j; $D_{dis}^{\min}$ and $D_{dis}^{\max}$ are the minimum and maximum distances between any two facilities.

To measure the similarity of facilities in their types, each facility is assigned with a two-digit code $[l_1, l_2]$. l_1 stands for facility type, and l_2 stands for its subtype. The similarity in facility type $S_p^{i,j}$ between facilities i and j can be calculated by (71.6).

$$S_p^{i,j} = \begin{cases} 0, & \text{if} l_1^i \neq l_1^j \\ 1, & \text{if } l_1^i = l_1^j \text{ and } l_2^i = l_2^j \\ 0.5, & \text{else} \end{cases} \tag{71.6}$$

To measure the similarity of facilities in their maintenance type, a one-digit code m is assigned to each facility. Particularly, in this paper, maintenance is categorized into 4 types, i.e. minor maintenance, medium maintenance, overhaul, and replacement, and each type of maintenance is assigned with a certain value. The similarity between facilities i and j in maintenance type $S_n^{i,j}$, can be calculated by (71.7).

$$S_n^{i,j} = \begin{cases} 0, & \text{if } m^i \neq m^j \\ 1, & \text{if } m^i = m^j \end{cases} \tag{71.7}$$

In group maintenance, maintenance actions of facilities in the same group are carried out at the same time and finished simultaneously. Hence facilities in different work stage should be assigned to a same group to accelerate the recovery of productivity of the system. For example, in a maintenance activity, Facility 1, 2 and 3 in the system shown in Fig. 71.2 need maintenance and all of them should be divided into 2 groups, which can't be maintenance simultaneously. If facilities 1 and 2 are clustered in Group 1 and Facility 3 in Group 2 and Group 1 is maintained first, the productivity can recovered to half of normal productivity once Group 1's maintenance ends. The similarity between facilities i and j in their structural position, $S_s^{i,j}$, can be calculated by (71.8).

$$S_s^{i,j} = \begin{cases} 0, & \text{if } s_1^i = s_1^j \,\&\, s_2^i = s_2^j \,\&\, s_3^i = s_3^j \\ 1, & \text{else} \end{cases} \tag{71.8}$$

To prevent too many facilities clustered in one group, the fifth measurement of similarity is introduced, denoted as $S_t^{i,j}$. The sum of maintenance time for two facilities is used to measure their similarity which can be calculated by (71.9) and (71.10).

$$\overset{\frown}{S}_t^{i,j} = t_m^i + t_m^j \tag{71.9}$$

$$S_t^{i,j} = (\overset{\frown}{S}_t^{\max} - \overset{\frown}{S}_t^{i,j})/(\overset{\frown}{S}_t^{\max} - \overset{\frown}{S}_t^{\min}) \tag{71.10}$$

where, $\overset{\frown}{S}_t^{\min}$ and $\overset{\frown}{S}_t^{\max}$ are the minimal and maximal time needed to maintain any two facilities considered in clustering. Hence the similarity $S^{i,j}$ between facility i and j can be calculated by (71.11).

$$S^{i,j} = W_l \cdot S_l^{i,j} + W_p \cdot S_p^{i,j} + W_n \cdot S_n^{i,j} + W_s \cdot S_s^{i,j} + W_t \cdot S_t^{i,j} \tag{71.11}$$

where W_l, W_p, W_n, W_s and W_t are corresponding weights for the five similarities.

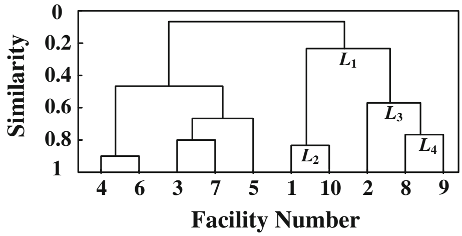

Fig. 71.3 Dendrogram

In this paper, Weighted Average Linkage method is employed to measure the similarity between two clusters. The similarity between clusters P and Q, denoted as $S_C^{P,Q}$, can be calculated by (71.12)

$$S_C^{P,Q} = \sum_{i \in G_P, j \in G_Q} S^{i,j} / (n_P \cdot n_Q) \tag{71.12}$$

where, G_P and G_Q are clusters P and Q, n_P and n_Q are numbers of facilities in clusters P and Q.

In this way, the similarity between two objects (clusters or facilities) can be calculated, and dendrogram is utilized to establish the groups, in which pairs of objects in close proximity are linked, until all facilities are clustered into one group. An example of dendrogram is shown in Fig. 71.3, in which each upside-down U-shape line is named a "link" between two objects. The height of a link is its similarity value. Then the partition process is carried out according to the inconsistency coefficient of each link. If the inconsistency values of one link and all the links below it are smaller than a prescribed threshold T_h^d, all objects connected by these links are clustered into one group.

As is shown in Fig. 71.3, the three links, i.e. L_1, L_2, and L_3 have similarities S_1, S_2, and S_3. The inconsistency value I_{con} of L_2 can be calculated by (71.13).

$$I_{con} = |S_2 - \mathrm{avg}(S_1, S_2, S_3)| / \mathrm{std}(S_1, S_2, S_3) \tag{71.13}$$

where $\mathrm{avg}(S_1, S_2, S_3)$ and $\mathrm{std}(S_1, S_2, S_3)$ are the average and standard deviation of S_1, S_2, and S_3. In this context only one level of links below L_2, i.e. L_1 and L_3, are used to calculate its inconsistency value. In fact, the depth of level, d_L, can also be adjusted so that more links below can be included into calculation. For instance, if the depth of levels is set as 2, link L_4 will also be included. For links that have no other links below them, their inconsistency values are set as 0.

In this paper, the depth of levels d_L is set as 3, and the threshold T_h^d is set as 0.8.

With the method above, facilities that need maintenance in one maintenance activity can be grouped according to their similarities under a certain level.

However, for different production systems with different characteristics, fixed weight allocation of the considered factors in clustering may not achieve reasonable grouping result. For example, in a series system, the consideration of structural positions of facilities loses its importance. Furthermore, the quantity and types of facilities that need maintenance vary from one maintenance activity to another. Even a facility in different maintenance activity may has different maintenance need. Hence, weight allocation should be considered in clustering process.

In this paper, weight allocation is optimized each time a maintenance activity is carried out via TS due to its property of fast convergence.

In addition, Hybrid Genetic Algorithm (Esbensen and Mazumder 1994) is employed for scheduling after grouping.

71.4 Case Study

71.4.1 Case Description and Parameter Settings

In this section, a case study on maintenance scheduling of a sliding bearing production system with 24 facilities is presented and maintenance cost is set as the objective of maintenance scheduling, which should be minimized. As shown in Fig. 71.4 facilities 0 and 25 are input and output respectively, which are assumed to have no maintenance need. Milling machines are labeled from 1 to 10, vertical drilling machines 11 to 15, radial drilling machines 16 to 22, and boring machines 23 and 24. And the layout of the workshop is also presented in Fig. 71.4. All the facilities form 3 production lines, i.e. a bearing cap production line, a bearing pedestal production line and an assembling line.

It is assumed that there are enough spare parts and consumables, while maintenance tools and maintainers are limited, which are out sourced according to the maintenance need of the maintenance activity. Particularly in this paper, the total number of maintainers or tools equals to 1/3 of the total need if all maintenance actions are carried out simultaneously. In addition, tools and maintainers assigned to a maintenance group are according to the maximum need to maintain any one facility in this group.

For each facility of the same type, the two parameters for reliability modeling, η and β, are derived from randomly generated simulation data subject to a same

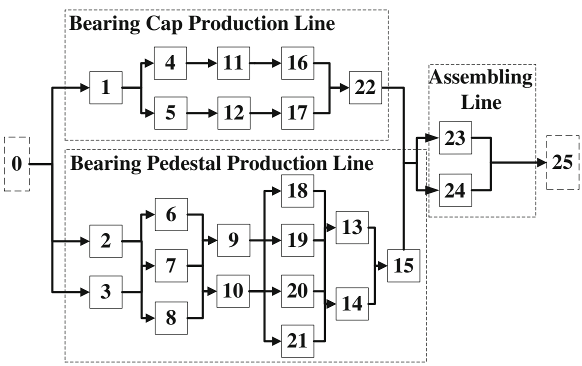

Fig. 71.4 Sliding bearing production system

distribution; and all facilities of one type has the same price and the resources and time needed for each kind of maintenance actions.

The three thresholds, T_h^1, T_h^2, and T_h^3, are set as 0.9, 0.75, and 0.6 respectively; and L_R is set as 0.2.

The set-up cost C_s of each maintenance activity is set as 1,000; the unit prices for four types of maintenance resources i.e. spare parts, tools, maintainers, and consumables are set as 100, 50, 50, and 10 respectively; the normal production value v_0 is set as 1,000/h.

71.4.2 Advantage Measurement of GM

With GT, several advantages can be gained when maintaining a group of facilities. Time can be saved by maintaining facilities within a close distance; similarities in structure and failure mode of a certain type of facilities can be utilized to accelerate maintenance; similar maintenance processes of a certain maintenance type can be carried out on a group of facilities simultaneously so that the efficiency can be improved. In this paper, a reduction factor is introduced to quantify the advantage, which is the weighted average of three subfactors, i.e. reduction factors considering distance, facility type similarity, and maintenance need similarity among facilities in one group.

Reduction factor considering distance can be obtained by firstly averaging the distances between any pairs of facilities in that group. Set N_g^k as the number of facilities in maintenance group k; the average distance can be calculated by (71.14).

$$D_{avg}^k = 2\sum_{i=1}^{N_g^k-1}\sum_{j=i+1}^{N_g^k} D_{dis}^{i,j} / [N_g^k \cdot (N_g^k - 1)] \tag{71.14}$$

Suppose the possible maximal, mean, and minimal values of distance between any two facilities on the shop are $D_{avg}^{\max}$, D_{avg}^{mean} and $D_{avg}^{\min}$. Assume that when the average distance in group k equals to $D_{avg}^{\min}$ or $D_{avg}^{\max}$, the maintenance time of this group will be reduced by 30 % or increased by 30 %. Then the reduction factor considering distance in maintenance group k can be calculated by a function $f_1(\cdot)$ obtained by fitting a quadratic curve to two data sets, i.e. $\{D_{avg}^{\min}, D_{avg}^{\mathrm{mean}}, D_{avg}^{\max}\}$ and $\{0.7, 1, 1.3\}$. An example is shown in Fig. 71.5.

Similarly, the average similarity in facility type and maintenance type in one group $S_{p,avg}^k$ and $S_{n,avg}^k$ can be calculated by (71.15).

$$S_{x,avg}^k = 2/[N_g^k \cdot (N_g^k - 1)]\sum_{i=1}^{N_g^k-1}\sum_{j=i+1}^{N_g^k} S_x^{i,j} \tag{71.15}$$

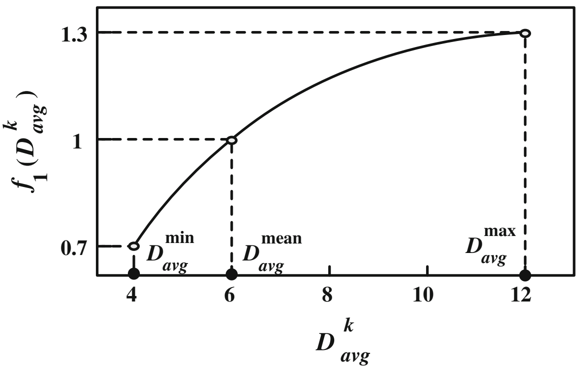

Fig. 71.5 $f_1(\cdot)$ obtained by fitting to {4, 6, 12} and {0.7, 1, 1.3}

It is assumed that when the average similarity of group k in facility type or maintenance type equals to 1, the time needed for maintenance actions in this group can be reduced by 40 % or 30 % respectively. The reduction factor considering facility type and maintenance type in group k can be calculated by $f_2(S^k_{p,avg})$ and $f_3(S^k_{n,avg})$. Function $f_2(\cdot)$ is obtained by fitting a linear function to data sets {0, 1} and {1, 0.6}, and function $f_3(\cdot)$ is obtained by fitting a linear function to data sets {0, 1} and {1, 0.7}.

Finally, the reduction factor F_{dus} in group k can be calculated by (71.16).

$$F^k_{dus} = W_1 \cdot f_1(D^k_{avg}) + W_2 \cdot f_2(S^k_{p,avg}) + W_3 \cdot f_3(S^k_{n,avg}) \tag{71.16}$$

where W_1, W_2, and W_3 are weights of the three sub reduction factors, particularly in this case, set as 0.4, 0.4 and 0.2. The time needed for any maintenance actions in maintenance group k is reduced by $(1 - F^k_{dus})$.

71.4.3 Simulation and Result Analysis

The maintenance scheduling is carried out for a time period of 1,000 working days in three scenarios i.e. only OM. OM & Rule-based Group Maintenance (RGM) (Yan et al. 2011), and OM & CGM.

Table 71.1 Optimal maintenance cost in three scenarios

Maintenance Activity	Maintenance Policy		
	OM	OM & RGM	OM & CGM
1	22,443	24,892	21,052
2	17,508	18,265	16,510
3	27,081	25,455	23,481
4	42,863	39,203	37,529
Total	109,895	107,815	98,572

Four maintenance activities occur in the simulation. The total cost and maintenance cost of each maintenance activity under the three maintenance policies are shown in Table 71.1. GM cost less, not only because of the advantage of group technology that shortens the maintenance time, but also due to smaller scale of the scheduling problem with which satisfactory result can be obtained more easily. Especially, CGM achieves least cost.

Compared with RGM, CGM possesses more flexibility by adjusting its weight allocation on five factors in clustering process. In 3rd maintenance activity, facilities 2, 8, 10–12, 15, 23 and 24 need minor maintenance; facilities 13, 14, 18–20, and 22 needs overhaul; and no facility needs replacement. The grouping and scheduling results under OM & RGM and OM & CGM are shown in Figs. 71.6 and 71.7 respectively. Among the facilities, numbers of facilities that call for minor maintenance and medium maintenance are relatively balanced, which are 7 and 5 respectively, and facilities requiring maintenance are mainly vertical drilling machines and radial drilling machines, with a number of 5 and 7 each. By optimization, a weight allocation of [0.12, 0.2, 0.24, 0.06, 0.38] is obtained. Among the weights, the weight for maintenance type and facility type are relatively larger, with which time can be reduced by grouping facilities with same maintenance type need or facility type. To avoid too many facilities grouped together, a large weight for maintenance time is obtained. As shown in Fig. 71.6, under OM & RGM, the group comprised of facilities 18–21 is unreasonable because of its long time consumed, while as shown in Fig. 71.7, under OM & CGM, facility 21 is singled out and no group's maintenance lasts more than 9 h.

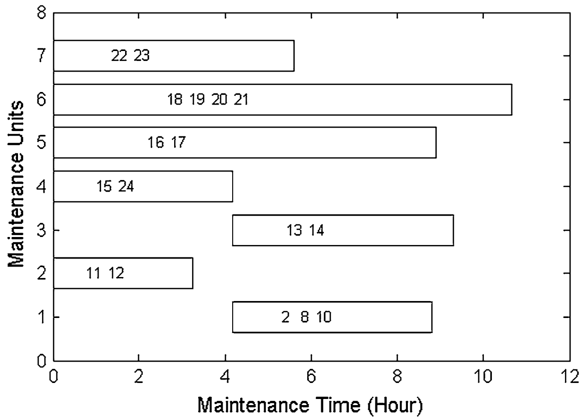

Fig. 71.6 Gantt chart of the 3rd maintenance activity under OM & RGM

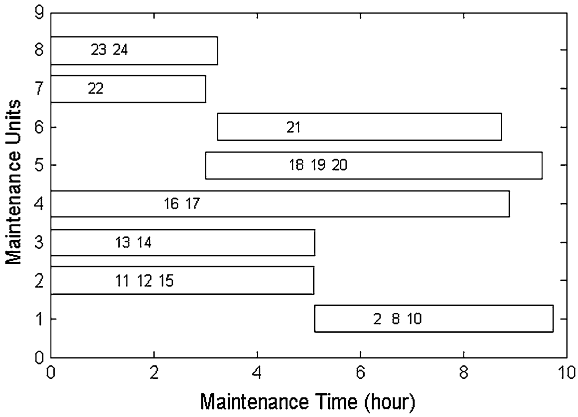

Fig. 71.7 Gantt chart of the 3rd maintenance activity under OM & CGM

71.5 Conclusions

In this paper, a novel maintenance methodology based on GT for complex systems is proposed.

Structure model of system is established to describe the structural dependence between facilities, upon which the production loss during a maintenance activity can be calculated with higher consistency with practice.

In the methodology, comprehensive consideration of the clustering factors leads to more satisfactory grouping results. And the flexibility derived from an optimized weight allocation of such factors enhances the methodology's adaptability to different systems and varying maintenance requirements. Furthermore, more factors could be included in clustering to expand the consideration in grouping, and the influence of such factors on maintenance could be analyzed. In this way, a system's characteristics could also be studied, upon which an optimized RGM could be obtained, which is often more easily implemented in practice.

In the future, similarity measurements in clustering would be investigated and refined, and the considered factors would be analyzed and selected. Moreover, the methodology to extract the characteristics of a system in terms of maintenance by analyzing the considered factors and their corresponding weight would be developed.

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Chapter 72
Research and Theory Application of Reliability Engineering Management on a Certain Type of Military Transport Aircraft Maintenance Training Simulator

Xiao-kun Wang, Tie-nan Li, Si-dong Wei, De-xiang Sun and Li-min Qiao

Abstract In this paper, the application of reliability engineering management on the design, manufacture, operation and maintenance process of a certain type of military transport aircraft maintenance training simulator has been studied with a view to improve its reliability, reduce the number of its failures. The methods and measures adopted during the reliability engineering management effectively improve the ability of continuing work and complete tasks of the simulator, and then reduce it's operation and support cost greatly.

Keywords Military transport aircraft maintenance training simulator · Reliability · Reliability engineering · Reliable engineering management

72.1 Introduction

Military transport aircraft maintenance training simulators as a hardware-in-the-loop simulation system can simulate military transport aircraft flight condition and working states, replicate real flight dynamic processes, simulate ground maintenance training and fault detection and elimination program. It can provide realistic emulation of vision, manipulation, audio, equipment operating status and movement sensation, furthermore, it also able to simulate special circumstances in the

X. Wang (✉) · S. Wei · D. Sun · L. Qiao
Aviation University of Air Force Changchun, Changchun, People's Republic of China
e-mail: wangxiaokun_yanyan@163.com

X. Wang
School of Optical and Electronic Engineering, Changchun University of Science and Technology, Changchun, People's Republic of China

T. Li
Fundamental Engineering Department of Research and Development Center, Changchun Railway Vehicles Corporation Limited, Changchun, People's Republic of China

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real flight and dangerous fault handling procedures. And compared with actual maintenance training, it can improve the training efficiency without restriction of the season and the weather. Now it has become widely used in international aviation, is recognized as the most effective means of training aircraft observer and ground maintenance personnel skills.

At present, military transport aircraft maintenance training simulators has gain a fast development than civil transport aircraft maintenance training simulators in China, but there is a relatively gap between China and other developed countries on the technical indicators of reliability, maintainability, supportability. As an important quality characteristic the reliability is a vital factor to determine the performance and the life cycle cost of the transport aircraft maintenance simulator. So it is crucial to take reliability engineering management in the life cycle of the transport aircraft maintenance simulator.

72.2 The Connotation of Reliability Engineering Management

The goal of reliability engineering is to ensure and improve product reliability and maintainability. Under given resource constraints reliability engineering can correct and control accidental failures, prevent and eradicate inevitable failures in the course of the whole life cycle of the products. Reliability engineering is involved in product design, prototype, test, setting the production, storage, use, maintenance, until the whole process of end of life. (Zhou 1999) National military standard GJB450-88 defines reliability engineering as following that "Reliability engineering is a series of work includes design, testing and production and so on, with the purpose to achieve the reliability." The basic tasks of reliability engineering can be summed up to determine and obtain the product reliability.

The reliability as inherent characteristics of equipment is formed through a series of engineering activities, such as design, manufacturing and so on, which need to be reasonably organized and supervised. Reliability management is to make an effective organization, coordination and supervision of these activities in the life cycle of equipment from the system point of view, to achieve the established reliability goals and the most efficient life cycle costs (Ma et al. 1996).

Reliability management includes: developing reliability programs and other documents, monitoring the production process and program evaluation, building failure reports, analyzing and improving the system; establishing failure inspection team, collecting reliability data and implement reliability education, etc. (Qin et al. 2002). The role of reliability management in the reliability engineering is as shown in Fig. 72.1.

Reliability management can make various aspects of reliability engineering operate effectively. Through process of equipment life cycle planning, reliability work organizing, all research staff coordinating and monitoring, reliability

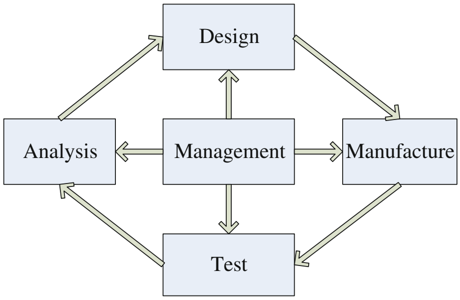

Fig. 72.1 Role of reliability management in the reliability engineering

management will fully display its role in equipment life cycle process, hence get optimal life cycle cost.

72.3 The Reliability Engineering Management Process of the Military Transportation Aircraft Maintenance Training Simulator

The military transportation aircraft maintenance training simulator as large and technically complex hardware-software integrated equipment involves a wide range of professional fields and integrates mechanical-electronic-hydraulic technology, which reliability engineering management is a system engineering project. The detailed process of reliability engineering management is as shown in Fig. 72.2.

72.3.1 Reliability Management of the Design Phase

Reliability management in the design phase is the key and basis of the whole reliability management process. (Guo and Liu 2008). In the design phase some basic work should be included: drawing out reliability management objectives, developing and implementing reliability control programs, reviewing and evaluating the reliability of the design, etc. During implementation the reliability management objectives should be primarily drawn according to reliability requirements of the simulator, then development and implementation of the reliability control program and organization of the reviewing and evaluating to the reliability of the design should be put in practice.

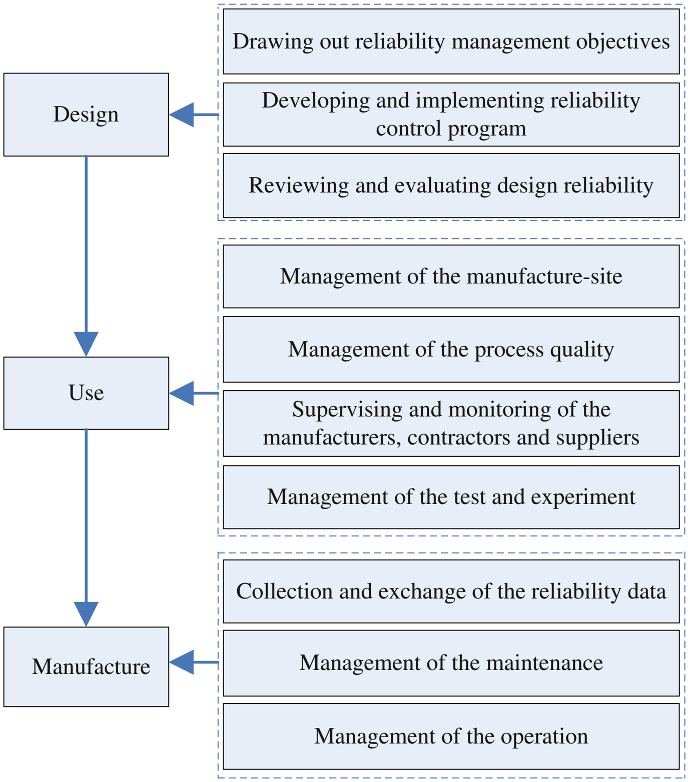

Fig. 72.2 Flowchart of transport simulator reliability engineering management

72.3.2 Reliability Management of the Manufacture Phase

The reliability management in the design phase establishes a foundation to the implementation of the military transport maintenance simulator reliability. The reliability management in the manufacturing phase is to ensure the realization of the simulator reliability goal.

The ultimate object of the reliability management during manufacturing phase is to master, evaluate and control the factors affecting the reliability of transport aircraft simulator in the process of machining, assembly, handling, storage and transportation, in order to fulfill design reliability requirements. The reliability management tasks of manufacturing stage include: manufacturing-site management, process quality management, supervision and control to the manufacturers, contractors and suppliers, management to the tests and experimentation.

72.3.3 Reliability Management of the Use Phase

Inherent reliability given to the transport maintenance training simulator in the phase of design and manufacture will declined and degrade due to various factors, such as transportation, storage, use, maintenance, etc. Therefore, reliability management implementation in the use phase will ensure a more effective long-term stable operation while maintaining the initial reliability level.

The reliability management tasks of manufacturing stage include: collection, exchange and feedback of reliability data, management of maintenance, management of operation.

72.4 Research and Theory Application of Reliability Engineering Management on a Certain Type of Military Transport Aircraft Maintenance Training Simulator

Reliability management process in the development, production and using of a certain type of military transport aircraft maintenance training simulator is basically similar to general product development process. The reliability management should be taken in a practical, scientific and rational way to the design, manufacture and use of the military transport aircraft maintenance training simulator consequently.

72.4.1 Establishment of the Reliability Regulatory Agencies

The reliability regulatory agency is placed under the military transport aircraft maintenance training simulator development unit and is supervised by the unit's key leaders. Many of the personnel who not only familiar with design and manufacturing but also master the knowledge of the reliability are appointed in the reliability agencies. The personnel include reliability designers, reliability managers, reliability information collectors, reliability supervisors. Some of them will be responsible for developing reliability management policy and plan, organizing, coordinating and supervising relevant departments to implement the tasks identified in the reliability program, others will take responsibility for design review, quality certification and unified management of components, collection and feedback of the reliability data and information.

72.4.2 *Reliability Management Measures in the Design Phase of the Military Transport Aircraft Maintenance Training Simulator*

The reliability indices are determined according to the military transport aircraft maintenance training simulator demander's reliability requirements, which are reference to the development of the reliability management project program. Furthermore, "Reliability Engineering Program" is developed by the chief engineer and director, the timeline of the start and the stop date will be definitely set in the program. The reliability management priorities, chart important events and relevant inspection, sampling and testing methods will also be formulated in this phase.

72.4.3 *Implementation and Development of the Reliability Work Plan*

In order to scientifically and efficiently implement reliability management and realize reliability management goals, the work plan of the military transport aircraft maintenance training simulator was developed in phases according to development procedures and reliability requirements.

Main contents of the reliability work plan included: clear reliability requirements and requirements of the military transport aircraft maintenance training simulator, implementing regulations of reliability work project, establishing principles and corresponding responsibilities of reliability management departments, detailed resource plan of personnel, organization and funds budget to ensure a smooth implementation of the reliability management. In addition, a detailed description of the coordination between reliability management department and design, manufacture department was included in it. The acquisition approach, delivery methods and procedures of required reliability data were also given in it.

72.4.4 *Reliability Evaluation of the Design*

Because a large number of new programs, new technologies, new equipment and new components were adopted in both software design and hardware development of the military transport aircraft maintenance training simulator, which would lead to high reliability risk, therefore, a rigorous evaluation to the design of the military transport aircraft maintenance training simulator was implemented, which was an important part of reliability management ensuring the reliability of the simulator.

Review and evaluation of the military transport aircraft maintenance training simulator design have been taken by phases according to reliability design and evaluation requirements.

Experts of professional standing and experience in the field of reliability who have not directly participated in the project plan have been widely invited to review and assess the progress and implementation of the reliability plan, analysis the main factors affecting the reliability of the simulator and develop corrective and improvement measures during each review and assessment. Hence advanced experiences and modern technology would be a timely and effective supplementation to the plan and design program of the military transport aircraft maintenance training simulator.

72.4.5 Reliability Management Measures of the Manufacturing Phase

Reliability management measures in the manufacturing phase of the military transport aircraft maintenance training simulator included: carrying out a rigorous training, theory and operation assessment to the design and manufacturing personnel, replenishing and perfecting the currently personal responsibility system of implementing personal responsibility and practicing competition and going on duty, developing quality record keeping system in order to strengthening precision management of manufacture site and the process, developing a strict quality inspection system and methods of materials, components and final products, establishing management system of tools, onsite fixtures and measurement instruments. In addition, the effective measures to relevant manufacturers, contractors and suppliers were: decomposed and assigned specific and quantified reliability responsibilities to them, made clear reliability requirements to all of the parts and components supplied by them, put an emphasis on supervision and control to acceptance and inspection to them.

72.4.6 Reliability Management Measures of the Military Transport Aircraft Maintenance Training Simulator During Using Phase

Considered the actual needs of equipment maintenance training, serials measures have been adopted after the military transport aircraft maintenance training simulator equipped to the military unit, contributing to high reliability and low maintenance costs during the using stage.

1. *The operating management measures of the military transport aircraft maintenance training simulator:* To ensure a normal operation of the military

transport aircraft maintenance training simulator, have assisted the military unit in organizing training courses for operating personnel to learn the skills, taboos of operation, to guide them to understand the ultimate bearing capacity of the operating mechanism before the simulator equipped. Real-time practice indirection and training have been implemented after the simulator equipped. These effective measures will ensure that the simulator maintain a high reliability of using.

2. *The Maintenance management measures of the military transport aircraft maintenance training simulator:* To reduce maintenance cost and time, increase remediation efficiency, a series of effective measures have been taken during the maintenance of the military transport aircraft maintenance training simulator, which included developing appropriate maintenance policy, planning and acceptance criteria and method according to the military transport aircraft maintenance training simulator use requirements and potential fault analysis, supervising the maintenance operation, establishing effective systems of organization and management, organizing training of technical personnel for operation, maintenance and management, perfecting regulations, duties and responsibilities of maintainers, strengthening recording data and times of inspections, tests and repairs, together with their disposition, to assist learning and to provide scientific data for analysis and improvement design.
3. *The collection and feedback of the reliability information:* Emphasis had been placed on data collection during operation and maintenance of the military transport aircraft maintenance training simulator. The combination of pertinently and designedly visiting customers, on-site information collection, analysis and special research has been adopted in the reliability information collection. A strict accountability and management system has been established, which specified the departments, units and personnel responsibilities in information collection, verification, analysis, processing, transmission and feedback. By setting goals, organization and implementation, supervision and inspection, the closed-loop control of data and information effectively ensured the training units for the full collection and using of the reliability data and information.

72.5 Conclusion

Reliability management is assurance approaches to military transport aircraft maintenance training simulator reliability project. System reliability is directly dependent on the degree of recognition to reliability requirements and management.[1] After a series of effective reliability management measures implemented, mean time between failures (MTBF) of the military transport aircraft maintenance

[1] U.S. military standard MIL-STD-785. Reliability requirements for systems and equipment.

training simulator is greater than 22 h, available utilization rate can reach higher than 98 %, higher than the reliability index requirements, in which the MTBF of the military transport aircraft maintenance training simulator is greater than 20 h, and in which the available utilization rate higher than 96 %, verified the effectiveness of the reliability engineering management on improving the reliability of the military transport aircraft maintenance training simulator.

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Chapter 73
Experimental Study of Transverse Crack Fault Diagnosis in Rotating Machinery

Jian-zhong Lou and Xing Li

Abstract The rotor transverse crack fault is one of the most typical faults of rotating machinery. The transverse crack fault mold was established to simulate the bearing fault state of transverse crack in the rotor test table of Bently in the laboratory. The main vibration characteristics were stated through the analysis of laboratory data when the bearing box was in the state of transverse crack fault. And it has been applied in practice.

Keywords Transverse crack · Bearing box · Rotating machinery · Fault diagnosis

73.1 Introduction

The large rotating machinery is one of the most important equipment in petroleum, chemical, petro-chemical, and other industries. It is also particularly important for us to diagnosis machine fault of large rotating machinery because it will cause serious economic losses and casualties. And it is very useful for people to monitor the fault diagnosis of large rotating machinery in order to avoid vicious equipment damage accidents, reduce corporate economic losses. The fundamental purpose of

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Author: Jian-zhong Lou (1973–), male, lecturer in Zhejiang Institute of Mechanical & Electrical Engineering, Ph.D., Zhejiang University.

J. Lou (✉) · X. Li
Department of Bio-systems Engineering, Zhejiang University, Hangzhou, China
e-mail: loujz160@sina.com

J. Lou
Department of Mechanical Engineering, Zhejiang Institute of Mechanical & Electrical Engineering, Hangzhou, China

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fault diagnosis is to ensure the large rotating machinery to run in safety, stable, long-period, full load statement. Transverse crack is the most common faults of rotating machinery and it is very important for us to get a research (Wei 2000; Wang 1996; Lou and Du 2008; Zhou and Xu 2001).

73.2 The Establishment of Transverse Crack Fault Model

The rotor system mechanics model is the premise of obtains the rotor vibration characteristics and analysis fault mechanism of rotating machinery. Figure 73.1 shows the typical rotor system and its cell division. The vibration differential equation was given as follows:

$$[\mathrm{M}]\{\ddot{q}\} + [C]\{\dot{q}\} + [K]\{q\} = \{Q\} \tag{73.1}$$

where the $\{q\}$ is the generalized displacement vector, the form of the vector $\{q\}$:

where:

v_i	displace the node along the y-axis direction,
w_i	displace the node along the x-axis direction,
β_i	the angle around the x-axis,
θ_i	the angle around the y-axis,
$[\mathrm{M}]$, $[C]$, $[K]$ and $\{Q\}$	respectively displace the mass matrix, damping matrix, stiffness matrix and generalized force.

The rotor with transverse crack is to reduce the overall stiffness of the rotor. There will have the effect on the system with the crack opened and closed when the rotor rotates. We looked it as a rotor with no crack when it closed. And when it fully opened, we looked it as a rotor with a slot. To establish the unit stiffness matrix of crack in the fixed coordinate system (including two parts which were the constant $[K_c^*]_m$ and variable $[K_c^*]_f$), and assemble with stiffness matrix without crack unit. The stiffness matrix of transverse crack rotor system and the vibration differential equation was given as follow:

$$[\mathrm{M}]\{\ddot{q}\} + [C]\{\dot{q}\} + [K][K_c^*]_m\{q\} = \{Q\} - [K_c^*]_m\{q_m\} \tag{73.2}$$

where: $\{q_m\}$ is the static deformation caused by its own weight of the rotor.

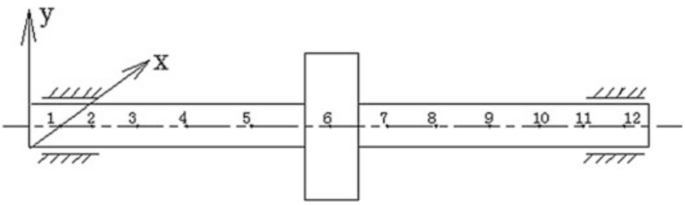

Fig. 73.1 Typical rotor system and unit dividing

Cracked rotor system vibration differential equation model of the rotor crack unit was established to simplify the impact of crack on the vibration of the rotor to an external force on the rotor which was given in equation:

$$\left[K_c^*\right]_t = \left(\left[K_c^e\right]_t/2 + \left[K_c^e\right] - \left[K_c^e\right]_m - \left[K_c^e\right]_t\right)\cos\omega t/2 \tag{73.3}$$

$\left[K_c^e\right]$ and $\left[K_c^e\right]_m$ are the constant does not change with rotation, $\left[K_c^e\right]_l$ changes periodically with the rotating.

Where E is the modulus of elasticity, l is the length of unit, Ix and Iy are the moment of inertia for x and y axes,

$$h = \sin 2\omega t,\ C = \cos 2\omega t$$

From Eq. (73.2) we can be seen to contain only $\sin 2\omega t$ and $\cos 2\omega t$, that means it only contains the second harmonic component.

$$\text{Order}:\ \left[K_c^e\right]_t \cos\omega t/2 = \left(\left[K_c^{3e}\right]_t + \left[K_c^{1e}\right]_t\right)/2 \tag{73.4}$$

where: $\left[K_c^{3e}\right]_t$ only contain $\cos 3\omega t$ and $\sin 3\omega t$, that means it only contains the third harmonic component.

$\left[K_c^{1e}\right]_t$ only contain $\cos\omega t$ and $\sin\omega t$, that means it only contains base harmonic component. $\left[K_c^{1e}\right]_t$ has the same matrix form. That is:

$$\left\{q_m^c\right\} = \left\{V_1\ 0\ 0\ \beta_1,\ V_2\ 0\ 0\ \beta_2,\ V_3\ 0\ 0\ \beta_3\right\}^T$$

We can see from above that the additional force $\left[K_c^e\right]_l\left\{q_m^c\right\}$ which was caused by the transverse crack rotor system is same in the rotor horizontal as in the vertical directions.

Phase difference is 90 degrees which is similar with the unbalanced force, but it excites the rotor with second harmonic vibration components.

$$\left[K_c^e\right]_l\left\{q_m^c\right\} = \left\{-\left[K_c^{3e}\right]/4 + \left[K_c^e\right]_f/2 - \left[K^{1e}\right]_l/4 + \left[K_c^e\right]_f - \left[K_c^e\right]_m \cos\omega t/2\right\}\left\{q_m^c\right\} \tag{73.5}$$

The above analysis only considers the bending stiffness of the crack unit. The shear stiffness of the crack unit also has the same conclusion. The linear increase naturally has the same features.

Through the analysis of the vibration differential equation of the cracked rotor system, you can see the rotor with transverse crack has the typical characteristics of the vibration and diagnostic information: The rotor with a transverse crack vibrate with high multiplier of the second harmonic, third harmonic components and cause the rotor power frequency component amplitude and phase changes.

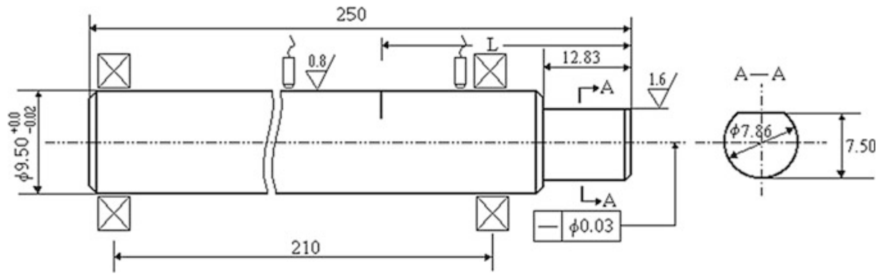

Fig. 73.2 Crack shaft used in test bench

73.3 Fault Setting and the Principle

Figure 73.2 shows the shaft with the transverse crack which was customized for this experiment. The shaft machined through the following processing. First, cut the notch in given depth in the specified location of the shaft and the notch width is about 0.12 mm, then cut the slot and embedded in piece of metal with the thickness of 0.10 mm and fixed it in the notch with No. 502 glue which is similar to opening and closing of the crack. The location of the crack was shown in Fig. 73.2 which was located on the right end (L = 100 mm), the crack depth is about 50 % of the diameter.

73.4 Experimental Results and Analysis

Through the above experiments, the result shows that: With an opening crack on the rotor, it appeared the rotation frequency of 2 times, 3 times and high-harmonic components. When crack propagation, stiffness further reduces, amplitude of 1 time, 2 times frequency also increased.

When the operating speed passed half of the critical speed, the amplitude will appear the resonance peak.

In order to find the phenomenon of frequency modulation cause by the phase modulation and reducing signal frequency modulation caused by the changing of rotational speed. We collected a group of data when the rotor speeds up in the same phase. Figure 73.3 shows the vibration signal time-domain waveform and the Fourier spectrum under the speed of 1,900 RPM with rotor transverse crack. From the figures we can find the two times frequency clearly.

73.5 Analysis of Data

One of air pressure machines in Fujian Petrochemical catalytic company was shut down in June 12, 2009 because of the fault. The monitoring system recorded the

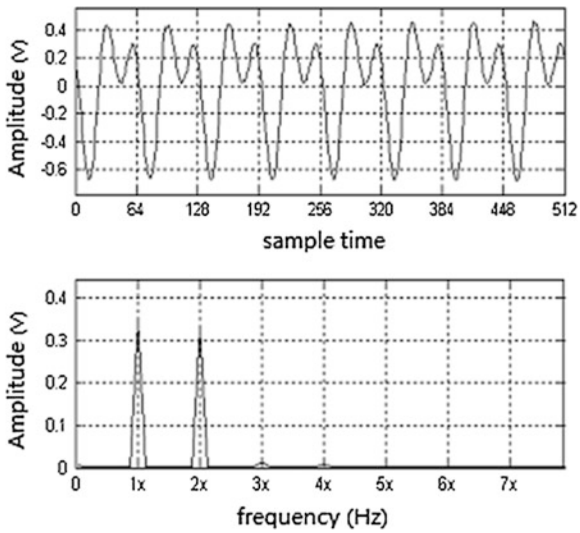

Fig. 73.3 Time-domain waveform and spectrum of vibration signal with rotor transverse crack

data in the black box in details. From the analysis of data, we found that some time before the machine shutdown, the speed of air pressure machine fluctuations. Then the security protection system worked, and the power system of air pressure machine shut down automatically and the air compressor stopped too.

Figure 73.4 shows the vibration waveform under normal operation, it is clear that there are 8 cycle sine waves. Its spectrum is shown in Fig. 73.5 which has only the fundamental frequency of the vibration amplitude. The amplitude of high frequency components is very small. Figure 73.6 shows the vibration waveform under fault states, it is clear that the vibration waveform is different from it in normal conditions. Spectrum also contains high frequency components which were shown in Fig. 73.7.

Normal speed of air pressure machine is 8,300 r/min. Due to the failure of pressure control system, the speed of air pressure machine fluctuations. The protective measures of control system began to work. The air pressure machine shut down. In this process, loads begin to lose. So speed instantly rose to 10,000 rpm, and instantly went back to normal speed, as shown in Fig. 73.8. From Fig. 73.9, the vibration amplitude of the high frequency spectrum of the vibration signal increased significantly, and speed soaring at the same moment, so it can prove that

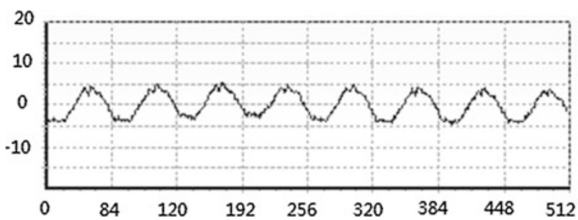

Fig. 73.4 Waveform in normal conditions

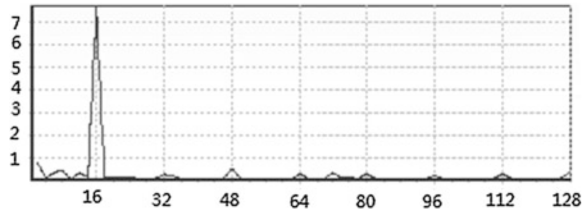

Fig. 73.5 Spectrum in normal conditions

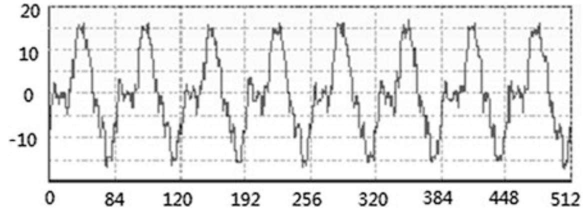

Fig. 73.6 Waveform in fault conditions

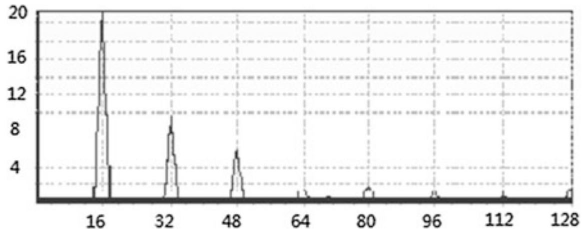

Fig. 73.7 Spectrum in fault conditions

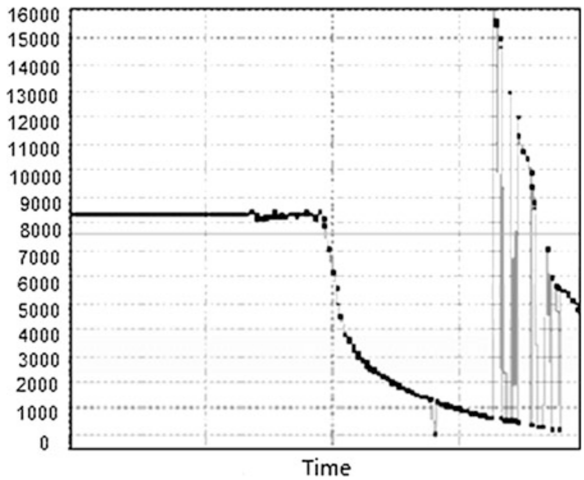

Fig. 73.8 Pressure machine speed trend in fault state

the result of the malfunction of the air pressure machine is load lost, which caused by transverse crack. After technical personnel adjust the control system, reboot, and the pressure resume to normal operation.

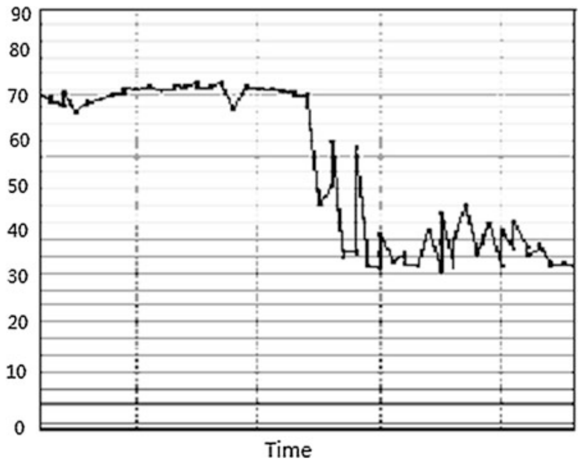

Fig. 73.9 Pressure machine base frequency trend in fault state

73.6 Conclusion

Through building the model to add the transverse crack in the rotor test table of Bently in the laboratory to simulate the bearing fault state of rotor transverse crack fault, through experimental results and theoretical analysis. The main vibration characteristics were stated through the analysis of laboratory data when the bearing box was in the state of transverse crack fault. This is a great help for fault diagnosis and research.

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Chapter 74
Traffic Detector Placement Models with Reliability Holder

J. Q. Liu and N. Zhu

Abstract Traffic flow information is an important source for a large number of transportation applications. Therefore, the number and sites of traffic counting sensors matters a lot. However, traffic sensors are subject to fail in varied situations. In this paper, we extend the classic traffic sensor location problem by considering the failure of sensors. Models aiming to improve the reliability are proposed. Existing sensors is also taken into account. Examples are provided to illustrate the proposed models. Several sensor locations patterns are found.

Keywords Traffic detector placement · Detector failure · Integer programming

74.1 Introduction

Considerable researches have been dedicated to develop models to reconstruct and update OD matrix. Two major methodologies are usually used for OD matrices estimation.

(1) Data survey such as household survey, roadside interview.
(2) By applying traffic flow counts as measurements of link flows in a network.

The first method yields the most accurate result for OD estimation, but it requires considerable resources and is not affordable. Comparatively speaking, the second alternative attracts a large number of studies in the past decades.

For the second type of methodology, OD estimator largely depends on traffic flow measurement. In reality, traffic counts are considered as a convenient and cheap way to obtain traffic information about travel pattern by comparing with the

J. Q. Liu (✉) · N. Zhu
College of Management and Economics, Tianjin University, Tianjin, China
e-mail: zh5553158@163.com

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extensive travel surveys i.e. road interviews, household surveys. Flow information is also used to predict OD pattern and its evolution process by combining with current and historical information since traffic sensors can provide recursive data over time. The accuracy of OD estimation depends largely on the quality and quantity of input data. Therefore the key problem becomes how to identify the minimum number and locations of traffic sensors.

In general, OD matrix estimation model have the following generic form (Yang et al. 1992):

$$\min_{v,\,T} F_1(T,\overline{T}) + F_2(v,\bar{v}) \tag{74.1}$$

$$s.t. \qquad v = M(T) \tag{74.2}$$

where $\bar{T}$ is the target OD matrix, T is the OD matrix to be estimated, $\bar{v}$ is the vector of observed, v is the vector of link flows to be estimated, $F_1(T,\bar{T})$ and $F_2(v,\bar{v})$ are the distance between estimated and prior OD matrix and between estimated and observed traffic flow.

Relating to the objective function, methods can be stratified as follows:

(a) Entropy maximization or Information Minimization model.

Van Vuylen and Willumsen (1980) proposed two models by using information minimization and entropy maximization principle to estimate OD matrix from traffic counts. Maximum likelihood method and prior OD matrix are used in these two models. Fisk (1988) developed a single mathematical model by combining maximum entropy trip matrix estimation with a user-equilibrium model.

(b) Generalized least square estimation and statistical approaches.

Cascetta (1984) proposed a generalized least squares estimator of OD matrix combining direct or model estimators with traffic counts via an assignment model. Bell (1991) presented a generalized least squares (GLS) approach to estimate OD matrix. It is proved that inequality constraints can improve the accuracy of fitted values, reducing their sensitivity to error in the inputs. Spiess (1987) formulated a model to estimate OD demand which was considered as independent Poisson distributions with unknown means to reproduce link flow. A maximum likelihood method was used. For other statistical methods, see Hazelton (2008) for more references.

The above mentioned studies demonstratedsquare estimation and there are strong connections between OD estimation and link count observation. Several scholars have been dedicated to interpret sensor location problem as OD covering problem.

Yang et al. (1991) introduced a concept named “Maximum Possible Relative Error” (MPRE). Accordingly Yang and Zhou (1998) proposed four basic sensor placement rule:

Rule 1. O-D covering rule: A certain portion of trips between any O-D pair should be observed.
Rule 2. Maximal flow fraction rule: For a particular O-D pair, link with the maximal fraction of that O-D flow should be selected.
Rule 3. Maximal flow-intercepting rule: Under a certain number of sensors constraint, the maximal number of O-D pairs should be observed.
Rule 4. Link-independence rule: The resultant traffic counts on the selected links should not be linearly dependent.

Yang et al. (2006) further proposed a new location strategy that offer robust traffic-counting location pattern without the need of considering the behavioral assumption on road users and the level of traffic congestion on the network. Ehlert et al. (2006) extended Yang and Zhou's (1998) work, taking existing traffic sensors and information content of prior OD flows into account. Bianco et al. (2001) formulated a two-stage procedure. First stage is the sensor location problem that determines the minimum number of sensors and location of counting points. Second stage is to update the OD matrix. Pravinvongvuth et al. (2005) proposed a methodology for selecting the most preferred plan from the set of Parato optimal solutions obtained from solving the multi-objective automatic vehicle identification (AVI) reader location problem limited by resource and OD flow coverage. Castillo et al. (2008d) dealt with problem of trip matrix and path flow reconstruction and estimation using plate scanning and link flow observations. Feasible subsets of scanned links are identified. Hu et al. (2009) proposed a linear algebra approach seeking to identify the smallest subset of links in a network which enables the accurate estimation of traffic flows on all links of the network under steady-state conditions. Castillo et al. (2007, 2008a, b) addressed observable problem which is similar with traffic sensor placement using algebraic techniques.

Without the failure of sensors, the ideal way is to install sensors on every link in order to obtain reliable estimation, but due to the limitation of budget, only partial links could be covered by sensors. In practice, traffic counting sensors are subject to failure. The previously proposed models and approaches did not consider the failure of traffic sensors. This paper is intended to choose a desirable set of links for which should be observed by considering the failure of traffic sensor. In particular, we are interesting in sensor location pattern change after considering the sensor failure.

Models proposed in this paper seek to identify influence and pattern of traffic counting sensor placement by taking consideration of failure of traffic counting sensors. We proposed some models that are divided into two categories.

One is to minimize the number of traffic counting sensors under a specific reliability requirement. The other is to cover as much traffic flow as possible by taking into account of sensor failure. The rest of paper is organized as follows: Sect. 74.2 introduces some new models via considering failure of sensor in order to increase the reliability or cover as much path flow as possible. Section 74.3 illustrates algorithm and results of resolving these models by using a test network. Finally, some concluding comments are provided in Sect. 74.4.

74.2 Traffic Sensor Placement Model Under Uncertainty

74.2.1 Notation

a	A link in a network.
w	OD pair.
l_a	la = 1 if a sensor is installed on link a, 0 otherwise.
δ_{aw}	$\delta_{aw} = 1$ if OD pair ^{w} pass over link a, $\delta_{aw} = 0$ otherwise.
Δ	the link OD pair incidence matrix.
p	Probability of sensor failure.
α	Reliability requirement.
n	Combinational result of probability of sensor failure and reliability requirement.
c_w	The number of sensor needed while there are some sensors existed.
a_w	The number of existing traffic sensors.
f_r	Traffic flow of route r.
y_r	Binary variable indicating that if route r is covered by a traffic sensor.
$l*$	Number of traffic sensor for placement.
δ_{ar}^{w}	$\delta_{ar}^{w} = 1$ if link a belongs to route r of OD w, $\delta_{ar}^{w} = 0$ otherwise.
c_f	path flow vector, each element of the vector is the path flow of a specific route.

74.2.2 Model Formulations

The basic utility of installation of traffic counting sensor is to estimate OD matrix. Yang et al. (1991) proposed a concept of "Maximum Possible Relative Error" (MPRE) to measure reliability of OD estimation. In his MPRE model, the MPRE could be infinite if any one OD pair is not observed. It is naturally leading to the OD covering rule (Rule 1).

The following binary integer programming model has been proposed to minimize the use of traffic counting sensors to cover all OD pairs.

$$\text{Model 1: Minimize} \sum_a l_a \tag{74.3}$$

$$\text{Subject to: } \sum_a \delta_{aw} \cdot l_a \geq 1 \quad \text{for all OD pairs w.} \tag{74.4}$$

$$l_a \in \{0, 1\} \tag{74.5}$$

Constraint (74.4) assumes the complete OD pairs coverage. It can be shown that the resultant sensor placement solution will cover all OD pairs. However, traffic sensors have a probability of failure in reality, so that more than 1 sensor is needed to assume a high probability of obtaining traffic information. An extension of Model 1 by considering traffic sensor failure is proposed as follow:

$$\text{Model 2 : Minimize} \sum_a l_a \tag{74.6}$$

Subject to: $\prod_a (1 - \delta_{aw} l_a (1-p)) \le \alpha$

$$\text{for all OD pairs w.} \tag{74.7}$$

$$l_a \in \{0, 1\} \tag{74.8}$$

where p is the probability of sensor failure, α is the reliability requirement for each OD pair. For instance, suppose $\alpha = 0.05$ which means enough number of sensors is needed to assume that only 5 % possibility traffic counting information cannot be obtained. Constraint (74.7) indicates failure probability of all sensors between each OD pair is required to be less than or equal to a reliability level represented by a scalar α. Constraint (74.8) is a binary constraint indicates that each link is prohibited for installation of more than 1 sensor. In Model 2, we still impose the binary constraints (74.8). This constraint will be relaxed in Model 4. Model 2 can be rewritten as follows for the sake of a standard commercial solver to solve it.

$$\text{Model 3 : Minimize} \sum_a l_a \tag{74.9}$$

Subject to: $\sum_a \delta_{aw} l_a \ge n$ for all OD

$$\text{pair w.} \tag{74.10}$$

$$l_a \in \{0, 1\} \tag{74.11}$$

where $n = \left\lceil {}^{\log \alpha}\!/\!{}_{\log p} \right\rceil^{+}$ is the minimum integer great than or equal to ${}^{\log \alpha}\!/\!{}_{\log p}$ which is defined as system reliability level requirement denoting by an integer. An intuitive exposition of constraint (74.10) is that several traffic sensors have to be installed to assume the reliability to be met. The minimum number of sensors satisfying the reliability level requirement is $\left\lceil {}^{\log \alpha}\!/\!{}_{\log p} \right\rceil^{+}$.

Figure 74.1 shows the number of counting sensors are needed when system reliability level requirement and probability of sensor failure is given. Probability of sensor failure is assumed to be identical and independent for all traffic counting sensors. The horizontal axis indicates the probability of sensor failure and vertical axis the system reliability level requirement. From the right-upper to left-bottom part, number of sensors needed to be installed in each OD pair is from 1 to 5, and more than 5 respectively. The smallest part in the left-bottom is that more than or

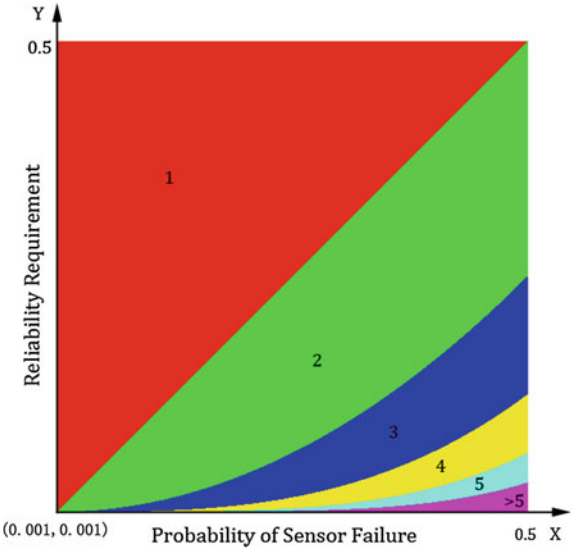


Fig. 74.1 Pattern of reliability level requirement and probability of sensor failure

equal to 6 sensors is needed. Value of horizontal axis from left to right is from 0.001 to 0.5, while from bottom to upper is same with vertical axis.

For model 3, the reliability level requirement cannot exceed the minimum number of links between OD pairs. Therefore, the binary constraint has to be relaxed to integer if higher reliability level requirement is applied which leads to Model 4.

$$\text{Model 4 : Minimize : } \sum_a l_a \tag{74.12}$$

$$\text{Subject to: } \sum_a \delta_{aw} l_a \geq n \quad \text{for all OD}$$

$$\text{pair w.} \tag{74.13}$$

$$l_a \text{ integer.} \tag{74.14}$$

In practice, many cities have already some traffic counting sensors installed. In this case, new sensors should be located to satisfy the reliability level requirement. Observability and reliability can be improved for urban transportation network if some sensors are already installed and more traffic sensors are available. Installed sensors might be located sub-optimally; therefore the pattern of new installed sensor could be changed by comparing with the case that no sensors are installed previously. This leads to the following Model 5 (Yang and Zhou 1998).

$$\text{Model 5 : Minimize} \sum_a l_a \tag{74.15}$$

$$\text{Subject to: } \sum_a \delta_{aw} l_a \geq c_w \quad \text{for all OD}$$

$$\text{pair w.} \tag{74.16}$$

$$l_a \text{ integer.} \tag{74.17}$$

where $c_w = n - a_w$, n is the number of sensors required by reliability level requirement and a_w is the number of existing traffic sensors, c_w is the number of sensors needed. c_w could be less than or equal to 0 which means the constraint associated with corresponding OD pair is already satisfied.

74.3 Numerical Results

In order to better understand the behavior of proposed models, Sioux-Falls network was used to test the above 7 models. The network model has been divided into 24 zones that represent origins and destinations. There are 76 links and 528 OD pairs of this network. Data about Sioux-Falls network comes from Transportation Network Test website.

Computation result for Model 1 is as following:

Numbers in cells of Table 74.1 are ids of links that are installed sensors.

74.3.1 Results for Model 3 (Binary Case)

For model 3, more than 1 sensor is not allowed to be installed on each link. We tested different reliability level requirement n. Result show in Table 74.2.

No feasible solution could be found when $n \geq 7$ because there are some OD pairs that only have $n = 6$ links between them. Under the rule of at most 1 sensor could be installed on each link, some OD pairs cannot meet this reliability level requirement. Figure 74.2 shows the relationship of the minimum number of needed sensors and reliability level requirement n which satisfies linear relationship approximately.

Some links are considered to be important in the sense that they are always chosen to have sensors installed, meanwhile some are considered to be unimportant because no sensor is installed on them. For our 6 scenarios (n equals from 1 to 6), link2, link4, link5, link14, link17, link20, link37, link38, link39, link74 are never chosen which are marked as red cross in Fig. 74.3a. They are considered unimportant. Meanwhile, link9, link11, link29, link48 are always chosen for all 6 scenarios which are marked as red circle in Fig. 74.3b. Link42, link49, link52, link62, link64, link65, link69, link71, link73, link76 are chosen 5 times among all

Table 74.1 Result for model 1

9	11	29	42	48	56	60	65	69	71

Table 74.2 Reliability level requirement versus minimum number of sensors installed

n	1	2	3	4	5	6
Number of sensors	10	20	28	38	48	58

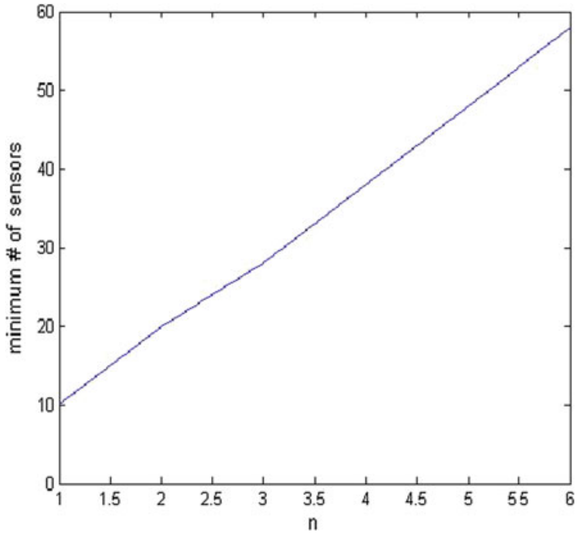


Fig. 74.2 Minimum number of sensors versus *n*

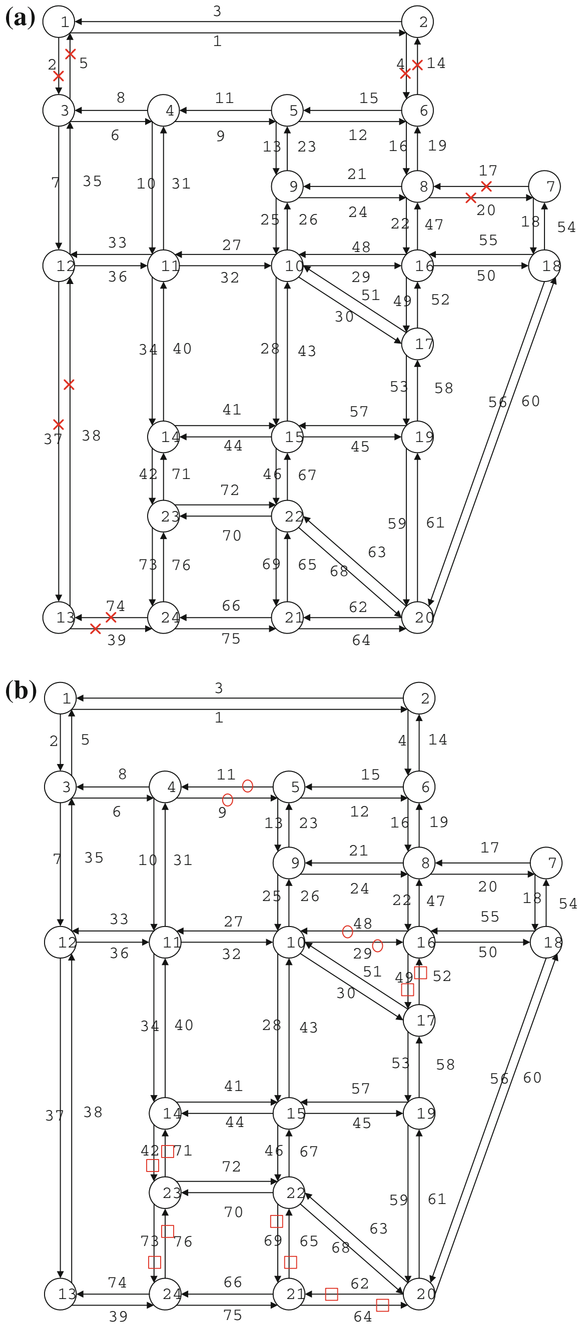
6 scenarios which are marked as red rectangle in Fig. 74.3b. All these links marked red in Fig. 74.3b are considered to be relatively important. An obvious observation is that all important links are topological significant in the sense of link degree. In this paper, link degree is defined as the number of links adjacent to a specific link.

74.3.2 *Results for Model 4 (Integer case)*

Binary constraint was relaxed to be integer so that high system reliability level requirement can be achieved. In this section, 500 hundreds n were tested ranging from 1 to 500. Taking the sensor failure probability of 0.2 as an example, n can be up to 29 if less than probability of 10^{-20} failure is allowed. Thus $n = 500$ is a very high reliability of system requirement. Another purpose of setting n from 1 to 500 is to find the sensor placement pattern.

Figure 74.4 is a scatter plot of how many times each links was chosen among 500 experiments where n is ranging from 1 to 500. All links can easily be divided into two categories. Part of them has a high probability to be chosen which are considered to be important meanwhile some of them are rarely to be chosen. The times each links was chosen can be used as a rank of links.

Fig. 74.3 “Unimportant” and “important” links



Observation 1: Important links are inside the network. Most links on the border of the network are considered to be unimportant.

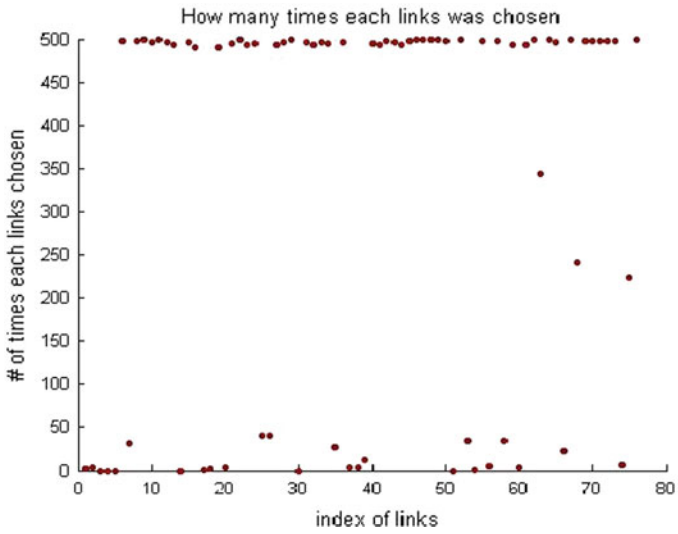


Fig. 74.4 Pattern of sensor placement of integer constraint

Observation 2: For a directed graph, two links connecting two same nodes are both considered important or unimportant.
Observation 3: The sensor location pattern is highly dependent on OD pair pattern.

74.3.3 Results for Model 5 (Existing Sensors Case)

Three types of existing traffic counting sensor location pattern were tested in this paper. Optimal traffic counting sensor location pattern without existing sensor is denoted as Optimal Set. The Optimal Set is defined as not only the location of observed links, but also the number of sensors installed on each link.

Case 1 Existing sensors were a subset of Optimal Set. In this case, the optimal location pattern does not change. The final location patter is the same with Optimal Set. The remaining sensors only need to be installed according to the Optimal Set.

Case 2 Partial existing sensor location was a subset of Optimal Set. The final location pattern is different from the Optimal Set. Total number of sensors needed (including existing sensors) is great than the number of Optimal Set. Also the location pattern is different.

Case 3 None of existing sensors was in the Optimal Set. It is necessary to compensate effect of existing sensors so that more sensors are needed to observe all OD pairs than case 2.

Lemma 1 *The total number of sensors (including existing sensors) is great than or at least equal to the number of sensors needed in the no existing sensor case.*

Proof Let's reform Model 4 in a matrix way.

$$\begin{aligned} &\text{Model 8 : Minimize } c * \vec{L} \\ &\text{Subject to : } \begin{array}{c} \Delta\vec{L} \geq \vec{n} \\ \vec{n}_i \text{ Integer} \end{array} \end{aligned}$$

where $\vec{L}$ is the vector, each element of $\vec{L}$ indicates number of sensors installed on a specific link. $\vec{n}$ is reliability level requirement vector, each element of $\vec{n}$ is n. c is the cost vector which is assumed all one.

Let's denote existing sensor vector as $\hat{L}$ which is known exogenously in following Model 9. The Model 5 can be reformed as:

$$\begin{aligned} &\text{Model 9 : } c * (\vec{L} + \hat{L}) \\ &\text{Subject to : } \begin{array}{c} \Delta(\vec{L} + \hat{L}) \geq \vec{n} \\ \vec{n}_i \text{ Integer} \end{array} \end{aligned}$$

Let's use L_8^* and L_9^* denote the optimal solution of Model 8 and Model 9. Since $L_9^* + \hat{L}$ is also a feasible solution of Model 8, it is obvious that $c * L_8^* \leq c * (L_9^* + \hat{L})$ by definition of Model 8. The lower bound of total number of traffic counting sensors is optimum of Model 8.

Lemma 2 *There is an upper bound of number of sensor needed no matter the number and location pattern of existing sensors.*

Proof The objective of Lemma 2 is to prove $c * L_8^* \geq c * L_9^*$.

Let's rewrite Model 9 as following:

$$\begin{aligned} &\text{Model } 9' : c * \vec{L} \\ &\text{Subject to : } \begin{array}{c} \Delta\vec{L} \geq \vec{n} - \Delta\hat{L} \\ \vec{n}_i \text{ Integer} \end{array} \end{aligned}$$

Since L_8^* is the optimal solution of Model 8, then $\Delta L_8^* \geq \vec{n} \geq \vec{n} - \Delta\hat{L}$, L_8^* is also the feasible solution of Model 9'. According to the definition of optimal value of Model 9', we obtain $c * L_8^* \geq c * L_9^*$ which means $c * L_8^*$ is the upper bound of number of new sensors needed.

74.4 Conclusion

In this paper, Extensions to existing classic traffic counting sensor location problem are proposed. One intuitive inspiration is from the failure of traffic counting sensors. All the models proposed aim to improve the performance of sensors location problems for the purpose of OD estimation.

Firstly, more sensors are allowed in be placed on the same link to increase the reliability of observation. Results show that links with higher topological degree are more important and can be used as weights to measure links. Secondly, locations of existing sensors are considered. Upper bound number of new traffic counting sensors needed for the purpose of fully OD coverage is provided.

Future directions include considering the budget constraints and propose new algorithm for large size network.

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Chapter 75
The Evaluation of Chinese Coal Miners' Coping Styles

Li-xia Niu and Nai-wen Li

Abstract To learn of the Coping Style level in Chinese coal miner. The valid random samples included 1800 miners from national and private coal mine in Tieling etc. The results showed better reliability and validity of TCSQ in miner; There were obvious working years characteristics of TCSQ in miner, the miner whose working year in 16–20 use negative coping style less frequently than that whose working years in 6–10 and over 21–25. The results can provide theory reference and realistic approach to coal mines' validity intervention on coping style.

Keywords Miner · Negative coping · Positive coping · Psychometric studies · TCSQ

75.1 Introduction

Coping style is the strategy and method of cognitive and behavior adjusting, when dealing with the specific internal and external environment requirements beyond the individual's ability to solve (Folkman et al. 1986), and it is one of the most important buffer factors in psychological stress processing, and it influences the nature and strength of the stress reaction, especially the individual's psychological health (Liang 2002). So its relevant studies become the focus on the psychological research (Shen et al. 2002). The individual with positive coping can resolve internal and external pressure more easily and reduce stress level; on the contrary, the individual with negative coping will produce more burnout feelings at stress events (Li and Yang 2004). The TCSQ established by JIANG Qian-jin, has been widely used in patients, students, teachers, and military groups' psychological

L. Niu (✉) · N. Li
Department of Business Administration, Liaoning Technology University, Huludao, China
e-mail: nlx8941@126.com

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health education practice and psychological science study (Li 2007; Meng 2008; Wang and Chen 2001). As the typical representative of heavy manual workers, cola miners have their own particular coping styles. At present, it does not yet have any quantitative reports about the level of miners' coping styles. This study randomly chooses 1,800 miners, using TCSQ to investigate, and analyzing the age, education degree, length of service and marital status characteristics of coal miners' coping style.

75.2 Methodology

75.2.1 Objects

Using the method of multi-stage random sampling, stratified sampling by area, selecting He-bei, Shan-xi, Shan-dong province in the north of China, three northeastern provinces, Jiang-su province in the east of China, He-nan province in the southern of China, Ning-xia province in the northwest of China, Chong-qing province in the southwestern of China; According to the GDP level of per region, selecting the matrix sample as: the coals in Tang-shan, Da-tong, Zao-zhuang, Tie-ling, Liao-yuan, Qi-tai-he, Xu-zhou, Ping-ding-shan, Yin-chuan, Chong-qing and so on; According to the properties and scale of the enterprise, dividing the sample matrix into state-owned key coal, state-owned coal mine, towns and local private coal mine three groups, numbering each group of coal mine and selecting five coal mines with extraction method, extracting 15 coal mines in total; Then according to the type of work, classifying and listing coal miners in selected coal miners, according to the principle of simple random, extracting three or more miners in member list randomly to answer the questions in anonymous way. Investigators bring the questionnaire back after it is completed. Issuing 1,880 questionnaires in total, receiving 1,229 valid questionnaires, the effective rate was 68.3 %. The demographic statistics material can be seen at Table 75.1.

75.2.2 Methods

1. Tools

Using the TCSQ established by Jiang and Zhu (1999). The questionnaire is divided into 2 dimensions and 20 items: positive coping style (PC), negative coping style (NC). Using the Likert5 class rating, the higher the score, the higher frequency in using NC and PC. Evaluating the coping characteristics with the total score, NC points and PC points three indexes.

Table 75.1 The demographic statistics material of coal miners' coping styles

Age (years old)	*n*	Post length of service (years)	*n*	Education degree	*n*	Marital status	*n*
≤25	97	0–5	360	Elementary school	74	Married	959
26–30	158	6–10	322	Junior high school	554	Unmarried	148
31–35	177	11–15	161	Senior high school or technical secondary school	398	divorced	34
36–40	316	16–20	146	High school above	137		
41–45	243	21–25	82				
46–50	114	≥26	37				
≥51	44						
Missing value	80	Missing value	121	Missing value	66	Missing value	88

2. Statistical Analysis

Describing the date with descriptive statistical analysis, item analysis, reliability and validity test, the general linear model analysis (GLM), comparing index between two with the method of LSD/T2.

75.3 Results and Analysis

75.3.1 Descriptive Statistical Analysis

As Table 75.2 shows, the scores of item 1, 2, 4 are higher, it reflects the mood characteristics of miners' negative coping. The results show that the miners are in a depressive mood state and resolve problems with negative emotions; the scores of item 7, 8, 9, 10 are higher, it reflects the difficulty situation characteristic of miners' negative coping. The results show that the miners face all kinds of difficulties with closing and helpless passive psychology, don't expect to get foreign aid; the score of item 6 is relevantly higher, it reflects the personal situation characteristic of miners' negative coping. The results show that the miners can't deal with interpersonal relationship well, and lack the opportunities and skills of interpersonal, and they can only passive response when meeting the interpersonal confliction; the score of item 5 is relevantly lower, it may be relevant with miners' traditional great man's doctrine, think "do not easily shed tears", so they always backlog negative feelings at the bottom of heart and do not look for comfort way actively.

The score of positive coping is higher; it reflects the miners' calm attitude when facing setbacks. Most of miners are peasant workers, have the characteristics of farmers' purity, bearing hardships and optimistic to meeting every situation. They have low expectations on work, so they also have smaller psychological reality

Table 75.2 The descriptive statistical analysis results of each item about coal miners' coping style

NC	Yd1	Yd2	Yd3	Yd4	Yd5
$M \pm SD$	3.36 ± 1.17	2.88 ± 1.13	2.83 ± 1.11	3.12 ± 1.16	2.58 ± 1.22
PC	Yd11	Yd12	Yd13	Yd14	Yd15
$M \pm SD$	3.33 ± 1.18	3.05 ± 1.14	3.55 ± 1.13	3.33 ± 1.10	3.22 ± 1.18
NC	Yd6	Yd7	Yd8	Yd9	Yd10
$M \pm SD$	2.80 ± 1.17	2.90 ± 1.11	2.91 ± 1.19	2.94 ± 1.23	3.16 ± 1.25
PC	Yd16	Yd17	Yd18	Yd19	Yd20
$M \pm SD$	3.33 ± 1.13	3.36 ± 1.17	3.61 ± 1.21	3.46 ± 1.18	3.27 ± 1.19

experience when facing defeat; On the other hand, most miners choose the occupation out of helpless, they believe fate, so have smaller legacy of "frustration" memory.

75.3.2 Item Analysis

The CITC of each item is between 0.303 and 0.486, all of them are more than the standard of 0.3; each item's relation with the total score is between 0.400 and 0.565($P < 0.01$), all of them are more than the standard of 0.4. All these show that each item has good convergence and differentiate degrees.

75.3.3 Reliability Test

The homogeneous reliability of TCSQ and its PC, NC questionnaire is between 0.822 and 0.865, the half reliability is between 0.806 and 0.845, all of them are more than the standard of 0.7. All these show that TCSQ has good internal consistency.

75.3.4 Validity Test

1. Content Validity: There is no significant correlation between positive coping and negative coping, the relevant scores of positive coping and negative coping with total score are 0.716 and 0.750($P < 0.001$), All these show that TCSQ has content validity.

Construct Validity: ① Convergent validity: The factor loading of each item is between 0.417 and 0.707, all of them are more than the standard of 0.4. ② Distinction validity: Each fitting index reaches psychometric requirements ($\chi 2/\mathrm{df} = 2.28$, $\mathrm{CFI} = 0.95, \mathrm{GFI} = 0.95, \mathrm{IFI} = 0.95,\ \mathrm{NFI} = 0.91,\ \mathrm{RMSEA} = 0.044$). It shows that the latent variables have good convergent validity and distinction validity.

75.3.5 The Demographic Characteristics of Coal Mines' Coping Styles

Analyzing the corelation between the dependent variable, the independent variable and association variables with the method of GLM, in order to understand the demographic characteristics of coal mines' coping styles. The results can be seen at Table 75.3.

1. The Age and Post Length Characteristics of Coal Mines' Coping Styles

The explanation to the post length of service has certain cross with age. The age characteristics of NC and PC have no significant difference ($F = 1.040$, 0.546; $P > 0.05$). The results of LSD show that the miners at the age of 46–50 have frequency in using negative coping than the miners over the age of 50. The mean distribution map shows that the miners less than 25 years have lower frequency in using both positive coping and negative coping; the miners at the age of 36–40 have higher frequency in using positive coping; the miners at the age of 46–50 have higher frequency in using negative coping.

The post length characteristic of NC has ($F = 1.195$, $P < 0.05$), while PC has no significant difference ($F = 1.110$, $P > 0.05$). The results of LSD show that the miners at the post length of 16–20 have lower frequency in using negative coping than the miners at 6–10 and 21–25; the miners at 0–5 have lower frequency in using positive coping than the miners at 21–25. The mean distribution map shows that the miners at 6–10 and more than 21 have higher frequency in using negative coping; positive coping have corresponding to the longer post length.

2. The Education Degree Characteristics of Coal Mines' Coping Styles

The education degree characteristics of NC and PC have no significant difference ($F = 0.412$, 1.671; $P > 0.05$). The mean distribution map shows that the miners with primary school education degree have higher frequency in using negative coping, lower frequency in using positive coping; the miners with senior high school or technical secondary school education degree have lower frequency in using negative coping, higher frequency in using positive coping.

3. The Marital Status Characteristics of Coal Mines' Coping Styles

The marital status characteristics of NC and PC have no significant difference ($F = 0.412$,0.212; $P < 0.05$). The mean distribution map shows that married

Table 75.3 The demographic characteristics results of coal miners' coping styles

Item		n	NC	PC
age	① ≤25	97	2.87 ± 0.79	3.20 ± 0.96
	② 26–30	158	2.98 ± 0.65	3.30 ± 0.66
	③ 31–35	177	2.93 ± 0.78	3.37 ± 0.83
	④ 36–40	316	2.95 ± 0.83	3.40 ± 0.78
	⑤ 41–45	243	2.91 ± 0.68	3.37 ± 0.80
	⑥ 46–50	114	3.14 ± 0.79	3.31 ± 0.76
	⑦ ≥51	44	2.75 ± 0.67	3.35 ± 0.73
	F		1.040	0.546
	Comparison between two ($P < 0.05$)		⑥/⑦	
Post length of service	① 0–5	360	2.89 ± 0.76	3.40 ± 0.79
	② 6–10	322	3.02 ± 0.72	3.34 ± 0.75
	③ 11–15	161	2.94 ± 0.86	3.31 ± 0.88
	④ 16–20	146	2.75 ± 0.70	3.48 ± 0.82
	⑤ 21–25	82	3.06 ± 0.67	3.45 ± 0.64
	⑥ ≥26	37	3.07 ± 0.46	3.40 ± 0.63
	F		1.195*	1.110
	Comparison between two ($P < 0.05$)		②/④; ④/⑤	①/④
Education degree	① Elementary school	74	3.06 ± 0.76	3.17 ± 0.78
	② Junior high school	554	2.95 ± 0.80	3.34 ± 0.80
	③ Senior high school or technical secondary school	398	2.92 ± 0.68	3.43 ± 0.78
	④ High school above	137	2.93 ± 0.75	3.28 ± 0.77
	F		0.412	1.671
	Comparison between two ($P < 0.05$)			
Marital status	① Married	959	2.93 ± 0.76	3.36 ± 0.81
	② Unmarried	148	2.30 ± 0.70	3.31 ± 0.74
	③ Divorced	34	2.84 ± 0.61	3.44 ± 0.43
	F		0.412	0.212
	Comparison between two ($P < 0.05$)			

Notice: ① Means P < 0.05 ② Except the results showed in table-list, the rest of comparison between two have no significant differences

miners have higher frequency in using NC and PC. The number of divorced miners is really low, have no significant meaning.

75.4 Discussion and Conclusion

75.4.1 The Reliability and Validity Characteristics of Questionnaire

Each project's CITC in TCSQ is between 0.303 and 0.486, and its correlation with total score is between 0.400 and 0.565; Homogeneous reliability and half reliability are between 0.806 and 0.865, all these show that TCSQ has good project differentiate and reliability in that group of miners; Negative coping style does not have significant correlation with active coping style, and their correlation with total score are above 0.75; Each project's factor loading is higher than 0.4; Two-factor structure's fitting is better, it explains TCSQ has good validity in that group of miners. But this questionnaire's reliability and validity in miners' group is lower than any other professional groups (Zhou et al. 2005), it shows that miners have their particular professional characteristics, for example, their ages concentrated in 36–40 years old, most of their post length are less than five years, the education degree focused on the junior middle school level; In addition, the sample size is different, all these factors are likely to make miners' coping style different with any other groups. But in general this questionnaire is still can be used as a measuring tool to deal with the miners' coping style.

75.4.2 The Demographic Characteristics of Coal Mines' Coping Styles

It is only negative coping style that shows significant differences in post length of service, it is consistent with the results of Noriko (Shikai et al. 2007). The choice of coping styles mainly depends on personality characteristics, pressure type involving and nature. But it doesn't mean that coal miners' demographic variables have no influence on coping styles, just linear function relation can not reach significant level.

1. The Age and Post Length Characteristics of Coal Mines' Coping Styles

Young miners (less than 25 years old) have lower frequency in using positive response and negative coping style. Maybe the reasons are: They have unrealistic illusion before work, after work, the contradiction between ideal and reality leads to emotional un-stability, stronger frustrating experience, these can easily change attitudes, the frequency in using positive response is lower; But on the other hand young miners just get into jobs, they believe that their work is still in the initial stage and have higher expectation and enthusiasm on future, the frequency in using negative coping style is also lower. They are consistent with other professional researches (Shang et al. 2006). The miners (ages between 36 and 40) have higher frequency in using positive response. The main reasons are: ① They are in the peak of the career development, established a stable professional identity and mature professional coping skills; ② the miners staying out after selective have high level on labor skills and high responsibility, they also work as a teacher in the group and gain most respects; ③ these miners' children are in education stage, the economic pressure and social pursuit dual power make this part of miners have more positive attitude on looking for support and changing negative coping style. The miners (ages between 46 and 50) have higher frequency in using negative coping style.

The main reasons are: ① Due to physical and health reasons, this part of miners do not have enough energy on work, they are more easy to have frustration, it is consistent with the result of Humpel (Humpel et al. 2001); ② The miners' children face work and marry, and their parents also need care, have more problems in life (Li and Niu 2010); ③ The miners have stable and mature cognitive style, personality characteristics and action mode, But social environment is constantly changing, make their adaption and coping more difficult, and the work environment underground is boring, have heavy work load but little leisure time, their social circle only is underground workers or person of hometown, meanwhile, coal mines' inefficient management, low humanization level, with the close environmental and defect management miners' coping styles attainable are relatively few (Zhou et al. 2005).

The explanation to the post length of service has certain cross with age. The miners' post length of service between 0 and 5 years is corresponding to the age below 25; the miners' post length of service between 6 and 10 years is corresponding to the age between 26 and 30, they are in a weary period, use negative coping style more often; the miners' post length of service between 16 and 20 years is corresponding to the age between 36 and 40, they have rich energy, work experience and professional skills, have more respects, use negative coping style less often; the miners' post length of service between 21 and 25 years is corresponding to the age between 46 and 50, they are close to exit work, the emergence of new generate crisis, use negative coping style more often.

Previous researches show the coping styles in young, middle-aged and old have significant differences (Aldwin 1991), but how to influence, the influence of strength and direction is still not clear in age. Kenji Kato's study shows that the coping styles do not have significant age difference (Kato and Pedersen 2005). Maybe different professional and scale can cause different results.

2. The Education Degree Characteristics of Coal Mines' Coping Styles

The coal miners' education degree influence to coping styles mainly embodies in their cognitive ability and professional skill. The miners with high education degree have lower frequency in using negative coping but higher frequency in using positive response, especially embodied in senior high school or technical secondary school groups. The probable reasons are: ① The miners with high education degree have more comprehensive and mature professional coping skills, have high work expectations and perfect concept of value system, tend to use positive response; ② The miners with high education degree play a dominant place in underground group, thus have more recognition and respect, have more opportunities to participate in social activities than other miners, making active way to the further development of coping, negative coping level is low; ③ The miners with high education degree can adjust themselves, have more validity social, physical and mental resources in stress conditions, negative coping use frequency is low.

3. The Marital Status Characteristics of Coal Mines' Coping Styles

Married miners take up larger proportion, and they have higher frequency in using positive and negative coping style. The probable reasons are: ① Married miners carry more family responsibility, so they risk their lives in engaging in the miner professional to let his family live a happy life, working with positive ideas; ② Both the domestic and foreign researches show that married miners can obtain more support than any other groups (Thomas 1995). When facing the stimulation of life and work stress, they have more available social resources to use, this will have a positive impact on miners' cognition and evaluation; ③ Miners are always highly nervous in underground working, meanwhile, they are often affected by both high spirits in family happiness and depressed spirits in family unfortunate, having heavier family stress and psychological pressure than other groups. Due to the "great man's doctrine", miners are not willing to share their troubles with family members, the pains depressed at the bottom of heart perform for the emotion coping at work.

According to the above analysis, coal miners' coping styles are less affected by demographic variables, individual factors' effects on coping styles may reflect on individual's psychological characteristics. However, how the choice of coping style is affected by the different combination of individual's psychological factors, is yet to be further studied with large sample and longitudinal study.

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Chapter 76
Study on "A Scoring Method" Model of Identifying Financial Risk of Budget Unit

Chang-sheng Wei and Chao-yang Guo

Abstract According to the audit situation of central budget execution and other budgetary revenues and expenditures announced by national audit office in 2010, causes of the financial risk of budget unit have been analyzed in this article. Through using the basic principles of "A Scoring Method", a financial-risk-identifying model of budget units has been established to predict its legal compliance, avoid offending risk and ensure legal and rational use of financial resources.

Keywords A Scoring Method · Audit situation · Budget unit · Financial risk

76.1 Background and Significance

The financial problem of budget unit has been concerned by the taxpayers all the time and our government has increased the supervision of budget unit. From department budget reform to the announcement of the treasury centralized paying management system, and the audit situation of central budget execution and other budgetary revenues and expenditures published by national audit office in recent years, all these have all indicated our country's determination to strengthen financial supervision and ensure scientific management and financial security of budget unit (Zhao 2005).

Financial activities of budget unit, including budget management, capital collection, state-owned assets management and government procurement, which are restricted by the related laws and regulations and its performance indicators also comply with the relevant laws, regulations too (Zhang 2010). Compared with profit-making enterprises, the management and control of the financial activities of

C. Wei (✉) · C. Guo
Business School of Hohai University, Nanjing, Jiangsu, China
e-mail: cuttlerain@163.com

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budget unit by the relevant laws and regulations are more strict, direct, concrete and detailed. And its managerial staff's use right suffers from more restriction. It shows that there are significant differences between budget units and profit-making enterprises on the strength of law enforcement. Once a budget unit has financial risks, it may confront with legal sanction and decrease of credibility. So the researches on the identifying analysis method of the financial risk of budget unit can avoid illegal risks and ensure legal and rational use of financial resources.

76.2 Theoretical Basis

76.2.1 Principle and Thinking of "A Scoring Method"

"A Scoring Method", also called Management Scoring Method, it classifies the phenomena and symbolic factors of entity unit risks, then grades and adds them up, lastly judges the operation and financial condition of the entity according to the total score (Li et al. 2005). For profit-making enterprises, the failure of enterprise management does not happen suddenly. Instead, it is a process. Firstly, there are some defects in enterprise operation, if they cannot be conquered, these weaknesses can turn into operation mistakes; if the mistakes cannot be corrected, and the obvious signs of bankruptcy will appear. At this moment if the enterprise still does not correct these mistakes, it will go bankrupt (Hu 2006). Therefore, this approach not only provides a good idea for enterprise to determine how to identify and manage risks, but provides a good foundation for the government and non-profit organizations to identify risks.

76.2.2 Definition of the Financial Risk of Budget Unit

It is unlikely for a budget unit to be bankrupt, but its financial risks mainly manifest illegal financial activities, which will lead to loss and low efficiency of financial resources. If not corrected, it will cause imbalanced financial condition and alienated expenditure structure (Feng 2007). Therefore, we can use "A Scoring Method" to identify and analyze the financial risk of budget unit.

76.3 Identification of the Financial Risk of Budget Unit

Financial compliance of budget unit refers to all of its financial activities must comply with the relevant laws and regulations. It is not only the basic principle of financial management of budget unit, but also the basic goal of it.

For budget unit, its financial risk is mainly budget management risk. As the approved budget is a legal document, the budget unit must achieve financial resources on the basis of it and finish the legal task. The approval of the budget means during the budget period, the quality and quantity of public products or services supplied by budget unit. The budget execution has rigid restriction and budget management is at the core of all financial activities of budget unit (Wei and Xu 2011).

According to contents of financial activities, flow of budget management and constitution of financial resources, this paper sorts out causes of financial risk of the sample units as follows (Wang 2009):

1. *Poor budget management.* It mainly manifests non-standardization and inaccuracy of budget compilation and report, incompliance of budget adjustment, lax of budget implement, not timely budget fund, incompleteness and inaccuracy of final accounts. Non-standardization and inaccuracy of budget compilation and report includes factors as follows: the budget not detailed to last or specific subject; omitted, false, or restated report; compilation and report for others; compilation without complying with regulation; the fitting rate between budget and reality is lower than 10 %; projects above 500,000 yuan not declared within the budget; omitted compilation of government procurement. Incompliance of budget adjustment means the insufficient basis of budget adjustment, the infeasible adjustment project, and the non-standardization of program. Lax of budget implement includes factors as follows: expanding expenditure scope freely; diverting funds; expenditure beyond budget or without budget; reporting subsidy falsely; deviation degree of budget implement is beyond 20 %. Not timely budget fund refers that budget fund cannot meet the need of implement budget. Incompleteness and inaccuracy of final accounts includes factors as follows: various situations appear because of incompliance of final accounts, such as not timely of final accounts (Wei and Zhang 2011).
2. *Poor management in funds collection and surplus management.* It mainly manifests violation of charge management, poor management of revenue, expenditure, current accounts, and surplus. Violation of charge management includes factors as follows: administrative service fee not collected according to the standard; holding back extra budgetary funds which should be turned over to treasury. Poor management of revenue includes factors as follows: the funds which need not repay have not entered into account book or report unfaithfully; revenues which not belong to the budget unit have not turned into treasury. Poor management of expenditure includes factors as follows: examining and verifying expenditure plan without complying with the budget and regulation; presenting expenditure beyond the budget; expanding expenditure range without permission and improving expenditure criteria; expenditure of worker treatment is beyond national standard. Poor management of current accounts means: current accounts are not sorted out in time. Poor management of surplus means: surplus has not been sorted out.

3. *Poor management in asset and government procurement.* It mainly manifests non-standardization of accounting and usage of asset, non-standardization of inspection and disposal of asset, setting up a private coffer, violation of government procurement. Non-standardization of accounting and usage of asset includes miscalculation of value or depreciation of asset; using state-owned property as collateral to make up an economic entity without complying with the regulation; renting out state-owned property without permission. Non-standardization of inspection and disposal of asset is inclusive of asset registration records not established and results of inspection are not on-file; the lack of periodic inspection of asset; approval process not strictly carried out; disposing state-owned properties without authorization; cheating in collusion and doing black case work to dispose state-owned property in low price; revenue not managed separately from expenditure. Setting up a private coffer means existence of private coffer. Violation of government procurement includes factors as follows: avoidance behavior of government procurement; not centralized purchasing relevant projects; avoidance of bidding behavior; facilities above 1.2 million yuan and projects above 2 million yuan are not bid in public; purchasing without complying with agreement; implement of organizational procedures, information announcement or expert choosing do not comply with regulations (Ministry of Finance of PRC 1998).
4. *Accounting errors*. Due to illegal or unreasonable accounting method or process, it will cause some situations as follows: program records omitted; spending expenditure which belongs to next year; mixing up accounting subjects; using imperfect or fake accounting vouchers.
5. *Others.* It mainly manifests poor management of project and investment, lack of risk awareness. Poor management of project and investment refers to illegal sub-contract; construction projects not accepted in time; accounts of completed project not finished; violation of regular construction procedure; misappropriation of public funds to invest; income from investment not recovered timely. Lack of risk awareness means violation behaviors because of irresponsibility of the relevant person in charge.

76.4 Analysis Model Construction

76.4.1 Problems Need to be Solved

Based on "A Scoring Method" principle, if we want to set up the analysis model to identify the existence of financial risk, we need to solve the problems as follows: Firstly, how many factors are there leading to financial risk of budget unit? Secondly, assignment values of the factors above; thirdly, determining a standard value to judge whether the budget unit has financial risk or not.

76.4.2 Research Samples and Data Acquisition

Due to the data of 2011 has not been released, this paper choose the audit situation of central budget execution and other budgetary revenues and expenditures in 2010 as the sample (File no: 31 2011a, b, c). Through the design of financial risks causes survey, we have made a statistics about 53 units such as Ministry of Foreign Affairs (MFA), National Development and Reform Commission (NDRC), National Committee of Political Consultative Conference (NCPCC), as Table 76.1 shows.

76.4.3 “A Scoring Method” Model

“A Scoring Method” is a weighted mean method which essentially values the risk factors as 0 or 1, then totals up. According to the theory of “A Scoring Method”, this paper established a model to identify budget unit financial risk:

$$Y = b_1X_1 + b_2X_2 + \cdots + b_{17}X_{17} \tag{76.1}$$

Table 76.1 Causes of the financial risk of budget unit in 2010

		MFA	NDRC	…	NCPCC
Budget management	Non-standardization and inaccuracy of budget compilation and report	√		…	
	Incompliance of budget adjustment	√	√	…	
	Lax of budget implement	√	√	…	
	Not timely budget fund			…	
	Incompleteness and inaccuracy of final accounts		√	…	√
Funds collection and surplus management	Violation of charge management			…	
	Poor management of revenue	√		…	√
	Poor management of expenditure	√	√	…	√
	Poor management of current accounts			…	
	Poor management of surplus	√		…	√
Management in asset and government procurement	Non-standardization of accounting and usage of asset	√		…	
	Non-standardization of inspection and disposal of asset			…	
	Setting up a private coffer			…	
	Violation of government procurement			…	
Accounting errors	Accounting errors	√		…	√
Others	Poor management of project and investment	√	√	…	√
	Lack of risk awareness			…	√

Table 76.2 Comparison of meaning of X_i

Variable	Meaning
X_1	Non-standardization and inaccuracy of budget compilation and report
X_2	Incompliance of budget adjustment
X_3	Lax of budget implement
X_4	Not timely budget fund
X_5	Incompleteness and inaccuracy of final accounts
X_6	Violation of charge management
X_7	Poor management of revenue
X_8	Poor management of expenditure
X_9	Poor management of current accounts
X_{10}	Poor management of surplus
X_{11}	Non-standardization of accounting and usage of asset
X_{12}	Non-standardization of inspection and disposal of asset
X_{13}	Setting up a private coffer
X_{14}	Violation of government procurement
X_{15}	Accounting errors
X_{16}	Poor management of project and investment
X_{17}	Lack of risk awareness

Among them, Y stands for weighted average score; bi stands for the weight of No. i factor; Xi stands for the value of No. i factor.

1. *Determination of X_i* (Table 76.2)

The X_i variable is used to explain whether No. i factor exists or not, so 0-1 assignment is used. It means if No. i factor exists, $X_i = 1$, if not, $X_i = 0$ (Kang 2008).

2. *Determination of b_1*

As Table 76.1 show, overall, the 53 units appear totally 377 times in the 17 financial risk performances. Among them, there are 33 units having the problem of "non-standardization and inaccuracy of budget compilation and report", accounting for 8.75 % of the 377 times. The result of number of units existing risks and the percentage can be seen in TABLE 76.3.

In Table 76.3, the percentage column is a reflection of the number of units exist the financial risk. The bigger the number is, the greater the factor affects the financial risk. Therefore, the percentage column in Table 76.3 is also a reflection of how much is the factors influence the financial risk of budget unit. We take this percentage as bi, which can be seen in Table 76.3.

76.4.4 Financial-Risk-Identifying Method for Budget Units

According to Table 76.1, we can determine the value of X_i, then figure out the value of Y on the basis of Formula 76.1. As Table 76.4 shows, after figuring out the Y value of 53 units, we divided them into 4 intervals (Altman 1968).

Table 76.3 Analysis of causes of financial risk of budget unit

Financial risk cause (variable)	b_i	%	Number of unit being affected
X_1	b_1	8.75	33
X_2	b_2	5.31	20
X_3	b_3	5.04	19
X_4	b_4	0.80	3
X_5	b_5	9.02	34
X_6	b_6	2.39	9
X_7	b_7	7.43	28
X_8	b_8	12.20	46
X_9	b_9	3.45	13
X_{10}	b_{10}	5.84	22
X_{11}	b_{11}	2.92	11
X_{12}	b_{12}	2.39	9
X_{13}	b_{13}	4.77	18
X_{14}	b_{14}	5.57	21
X_{15}	b_{15}	10.34	39
X_{16}	b_{16}	5.04	19
X_{17}	b_{17}	8.75	33

It is assumed that unit X has financial risk, through analysis we can estimate that if the unit do exists financial risk, then the estimation is true; if the unit does not exist financial risk, then false. Usually, this kind of mistake is called the first mistake. Similarly, the second mistake mistakes the non-exist financial risks for the exist ones.

According to Table 76.4, using different Y marginal value, the probability of making the first mistake is different. The relation between Y marginal value and the probability of making the first or second mistake is: the bigger Y value is, the higher the probability of first mistake is, but the second, lower; the smaller Y value is, the lower the probability of first mistake is, but the second, higher. For the general decision makers, making the first mistake make them suffer more than making the second, so the probability of making the first mistake is more considerable when establishing the financial-risk-identifying model, that is to say, the probability of first mistake should be controlled within the acceptable limits. So if Y marginal value is determined as 24 or 26, the probability of first mistake will be controlled in 3.77 %, or below 7.55 % (Wooten et al. 3003). Usually, such probability of mistake can be accepted by most people, so this paper determines the Y marginal value as 24 and 26, and establish a financial-risk-identifying model for budget units, as Table 76.5 shows.

76.5 Limitations

The defects of the model are as follows: (1) Different people may choose different variables when identifying the same financial risk existence; (2) Different risk

Table 76.4 Distribution of existence of budget financial risk in different Y interval

Y interval	[0, 20)	[20, 22)	[22, 24)	[24, 26)	[26, 30)	[30, 90)
Number of unit	0	1	1	2	4	45
Accumulated	0	1	2	4	8	53
%	0.00	1.89	3.77	7.55	15.09	100

Table 76.5 Financial-risk-identifying model for budget unit

Y	[0, 24)	[24, 26)	[26, ∞)
Financial risk existence judgment	Possibility of existence of risk is low, safe	In a gray area, financial risk may exist	There is a strong possibility of existence of financial risk

factors may overlap with each other, this may cause the fuzziness of marginal value; (3) Only the first mistake are considered and ignored the second; (4) the accuracy of the financial-risk-identifying model and the criteria need to be adjusted and updated with the newest statistics information.

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Chapter 77
A Research on the Comprehensive Influential Factors of Energy Conservation in Chinese Public Building

Dong-xu Yang

Abstract The high energy consumption of public building, the prominent problem of low energy efficiency, high potential of energy conservation. At present, the public building energy conservation mode in our country mainly depends on the government investment, which leads to enormous capital pressure of energy conservation, In order to achieve the goal of public building energy conservation, it needs the national policy, the decision of proprietor and public participation and a series of factors involved is the inevitable choice. This paper researches the impact of the government decision-making, behavior of the proprietor and the active participation of public on public buildings' energy conservation in order to provide advice to it in China.

Keywords Public building · Energy conservation · Energy consumption · Government policy · Public participation

Public building is a kind of non-productive building refers to people's social activities, including office buildings, commercial buildings, scientific, educational, cultural and health-care buildings, communication buildings and transportation buildings (What is Public Building [EB/OL] 2005). With the rapid development of economy and society in China, the demand of comfortable interior environment becomes more and more popular. Some public buildings neglect the level of local economic development and the actual demands in the construction process, the issues in pursuit of luxury, splendid style and the abuse of aimless comparison is becoming more serious, which lead to the high energy consumption problem of public building becomes prominent (Wu and Liu 2007). Compare with the residential building, the gross energy consumption of public building is lower, but the

D. Yang (✉)
College of Management and Economics, Tianjin University,
Tianjin, China
e-mail: yyddxx123@sohu.com

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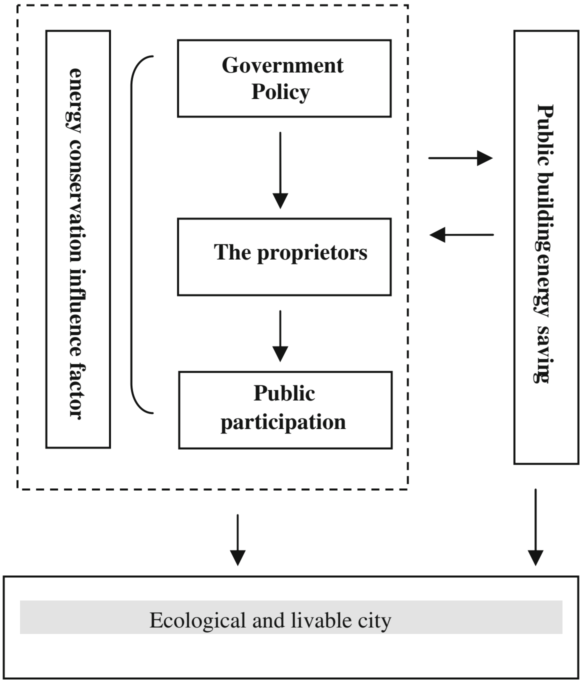


Fig. 77.1 Public building influence factor analysis graph

unit energy consumption is higher, it is similar to the northern residential building with central heating, the potential of energy conservation is great. Therefore, the management of energy conservation in public building is important for achieving the goal of building energy conservation strategy in China. Additionally, it plays a decisive role in promoting energy conservation and reasonable utilization of resources and alleviating the conflict between the sources of energy supply and economic development. Meanwhile, it is also conducive to transform and upgrade for the traditional construction industry, to realize the sustainable development as well (Yu 2007; Tu and Wang 2004; Yi 2005).

Along with the deepening of cognition and the development of technology, the management mode of energy conservation in public building will be more rigorous and appropriate. However, to implement energy conservation policy in the urban constructions, it also need a stepwise process which "from top-to-bottom", since the engineering project from the urban construction is a systematic engineering, it must depend on the government policy guidance and regulations to drive, and then it depends on the implementation of the propitiator's decision making, finally, it needs to raise the consciousness of the whole people and the participation of public (Zhou et al. 2003; Liu and Lv 2002). This paper will research the effect on the public building energy in terms of the government decision-making, behavior of the propitiator and the active participation of public (Fig. 77.1).

77.1 Government Policy as an Active Guidance

The government needs to formulate laws and regulations, to create specialized management institutions. The public buildings must reach the mandatory energy efficiency goals, but it is low-effective by only depend on market mechanism to realize building energy efficiency, the government policy plays an essential role in the development, especially for public buildings. The absolute sense of low carbon energy conservation building only exists in an ideal condition. Under realistic conditions we cannot avoid the issues of economic development and have to follow, in order to balance the dialectical relationship between economic development and ecological environment. To solve this problem, it must have an effective intervention in the operation, to formulate laws and regulations.

77.1.1 Law and Policy

Energy conservation involves attributes of public service, it has market failure. To promote energy conservation by the government, to establish energy conservation work mechanism and intensify the energy conservation function of government, it may fundamentally change the" resources—products—pollution discharge" which is a substance one-way flow of traditional economy. In China, it not only create energy conservation law, but also specially formulated a series of building energy codes, standards and other legal documents, as founded in 1998 "The law of energy conservation" etc. All above are aim to put energy conservation and protect environment to the first place, to promote the progress of science and technology as the starting point, It implies that the" people-oriented" modernized model has begun to" take the environment as the center" model of sustainable development (Yu and Kang 2003).

77.1.2 Industry Standard

In recent years, China has begun to draw lessons from the advanced experience of foreign developed countries. To save resources, take the road of sustainable development has been treated as basic national policy. It successful completed the goal of reducing the ratio of energy consumption per unit of GDP by 20 %, from the end of "the tenth five-year project" to "the eleventh five-year project". With the strengthening of ecological environment social concerns and building energy-conservation goals, a number of policies, guidance and norms have been promulgated. Such as the" public building energy conservation design standard" (GB50189—2005) by Ministry of Construction and the " building energy conservation regulations" (Draft for Soliciting Opinions) has been released in early 2006, which promote the construction, particular in public buildings, of energy-efficient by reward and punishment, the brilliant approach is to use the approach of “stick and carrot” to guide the construction energy conservation, to establish energy conservation building tax and fees preferential system, to achieve construction energy conservation target of 65 % in 2020. These industry standards, implementation and effectiveness play an important role in management of the old public building energy conservation, and stepwise operation of new public buildings market access system. (Tu and Wang 2004; Kang and Li 2006)

77.1.3 The Incentive Policy

Incentive is an important way to promote the construction conservation, which seldom with the compulsive nature, but it has a strong stimulating effect. It may force the related groups had to take some action to adapt to the requirement of market mechanism. The government plays a guidance role in the marketization process of construction conservation through the development of a series of market based incentive policy. To guide for the deferent main bodies adopt energy conservation consciously, and make them obtain benefits from the energy conservation.

Compare with the administrative control policy, the executive effect is more remarkable and the cost of implementation is lower by using incentive policies on intervention of building conservation market. Incentive policy gives actors higher autonomy, if policy could make most people’s welfare increased, the related main bodies could work positively without strictly supervised, government spending can be greatly reduced, the implementation effect becomes better as well (Goldstein 2006). Therefore, the implementation of incentive policy is the key to advance building energy conservation in China.

77.2 The Proprietors Need to Maintain Rational Attitude

The investment decision making of the proprietors refers to the owners (developers) in order to adapt to market demand, obtain the great economic benefits, then to achieve the objectives of operation management of a series of selection activities. The contribution of proprietors in the project construction is based on the goal of government policy, putting forward the related proposal of construction scheme. Generally, in the city construction the proprietors hope to obtain the maximum economic benefits, the initial cost of energy conservation building is higher than ordinary buildings, but with the passage of time, the comprehensive benefit advantage will gradually show out. In the project decision-making, it should be fully aware of the use of energy-efficient technology could not only reduce the later maintenance cost, but also could increase the benefits (Liu and Ma 2004).

Fundamentally speaking, completely off the economic interests, only emphasize the responsibility and contribution, it is really difficult to access to owners of the response, and hard to push the development of energy conservation in public building.

77.2.1 The Balance Between Long-Term and Short-Term Benefits

Energy conservation of public building is a meaningful work. In order to make it becomes the conscious action by proprietors. It needs to undertake adjustment via market mechanism, to recognize that energy conservation building not only beneficial to later generations, but also profitable to their current interest. In general, the decision making problems confused by owners are those contradiction between short-term interest and long-term interests and also between economic benefits and comprehensive benefits. Hence, the proprietors need to consider the construction cost in total life cycle. To understand the meaning of the time value of money comprehensively, to create balance mechanism of short-term and long-term interest of decision making, it has great significance for the start of public buildings' energy conservation.

Profit is the highest goal of market behavior, there are no blame for the owners to pursue the maximization of economic benefits subjectively, but economic benefits is not only a static initial investment, it should include that project planning, project operation, the life cycle cost and access to social value of dynamic relationship, not only consider its economic benefits, but also need to take into account the social benefit and environmental benefit, the truly visionary proprietors would not to do stupid things like "for want a nail, the shoe was lost".

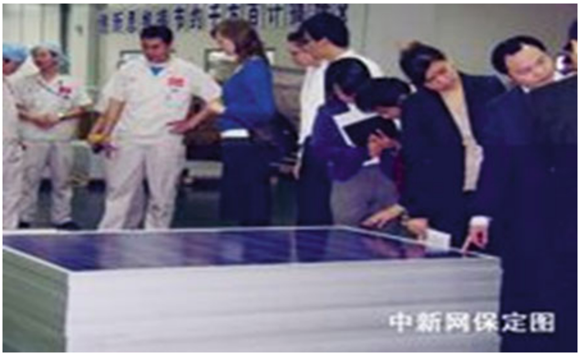
77.2.2 *Perfection of Planning Mechanism in the Prophase Of Construction*

The planning in the prophase of construction depends on the object of overall plan to set, it based on practical survey to analyze the research target objectively by the application of modern technology. Finally, it achieves the method and procedure followed by the established goal in a quantitative way (Zhuang 2000). Through the development of a detailed feasibility research report and construction plan of site, Proprietors ensure that the project design would be completed with high economic benefit, environmental benefit and social benefit, to avoid the aimless decision-making, the concept is to use " rationality" as the standard of judgment.

The planned economy system in our country has been applied for a long-term. The major public buildings always managed by national public investment, as the hotbed of leader's opinion. Hence, those project of political achievements, such as the "first in world" project and "offering project", etc. the lack of pre-planning work is an indisputable fact. These negative issues lead a great waste of resources for both society and proprietors, and if the project is more, and period is longer, the negative impact on the society and proprietors will be more and more serious. Because of the long life cycle, large scale of investment, and high professionalism, public buildings as a kind of building types which could reflect the necessity of construction planning the most. How to balance the various benefits, realize the system goal has became a problem, thus, the scientific prophase construction just like a injection of life vigor to solve the problem, which not only fit the market economic system in our country, but also reflect the scientific investment and operation mechanism, and to realize the effective risk aversion of the public building energy conservation management.

77.3 Public Participation Need to be Supported Positively

The "public participation" refers to in the social and economic activities which involve public interest, the public could exercise their democratic power more extensively based on enjoying legal protection of fundamental rights (the right to equality, the right to know, the right of disposal, etc.) (Zhang 2005). Public participation is a necessary guarantee for the achievement of sustainable development in China, under the realistic background, the green awareness and participation awareness of public should be strengthen, only like this, the energy conversation of public construction could have a broad and solid foundation of existence.



77.3.1 The Advocating of Green Consumption Enlightenment

Consumption is an important section in economic operation. The traditional economic consumption concept is characterized by encouraging high consumption, one-time consumption and non circular consumption. It not only wastes a lot of energy, but leads to serious environmental pollution, even endangers the living of human. According to the declaration on the human environment—"21st century agenda" (Rio de Janeiro 1992, In environment and development congress, U.N). It clearly pointed out that "the main cause of the continued deterioration of the global environment is unsustainable consumption and production pattern." The Facts have proved that the root cause of the poverty of human social and the worsening relationship between human and nature is unsustainable consumption mode. Therefore, we should to realize sustainable development and ecological objectives, change our consumption patterns, and advocate green consumption concept as the essential section.

Sustainable consumption is a new consumption mode. If the previous alignment and unsustainable consumption has been called the "grey consumption", then the sustainable consumption mode is a kind of "green consumption". The green consumption would not deny the improving of life quality, but this improving should be based on consumption optimization in order to achieve the long-term maintenance of the resources and the environment service quality. Green consumption is a historic change in the mankind's mode development, even for the production style and the way of thinking is also a kind of change. In developed countries, the green value view and consumptive outlook which involve the characteristics from emphasizing material value to the intangible value are very common among the people. It shows that the scientific evaluation of nature value has been transformed from truth and value evaluation to the moral evaluation. According to a survey in 1990, there are 67 % Dutch, 80 % Germans, 77 % of Americans will consider environmental issues in the purchase process, while 20 % of the Japanese prefer to buy the more expensive "ecological products". Drawing lessons from foreign experience, promoting all-round, multi-level media campaign, providing information and services in time, all of these could help advocating the enlightenment and the establishment of green consumption (Zhou 1998).

As production determines the consumption, the consumption in turn to affect and guide the production as well, the conception of green consumption suppresses the traditional production sales from the source of production and marketing chain, which is a fundamental solution of the operation, but for social ecological transformation it is a kind of timely assistance, and it helps the ecological construction objectively. In order to realize the "Green Olympics" concept in Beijing 2008 Olympic Games, it need to enhance the environmental awareness of the whole society, encourage the public to consciously choose green consumption, and actively participate in various environmental improvement activities.

77.3.2 Complete the Establishment of Public Participation Mechanism

As the public buildings' consumer, the active participation of public opinion has significant affect on whether the operation of construction is successful or not. The public directly participate in large space public building survey, conception, appraisal and decision making. It plays the main role in fill the vacuum space which free market forces and government macro-adjusting control force can't reach to, a another kind of "non market power". The specific performance takes place in the prophase planning and scheme selection of construction. The ultimate goal of establishment of public participation system is: to express the requirements of constitution, to safeguard the public interests; to respect citizens' individual differences, to coordinate different class interest; to create balanced social power system, and to advocate the science of decision making.

The publics' right to know and right to participate represents the open and transparent civilized mechanism of democratic society, the extensive involvement of the public show their strong sense of social responsibility and awareness and concern for the public interest, it is beneficial to the increase of social capital and the establishment of a harmonious society, and form from only elite's decision-making to dominate by elite, and public participate in, to benign an interactive environment. In the construction scheme selection stage, public support for the ecological design is an important influence factor. In the 2008 Beijing Olympic National Stadium design competition, it shows design alternative to social publicity, sets up the section of public voting, which to build a good start for public participation mechanism. Do not stick to one pattern and to encourage the free airing of views is an important objective principle to perfect the mechanism of public participation. Of course the public aesthetic, consumption values is the key in effect. If there is no properly guide to the progressive philosophy of the times, the outcome of the public participation may run counter to our desire, which highlights the enlightenment to advocate green consumption view of the importance (Wang 2000).

In conclusion, the government, the proprietors, the way and degree of public participation will determine the realization process of sustainable development goal. Three aspects should be involved in the overall sustainable development, the public and the proprietors not only have to participate in environment related decision making by government but also join in the supervision of policy execution process. Through the enlightenment to advocate green consumption concept and to perfect the participation mechanism of public and proprietors, it may form the effective participation motivation and channels, which conducive for everyone to understand that energy conservation related to its life interest and helps them to have a good ecological environment.

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Chapter 78
A Simulated Road Crossing Study in Elders with Mild Alzheimer Disease

Yang-Kun Ou, Chen-Wen Fang and Yung-Ching Liu

Abstract Road-crossing safety is an important issue in an aging society. To assess the risk of unsafe crossing behaviors in patients with Alzheimer's disease (AD), we compared 12 pedestrians with mild AD and healthy controls using a battery of cognitive, visual, and motor tests. With a simulated simple road-crossing situation, we determined the remaining time and safety margin for each participant in different traffic situations with variable vehicle speed, time gap, and time of the day. We found that pedestrians with AD were more vulnerable to traffic accidents while crossing the road than control subjects. Impaired visuoconstructional ability and visual attention predicted worsening of safety errors within the AD group. We also found that environmental traffic factors, such as fast oncoming vehicle speed, short time gap, and time of day, also affected road-crossing safety. This report provided important suggestions for road designing and future supplementary gears for AD patients during road crossing.

Keywords Age · Alzheimer's disease (AD) · Decision · Road crossing

78.1 Introduction

There was a 12–20 % pedestrians mortality rate every year of pedestrians while road crossing. (NHTSA 2009; Hakkert et al. 2002; ATSB 2002; OECD 2001). Of all mortality in traffic accidents, pedestrian consisted of 10.7 % (BTS 2006).

Y.-K. Ou · Y.-C. Liu (✉)
Department of Industrial Engineering and Management, National Yunlin University of Science and Technology, Yunlin, Taiwan
e-mail: liuyc@yuntech.edu.tw

C.-W. Fang
Department of Neurology, National Taiwan University Hospital (Yunlin Branch), Yunlin, Taiwan

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Although pedestrian mortality rate in traffic accident decreased in these years following improvement of road design and pedestrian education, it remained high in the older group. Elders (>65-year-old) had an average of 18 % fatality rate in traffic accidents (NHTSA 2009). The effects of pedestrian–vehicle crashes are greater for the elderly than for other age groups (Gorrie et al. 2008; McCoy et al. 1989). Aging debilitated the motion ability and were accompanied with prevalence of cognition impairment (Such as dementia). It became a major topic in road safety to explore the decision behavior on road crossing in different types of aged people.

Previous studies had indicated that people would change their road crossing behaviors due to age-related problems, such as decreased walking speed, slow decision making, cognitive ability decline and difficulty selecting safety gaps between the oncoming vehicle and in turn unable to evaluate correctly the safety margin while crossing roads (Holland and Hill 2010; Lobjois and Cavallo 2007, 2009; Oxley et al. 2005, 2006). Most studies simulated conditions of road crossing and tried to discuss about age factors in different vehicle speed or time gap. Oxley et al. (2005) compared three groups with younger (age 30–45), young-old (age 60–69) and old–old (age over 75) ages. They established a one-way road crossing experiment and asked them to judge as soon as possible whether crossing the road between two vehicles. The result showed that longer time gap was easier to cross safely for all age groups but there was still a 70 % chance of risky crossing in old–old group compared with 18–19 % in the other two groups.

Cognitive impairment is a main characteristic of dementia. Alzheimer's disease (AD) is the most common primary cause of dementia. Few studies discussed about pedestrian safety in elders with dementia. Gorrie et al. noticed the relationship of neurofibrillary tangles (NFT), a pathological hallmark of AD, and the mortality of pedestrian (Gorrie et al. 2004, 2006, 2008; Harrell 1991). The brains of 52 pedestrian and 52 control groups were collected. The pedestrian group had died following the vehicle–pedestrian accident. The control group had died from another cause. The result showed that there was a higher rate of NFT scores III-IV (Braak and Braak staging) in pedestrian group (Pedestrian: 43 % vs. Control: 23 %). Gorrie et al. thought that higher NFT score may have poorer judgment about when it is safe to cross the road. This study focused mainly on the brain pathology and implicit that people with dementia trait tended to have pedestrian-vehicle accidents. The behavior while decision making was not shown. This would be a major concern in all aging society.

In this study, we intend to explore, between elders with and without AD, (1) the decision making under different vehicle speed, time gaps and time of day, (2) the correlations of mental examinations and ability to cross road.

78.2 Methodology

78.2.1 Participants

The research was approved by the Research Ethics Committee of National Taiwan University Hospital Yun-Lin Branch. Thirty-six participants, including 12 AD patients (4 M/8F) and 24 controls (12 M/12F) joined this exam. There were 2 patients with mild AD (CDR = 1), and 10 individuals with minimal cognitive impairment (CDR = 0.5). The mean ages of AD and control groups were 73.61 ± 6.73 and 70.04 ± 3.30, respectively. AD patients underwent a standard neurological examination, including Mini-Mental Status Evaluation (MMSE) and Clinical Dementia Rating Scale (CDR).

78.2.2 Visual and Cognitive Testing Battery

All of the participants were tested a battery of cognitive, and visual tasks. Visuoconstructional ability was tested using Rey-Osterrieth Complex Figure Test, CFT); Clock Drawing Test (CDT) was tested Visuospatial ability; Trail Making Test (TMT) parts A and B was tested executive function; Visuoperceptual Function was evaluated using the Visual Form Discrimination (VFD); The useful field of view (UFOV) (Visual Resources, Inc) task was used to measured visual attention. UFOV task has been used successfully with AD and PD patient's drivers to predict traffic accident. The UFOV task was divided into three subtasks to determine a driver's risk of accident involvement: (1) information processing speed, (2) divided attention and (3) selective attention. Sum of 3 subtests of the UFOV task (UFOVTOT) was used in our analyses.

78.2.3 Stimulus Materials

The simulated street-crossing scene, which was pre-recorded from a real street, was projected to the 17-inch LCD. The visual scenes represented a 3.5 m wide, two-way street with vehicles moving from left to right (in reference to the pedestrian's standing at the sidewalk) (Fig. 78.1). The images refresh rate was 30 Hz. Traffic sound effects were broadcast from 2-channel amplifiers.

78.2.4 Experiment Design

Four factors were involved in this mixed factorial experiment study, including the elder groups (normal older vs. AD patient; between-subjects), vehicle speed

Fig. 78.1 Experimental setup: Scenery example from the participant's point of view at the starting position

(40 vs. 60 vs. 80 km/hr; within-subjects), time gap (5 vs. 7 vs. 9 s; within-subjects) and time of day (midday: 11:00–13:00 vs. dusk:17:50–18:10; within-subjects). The midday was adapted from the central weather bureau, Taiwan (CWB 2011). To avoid vehicle lamp effects, the vehicle was open the lamp for the two conditions (midday and dusk).

Dependent variables including: (1) 10 m walk speed: normal walking pace and fast walking pace. (2) Remain time (the time period remains for pedestrian safely crossing road) which can be obtained by (time gap—the time of participant can safely crossing-road with his walking pace). (3) Safety margin which can be obtained by (the time remaining—the time of the pedestrian walked normally in 3.5 m distance), and the normal walking speed was obtained in this study by asking the participants walked normally in 10 m distance. Based on the formula, if the safety margin value was greater than zero, then the pedestrian speed crossing the road was "safe", otherwise, if the safety margin value was less than zero, the pedestrian speed cross the road was "in danger".

78.2.5 Procedure

The participants gave their consent for this study and were given information about the purpose of this experiment and the tasks they were about to perform. They then received the visual and cognitive battery tests. They took approximately 1 h with a ten-minute break for the participants.

The participants were asked to walk 10 m with two different paces twice (normal walking pace and fast walking pace) with their walking speed calculated. In the real trial, each participant was seated at a desk approximately 60 cm in front of a 17-inch LCD monitor located at eye height with a computer keyboard placed in front of them. They were instructed to place their index fingers on the space key. With each scene, the participants needed to decide when is the "last moment" for them to cross the road safely. When the moment came, they had to immediately press the space key and said "pass" loudly. We recorded the time used. The participants had 4–10 rehearsal trials. A total of 18 experimental trials were randomly assigned to the participants and there were 2 trials for each road crossing condition. The road crossing experiments required approximately 1 h to complete.

78.2.6 Data Analysis

The variance of the results was analyzed using SPSS v.12.0 statistical software (SPSS Inc.), and post hoc analyses were conducted using the least significant differences (LSD) test. The level of significance used for all analyses was $\alpha < 0.05$. Numerical data were analyzed using the non-parametric Mann–Whitney test.

78.3 Results

78.3.1 Demographics

Table 78.1 shows the results of patients' demographics. The two groups did not differ in sex, age and education. Subjects with AD performed significantly worse than controls on all test of cognition and visual perception.

78.3.2 Crossing Road Behavior

78.3.2.1 Crossing Time

The baseline crossing behavior assay showed that the crossing time, either under normal or fast pace conditions, of patients with PD was significantly longer than the control subjects. Under normal condition, the mean crossing time for 3.5 m distance was 3.35 ± 0.55 s in control group and 4.87 ± 1.18 s in PD patient group ($P < 0.001$). Under the fast pace condition, the mean crossing time for the same distance was 2.46 ± 0.38 s in control group and 3.61 ± 0.53 s in PD patient group ($P < 0.001$).

78.3.2.2 Remaining Time

The results showed that the remaining time for the pedestrian at dusk was significantly longer than that at midday (midday: control: 3.51 s, AD: 2.54 s; dusk: control: 4.15 s, AD: 3.43 s, $P < 0.001$). In addition, the approaching vehicle speed will affect the pedestrian's walking remaining time, the faster the vehicle speed,

Table 78.1 Comparison of control and AD groups using wilcoxon rank sum test, means (S.D.)

	Controls (n = 24)	AD patient (n = 12)	p-values for difference
Demographics			
Sex(M, F)	12,12	4,8	0.35
Age, y	70.04(3.30)	73.67 (6.73)	0.07
Education, y	6.83(4.48)	4.17 (3.04)	0.18
Cognitive tests			
MMSE	26.79 (2.45)	20.50 (3.94)	<0.01*
CFT-Copy	29.97 (7.47)	24.07 (3.50)	<0.01*
CFT-Recall	11.15 (7.33)	3.75 (5.82)	<0.01*
TMT-A	53.14 (30.80)	99.27 (38.37)	<0.01*
TMT-B	94.89(55.74)	184.19(80.23)	<0.01*
TMT-B-A	41.75(36.06)	84.92(81.70)	0.02*
CDT	15.38 (1.21)	12.25 (2.85)	0.01*
Visual tests			
UFOV-1	53.04(48.10)	168.83(84.40)	<0.01*
UFOV-2	226.63(170.54)	481.75(43.20)	<0.01*
UFOV-3	373.13(103.88)	478.92(54.82)	<0.01*
UFOVTOT	652.79(259.73)	1129.50(136.93)	<0.01*
VFD	25.50 (4.66)	20.67 (4.03)	<0.01*

MMSE mini-mental state examination; *CDR* clinical dementia rating; *CFT* copy, complex figure test-copy; *CFT* recall, complex figure test-copy; *TMT A* trail making test subtest A, *TMT-B* trail making test subtest B; *CDT* clock drawing test; *UFOV* useful field of view task; *VFD* visual form discrimination; *y* years

the longer the time remaining the pedestrian selected (80 km/h: control: 3.48 s, AD: 2.42 s; 60 km/h: control: 3.82 s, AD: 3.08 s; 40 km/hr: control: 4.21 s, AD: 3.46 s, $P < 0.001$). The time remaining increased with the similar trend as the time gap increased (time gap 5 s: control: 2.98 s, AD: 2.12 s; time gap 7 s: control: 4.10 s, AD: 2.81 s; time gap 9 s: control: 4.44 s, AD: 4.02 s, $P < 0.001$). For the two different age groups, the remaining time for control group was significantly longer than AD group (control: 3.84 s, AD: 2.99 s, $P = 0.05$). These results suggest the factors that affect the decision making of cross road depend mainly on the vehicle speed, time gap and time of day.

78.3.2.3 Safety Margin

It is only when the remaining time was longer than the crossing time, with time difference defined as safety margin, that it was safe to cross the road. The average crossing time of each individual was the mean value of crossing time at normal and fast pace over a 10 m distance. Therefore, if the safety margin was positive, it was safe for the pedestrian; otherwise, if the safety margin value was negative, it was dangerous for the pedestrian to cross the road. The safety margins for yes crossing responses plotted as walking times and the dispersion patterns are separately for two participant groups (Fig. 78.2). The dispersion pattern is shows the

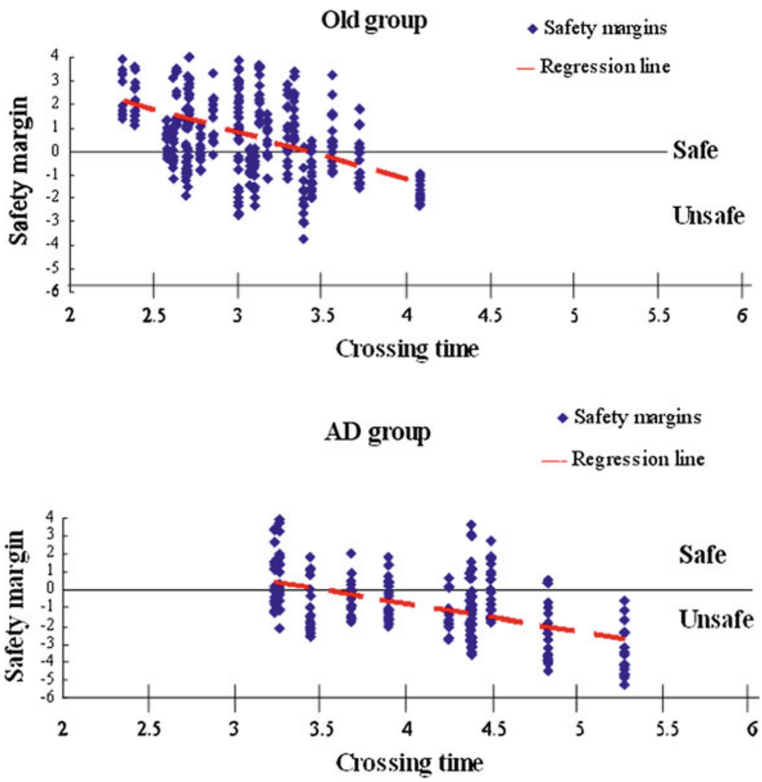

Fig. 78.2 The safety margins for yes crossing responses plotted as walking times

zero-line that denotes where the average safety margin for each group coincides with walking time. Points are below the zero-line indicating dangerous for the pedestrian to cross the road, while points above the line indicate safe for the pedestrian. The results showed that the successful crossing road for the control group was significantly higher than for the AD groups [Control groups: 60.8 % vs. AD groups: 28.2 %, $P < 0.01$]. In the AD groups, the successful road crossing was significantly lower during the 5 s (5.6 %), followed by the 7 s (25.7 %) and 9 s (53.5 %) time gaps. If the time gap is longer such as 9 s, the AD group behavior did not change significantly compared to the control group [control: 65.3 %, AD: 53.5 %, $p = 0.37$].

78.4 Discussion

Pedestrians with AD made risky crossing decision (indicated by negative safety margin) more often than matched normal elder. AD patients also had significant shorter remaining time and safety margin, indicating they might not be aware of their declining cognitive abilities in performing this road crossing decision and thus increasing the danger possibilities.

Road crossing is a dynamic activity that requires synchronized actions of pedestrians facing different traffic situations, such as Visuoconstructional and discrimination of coming vehicles, cortical flexibility and executive function to judge and decide the crossing time, and activation of the relevant motor controls for crossing the road. We found measures of MMSE, visual perception (VFD), visual attention (UFOV), visual memory (CFT-recall), and executive function (TMT B-A) correlated significantly with the outcome of safely crossing the road. Previous studies have shown that cognitive function (MMSE) decline with AD pedestrians is a major risk factor risk factor for unsafe road crossing by pedestrians (Hakkert et al. 2002; ATSB 2002). In addition, the pedestrian situation awareness must rely on visual attention (UFOV) and visual perception (VFD) in crossing road environments. TMT B-A was measured with mental process speed, task switch and cognitive flexibility. In line with crossing road behavior, we switch attention between oncoming vehicles and self-walking speed, until making safe decisions on when to react and where to stop. The CFT-recall predicted unsafe outcomes indicate the important role of visual memory in crossing road safety. These results clearly show that cognitive function, perception, attention and executive ability are important risk factor that effects of the crossing decisions of all pedestrian populations, especially AD patients.

Given that factors of traffic environment also contribute to road safety, we findings that fast coming motor vehicle speed (80 > 60 > 40 km/hr), decreased time gap between vehicle and pedestrians (5 > 7 s = 9 s) and mid-day as the time of day increased risk of unsafe crossing road behaviors in both AD and control subjects. Previous studies have shown that the pedestrian making crossing judgments primarily on vehicle distances (Lobjois and Cavallo 2007; Oxley et al. 2005, 2006). When the approaching vehicle speed increases, the pedestrian tends to overestimate the distance between them and thus reduces the time remaining for walking across the road safely. The observed decrease in the time gap as vehicle speed increased resulted in a smaller safety margin and a higher percentage of unsafe decisions regardless of AD or control subjects. The most surprising finding was that the AD groups crossing road safety margin at 9 s time gap did not change significantly compared to the control groups. If the time gap is shortest such as 5 s, the AD subjects were significantly made more unsafe decision than control subjects. AD disease affects not only memory, especially in cognitive function such as perception ability (i.e., judge speed and distance), attention and spatial ability (Gorrie et al. 2006). Because of reduced cognition ability, as a result of the AD disease, is a major risk factor for unsafe road crossing (Gorrie et al. 2004, 2006, 2008; Harrell 1991; RTA 2002). Future large sample studies are warranted to confirm our findings. This report also provided important road environment factors to design future supplementary gear for AD patients or normal elder during road crossing.

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Chapter 79
Analysis of Impact of Construction Safety Design of the Owners

Ting-sheng Zhao, Xin Wang, Jing-jing Tang and Xian-zhi Liu

Abstract Owners in the core position of the whole process of the project at the design stage to strengthen the guidance on the design of construction safety can effectively eliminate the insecurity in the construction process, from the accident source control accidents occurred. In this paper, a questionnaire survey and statistical analysis, conducted a random survey for 500 designers in Wuhan, on the construction safety design for the owners. The results showed that the owners involving in construction safety design were not so common, there were still many obstacles. For example, better design bidding, only 17 percent of the owners considered the construction of safe design capacity. More than 50 percent of the owners did not meet safety design requirements, and it was difficult to design advices on accident prevention, security, selection of equipment and materials. About 65 percent of the owners did not establish a construction safety design incentives. Based on these results, the paper proposed advices through five aspects to further promote construction safety design recommendations.

Keywords Construction · Owners · Safety design · Statistics

79.1 Introduction

According to the accident causal chain theory, the design prior to construction, the design may be one of the causes of the accident. Construction safety design guaranteed building products their own safety, but also takes into account the consideration of construction workers safety in design. Construction accidents may cause insecurity into the construction process without prior exclusion, missing an

T. Zhao (✉) · X. Wang · J. Tang · X. Liu
School of Civil Engineering and Mechanics, Huazhong University of Science and Technology, Wuhan, China
e-mail: 102343449@163.com

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important node in the accident, so as to control the accident occurred. The domestic construction industry would be arranged for safety in general preparation phase of construction, so the design effectively prevent, eliminate, reduce risk, have not been fully recognized now. Investing 12 million yuan to build the Tuo River bridge in Hunan Fenghuang collapse in the whole place before the completion on August 13, 2007. The accident 64 people were killed and 22 people were injured. The main reasons were the masonry materials of main arch and technology could not meet the design and specifications. The accident had fully exposed the gap between design and construction safety, the designer of the main arch ring did not give material selection and process safety advice, which led to accidents. So components with the actual construction focusing on construction and maintenance security, construction units were often able to make temporary security measures taken to achieve the purpose of reducing construction accidents (He and Lu 2008).

Construction industry was a misunderstand that the impact of architectural design quality only the quality of the construction itself, while the construction phase has little effect. Deep-rooted concept of the designer was to ensure that designs boast collapse, overturning in building construction and use. How to prevent security incidents in the construction process was not considered design responsibility. In most cases, only one-sided emphasized on structural design, the construction of the main requirements were to implement the technical specifications to ensure that construction and engineering functions to play a structural safety, and operations personnel for the safety of the construction process, and there was little systematic consideration. Major design companies have conducted a survey to assess the design decisions take into account the safety of construction workers, only one third of respondents said they considered the safety conditions of construction workers in U.S (Hinze and Wiegand 1995). Construction safety design is the production of a new research direction. The industry there is certain strangeness to it, and lack of appropriate management mechanisms and the development environment. The design causes of accidents in production had not been effectively controlled. In addition, the design unit task was full, and overtime was common. Design companies did not have the time and effort in safety design.

China's construction market is still in a buyer's market. The owners are at the core of the entire project. Owners can effectively communicate and coordinate the participants, manage information channel upstream and downstream in the construction phase. Today, national safety of the owners involved in construction design requirements continues to strengthen. In 2009, National Development and Reform Commission, the seven departments jointly issued the "major project on the strengthening of security measures to protect the quality of the notice" [Investment Development and Reform (2009) No. 3183], noticed that the owners wanted a clear overall responsibility for project quality and safety, to implement reasonable design schedule, to guide design services to enhance safety, strengthen the design companies in the project implementation process of site design services. The designers put forward specific requirements and measures for construction safety, according to the progress of the project, and continue to optimize the design, reduce project risk. In 2010, the State Council issued the "State Council on Further Strengthening the safe production work", which further emphasized that business owners need monitor the safety infrastructure and construction projects.

79.2 Related Research

ILO through experiments that the design team at work, to consider the safety of the construction site, construction accidents could be reduced in 1985 (Lin 2009). The British issued a "Safety and Health Regulations" in the proposed designer's responsibility was to make every effort to maximize the elimination, construction and maintenance to avoid and reduce the risk of the process may be, when the risk still existed, the designer measures must be taken to make the construction process to minimize the risk in 1994 (Lan 2003). Professor Szymberski from architectural concept design, preliminary design, construction began to safety as the most important part to consider the resolution of construction safety best methods of construction in (1997). Hinze, Professor studies had shown that, with the emphasis on construction safety property owners, requiring designers to break through the traditional concept, consider the construction safety trends were becoming evident. From the level of professional ethics, the designer had the obligation to provide construction safety design; from the legal perspective, the designers did not have these responsibilities, however, as changes in regulations and training, this situation was rapidly shifting in (2000). Carpenter survey showed that some of the designers because of the habits and safety education, lack of training, still did not recognize the design work on the impact of building construction safety in (2001). Professor Jerry and DouglaS analysed the safety situation in the UK construction, from the causal point of view, the design decisions and construction safety was a clear link in 2005 (Behm 2005). Professor Fang Dongping, etc. in the "Construction Safety Management" also made the designer's responsibility for security in the design in 2005 (Fang and Huang 2005). Gambatese set up a panel of experts reviewed the cases of 224 people were killed and engineering, the results show that 42 % of the events and construction of safe design linked in (2008).

79.3 Results

This study used a questionnaire survey form, the owners of the construction safety at the design stage to investigate the impact of design, object design for the architectural design company officers. Survey using the questionnaire in 2010–2011 and a random sample of 500 designers in Wuhan City, to remove the failure to fill out the provisions of the 27 invalid questionnaires, a total of 473 valid questionnaires, the effective rate of 94.6 %, which surveyed the building and the structural design professionals accounted for 83.7 %, in line with the characteristics of two professional dominant position in the architectural design. Meanwhile, professional designers surveyed more than 5 years of age accounted for 55.6 %. This showed that the respondents had some design experience and professional competence. As the investigation was limited to Wuhan City, the statistical results had region and limitation.

The results were shown in Figs. 79.1, 79.2, 79.3, 79.4, 79.5 and 79.6:

Figure 79.1 was construction safety design capabilities as a design tender indicator. As can be seen from Fig. 79.1, at present, only 17 % of the owners the ability to design construction safety important as the design requirements of the tender, the majority of owners did not attach importance to this area, mainly due to the current safety laws and regulations for building owners not explicitly designed to promote construction safety requirements, the owner of the construction safety design concept to be improved. Meanwhile, the "construction and engineering design contract (GF-2000-0209)" in terms of the contract did not specifically related to construction safety design, although the contracting parties agreed in the special provisions of the relevant part of the contents, the traditional design requirements and charging implemented under construction safety design faced with many difficulties.

Figure 79.2 was the proportion of owners giving incompatible with the safety design requirements. From the statistical results of 50–70 % of the owners during the design phase, did not meet safety specifications of the requirements. Among them, the main requirements put forward include: Designed to violation of energy-saving specifications. The insulation design is not in place. One-sided emphasized on cost, simplify the design of fire safety. Structural design was unreasonable and difficult construction. Not pay attention to safety, blindly demanding to reduce the amount of steel (Liu 2011). The design only considered the use of the load, ignoring the construction loads. The proposed structure, water, electricity does not meet the specification requirements.

Figure 79.3 was the design requirement considering the safety of the technology and operations. As can be seen from Fig. 79.3, 86 % of the owners of the construction process in the design and operation of protective security is not required, or when required, but requested blurred. It was mainly due to the construction drawing stage, the owners generally did not intervene in the design, the

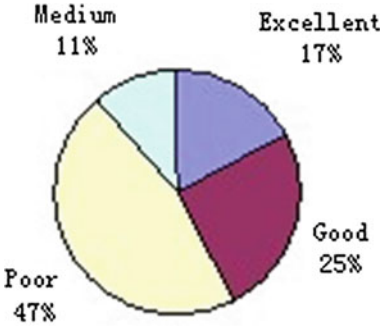

Fig. 79.1 Construction safety design capabilities as a design tender indicators

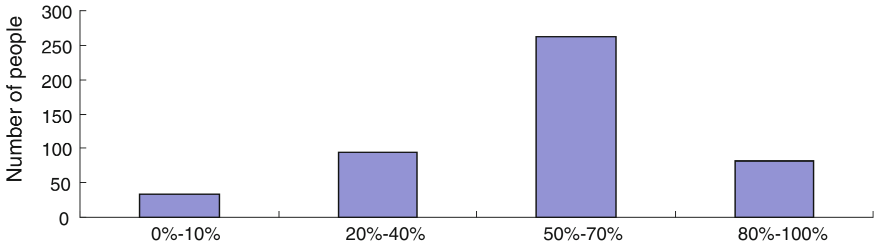

Fig. 79.2 The proportion of owners giving incompatible with the safety design requirements

Fig. 79.3 The design requirement considering the safety of the technology and operations

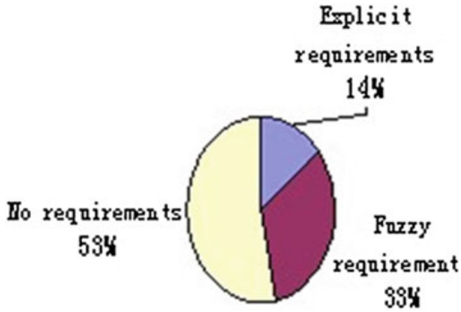

Fig. 79.4 Design provide safety advice of equipment and materials

Fig. 79.5 Owners to establish the implementation of the incentive mechanism

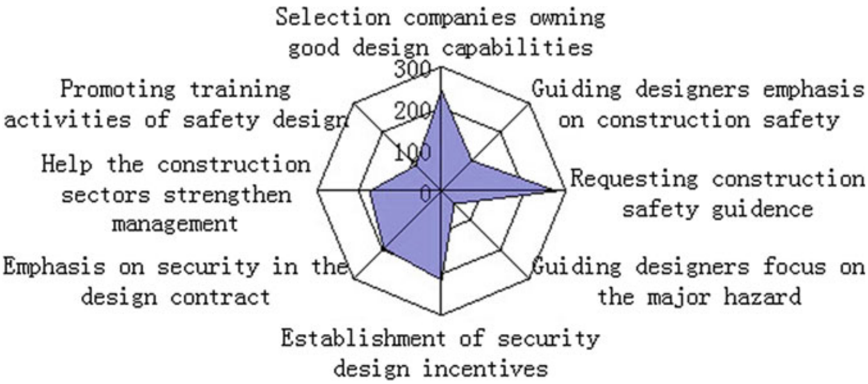

Fig. 79.6 Effective measures to improve construction safety design capabilities

designer was also based on habit, only the design itself was responsible. Construction technology options relied mainly on the construction unit of structure, security, selected by the designer and experience. Operation protection design specifications asked for much, so designers were generally not of particular concern. This would lead to a small diameter such as beam reinforcement label, the impact of pouring, bringing the construction hidden (Yang 2010). In addition, the owners often relied on to manage the construction supervision, design documentation for the management of more extensive. The design contracts were not also listed in this content, the owners had not specific operating requirements, especially with regard to pile, excavation, formwork.

Figure 79.4 was design staff to provide safety advice of equipment and material. As can be seen from Fig. 79.4, 46 % of the owners proposed to accountant selection of equipment and materials to provide safety advice, but were a mere formality, which was mainly due to designers generally given only the specifications of equipment and materials and styles, selection of equipment and materials for safety with little experience, and equipment and materials were often determined by the owners and the construction unit, the owners of the designer's more overlooked relevant functions.

Figure 79.5 was owners to establish the implementation of the incentive mechanism. As can be seen from Fig. 79.5, 65 % of the owners did not create incentives to strengthen construction safety design. This was mainly due to one-sided that by the owners to enhance construction safety better. So during the design phase would consider incentives (Shen et al. 2006). Meanwhile, the design of construction safety were considered to be indirect effects, the effect was not easy to measure safety design, the more restricted the owners to establish positive incentives, many owners lacked the entire course of construction safety management awareness, and not in the design phase of construction safety .

Figure 79.6 was Effective measures to improve construction safety design capabilities. It could be seen, selection of design and strong design units, requested guidance on construction safety, the establishment of security design incentives, contract design emphasizes safety, to help strengthen the management of the executive branch. These five measures of the owners were designed to enhance the security capabilities of major construction effective measures.

79.4 Discussion

79.4.1 Choose a Strong Sense of Safety Design and Design Units

Owners in the design of the tender, design engineering companies will be designed to undertake the construction and rationality as one of the criteria, rather than the current design of the qualification and only design unit as a security product designed to judge the eligibility criteria in the future.

79.4.2 Emphasize in Design of Contract Construction Safety

Owners and designers of the contract should be expressly agreed, the necessary safety elements were designed to reduce the risk of workers at the site operation, design guidance on the temporary construction companies to take effective safety measures. At the same time, the contract should be clearly the responsibility of the design and construction companies to maintain good communication and listen to difficulties in the construction side of construction, from design points of viewing to enhance the project constructability (Wu 2011).

79.4.3 Construction Safety Officer to Guide Design

Owners guide the design of the designer to consider the construction process and worker safety. Designers guide safe operation in the design documents, and choose safe and comfortable equipments. The designers specify the parts and links related to construction safety, put forward the views of the safety selection and installation of equipments. The design uses operable, safe and reliable construction machinery and equipment, and tools. Provide guidance to the seasonal construction. Design companies should be involved in the construction site temporary structures in the layout and design (Zhang 2006).

79.4.4 Promote Sound Management in Construction Safety Regulations on Design Content

The owners should promote the construction administrative departments organized experts to study the techniques designed to improve construction safety. Owners develop specific design specifications, the safety design specification to follow, well documented. At the same time, owners can also use the administrative department of resources, from the professional division of labor needs; foster a number of specialized agencies in the security design optimization, design of professional development to promote safety.

79.4.5 Establish Incentive Mechanisms of Safety Design

The owners and designers are the principal—agent relationship. Owners can consultant with the design units to a certain percentage of the total cost of the Construction Engineering as safety design award. If the safety design contributes to construction safety, safety design award paid to the design companies. If the assessment of safety design does not do a good job, not contribute to the project construction safety, do not pay the security design awards. It can inspire the design companies involved in construction safety design. In addition, the contract may be to some extent, increase the responsibility of the designer. Should make rules: if the investigation determines that the design did not consider the construction safety construction safety incidents directly or indirectly, to deal with the design units to impose economic and administrative penalties.

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Chapter 80
Analysis of the Relationship Between Safety Execution and Safety Performance

Guo-yu Liu, Hui Xu, Yi-hang Wei and Jun-mei Wang

Abstract To investigate the relationship between safety execution and safety performance, this paper analyzes their mutual effects in safety management while their concepts, contents and research methods are further clarified so as to improve corporate safety management. Through the factor analysis, factors of safety execution and safety performance are obtained. Based on the empirical research a structural equation model is constructed. Meanwhile, the coefficients for the influence factors of safety execution and safety performance are calculated. Furthermore, major factors and indexes affecting safety execution are verified so that more theoretical bases can be provided to improve corporate safety execution and safety performance.

Keywords Factor analysis · Safety execution · Safety performance · Structural equation model

Although safety in production is highly valued by the country, a large amount of human resources and material resource has invested in security construction in recent years, a series of strong policies and regulations have been developed, and science and technology input also has reached unprecedented level, industrial

G. Liu (✉)
Faculty of Resources and Safety Engineering, China University of Mining and Technology, Beijing, People's Republic of China
e-mail: zhongkuangyuan@126.com

H. Xu
College of Construction Management and Real Estate, Chongqing University, Chongqing, People's Republic of China

Y. Wei
College of Safety Science and Engineering, Henan Polytechnic University, Jiaozuo, People's Republic of China

J. Wang
College of Management and Economics, Beijing Institute of Technology, Beijing, People's Republic of China

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accidents still have a high rate, that is because the laws and regulations on safety production are poorly enforced at the grassroots. Some laws, decrees and policy measures still remain in the paper form (Yan and Zhang 2008). Little has been implemented. Where there are policies from above, there are always counter-policies from below.

Execution has been a hot spot in management research, whether in Western management system or the traditional management in the booming sinology. In the end it comes down to the integration of decision-making and implementation. In the field of safety production, safety management should be a priority. According to the basic principles of western management, human behavior can be quantitatively analyzed (Much 1992), how to accurately know employee's ability to execute is the key of safety production. Putting its implementation in place, management focuses on managing the people. Most of the directors will face the same problem. Thus we need a quantitative evaluation system to support safe development of the enterprise, to make the safety management carry out clearly and quantitatively, and to analyze the gap between executive ability and objective.

80.1 Safety Execution and Safety Performance

80.1.1 Safety Execution

The concept of execution originated from western management. Before the concept, we have already known core competence, leadership and other terms. The word Execution came into the attention in 2002 when Larry Bossidy and Rma Charan published their book *Execution: The Discipline of Getting Things Done* in the United States. In January 2003 the book was translated and published in China; It has been listed at the top of best-sellers for two years. Execution is an important link in the enterprise management and consists of three core processes—strategy, staff and operation. Integration is the essential of execution and execution is a systematic process (Charan 2007). Managers think that many problems are not solved effectively. Actually policy and system is not the fundamental problem. Leaders often develop strategic decisions which have not been effectively implemented at the grass roots level. No matter how correct the strategy or system is, the objectives cannot be achieved without effective implementation, which is the key factor. In conclusion, this paper argues that safety execution is a systematic project which is a harmonious state between person and person, people and the machine and people and the environment. This paper argues that safety execution needs to be performed in a unified concept and based on the actual situations. We must implement and practice rules and regulations earnestly and unshakably and carry through safety responsibility at all levels.

80.1.2 Safety Performance

Luo Shuangping in Chinese Personnel Academy argues the employees will emphasize the same indicators as those used by the managers in performance evaluation. It has been proved that you will get what you want to check since there is a link between execution management and quantizing performance (Luo 2010). They act upon each other. Performance evaluation and management is also a part of the execution, which allows companies to effectively measure the indicators. This measure will clearly reflect the state of performance as a basis and guarantee of execution. Safety performance management system is based on advanced safety culture and safety management system (Hongtao and Jianhong 2008). There are differences in the definition of safety performance, which can generally be divided into three types: (1) using situation and consequence of production safety accidents to define safety performance; (2) using enterprise actual performance to evaluate the operating results of safety work; (3) using accident conditions and enterprise actual performance to define the safety performance (Liu 2008).

If the security work is arbitrary, there will be no safety index, which means no standard. This is bound to affect the survival and development of enterprises. Performance can be evaluated using the task performance (safety compliance behavior) and contextual performance (safety participation behavior) (Wu 2003; Griffin 2000). Some scholars also suggest assessing the safety performance through monitoring behaviors (Motowidlo and Scotter 1994). This article argues that safety performance should be analyzed qualitatively and quantitatively to find the problems that need to be improved. The aim is to improve safety work through the evaluation and to improve the safety execution. Safety objectives should be broken down to each security manager, and carried out through effective process tracking, performance evaluation, development encouragement and suggestions. This does not only focus on results but also emphasize safety monitoring in the implementation process to prevent accidents. The golf of safety management is a good integration of the safety execution and safety performance. Each aspect of safety evaluation: planning, implement, evaluation and performance feedback should all reflect this requirement.

80.2 Research Method

In order to analyze from an empirical perspective on the factors of safety evaluation and performance, this paper uses questionnaire survey for data collection and analysis.

Table 80.1 Questionnaire list

Category	Project	Number	Proportion %
Sex	Man	209	70
	Woman	103	30
	High school and below	40	13
Education	Junior college	84	27
	Undergraduate	123	39
	Postgraduate	65	21
Age	Below 20	28	9
	20–29	116	37
	30–39	152	49
	40 and above	16	5

80.2.1 Questionnaire Development

Questionnaire is one of the main tools for research, which is widely used. To prepare a high-quality questionnaire, it is necessary to do a lot of preliminary work, including the preparation of pre-trial questionnaire, trial test, collecting and numbering, item analysis, validity analysis and reliability analysis. In the analysis of the project will also include the re-scoring, calculating the total score, sorting by high and low scores, and T Test analysis of difference (Glendon 2001). This study, based on literature review, initially identified the scope of the collection of the questionnaire entries, and determined the forecast topic for subjects, covering safety evaluation scale and safety performance scale uses a five-point Likert scale to measurement: 1 totally disagree, 2 disagree, 3 do not know, 4 agree, 5 totally agree. While No. 15, 29, 34, 35, 40, 42, are reverse referred, which means higher scores indicate higher influence. In order to improve the accuracy, a small scale survey of 100 people was first carried out. Then a larger scale questionnaire survey was carried out to 350 mining practitioners. 312 valid questionnaires were received and the effective rate is 89 percent. The characteristics of the informants are in Table 80.1.

80.2.2 Statistical Method

Data were analyzed using SPSS 20 and structural equation modeling AMOS software 20, including processing of data, validity test, factor analysis, and building security implementation of safety performance impact of structural equation models.

80.3 Research Results And Analysis

80.3.1 Factor Analysis

This paper uses principal component analysis and extracts 9 factors with the greatest variance rotating so that each item has a higher loading on as few factors as possible, so factors with loading less than 0.40 are deleted. According to meanings of these factors, they were named safety culture, safety system, leadership responsibility, safety training, safety implementation, process monitoring, target assessment, safety awareness, and safety actions. Exploratory factor analysis results in a two-factor solution, of which KMO value is 0.871 and the cumulative contribution rate of 64.87 %. Cronbach internal consistency coefficients alpha are within 0.50 to 0.90. This means that the scale is reliable and efficient. Based on the above analysis and a literature review, a structural equation model of safety execution has been built (Liu and Li 2012).

The correlation analysis investigates the relations between the variables and their changing trends (Du and Jia 2009). The power of factors underlying statistical values and the associated matrix are shown in Table 80.2.

The analysis of related factors of safety executive ability shows that safety executive and security performance are mostly correlated with these dimensions, safety implementation, leadership responsibility, safety culture, safety system and safety training. However, the analysis itself does not indicate causal relationship, so there is a need of further study through the structure equations.

Table 80.2 The score matrix between various dimensions, each dimension and the correlation coefficient

	A	B	C	D	E	F	G	H	I
A	1								
B	0.569**	1							
C	0.639**	0.560**	1						
D	0.288**	0.281**	0.385**	1					
E	0.045	−0.002	0.203**	0.215**	1				
F	0.605**	0.464**	0.658**	0.280**	0.196**	1			
G	0.551**	0.452**	0.703**	0.474**	0.344**	0.510**	1		
H	0.203**	0.263**	0.385**	0.290**	0.471**	0.270**	0.494**	1	
I	0.603**	0.459**	0.648**	0.376**	0.353**	0.675**	0.642**	0.340**	1

Note A safety culture, *B* safety system, *c* leadership responsibility, *D* safety actions, *E* safety awareness, *F* safety training, *G* safety implementation, *H* process monitoring, *I* target assessment; *P < 0.05, **P < 0.01

80.3.2 Safety Executive and Safety Performance Model Analysis

Fitness is an important index to analyze whether the model fits the original data (Hau et al. 2004). The author accords with international practice, using such indicators as $\chi 2$/df, GFI, RMSEA, AGFI, NFI, IFI and CFI to assess the model (Wen and Hau 2004). $\chi 2$/df is a value to test the similarity between sample covariance matrix and the estimated variance matrix, and its theoretical value is 1. The closer $\chi 2$/df is to 1, the better the model fits. In the actual study $\chi 2$/df should be close to 3. When the sample size is large, 5 would also be acceptable. At present, most scholars believe that if GFI $\geq$ 0.90, AGFI $\geq$ 0.8, the model fits better (some scholars think that at least GFI should be greater than 0.85 or at least 0.80). It is believed that if TLI $\geq$ 0.9 and CFI $>$ 0.9, the model fits well. It is generally believed that if RMSEA $=$ 0, the model fully fits; if RMSEA $<$ 0.05, the model closer to fitting; 0.05 $\leq$ RMSEA $\leq$ 0.08 means the fitness is reasonable, 0.08 $<$ 0.10 $<$ RMSEA means the fitness is acceptable. The indexes are shown in Table 80.3.

According to the Table 80.3, the fitness of the model in this study can be accepted. As the survey data largely come from mass-roots enterprises in the coal mines, there are certain limitations in the data collection. The data are not yet fully representative of the model, but they can objectively reflect the actual implementation of safety laws and regulations in the mining industry. A structural equation model of **s**afety execution and safety performance is shown in Fig. 80.1.

We can see from the figure above that safety execution and safety performance impact each other. Efficient security implementation will bring good safety performance; similarly, advanced performance management enhances the power of security execution. The two reinforce each other, so this model should be non-recursive models (Taisheng 2009). We need to analyze the relationships between factors. The coefficients between **s**afety execution and safety performance, and those between the factors are also shown in Fig. 80.1. It can be concluded that influencing factors of **s**afety execution are safety culture, safety system, safety training, leadership responsibility and target examination. Safety execution has a

Table 80.3 Fit indicators of confirmatory factor analysis model

Indicator	Value
χ^2/df	3.518
RMR	0.050
GFI	0.945
AGFI	0.898
NFI	0.937
IFI	0.954
TLI	0.931
CFI	0.954
RMSEA	0.090

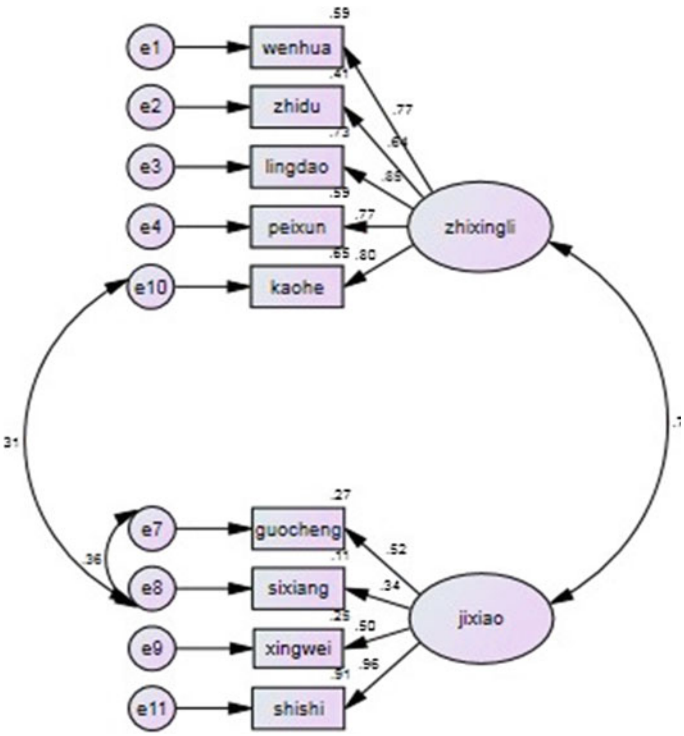

Fig. 80.1 Safety execution and safety performance equation model

loading of 0.77 on security culture main bases in the questionnaire include: security culture should be implement in the grass-roots; colleagues have good collaboration; safety environment will have effect on the implementation; the safety culture is the realization of the vision of enterprise safety and the construction of a safety culture should be integrated into all aspects of production.

Safety execution has a loading of 0.85 on leadership responsibility, main bases in the questionnaire include: management staff has commitment to safety, team leaders as role model in safety work, mine managers accompany workers into the mines, which reflects the importance of leadership responsibility in security work. Safety execution has a loading of 0.77 on safety training. Main work includes: companies organize safety training and pre-service training, there should be emergency plan for each step in production, and safety training is the key; Safety execution has a loading of 0.80 on target assessment. Target assessment influences safety performance greatly. Safety execution has a loading of 0.64 on safety system. The security system greatly influences the implementation of policy.

Safety performance management system is based on the implementation of safety awareness, safety implementation, process monitoring, and safety actions. From the structure model above, safety performance has a loading of 0.96 on safety implementation. Safety implementation has significant effects on safety performance. Safety implementation includes team meeting about safety, effective safety implementation between colleague and soliciting opinions of the employees when setting the safety objectives. All of this should reflect the idea of "putting people first" in safety management. Safety performance has a loading of 0.34 on safety awareness. The performance assessment should not be confined to the physical aspects. A good safety performance goal should allow the employees to have safety awareness. The idea of "safety first, prevention first" should be accepted by the public, motivating employees to shift from "I am required with safety" to "I want safety by myself". Safety performance has a loading of 0.52 on process monitoring. Performance assessment should not merely be reward or punishment after the accidents. Evaluation and monitoring should be emphasized throughout the entire implementation process, so that problems can be timely detected and timely rectified. The model in this research work aims not only to improve safety management from experience-based to scientific, improve the effect of accident prevention and benefit the theoretical system for understanding the safety system. It will also have practical significance for the discipline of safety science and technology (Gui 2005).

The model of **s**afety execution—safety performance indicates that they are significantly related and the coefficient is 0.79. The factors of safety execution significantly impact safety performance while safety performance promotes the favorable development of factors of safety execution.

80.4 Conclusion

Through a factor analysis of data collected from a questionnaire survey, this paper obtained 9 factors that affect safety execution and safety performance. A structural equation model has been built to analyze the relationships between the factors, safety execution and safety performance.

This empirical research indicates that safety execution has a significant impact on safety performance. The improvements of safety performance and safety execution are mutually affected. The assessment of safety performance is also an important part of improvement of safety execution. Performance assessment should be emphasized through the implementation process rather than just on the results.

Previous studies suggested that safety performance evaluation should emphasize the quantitative reward or punishment of the employees and often neglect the importance of the safety awareness of the awareness. The improvement of safety performance should allow employees to share a common need of safety with the enterprise and voluntarily engage in safe production.

The development of safety culture should be integrated into the safety system to strengthen the construction of people-oriented safety execution, caring the health and life of the employees.

Through the quantitative analysis between safety execution and safety performance, the standardized coefficients for each factor are obtained. Understanding the structure of the indicators of each factor provides the theoretical basis for empirical research to enhance the safety execution and safety performance.

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Chapter 81
Improvement and Application of Modern Accident Causal Chain Model

Zheng-yu Xue, Na Wei, Xiao-qing Yu, Kai Ji and Bin Liu

Abstract Based on the theoretical research of modern accident causal chain model, the paper puts forward some specific measures for improvement in allusion to the abstract, complicated problems, such as unsafe human behavior, unsafe condition of things, working conditions, personal reasons and management defects that existed in the model. And through the analysis of the accident example, the paper verifies the validity and practicability of the improved model.

Keywords Analysis of an accident · Improved model · Modern accident causal chain model

81.1 Introduction

Accident Causal Chain Theory (Chai 2011) mainly includes Heinrich's Causal Chain Theory, Bod's Causal Chain Theory and Kitagawa Tetsuzo's Causal Chain Theory. Bod's Causal Chain Theory is also called Modern Causal Chain Theory. Its viewpoint that the faults of management is the most important reason of accidents is in line with the modern safe viewpoint further, thus it is of scientific guiding significance to the study of accidents.

Z. Xue (✉) · N. Wei · X. Yu · K. Ji · B. Liu
The Service Academy of Chinese Air Force, Xuzhou, Jiangsu, China
e-mail: yuzhengxue@163.com

N. Wei
e-mail: hcwn2007@126.com

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81.2 Modern Accident Causal Chain Model

81.2.1 Modern Accident Causal Chain Model

The content of Modern Accident Causal Chain Theory is “accident is caused by the causation chain similar to a domino effect”. The model (Yuan et al. 2010) as shown in Fig. 81.1.

Modern Accident Causal Chain Model includes five factors, which can be used to show by five dominoes:

The 1st, the faults of management (Domino 1). Security management system should be adjusted and improved constantly with the development of production, the perfect management system doesn’t exit.

The 2nd, the condition of work and personal reasons (Domino 2). These are caused by the faults of management. The condition of work includes imperfect safe operating regulations, improper equipments and materials, and the presence of harmful environmental factors; the personal reasons include the lack of safe knowledge or skill, the wrong behavior motivation and the physical and mental problems.

The 3rd, people’s unsafe behavior and unsafe condition of things (Domino 3). These are caused by the condition of work and the personal reasons, and they are the presentation of deep reasons of accidents.

The 4th, happen of accidents (Domino 4). The accident is seen as a human body or an object contacts with the energy that exceeds the threshold energy, or a human body contacts with the substances that prevent the normal physiological activity.

The 5th, loss of accidents (Domino 5). The personal injuries and the loss of property are holly called the loss of accidents. Personnel injuries include the injury suffered on the work, the occupation disease, the mental trauma and so on.

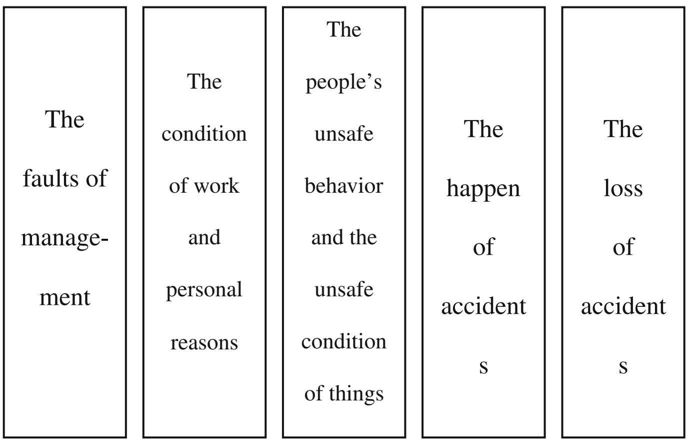

Fig. 81.1 Modern accident causal chain model

Modern accident causal chain model divides the causal analysis process of accidents into five layers and expressed by five dominoes. When the 1st domino falls down, the 5th domino also does by the chain. This model has the significance of scientific theoretical guidance to the analysis and the measures of modern accident Causal Chain relationship.

81.2.2 The Faults of Modern Accident Causal Chain Model

Modern accident causal chain model is used for the analysis in all kinds of systems, but when it is used in common accidents; it has such faults (Fan 2007; Fang 2009; Fu 2005)

(1) The content of dominoes in modern accident causal chain model is not specific and direct, which can't reflect the specific events of the Causal Chain process directly. It is necessary to analyze and explain the content of each domino based on the specific accident in practical application.
(2) The causation of modern accident causal chain model is a chain relationship similar to the crash between dominoes. In practical application, there is a complex relationship among the faults of management, the condition of work and the personal reason, people's unsafe behavior and unsafe condition of things.

81.3 Improvement of Modern Accident Causal Chain Model

Based on the 'Provisional Rules of Special Major Accident Investigating Procedure' published by the State Council, common accident is the accident leads to the number of death under 3 or the number of serious injury under 10 or direct economic loss under 10 million Yuan. Using modern accident causal chain model, the events in every modern accident causal chain domino are under 8–10 terms (Hui 2010) so the layers of causation of accident can be embodied.

The improving methods to modern accident causal chain model: Firstly, using the specific accident and loss to descript Domino 4 and Domino 5 of the modern accident causal chain model; Then divide Domino 1, Domino 2 and Domino 3 into several independent modules and fill in the specific events according to the experience of experts, relevant technical regulations and results of spot analysis. At last, use arrowheads to link these modules to show the causation. The improved accident causal chain model is used for common accident and isn't for major accident or the accident in the complex system.

The specific constructing methods of the improved model are as follows:

(1) Fill the visible loss, such as the death and injury of people or the loss of property, which brought by the accident directly in the Domino 5.
(2) Fill in the Domino 4 the specific description of accidents, such as falling from high buildings, the collapse of construction, the powder exploding, the vessel exploding and the boiler exploding etc.
(3) Divide people's unsafe behavior to several independent events that named people's unsafe behavior a, people's unsafe behavior b, people's unsafe behavior c and so on; Also divide the unsafe condition of things to several independent events which named the unsafe condition of things a, the unsafe condition of things b, the unsafe condition of things c and so on. Fill them into the Domino 3.
(4) Similar to (3), divide the condition of work and the personal reasons into independent events which named the condition of work a, b,… and the personal reason a, b, …, then fill them into the Domino 2 as independent event modules.
(5) The faults of management can be achieved directly from the concise analysis of the construction department, the user department and the supervision department. They also can be divided into the independent fault of management a, b, c, …, then be filled into the Domino 1.
(6) Determining causality analysis and use arrowheads that mean "lead to" to link the modules in layers. As shown in Fig. 81.2.

The improved accident causal chain model realizes the improvement from abstraction and complexity to embodiment and convenience, it is for the analysis of common accident.

81.4 Application of the Improved Accident Causal Chain Model

81.4.1 An Example of Accident

In a building company, a brick layer standing on the scaffold between two balconies on the sixth floor was irrigating concrete. Because of the lack of special unloading platform, the hanging concrete had to be unloaded on the temporary steel template which laid on the scaffold. When the third hopper of concrete was unloaded and the brick layer was cleaning the hopper, the scaffold broke suddenly and the steel template fell down. The brick layer also fell down the ground and internal organs were seriously hurt, then with invalid rescue he's dead (Analysis and Prevention of Common Accidents Books Editor Commission 2004).

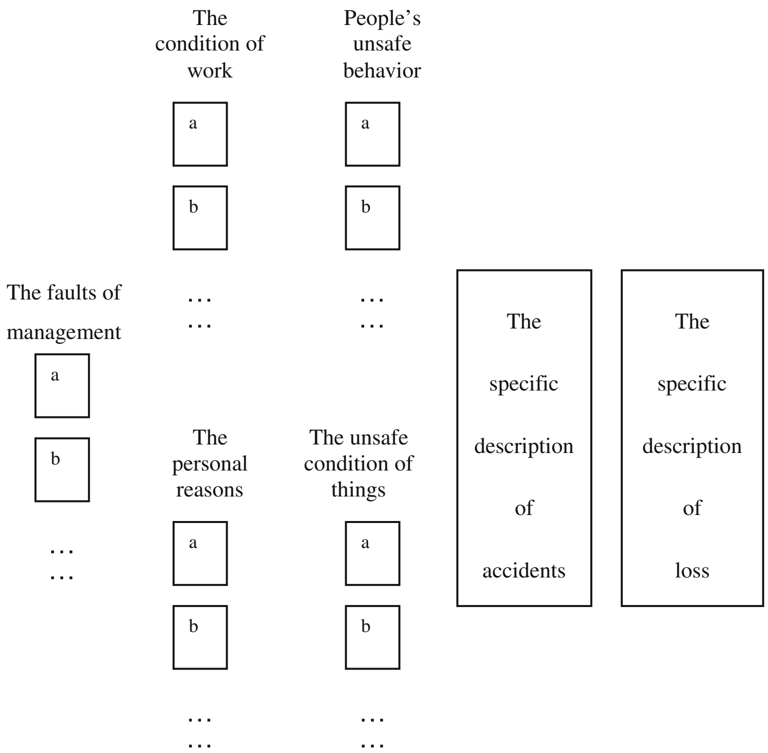

Fig. 81.2 Improved modern accident causal chain model

81.4.2 Application of the Model

According to the specific constructing methods of the improved model, the analysis of the causation of this example is as follows:

(1) The example is a dead accident and the specific description of loss is "the brick layer is dead". So fill it into Domino 5.
(2) Based on the GB6441-86 'Company Worker Injury and Dead Accident Classification Rule'[1]. The direct description of accidents, such as against objects, vehicle injuries, mechanical injuries, lifting injuries, electrocution, drowning, scalding, fire, falling, poisoning and suffocation and so on, should be used as "the description of accidents". The "description of accident" in the example is "the scaffold breaks and the brick layer falls down". So fill it into the Domino 4.

[1] State Standard Bureau, GB6441-86, Rule of Company Worker Injury and Dead Accident Classification

(3) People's unsafe behavior is the behavior of "brick layer's cleaning hopper" and unsafe condition of things are "the abnormal facilities and equipments or the faults of material". They are described as follows:

People's unsafe behavior: The brick layer's cleaning hopper.
unsafe condition of things:

(a) the steel molding plate platform with insufficient strength
(b) the over-load concrete on the platform

So fill three modules into the Domino 3.

(4) The condition of work is generally the abnormal or unreasonable condition of external work on the spot. And the personal reason mainly includes the careless attitude of workers, the lack of safe knowledge and sense of the workers, the bad physical and mental condition of workers and so on.

The condition of work: The lack of special material platform.
People's unsafe behavior:

(a) the insufficient safe knowledge of platform builder.
(b) the insufficient safe sense of brick layer.
(c) the careless attitude of managers and supervisors on duty.

So fill four modules into Domino 2.

(5) The reasons of management defects generally come from the construction department, the user department and the supervision department. In the example, the reason must be analyzed from four aspects, which are the investor, the designer, the constructor and the supervisor. The specific events are as follows (Li 2009; He and He 2006):

The investor: investment is whether in time, fund operation is whether scientific.
The designer: the control to designers, the supervision to pictures.
The constructor: the safe education of workers, the control to managers and safe officers, the control to machine and equipment, the control to facilities, the control to material and the constructing plan is whether reasonable.
The supervisor: the control to supervisors, the supervision to the structure of constructions.
There is no fault of the designer in this example, so the fault of management includes:

(a) the investor's investment isn't in time.
(b) the constructor's safe education isn't enough.
(c) the constructor's control to managers isn't enough.
(d) the constructor's plan isn't considerate.
(e) the supervisor's control to its people isn't enough.

So fill five modules into Domino 1.

(6) Analysis of the causation among layers.

① The causation between the Domino 1 and Domino 2. The investor's investment isn't in time and the constructor's plan isn't considerate "lead to" the lack of special material platform. The constructor's safe education isn't enough "lead to" the lack of safe knowledge of platform builder and the lack of safe sense of brick layer. The constructor's control to managers isn't enough and the supervisor's control to its people isn't enough "lead to" the careless attitude of managers and supervisors on duty.

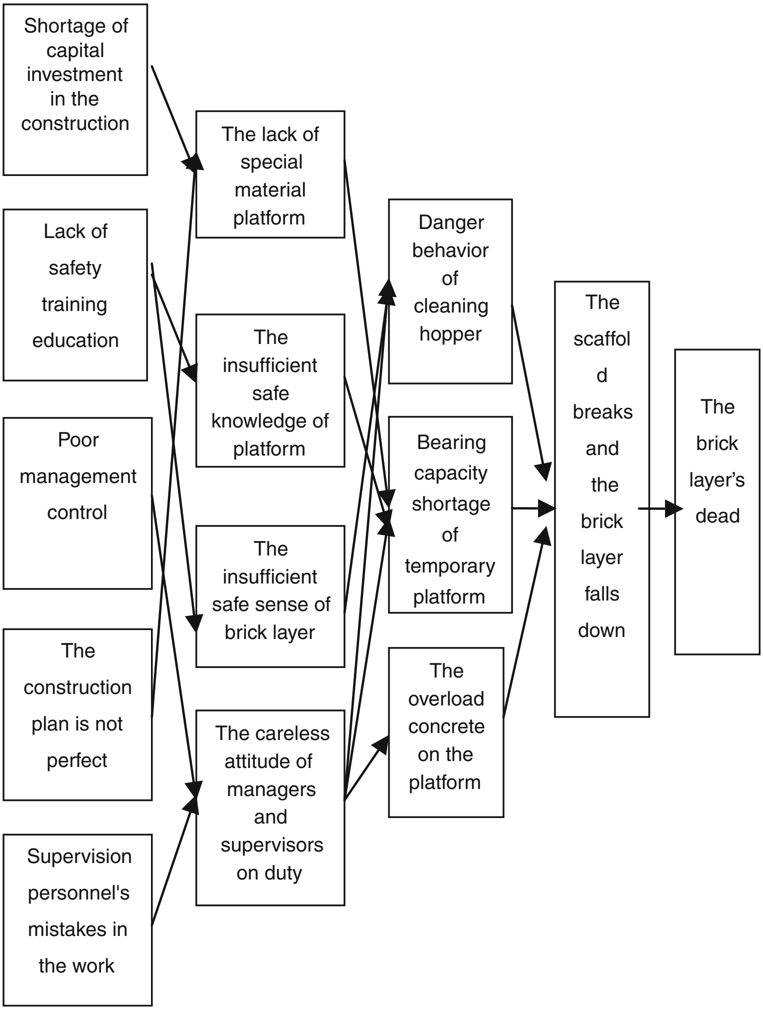

Fig. 81.3 The causation of the falling-building accident

② The causation between Domino 2 and Domino 3. The lack of special unloading platform "lead to" the concrete is unloaded on the steel template which has no sufficient bearing capacity; The insufficient safe knowledge of platform builder "lead to" the platform of temporary steel template is built on the scaffold; The insufficient safe sense of brick layer "lead to" the brick layer's danger behavior of cleaning hopper. The careless attitude of managers and supervisors on duty "lead to" all events in Domino 3.

③ Domino 3 is the direct reason of Domino 4, Domino 5 is caused by Domino 4.

Through the analysis, the Causation of the falling-building accident is shown as Fig. 81.3.

It is convenient, clear and complete to analyze the causation of the falling-building accident based on the improved modern accident causal chain model. Figure 81.3 reflects the specific and independent events of the five layers and the causation among the layers directly.

81.5 Conclusion

In the real world, it is impossible to avoid accidents and it is complex to analyze the causation. Even the causation which has been analyzed is lack of systematicness, completeness and practicality. Using the improved modern accident causal chain model to construct the causation model diagram of the falling-building accident, researchers can describe the specific events that lead to the accidents fully and clearly. So the improved modern accident causal chain model provides a practical mode to the analysis of causation of common accidents and the solution to the relevant questions.

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Chapter 82
Key Element and Improvement Strategy of Management Innovation in High-Tech Enterprise

Liang Liu

Abstract High-tech enterprises are the Main Body of China's economical System and science system. They have a great significance on the operation of enterprises, management innovation is vital for the enterprises to success in competition. Based on wide spot investigation of the enterprises at Binhai New Area of Tianjin, we hope to find the demand of them in management innovation. Finally, we find the basic methods to promote management level, include management information, lean research, lean design and lean production.

Keywords High-tech enterprise · Improvement strategy · Key element · Management innovation

82.1 Introduction

The definition of innovation comes from Schumpeter (2000) who defined it as some different combinations between production factors and production conditions. Since then, the meanings of innovation theory have extended by academia in domestic and abroad. The concept of management innovation is then generated from these processes. In some classifications innovation include institutional innovation, technological innovation and management innovation. Compared with foreign and domestic research achievements and the latest applications in institutional innovation and technological innovation, management innovation is a new subject. Wang (2003a) described management innovation as a comprehensive efficiency process in which new ideas, new technology, new methods of enterprise management strategy, enterprise culture and so on influence together. Li (2003)

L. Liu (✉)
College of Management and Economics,
Tianjin University, Tianjin, China
e-mail: liuliang@tju.edu.cn

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thought management innovation concludes the method of management improvement, the system of management improvement and so on. Wang (2003b) divided management innovation into effective and invalid two forms. Before the effective management innovation success, there must be a process of waste resources, staff and times. Invalid management innovation is an important prerequisite and guarantee for the promotion of effective management innovation development. Shiping (2005) thought management innovation is entire process management. Ettlie (2006) provided a broad perspective of how technological change can be effectively managed in modern organizations. Altshuller (1999) collected numerous empirical case from different areas of engineering. Liu (2011) explained the implications, principals and contents of management innovation in China's enterprises. Hamel (2006) gave three conditions where a management innovation could create long-lasting advantage. Joson and Liu (2004) thought the technical innovation was the key to the competitiveness of enterprises in the remaining economic condition.

Based on points of views above, we try to seek the relationship between industrial engineering and management innovation. And we want to know what the key factor in management innovation is. We described management innovation as a comprehensive whole process in which industrial engineering as a tool from market research and analysis to after-sale services. Based on the theories of industrial engineering, we interview with several companies in Tianjin city to find the relationship between them.

82.2 Enterprises Investigation

82.2.1 Options of Enterprises

Binhai New Area of Tianjin was established 24 years ago. The opportunity of enterprises development in Binhai has increased year by year. The innovation capacity of enterprises also has increased. As one of the first national innovative technology park, Binhai New Area is one of the fastest development regions for many years in north China, leading technology in our country (Qi and Xu 2010).

82.2.2 Questionnaire Surveys of Enterprises

There are a lot of large international enterprises, small businesses, early-stage entrepreneurs and all sizes in Binhai New Area. Because of lack of institutional innovations, management ideology, management mode and the management cultures in some early-stage entrepreneurs, we made an enterprise survey try to seek the relationship between industrial engineering and management innovation.

We described management innovation as a comprehensive efficiency whole process in which industrial engineering as a tool from market research and analysis to after-sale services, so we want to find the relationship between industrial engineering and mechanism of management innovation in different entrepreneurs. In this survey, firstly we took exchange symposiums with executive leaders of companies. Through questionnaire surveys and interviews with experts, we want to know the most needed methods of innovation management and the role of industrial engineering for companies. Secondly we sum up the methods and experience of innovation management. Finally, propose countermeasures pointedly how to develop the theory of management innovation in companies.

Industrial engineering as a tool is the base in manufacturing system, and industrial engineering is very important to companies. Industrial engineering is the very representation, in another way, the perfect practical method of the scientific development. Industrial engineering is firstly a scientific notion, and then a scientific method (Qi and Yanfang 2003a, b; Qi 2007, 2010) (Fig. 82.1).
Industrial engineering is concerned with the development, improvement, implementation and evaluation of integrated systems of people, money, knowledge, information, equipment, energy, materials, analysis and synthesis, as well as the mathematical, physical and social sciences together with the principles and methods of engineering design to specify, predict, and evaluate the results to be obtained from such systems or processes. Based on points of views above, we describe industrial engineering as a basis tool, we described management innovation as a comprehensive efficiency whole process in which industrial engineering as a tool from market research and analysis to after-sale services.

We made a enterprise survey from the aspect of strategy management, technical innovation, decision management, operations management and so on. We find that:

1. In the respect of operation management, 12.5 % of all companies leaders think management techniques is very useful for the innovation of production and

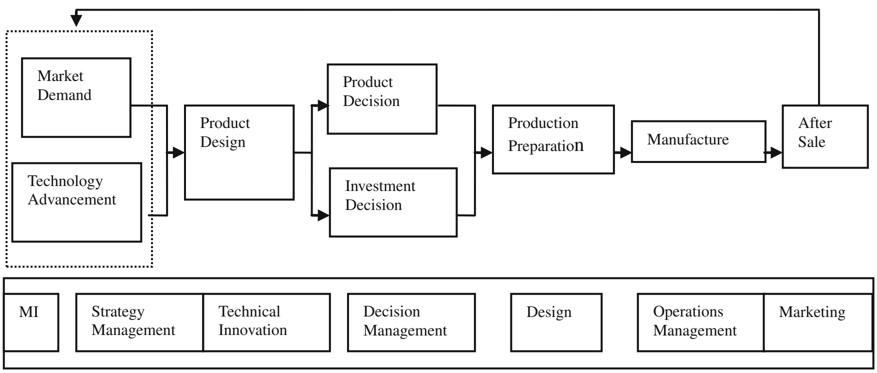

Fig. 82.1 The whole process of management innovation

technology. 53.3 % only see management techniques as a tool or a method. 20 % of enterprises even don't know about lean production.
2. In the respect of technological innovation management, all enterprises take more attention to the integration of technology and the market innovation.
3. In the respect of strategy management, most enterprises do not have very clear strategy plans. Some enterprises have made specific strategies and plans about future, but application is also not very ideal.
4. In the respect of organization innovation, 66.7 % of companies are trying to be learning to confront the continuous environment's change and build the sustainable competitive advantage. 37.5 % of these enterprises leaders think corporate governance and organizations which has become a crucial bottleneck for development are the weaknesses. The path and enterprise implementation of organizational skills don't match.
5. In the financial side, 75 % of these enterprises have established total financial budget system. 79.17 % of leaders described total financial control process as a key factor to control cost.
6. Most enterprises leaders see marking, human resources and technology as important factors to help enterprises development faster (Fig. 82.2).

The various topics of concern to industrial engineers include management science, supply chain management, engineering management, process engineering, safety engineering, operations research, financial engineering, systems

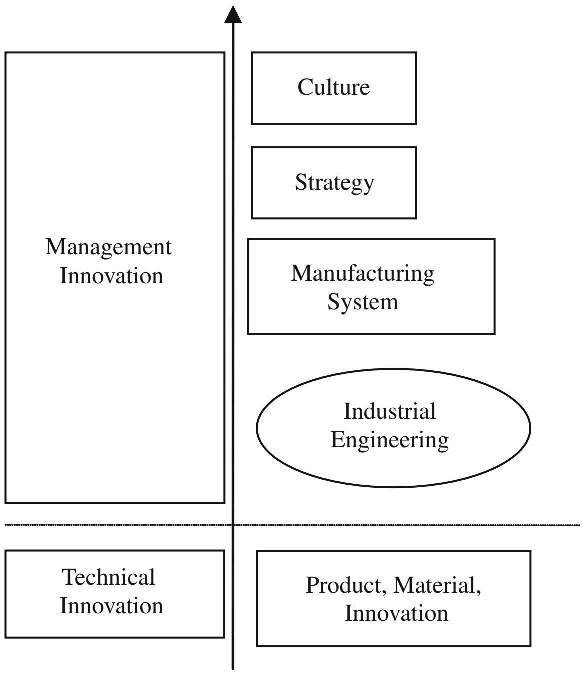

Fig. 82.2 The relationship between industrial engineering

engineering, cost and value engineering, facilities planning, quality engineering, and the engineering design process. Traditionally, a major aspect of industrial engineering was planning the layouts of factories and designing assembly lines and other manufacturing paradigms.

And now, in so-called lean manufacturing systems, industrial engineers work to eliminate wastes of time, money, materials, energy, and other resources industrial engineering should be seen as a technology which is use for design, process improvement, cost savings and so on. Industrial engineering being used in manufacturing system is the basic in management innovation.

82.3 Developing Management Innovation

Based on research and practice, business leaders focus on innovation and industrial engineering. This part concentrates on how to improve management innovation using industrial engineering as a tool. We find that the management levels of these enterprises are increasing greatly, but with the scale expansion management improvement are still big problems. To overcome these problems, Chinese companies have recently embarked on a strategy of developing management innovation. In order to overcome the existing problems, these enterprises should set up lean management method in the whole process of production. Based on lean management which is an important theory of industrial engineering we set up the whole process from the research and strategy to sale-after service. We give enterprises some suggestions below to develop management innovation.

1. Forwardly push the usage of lean production. The lean production way is a production mode that its primary aim is to reduce resource impropriated by enterprise and the cost of business management.
2. Information technology is the branch of industrial engineering that deals with the use of computers and telecommunications to store retrieve and transmit information and it is very helpful for management development in enterprises.
3. Technological innovation methods should be widely applied. Industrial engineering as a tool is the base in manufacturing system, and industrial engineering is very important to companies.
4. Electronic data. Inventory information, sales documents and so on format into database in computer. A general-purpose database management is typically a complex software system that meets many usage requirements, and the databases that it maintains are often large and complex. The utilization of databases is now so widespread that virtually every technology and product relies on databases and database management for its development and commercialization, or even may have such software embedded in it. Also, organizations and companies, from small to large, depend heavily on databases for their operations. The correct choice of software tools and methods is a critical

success factor to reach and maintain market leadership. A mature approach to estimate the impact and risk of technology adoption is required.

82.4 Lean Method for Management Innovation of High-Tech Enterprises

Through the above researches, we found that after a rapid development, both the overall strength and management level had greatly improved. However, along with the expansion of the market and business scale, enterprises have to increase demands on their management capabilities, and also, problems and needs on management have been emerging. Therefore, in order to overcome the issues related to high-tech enterprise management innovation, we should build the whole process of lean management methods that are high-tech enterprises oriented. Namely, the methods are promotion strategies which are based on enterprises informatization and are lean R&D, lean design, lean manufacturing and knowledge management-oriented (Fig. 82.3), and specifically include:

82.4.1 Lean R&D Technology

Lean R&D is a method that with lean as the target, quality as the coordination, and virtual prototype as the carrier. It integrates three core technologies: technology innovation, collaborative simulation, and three-dimensional quality design together, therefore, it can improve the quality and technical content of products while not significantly increasing the costs, thus enhancing the value of the products and achieving the improvement of product quality by leaps and bounds. And all this finally will encourage the high-tech enterprises to establish a continuous, balanced and flexible lean R&D process.

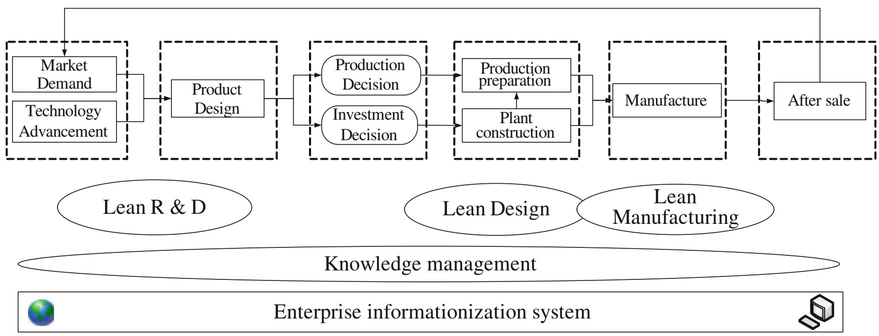

Fig. 82.3 The whole process lean management innovation methods of high-tech enterprise

82.4.2 Lean Design Technology

Lean Design applies Lean Thinking to the plant design stage. It integrates Value Engineering, Human Factors Engineering, Concurrent Engineering and other advanced management concepts together, and it emphasizes that Lean Philosophy should be considered in the design phase of plant layout, logistic systems, processes, information systems, so as to eliminate the waste of enterprises from the source, instead of improving those production processes which have already been with problems from a single part. Overall, the Lean Thinking should be throughout the whole life cycle of products, namely, quality assurance of products should start from the design.

82.4.3 Lean Manufacturing Technology

Lean manufacturing is a production technology and also a management technique that aims to thoroughly pursue the production of rationality, efficiency and flexibility to produce high-quality products in order to meet the diverse needs, the basic principles and methods of lean manufacturing have a positive meaning to the manufacturing industry. The core of lean manufacturing, that is, the basic idea of production planning and control, and inventory management, has an important role on the enrichment and development of modern production management theory. The lean manufacturing system should be consistent with the marketing system and the construction of the supply system, letting the plan and information exchange in real time.

82.4.4 Enterprises Informatization Technology

Enterprises informatization is a man–machine-one-level systems engineering, which including the concept of leaders and staff informatization, corporate decision-making and organization management informatization, business means informatization, design, processing and application informatization.

82.5 Conclusion

Innovation is the key for enterprise survival, the management level of the enterprise directly determine the enterprise efficiency. Based on wide spot investigation of the enterprises at Binhai, we hope to find the demand of them in management innovation. Finally, we find the basic methods to promote management level, include management information, lean research, lean design and lean production. Industrial engineering as a tool is the base in manufacturing system, and industrial engineering is very important base in management innovation.

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Chapter 83
Measures Against Emergencies in Time of Large-Scale Competition

Li-wei Li

Abstract In the history of world competitive sports, incidents had brought tremendous challenges to the hosting of big sports games, and traditional emergency response management modes had failed to adapt to the dealing of incidents occurring in modern sports games. By referring to successful experiences in the security of big sports games in the history of world competitive sports, and by applying early warning management principles and analytical methods, the authors expatiated on the contents and processes of the management activities of early warning for big sports games. Based on early-warning management principle, the early-warning management of emergencies in large-scale sporting events should be fulfilled by early warning analysis and pre-control measures. And early warning analysis process includes the event emergency warning and monitoring, early warning identification and early warning diagnosis; pre-control measures includes the preparation for emergencies, the daily monitoring for potential incentive, and the crisis management process after the incident.

Keywords Early-warning management · Emergency · Large-scale sporting events

83.1 Introduction

In recent years, China's economic and society has developed by leaps and bounds. More and more large-scale international, domestic competitive sports undertaken in China and their scale are expended and the factors that affect the security of the

L. Li (✉)
Department of Physical Education, Harbin University of Science and Technology, Harbin, China
e-mail: Liliwei1965@126.com

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sports are getting complex day by day. The traditional emergency management after the events which was based on historical experience highlights the lack of theory and deficiencies of practical application. Early-warning management theory indicates that administrators establish different monitoring and early-warning indicators and supervision standards according to different target, and apply these standards to monitor their objects, and send different warning signals, so as to provide the basis for pre-control and emergency decision (Yu 2003). It acts through the early-warning management control of the pre-emergency control system to achieve the goal of crisis prevention systems; while providing a state of emergency decision-making under the crisis, and dealing with systemic risk timely and efficiently in order to reduce the loss when systems meet inevitable incidents. Therefore, this article attempts to take an approach of precautionary management and apply the basic principles to make a concrete analysis of the activities and processes of precautionary management in order to provide new insights into precautionary management of emergencies in big sporting events.

83.2 The Connotation of Early Warning Management of Emergencies in Large-Scale Sports Events

Early-warning management of emergency in Large-scale sporting events, is refer to the process that an organizing of a large-scale sporting event, according to early-warning management principles, the security department collect information and intelligence of emergencies which may affect the smooth progress of events. Through the analysis, screening and assessment of these factors, the department can ensure the typical cause that may lead to unexpected events. Accordingly, set up monitoring and early-warning indicators and emergency threshold limit value, and on this basis output emergency warning signals. Lastly, make decisions such as to control, to be on guard, to evade or to response according to different levels of early warning signals so as to minimize the possible losses caused by unexpected events.

83.3 Factors of Emergencies in Large-Scale Sports Events

On the principle of the early warning management, the hazard mechanism of emergency is “people—Machine—Environment”, and the disharmony among elements. While In the large-scale sporting events, the main reason for unexpected events is “person—venue—environment” and the interaction of each three elements.

Table 83.1 Statistics on the Olympic, Athletes, journalists

Time	Session	Site	Delegations	Athletes	Journalists
1988	24th	Seoul	159	8,465	11,331
1992	25th	Barcelona	169	9,367	13,082
1996	26th	Atlanta	197	10,318	15,108
2000	27th	Sydney	199	10,651	16,033
2004	28th	Athens	201	11,099	21,500
2008	29th	Beijing	204	11,438	24,000

83.3.1 Human Factors

In large-scale sporting events, management from people is the most active factors in the object of the early-warning management. During big events, a great number of people from different regions or countries involve athletes, coaches, sports officials, journalists and the audience flooded into the same area in a very short period of time, the participant is in high population risk and complicated medley (see Table 83.1) is the destabilizing factors in security. In large-scale sporting events, the fanatical sports fans, extremist terrorists, national separatists and criminal elements are all need to pay highly concern.

The most astonishing event was the terrorist incidents in the 20th Olympic Games in Munich. In 1972, during the 20th Olympic Games in Munich, Germany, five Palestinian, members of "Black September" attack the Israelis in Athletes Village, caused bloodshed with 11 Israelis death. In 1996, during the Atlanta Olympics, the Olympic Park bombing also caused the deaths. With the development of large-scale international sports and modern competitive sports, more and more casualty accidents of fans inside and outside the stadium took place. Owing to ball games fans casualties were often reported (see Table 83.2). It is difficult to analysis the reasons. There are five main causes: the contrasting feeling of each fans group due to different results; conflict and unsportsmanlike behaviors during games; the capability and level of law enforcement of referees; the imprecision of security facilities; or even because of religious beliefs, geopolitical and ethnic conflicts, which become the reasons in various degrees causing public safety emergencies. In addition, in some European countries, in recent years, appears a group of people that are so-called "soccer hooligans" who do not regard watching

Table 83.2 Typical examples of casualty incident in stadium

Time	Site	Ports	Reasons for Injuries	Toll	Number of injury
1982	Moscow	Football	Stampede	340	Unknown
1985	Brussels	Football	Collapse of grandstand	39	Unknown
1989	England	Football	Stampede	108	About 60
1996	Guatemala	Football	Stampede	90	Unknown
1999	Alexandria	Football	Stampede	11	Unknown
2000	Zimbabwe	Football	Stampede	13	Unknown

the match as part of their purpose, but to make a mass deliberately and stir up troubles during the competition and hurt the opposing innocent fans, which brought about a negative influence on society.

83.3.2 Venue Factors

The management of venues is another important factor concerning with early warning system. Venue factors leading to sports incidents include main facilities system and hardware facilities system applied for great sports events, both of which are "hardware system" that can ensure great sports events going smoothly. The former one consists of fire control, shock proof, lighting protection, passenger flow and position of corridors, illumination, seating capacity, playing field, water and power facilities while the latter one covers equipments and devices, press system, cyber system and communication system, etc. As the supporting body of sports events, the safeness of Venues decides life safety of all the relevant people. On January 12th, 2007, British Colombia stadium collapsed. Serving as the holding place of opening and closing ceremony of 2010 Winter Olympic Games, this stadium is one of the biggest dome constructions in the world, the dome of which is made of two layers of glass fiber, like a big balloon applicable to be filled with hot-air so as to melt snow cover (Liu 2007a). We are shocked to hear of the investment report of Brazil Architecture and Engineer Union that the same potential safety hazard occurred to 80 % of stadiums (Liu 2007b).

83.3.3 Environmental Factors

Environmental factors mean the natural environment, transportation condition, public security and sanitation condition in the host city. It's an important aspect concerning with the early warning system to handle inner and outer environmental disaster-causing factors. There were lots of cases that sports events were postponed or cancelled in the history because of bad weather like high-temperature, snow and typhoon, etc. There were also such cases that disturbance and panic hit because of traffic accidents, social security or sanitation system. Sponsors of great sports events should pay much attention to provide good atmosphere and unreserved services through early warning on environmental factors. In 2005 when the World Championships in Athletics were held in Helsinki, Finland, the courts were hit by rainstorm. Second round of Man's 200 m and triple jump qualifying competition had to be reset and Women's discus final competition had to be postponed (Wu 2005). On January 8th, 2008, Switzerland figure equitation team declared not to take part in Dressage in Olympic Games held in Hong Kong. Because the head man Salvia Ikla, ranks No. 4 in the world, thought high temperature and moisture would do harm to the health of horses (Yanna 2008). Sanitation factors have also become a potential hazard of incidents since SARS happened. Therefore sanitation condition and the ability to resist infectious diseases and ensure the safety of food are important aspects of environmental factors.

83.3.4 Management Factors

The management of sports events is a critical part to ensure the successful holding of great sports events. Security work has become a cardinal task since Munich massacre happened in 1972, especially after "9.11 incident". Management factors involve management on people, venues and environment. For the subject of management, these factors include self safety control (inner) and the measures taken by local Emergency Preplan Authorities (outer) to handle incidents. Inner management mainly lies in whether the organization structure, efficiency and regulatory framework of sponsors is comprehensive or not, whether the administrative staff are of high quality or not, which is the main cause of sports incidents. Outer management is mainly decided by the emergency preplan system, emergency relief institutions and efficiency and means of cooperation (Li 2005).

83.4 The Process of Early Warning of Large-Scale Sports Event

The activity of early warning of large-scale sports events is consisted of early warning analysis and countermeasures. Early warning analysis is to recognize, analyze and evaluate the factors of incidents of large-scale sports events, and makes the forehand management activity (Jin 2004). Countermeasure is the activity which corrects, avoids and controls factors of major incidents according to the results of early warning analysis.

83.4.1 Early Warning Analysis of Large-Scale Sports Events

Early warnings can be divided into three procedures, monitoring, recognition and diagnosis.

1. *Early Warning Monitoring*: Monitoring requires setting the significant factors which results in accidents in significant events as monitoring objects. Analyze the factors that result in accidents in the events, the monitoring objects include people, stadium environment and management (Law of People's Republic of China on emergency response Law of People's Republic of China on emergency response 2007). The four factors include sub-factor in the discussion.

The two sectors of the monitoring are the monitoring of the events and the other is the treatment of information. The treatment of information refers to classification; restoration spread of information, and setting up information documents, and making comparison of history and society. This information is shared by the pre-caution management system and is the basic recognition of the whole pre-caution management activity. They can identify the main factors that cause accidents during significant sports events.

2. *Early Warning Recognition*: The task of recognition is to judge which section of the competition is changing, namely real accident factor (Qi 2002). Another task is to recognize the chain reaction which is caused by the abnormality of one (or same) section of the competition, the dynamic development tendency which causes the unexpected events, such as the tendency of incidents are to be ease or to be continuingly deteriorating Early warning diagnosis.
3. *Early Warning Diagnosis*: The process of diagnosis is to fully analyze the recognized real factors and figure out which is the main cause of the incidents (Zhong and Liu 2008). Such as aggressive behaviors of players and disturbance of fans because of the unfair judgments of referees, the judging section is the main cause. The major task of diagnosis is to raise the most dangerous and the worst hazard factors among so many problems and phenomenon in the environment of error corrections, and carry out element analysis and loss evaluations (including the loss of the organizing committee and social loss because of this).

83.4.2 The Process of Prediction Implementation

The goal early warning management activities are to protect and control incidents of large-scale sports events, implement the crisis management mode when incidents happen. This precautionary control includes organization preparation, daily monitoring, and crisis management.

1. *Organization Preparation*: Organization preparation refers to early warning management protection activities carried out by the organizing committee (Zhang and Tan 2005). It includes formulation and implementation of incident countermeasures, and formulation of related institutions, regulations, standards, which aims to provide organized security for control activities and the early warning management. Organization preparation has two specific tasks, one is to regulate the early warning management system, the second is to provide organization treatment and countermeasures for incidents of large-scale sports events, namely countermeasures database.
2. *Daily Monitoring*: Daily monitoring refers to special incentive monitoring of activities of large sports events according to early warning. It has two main functions that are daily tasks, crisis countermeasures. Daily tasks play a role to

take precaution against and correct incidents of large-scale events and turn them to be normal (Wang 2006). Crisis simulation refers to the hypothesis and simulation which could be brought to larger hazards when incidents of sports events cannot be controlled effectively, and makes preparation for future crisis. Large sports daily monitoring objects are mainly events environment, teams and athletes, judges and audience. The key point of Daily monitoring are “real incentive” and “risk incentive” of large-scale events identified by analysis of early warning.

3. *Crisis Management:* Crisis management refers to treatment of sudden accidents which is resulted from inefficient avoid in daily monitoring and lastly becomes disaster. Take the Munich massacre for example; the Organizing Committee of the competition is even a kind of management style in case of emergency (Wang 2003). When accidents happens during significant sports, when the crisis becomes very urgent, they should control the deterioration of the accident, set up fire wall and separate crisis, according to the features of the large number of athletes and audience. Meanwhile, the organizing committee should sent specialized staff to handle the problem and ensure the routine procedure of the competition. Once accident happens, the rescue system should be used immediately, the procedure can be divided into answer, set up, rescue and restore. When the crisis is overcome, a significant measure is to make or readjust the plan. Arrange daily activities to make the organizing committee and tasks back into routine, and make compensations to the victims and draw experiences from accidents, make improvement in order to improve the immunity ability against accidents and prevent them from happening (Lijie et al. 2008).

83.5 Conclusion

From the perspective of precaution management, large-scale events are the results of “people—stadium—environment”, people, stadium, environment and management are four main factors which arouse incidents (Lu 2005). Large sports events in the early warning management based on the analysis of the cause, was carried out by warning analysis, including preparation of crisis management, daily monitoring and warning countermeasures. Thus, maximize the loss of major sports events, athletes, spectators and make sure the safety of athletes and audience and the security of sports venues and the property to reduce adverse social impact hazards brought by major incidents (Fig. 83.1).

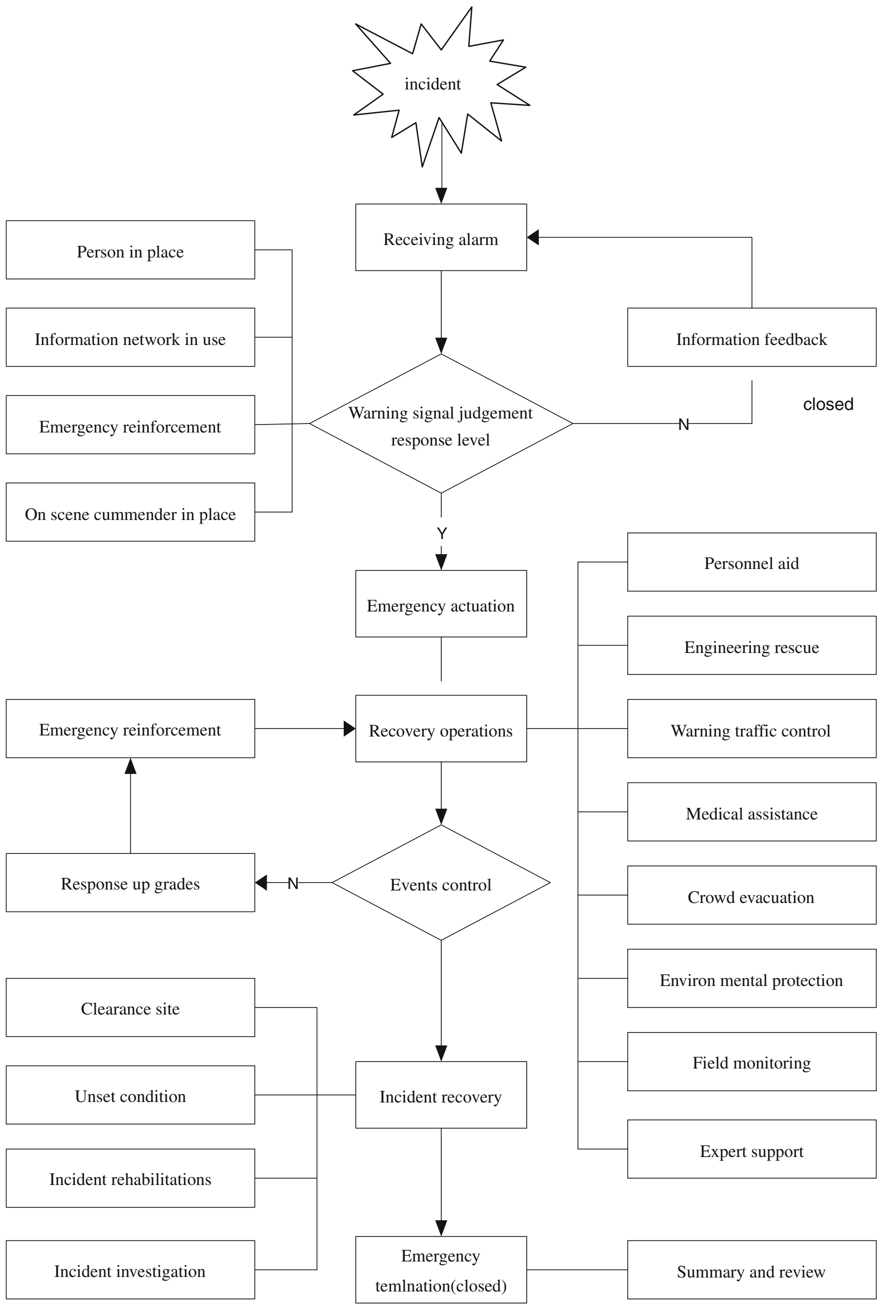

Fig. 83.1 Emergency treatment system response procedures

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Chapter 84
Multilevel Grey Evaluation on the Risk of Chinese Oil Companies' Transnational M&A Project

Yu-qi Wang and Wen-juan Chen

Abstract This paper comes up with multilevel grey evaluation method by applying Grey system theory and Analytic hierarchy process (AHP), and sums up the risk evaluation index system for Chinese oil companies' transnational mergers and acquisitions (M&A) in the light of the characteristics of international M&A. On the basis of this, the paper carries on risk evaluation by using multilevel grey evaluation method combined with practical example. The research shows that the method has the advantages of feasible, high precision, etc.

Keywords Index system · Multilevel grey evaluation · Risk management · Transnational M&A

84.1 Introduction

China has become the 2nd largest oil consumption country only after the United States in the world. According to the data from China's energy information network, China's crude oil consumption reached 460 million tons in the year 2011, and the foreign dependence rate is up to 55 %. It's estimated that China's oil supply–demand gap will reach 300 $\sim$ 350 million tons by the year 2050. Thus, to implement transnational operation has become an inevitable choice for Chinese oil companies. Since the "going out" policy being adopted late, Chinese oil companies are lack of experience on dealing with the risk of transnational M&A (Hu and Zhang 2007). Besides, oil companies' transnational M&A will be confronted with the influence of various factors such as political sensitivity, high capital input, information asymmetry, environmental protection requirement, etc., and has a very high risk (Yang 2010). Therefore, Chinese oil companies have to conduct accurate risk evaluation so as to reduce failure in future's transnational M&A projects.

Y. Wang (✉) · W. Chen
School of Management, Harbin University of Science and Technology, Harbin, China
e-mail: wangyuqi@vip.sina.com

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84.2 Multilevel Grey Evaluation Method

Grey comprehensive evaluation method is a kind of comprehensive evaluation method based on expert judgment and directed by grey relation analysis theory. The process is: to establish a grey comprehensive evaluation model; to choose weights for all evaluation factors; to carry on comprehensive evaluation.

Although grey comprehensive evaluation method provides a quantitative tool for democratic and scientific decision-making, it has the following shortcomings: first, there isn't a relatively objective evaluation index system for the assessment of people or things; second, no solution has been given for the weight of each evaluation index towards the objective. But the two problems can be readily solved if introducing AHP into grey comprehensive evaluation method and forming a multilevel grey evaluation method.

For oil companies' transnational M&A projects, many factors can not be conducted with quantitative evaluation, only qualitative evaluation suited, and these factors are often complex, multi-layered. Meanwhile, serious information asymmetry existed in the process of M&A will make the M&A project appear an un-transparent state of partially certain and partially uncertain, and have a very high grey level (Deng 1990). So, multilevel grey evaluation method is applicable to this sort of transnational M&A projects.

84.3 Evaluation Index System for Transnational M&A

By summing up the related literatures and the suggestions from a number of related industrial experts, a multilevel risk evaluation index system of oil companies' transnational M&A is summarized as follow: (Table 84.1)

1) *Objective layer*: The top layer is the general objective layer W, this layer clarifies the risk of Chinese oil companies' transnational M&A.
2) *Theme layer*: First level of evaluation index U_i, $i = 1, 2, 3, \ldots, m$.
3) *Index layer*: Second level of evaluation index V_{ij}, $i = 1, 2, 3 \ldots, m$; $j = 1, 2, 3 \ldots, n$.

84.4 Process of Multilevel Grey Evaluation Method

84.4.1 Ranking Standard of Evaluation Index V_{ij}

Evaluation Index V_{ij} is subjective index, namely qualitative index. By laying down the grading rank standard of evaluation index, qualitative indexes can be transferred into quantitative indexes (Hu 1996). Evaluation index V_{ij} can be divided

Table 84.1 Evaluation index system

Objective layer	Theme layer	Index layer
W	External environment risk U_1	Political risk V_{11}
		Legal risk V_{12}
		Cultural risk V_{13}
		Economic risk V_{14}
	Objective decision risk U_2	Decision-making fault risk V_{21}
		Information asymmetry riskV_{22}
	Implementation risk U_3	Pricing risk V_{31}
		Financing risk V_{32}
		Payment risks V_{33}
	Integration risk U_4	Human resource risk V_{41}
		Operation risk V_{42}
		Technology risk V_{43}
		Accounting risk V_{44}

into 4 levels, corresponding to the risk degree of "low", "medium", "comparatively high" and "high", the index can be valued with 4, 3, 2, 1, in the light of the superiority and inferiority of evaluation ranks. When the rank of index is in the middle of two adjacent levels, corresponding to a score of 3.5, 2.5, 1.5.

84.4.2 Weight of Evaluation Index U_i and V_{ij}

For evaluation index system, the importance is different between the evaluation indexes of U_i and V_{ij}. When measuring the importance of each index to the objective, different weight should be given, and the important one should be given greater weight. There are many methods for determining the weight, and Delphi method, AHP and Factor analysis method are often applied (Liu and Lu 2009). When AHP method is adopted, through comparing the importance of the pairs, the judgment matrix can be established. Then using root algorithm to find the eigenvector and eigen-root of the matrix, the eigenvector's sub-vectors corresponding to the judgment matrix which meeting the consistency are the weight of the index layer (PAN 1992). The weight set of U_i is:

$$A = (a_1, a_2, a_3, \ldots, a_n), a_i \geq 0, \sum_{i=1}^{n} \mathrm{a_i} = 1 \tag{84.1}$$

The weight set of V_{ij} is:

$$\begin{aligned} A_i =&(a_{i1}, a_{i2}, \ldots, a_{ip}, \ldots, a_{ij}), a_{ip} \geq 0, \sum_{p=1}^{j} \mathrm{a_{ip}} = 1, \\ i =&1, 2,\ 3,\ 4\, j = 4,\ 2, 3,\ 4 \end{aligned} . \tag{84.2}$$

84.4.3 Evaluation Sample Matrix

By selecting oil companies with many years experience on transnational M&A and experts with related research, through phone call, E-mail, fax, etc., the scores of related M&A plan's evaluation index V_{ij} can be rated in light of the evaluation rank standard. If the score given by expert k ($k = 1, 2,\ldots, m$) to the evaluation index V_{ij} is marked as d_{ijk}, then the evaluation sample matrix is obtained as D:

$$D = \begin{array}{c} \begin{pmatrix} d_{111} & d_{112} & \cdots & d_{11m} \\ d_{121} & d_{122} & \cdots & d_{12m} \\ & & \vdots & \\ d_{211} & d_{212} & \cdots & d_{21m} \\ & & \vdots & \\ d_{441} & d_{442} & \cdots & d_{44m} \end{pmatrix} \end{array} \begin{array}{c} V_{11} \\ V_{12} \\ \vdots \\ V_{21} \\ \vdots \\ V_{44} \end{array} \tag{84.3}$$

84.4.4 Evaluation Grey Category

Determination of evaluation grey category is to determine the rank number, the grey degree and the whitenization weight function of evaluation grey category. To set the serial number of evaluation grey category as x ($x = 1, 2,\ldots, n$), so there are n evaluation grey categories. According to the evaluation rank standard, the evaluation rank can be determined as 4 ($x = 4$) categories, that is "low", "medium", "comparatively high" and "high", and the corresponding grey clustering set is:

$$\otimes=(\otimes_1, \otimes_2, \otimes_3, \otimes_4) \tag{84.4}$$

In order to describe the grey category, the whitenization weight functions of each grey category need to be determined.

(1) *Grey category* 1: low risk ($x = 1$), the grey number is $\otimes_1 \in [d_1, \infty)$, the whitenization weight function f_1 is:

$$f_1\left(d_{ijk}\right) = \begin{cases} \frac{d_{ijk}}{4} & d_{ijk} \in [0, 4] \\ 1 & d_{ijk} \in [4, \infty) \\ 0 & d_{ijk} \notin (0, \infty) \end{cases} \tag{84.5}$$

(2) *Grey category* 2: medium risk ($x = 2$), the grey number is $\otimes_2 \in [0, d_2, 2d_2]$, the whitenization weight function f_2 is:

$$f_2(d_{ijk}) = \begin{cases} \frac{d_{ijk}}{3} & d_{ijk} \in [0,3] \\ \frac{d_{ijk}-6}{-3} & d_{ijk} \in [3,6] \\ 0 & d_{ijk} \notin [0,6] \end{cases} \tag{84.6}$$

(3) *Grey category* 3: comparatively higher risk ($x = 3$), the grey number is $\otimes_3 \in [0, d_3, 2d_3]$, the whitenization weight function f_3 is:

$$f_3\left(d_{ijk}\right) = \begin{cases} \frac{d_{ijk}}{2} & d_{ijk} \in [0,2] \\ \frac{d_{ijk}-4}{-2} & d_{ijk} \in [2,4] \\ 0 & d_{ijk} \notin [0,4] \end{cases} \tag{84.7}$$

(4) *Grey category* 4: highest risk ($x = 4$), the grey number is $\otimes_4 \in [0, d_4, 2d_4]$, the whitenization weight function f_4 is:

$$f_4\left(d_{ijjk}\right) = \begin{cases} 1 & d_{ijk} \in [0,1] \\ \frac{d_{ijk}-2}{-1} & d_{ijk} \in [1,2] \\ 0 & d_{ijk} \notin [0,2] \end{cases} \tag{84.8}$$

84.4.5 Grey Evaluation Coefficient

For evaluation index V_{ij} belongs to M&A project's No. x evaluation grey category, its grey category evaluation coefficient is noted as Y_{ijx}:

$$Y_{ijx} = \sum_{k=1}^{m} f_{\mathrm{x}}(d_{ijk}) \tag{84.9}$$

For evaluation index V_{ij} belongs to M&A project's every evaluation grey category, the overall grey category evaluation coefficient is noted as Y_{ij}:

$$Y_{ij} = \sum_{x=1}^{n} Y_{ijx} \tag{84.10}$$

84.4.6 Grey Evaluation Weight Vector and Weight Matrix

For evaluation index V_{ij} evaluated as No. x grey category by all evaluation experts, its grey evaluation weight is noted as Z_{ijx}:

$$Z_{ijx} = \frac{Y_{ijx}}{Y_{ij}} \tag{84.11}$$

Thus, the grey evaluation weight vector of the evaluation index V_{ij} to each grey category is $Z_{ij} = (Z_{ij1}, Z_{ij2}, Z_{ij3}, Z_{ij4})$. And the grey evaluation weight matrix of the evaluation indexes V_{ij} belong to the evaluation index U_i is noted as B_i:

$$B_i = \begin{bmatrix} Z_{i1} \\ Z_{i2} \\ \vdots \\ Z_{ij} \end{bmatrix} = \begin{bmatrix} Z_{i11} & Z_{i12} & Z_{i13} & Z_{i14} \\ Z_{i21} & Z_{i22} & Z_{i23} & Z_{i24} \\ \vdots & \vdots & \vdots & \vdots \\ Z_{ij1} & Z_{ij2} & Z_{ij3} & Z_{ij4} \end{bmatrix} \tag{84.12}$$

84.4.7 Comprehensive Evaluation

To carry out a comprehensive evaluation of the second level evaluation index V_{ij}, its comprehensive evaluation result is noted as M_i,

$$M_i = A_i \cdot B_i = (m_{i1}, m_{i2}, m_{i3}, m_{i4}) \tag{84.13}$$

From the comprehensive evaluation result of the second level evaluation index V_{ij}, the grey evaluation weight matrix of the first level evaluation index U_i to each evaluation grey category is noted as B:

$$B = \begin{bmatrix} M_1 \\ M_2 \\ M_3 \\ M_4 \end{bmatrix} = \begin{bmatrix} m_{11} & m_{12} & m_{13} & m_{14} \\ m_{21} & m_{22} & m_{23} & m_{24} \\ m_{31} & m_{32} & m_{33} & m_{34} \\ m_{41} & m_{42} & m_{43} & m_{44} \end{bmatrix} \tag{84.14}$$

To carry out a comprehensive evaluation of the first level evaluation index U_i, its comprehensive evaluation result is M,

$$M = A \cdot B = A \cdot \begin{bmatrix} A_1 \cdot B_1 \\ A_2 \cdot B_2 \\ A_3 \cdot B_3 \\ A_4 \cdot B_4 \end{bmatrix} = (m_1, m_2, m_3, m_4) \tag{84.15}$$

84.4.8 Comprehensive Evaluation Value

To calculate the comprehensive evaluation value is just to get the final score of risk. The higher score indicates that the M&A project has a better comprehensive performance on all related evaluation indexes, and a lower risk; the lower score indicates that the M&A project has a higher risk.

After carrying out a comprehensive evaluation of every evaluation index, the comprehensive evaluation vector M can be obtained. In order to make the comprehensive numerical value more accurate, the comprehensive evaluation vector M must be single threshold processed.

To endow all evaluation category with value (threshold) in the light of "grey level", then each evaluation grey category's grey level threshold vector $C = (4, 3, 2, 1)$. So certain M&A project's comprehensive evaluation value is as $N = M \cdot C^T$

84.5 Empirical Study

By taking the North Caspian Sea acquisition project of China National Offshore Oil Company (CNOOC) as an example, to carry on risk evaluation by applying multilevel grey system model (Wang and Hu 2007).

84.5.1 Evaluation Index Weight

By using AHP method, calculates the weight-vector of evaluation index U_i is $A = (0.454, 0.255, 0.051, 0.240)$, the weight-vector of evaluation index V_{ij} are respectively $A_1 = (0.465, 0.273, 0.037, 0.225)$, $A_2 = (0.750, 0.250)$, $A_3 = (0.512, 0.305, 0.183)$, $A_4 = (0.046, 0.397, 0.397, 0.160)$.

84.5.2 Evaluation Sample Matrix

By inviting 5 experts to evaluate each evaluation index, then we get the evaluation matrix D:

$$\mathrm{D} = \begin{bmatrix} 1 & 1.5 & 1 & 1.5 & 1 \\ 2.5 & 2 & 2 & 2 & 2.5 \\ 3 & 3.5 & 3 & 3.5 & 3.5 \\ 2.5 & 3 & 3 & 2.5 & 3 \\ 1.5 & 2 & 2 & 1.5 & 2.5 \\ 3 & 3.5 & 3 & 3 & 3 \\ 3 & 3.5 & 3 & 3.5 & 3.5 \\ 3.5 & 3.5 & 3.5 & 3 & 3.5 \\ 3.5 & 4 & 3.5 & 4 & 3.5 \\ 3.5 & 4 & 3 & 3.5 & 3 \\ 3 & 2.5 & 3 & 3.5 & 3 \\ 2.5 & 3 & 3 & 3.5 & 2.5 \\ 3 & 3 & 2.5 & 3.5 & 3 \end{bmatrix} \tag{84.16}$$

84.5.3 Evaluation Grey Category

(1) *Grey category* 1: low risk ($x = 1$), the grey number is $\otimes_1 \in [4, \infty)$, the whitenization weight function f_1: (Fig. 84.1)
(2) *Grey category* 2: medium risk ($x = 2$), the grey number is $\otimes_2 \in [0, 3, 6]$, the whitenization weight function f_2: (Fig. 84.2)
(3) *Grey category* 3: comparatively higher risk ($x = 3$), the grey number is $\otimes_3 \in [0, 2, 4]$, and the whitenization weight function f_3: (Fig. 84.3)
(4) *Grey category* 4: high risk ($x = 4$), the grey number is $\otimes_4 \in [0, 1, 2]$, the whitenization weight function f_4: (Fig. 84.4)

84.5.4 Grey Evaluation Coefficient, Grey Evaluation Weight Vector and Weight Matrix

The grey evaluation coefficient of evaluation index V_{11} belongs to No. x evaluation grey category is noted as Y_{11x}:

$$\begin{aligned}
x = 1 \quad Y_{111} &= f_1(1) + f_1(1.5) + f_1(1) + f_1(1) + f_1(1.5) \\
&= 025 + 0375 + 025 + 025 + 0375 = 15 \\
x = 2 \quad Y_{112} &= f_2(1) + f_2(1.5) + f_2(1) + f_2(1) + f_2(1.5) = 2 \\
x = 3 \quad Y_{113} &= f_3(1) + f_3(1.5) + f_3(1) + f_3(1) + f_3(1.5) \\
&= 05 + 075 + 05 + 05 + 0.75 = 3 \\
x = 4 \quad Y_{114} &= f_4(1) + f_4(1.5) + f_4(1) + f_4(1) + f_4(1.5) \\
&= 1 + 05 + 1 + 1 + 05 = 4
\end{aligned}$$

So the overall grey evaluation coefficient of evaluation index V_{11} belongs to all evaluation grey category is noted as Y_{11}, and $Y_{11} = 1.5 + 2 + 3 + 4 = 10.5$.

The grey evaluation weight of the evaluation index V_{11} evaluated as No. x grey category by all evaluation experts is noted as Z_{11x}:

$$x = 1 \quad Z_{111} = \frac{Y_{111}}{Y_{11}} = 0.143$$

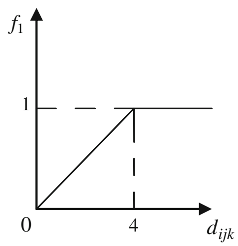


Fig. 84.1 Whitenization weight function f_1

Fig. 84.2 Whitenization weight function f_2

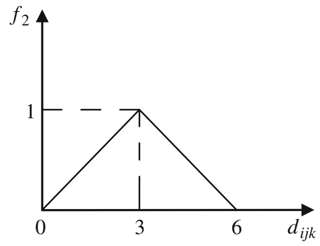


Fig. 84.3 Whitenization weight function f_3

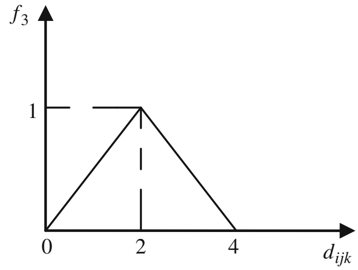
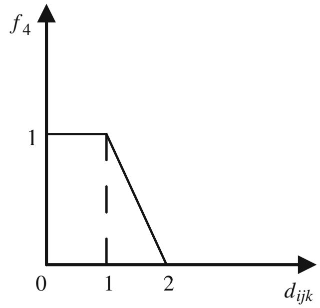


Fig. 84.4 Whitenization weight function f_4



$$x = 2 \quad Z_{112} = \frac{Y_{112}}{Y_{11}} = 0.190$$

$$x = 3 \quad Z_{113} = \frac{Y_{113}}{Y_{11}} = 0.286$$

$$x = 4 \quad Z_{114} = \frac{Y_{114}}{Y_{11}} = 0.381$$

The grey evaluation weight vector of the evaluation index V_{11} to each grey category can be noted as Z_{11}:

$$Z_{11} = (Z_{111},\ Z_{112},\ Z_{113},\ Z_{114}) = (0.143, 0.190, 0.286, 0.381)$$

By the same reason, the grey evaluation weight vector of each evaluation index to every grey category can be obtained. Then, the grey evaluation weight matrix of the evaluation index V_{Ij} affiliated to U_1 to each grey category can be calculated B_i:

$$B_1 = \begin{bmatrix} Z_{11} \\ Z_{12} \\ Z_{13} \\ Z_{14} \end{bmatrix} = \begin{bmatrix} 0.143 & 0.190 & 0.286 & 0.381 \\ 0.252 & 0.336 & 0.412 & 0 \\ 0.398 & 0.434 & 0.169 & 0 \\ 0.313 & 0.418 & 0.269 & 0 \end{bmatrix}$$

$$B_2 = \begin{bmatrix} Z_{21} \\ Z_{22} \end{bmatrix} = \begin{bmatrix} 0.231 & 0.308 & 0.413 & 0.049 \\ 0.354 & 0.441 & 0.205 & 0 \end{bmatrix}$$

$$B_3 = \begin{bmatrix} Z_{31} \\ Z_{32} \\ Z_{33} \end{bmatrix} = \begin{bmatrix} 0.398 & 0.434 & 0.169 & 0 \\ 0.422 & 0.430 & 0.149 & 0 \\ 0.474 & 0.421 & 0.105 & 0 \end{bmatrix}$$

$$B_4 = \begin{bmatrix} Z_{41} \\ Z_{42} \\ Z_{43} \\ Z_{44} \end{bmatrix} = \begin{bmatrix} 0.422 & 0.430 & 0.149 & 0 \\ 0.283 & 0.377 & 0.340 & 0 \\ 0.293 & 0.391 & 0.361 & 0 \\ 0.344 & 0.427 & 0.229 & 0 \end{bmatrix}$$

84.5.5 Comprehensive Evaluation

The comprehensive evaluation result of evaluation index V_{ij} is:

$$M_{\mathbf{1}} = (0.2204,\ 0.2902,\ 0.3122,\ 0.1479)$$

$$M_2 = (0.2618,\ 0.3413,\ 0.3610,\ 0.0368)$$

$$M_{\mathbf{3}} = (0.4192,\ 0.4304,\ 0.1512,\ 0)$$

$$M_{\mathbf{4}} = (0.3031,\ 0.3930,\ 0.3218,\ 0)$$

So the grey evaluation weight matrix of the evaluation index U_i to every evaluation grey category is noted as B:

$$B = \begin{bmatrix} 0.2204 & 0.2902 & 0.3122 & 0.1479 \\ 0.2618 & 0.3413 & 0.3610 & 0.0368 \\ 0.4192 & 0.4304 & 0.1512 & 0 \\ 0.3031 & 0.3930 & 0.3218 & 0 \end{bmatrix}$$

The comprehensive evaluation result of evaluation index U_i is $M = (0.2609,$ $0.3351, 0.3187, 0.0765)$.

84.5.6 Comprehensive Evaluation Value

The comprehensive evaluation value of the acquisition project is $N = M{\cdot}C^{\mathrm{T}} = 2.7628$.

84.6 Conclusion

The comprehensive evaluation value $N = 2.7628$, means that the overall risk of this M&A project is between medium risk and comparatively highest risk level. By normalizing the comprehensive evaluation result M, we can get the vector of (0.2632, 0.3381, 0.3215, 0.0772), namely the ratio of low risk is 26.32 %, the ratio of medium risk is 33.81 %, the ratio of comparative high risk is 32.15 %, and the ratio of high risk is 7.72 %.

The evaluation value of each sub-factor can be get in the evaluation process, they are $N_1 = 2.5245$, $N_2 = 2.8299$, $N_3 = 3.2704$, $N_4 = 3.0278$. The result shows that the risk level of external environment is higher than the comprehensive risk (Kent and Miller 1992), means that more emphasis should be placed on the external environment risk when formulating risk response policies (Subodh and Subodh 2001). At the same time, the weight of political risk accounts for the highest percentage in overall external risks on all evaluation indexes, means political risk is the most difficult risk for Chinese oil companies to handle in transnational M&A (Shapiro 1981), and it's often the fatal reason for M&A failure.

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Chapter 85
Post-Earthquake Fire Risk Decision Research Based on Bayesian Networks

Jing Liu

Abstract This paper applies the Bayesian Networks in post-earthquake fire risk decision. The model based on Bayesian Networks is proposed. Post-earthquake fire risk model is presented for analyzing risk and possible economic losses, which is used for disaster prevention and reduction decision supporting. In the end, the paper gives a particular explanation of post-earthquake fire risk model for knowledge discovery and decision-making in order to provide some references to earthquake rescue and fire forces.

Keywords Bayesian networks · Distribution of factors · Discretization · Fire risk · Post-earthquake

85.1 Introduction

Bayesian Networks acquires complicated relation between information by learning. Techniques of statistical sampling and field survey are taken on the Bayesian Networks model of post-earthquake fire risk to reflect post-earthquake fire evolutional mechanism. Post-earthquake fire risk decision is not the same as general calculation formula but the comprehensive simulation and embodiment of post-earthquake fire risk (Chen et al. 2004). In this paper, Bayesian Networks model on post-earthquake fire risk decision is established for the analysis and research on post-earthquake fire risk (Gowdy et al. 2004). By the analyzing and evaluating the post-earthquake fire hazard, post-earthquake fire disaster vulnerability and quantitative and qualitative relationship between post-earthquake fire risk and situation of disaster (Kampke and Elfes 2001), it is provided the theoretical basis for the decision disaster prevention and reduction (Tian and Lu 2004).

J. Liu (✉)
Institute of Energy and Safety, Anhui University of Science and Technology, Langfang, China
e-mail: l_j_amy@163.com

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85.2 Index System of Post-Earthquake Fire Risk Decision

Post-Earthquake fire risk refers to an aggregate of probability distribution function of fire intensity and loss after earthquake (Rahimi and Darrell2002). To see from the formation mechanism perspective, the structure of post-earthquake fire risk comprises of the probability distribution function of fire intensity (Post-Earthquake Fire Hazard) (Stephenson et al.2002), the function expression of post-earthquake fire intensity and fire losses (Post-Earthquake Fire Disaster Vulnerability) and the probability distribution function of fire losses (Fire Disaster Loose). Theses three parts constitute an entire post-earthquake fire risk structure (Tian and Lu 2004). Given the probability distributions, full information needed for risk computation exists.

85.2.1 Index System of Post-Earthquake Fire Risk Based on Bayesian Networks

It is one of important point for disaster prevention and reduction decision how to describe and evaluate systematically the post-earthquake fire risk. The analysis research must be qualitative, and quantitative for the evolution law of post-earthquake fire (Wellman 2000). A general planning scheme for disaster prevention and rescue need describe scientifically the scale, intensity, economic losses and the qualitative and quantitative in disaster forecasting. In the index system of post-earthquake fire risk, there are index of qualitative and quantitative ones, natural variations for disaster-making factors and economic losses for disaster situation, as well as time and space. A scientific index system is premise and basis for the post-earthquake fire risk.

We can describe post-earthquake fire risk by these factors:
Earthquake intensity (A);
Building density (B);
Population density (C);
Fire engine density (D);
Water supply (E);
Reaction rate (F);
Wind speed (G);
Disaster area (H);
Losses (I).

85.2.2 Discretization of Numerical Attributes

Bayesian Networks requires discrete attributes, which is same as other machine learning algorithms, classification algorithms and uncertain reasoning algorithms.

It is needed to realize discretization for continuous variables of the post-earthquake fire database. The discretization refers to subdividing domain of numerical attribute into some sub-ranges, each of which corresponds to one discrete attribute, and then the original data are replaced by discrete values. Numeric discretization requires make certain of the corresponding relation between continuous attributes and discrete attributes automatically (Wong et al. 1999). Discretization falls into unsupervised discretization algorithm, such as the equal-width method, the equal-frequency and K-means algorithm and the supervised discretization algorithm, such as decision tree discretizaiton algorithm, Chimerge algorithm. The WILD algorithm that is the simplest equal-width method is used in the discretization of continuous attributes in post-earthquake fire database. The range of numerical attribute is divided several same width intervals according to number of intervals specified by user. WILD algorithm is the supervised discretization algorithm base on information theory (WILD-Weighted Information-Loss Discretization) (Zhu 2002). Part of index of post-earthquake fire data can be divided directly according to national standard without dicretization. WILD method is described briefly here.

If there are two attributes whose range is $[X_{min}, X_{max}]$, category attribute is C whose range is discrete, denoted as $\{C_1, C_2, \ldots, C_k\}$.

Firstly, construct initial interval with all the different observed values of X in the sample set. If the observed values are $x_1, x_2, \ldots, x_n$ from larger to little, the initial intervals are $x_1, x_2, \ldots, x_n$, the construction of it is $[(x_{min}, x_1), (x_1, x_2), (x_2, x_3), \ldots, (x_{n-1}, x_{max})]$ in which there is only one observed value in each initial interval. In extreme cases, the number of initial intervals is equal to that of samples when the values of X are different in the sample set.

Then m adjacent intervals belongs to one group and choose the most suitable set from each interval $[I_1, I_2, \ldots, I_n]$, $[I_2, I_3, \ldots, I_{n+1}], \ldots, [I_{n-m+1}, I_{n-m+2}, \ldots, I_n]$ together into a large interval with WILD. Repeat the process until they meet the requirements.

It is needed to compute information losses and make a merge to the least weighted information losses, for there are always losses during the discretization with WILD.m and D-2 algorithm.

A weighted information loss is:

$$WILD = \frac{|I|}{N} Information - loss \tag{85.1}$$

$|I|$ is the number of samples of attribute X in the interval. *Inforrmation-loss* is the information losses before and after the merge of adjacent intervals.

$$Information - loss = Ent(I) - Ent(I_1, I_2, \cdots, I_m)$$

in which $Ent(I_i)$ is category entropy, defined as:

$$Ent(I_i) = -\sum_{i=1}^{k} p(C_i, I_i) \times \log p(C_i, I_i) \tag{85.2}$$

Table 85.1 Parameter attributes of post-earthquake fire risk decision

Discreted value	1	2	3	4	5	Discreted value	C: Population density
A: earthquake intensity	<3	3–5	5–7	7–9	9–12	1	<50
B: Building density	<25	25–50	50–75	75–100	>100	2	50-60
D: Fire engine density	<129	129–259	>259			3	60–70
E: Water supply	<1	1–2	2–3	3–4	>4	4	70–80
F: Reaction rate	Average	Faster	Fastest			5	80–90
G: Wind speed	<3	3–5	>5			6	90–100
H: Disaster area	<1,000	1,000–3,000	>3,000			7	100–110
I: Losses	General	Bigger	Heavy			8	110–120
						9	120–130
						10	>130

$p(C_i, I_i)$ is the probability of attribute X on the interval whose category attribute is C_i.

$Ent(I_1, I_2, \cdots, I_m)$ is category entropy before merging an adjacent interval $(I_1, I_2, \cdots, I_m)$ into one interval.

$$Ent(I_1, I_2, \cdots, I_m) = \sum_{i=1}^{m} \frac{|I_i|}{|I|} \times Ent(I_i) \tag{85.3}$$

In the analysis of post-earthquake fire risk, the attributes reaction rate and losses are suitable discretization with WILD algorithm. In order to simplify computation, only a small number of attributes around 3–5 are chosen. Improvement of forecast accuracy can be archived by increase quantity of attributes in practice. The sample attributes after discretization is listed as follows (Based on the above discretization algorithm, make a merge to part of complicate results according to expert knowledge without affection on post-earthquake fire risk Bayesian Networks study) (Table 85.1):

85.3 Post-Earthquake Fire Risk Decision Model Based on Bayesian Networks

85.3.1 Training Sample Set

50 sets of data are collected as samples for post-earthquake fire risk model from literature (Lu 1995). Training sample set containing 45 samples are generated after related continuous data are treated and discrete (Table 85.2).

Table 85.2 Samples for post-earthquake fire risk decision

Case	A	B	C	D	E	F	G	H	I
1	4	3	4	2	2	3	2	2	2
2	3	3	4	1	2	3	1	1	1
3	5	3	4	3	3	5	3	3	3
4	5	3	5	3	3	5	3	3	3
5	4	3	5	2	1	3	1	2	2
…	…	…	…	…	…	…	…	…	…
45	2	3	5	1	1	3	1	1	1

85.3.2 Topological Structure

The Bayesian Networks topological structure of post-earthquake fire risk decision can be obtained with SA-MMI-R algorithm, which described as figure (Fig. 85.1).

In which,

A is earthquake intensity;
B is building density;
C is population density;
D is fire engine density;
E is water supply;
F is reaction rate;
G is wind speed;
H is disaster area;
I is losses.

85.3.3 Distribution of Factors

Bayesian Networks factors of post-earthquake fire risk decision are conditional probability table, respectively the probability of $P(A)$, $P(B)$, $P(D)$, $p(F)$, $P(C|A,B)$,

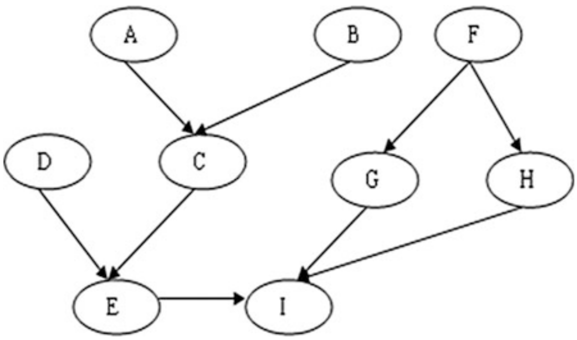

Fig. 85.1 Structure of Bayesian networks for post-earthquake fire risk decision

$P(G|F)$, $P(H|F)$, $P(E|C)$, $P(I|E,G,H)$. 45 samples are chosen as training samples and obtained Bayesian factors distribution of post-earthquake fire risk with maximum likelihood estimating. Distribution of factors is shown in Table 85.3:

85.4 The Explanation of Post-Earthquake Risk Decision Model

Bayesian Networks of post-earthquake fire risk decision can reflect dependence of large stores of data over relating domains. The explanation is for the purpose that has a better understanding to the meaning of model. This paper gives a account of dependent relationships of probability.

Quantitative Knowledge. Probability dependent relationship is described as follows:

<(G)> depends directly on <(F)>;
<(H)> depends directly on <(F)>;
<(C)> depends directly on <(A)> and <(B)>;
<(E)> depends directly on <(C)>;
<(I)> depends directly on <(E)> and <(G)> and <(H)>.

Quantitative Knowledge. Node A, B, D, F has no father in the model, which use prior probability to reflect different state of them.

<(A)> is <p (A)> to be <1, 2, 3, 4, and 5> in this domain;
<(B)> is <p (B)> to be <l, 2, 3, 4, and 5> in this domain;
<(D)> is <p (D)> to be <1, 2, and 3> in this domain;
<(F)> is <p (F)> to be <1, 2, 3, 4, and 5> in this domain;
Node C, E, G, H, I has father, which use conditional probability to describe them.
When <(A)> is <state of (A) l, 2, 3, 4, 5)>, and, <(B)> is <state of (B) 1, 2, 3,4, 5>, <(C)> is <p (C|A, B)> to be <state of (C) l, 2, …, 10>;
When <(F)> is <state of (F) l, 2, 3, 4, 5)>, <(H))> is <p (H|F)> to be <state of (H) l, 2, 3>;
When <(F)> is <state of (F) 1, 2, 3, 4, 5)>, <(G)> is <p (G|F)> to be <state of (G) l, 2, 3>;
When <(C)> is <state of (C) 1, 2, …, 10>, (E)> is <p (E|C)> to be <state of (E) l, 2, 3>;
When <(E)> is <state of (E) 1, 2, 3)>, and <(G)> is <state of (G) 1, 2, 3>, and,<(H)> is <state of (H)1, 2, 3>, <(I)> is <P (I|E, G, H)> to the state of (I) 1, 2, 3>.

Table 85.3 Samples for post-earthquake fire risk decision

P(B|A)	a_1	a_2	a_3	a_4	a_5	P(A)	G	P(C|A)	a_1	a_2	a_3	a_4	a_5
b_1	0.980	0.521	0.243	0.000	0.000	a_1	0.121	c_1	0.833	0.824	0.001	0.000	0.001
b_2	0.020	0.179	0.212	0.000	0.000	a_2	0.157	c_2	0.157	0.168	0.057	0.017	0.002
…	…	…	…	…	…	a_3	…	c_3	0.010	0.008	0.920	0.776	0.122
b_9	0.000	0.000	0.067	0.867	0.855	a_4	0.373	c_4	0.000	0.000	0.023	0.207	0.875
b_{10}	0.000	0.000	0.000	0.045	0.084	a_5	0.089	c_5	0.000	0.000	0.000	0.000	0.000

85.5 Conclusion

This paper focuses on problem of the post-earthquake fire risk using Bayesian Networks as tool, establish Bayesian Networks model of post-earthquake fire risk and make an explanation of probability dependent relationships to the model, which provide the theory basis for disaster prevention and reduction. The Bayesian Networks of post-earthquake fire decision is still on testing period. There remains a considerable gap for us to solve practical problems. One hand, it needs to solve learning problem of model to improve the accuracy and speed of model learning. Another hand, parameter variables will be made refining treatment to obtain accurate value. These matters should be completed further.

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Chapter 86
Pricing Basket Credit Default Swap Based on Mix Copula Functions

Yan-ping Liu, Jian-hua Liu and Peng Shao

Abstract This paper deals with modeling dependence structure of credit risks. The choice of tail dependency structure is important on the pricing of multi-name credit derivatives such as basket credit default swap. An alternative to the Gaussian copula is mix Copula consisting of three types of Archimedean Copulas (Gumbel Copula, Clayton Copula and Frank Copula), which capture fat tail dependence structure between the underlying variables at extreme values. By using Monte Carlo simulation, we find that the tail dependence of mix Copula functions is better than that of normal Gaussian Copula functions. Based on the characteristic of copulas, this paper builds up the pricing model of Basket Credit Default Swap, and creates the pricing framework.

Keywords Archimedean copula · Basket credit default swaps · Dependence structure · Monte Carlo simulation

86.1 Introduction

Since the 1990s, credit derivatives have become an important tool of risk management aimed to transfer and hedge credit risk. They are designed to reduce and transfer credit risk from the buyer to the seller without selling the reference entity. They allow investors and financial institutions to more effectively manage their exposures to credit risks. As the most actively-traded credit derivative, credit default swaps (CDS) has become the pricing benchmark for other credit

Y. Liu (✉) · J. Liu
Faculty of Management and Economics, Dalian University of Technology, Dalian, China
e-mail: sylyp008@dlut.edu.cn

P. Shao
School of Mathematics and Science, Dalian University of Technology, Dalian, China

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derivatives. CDS manages to strip the credit risk of the fixed-income products and transfer it between the buyer and the seller. In China, the credit risk management is still one of the most important tasks to commercial banks. The credit derivative tools yet to be developed have great practical significance for the healthy development of our banking industry, for the innovation requirements of the entire financial industry.

One of the key points in developing CDS products is the pricing issue, on which many scholars have made various deep studies. Duffie (1999) first gave a specific introduction on the basic model of CDS pricing. Then, Hull and White (2000) presented the pricing model in view of the relationship between the seller and the reference entity. Skinner and Townend (2002) proved the CDS to be a put option based on Option Pricing Theory. Longstaff et al. (2004) figured out a theoretical pricing model of the credit default swaps within the framework of random intensity in the simplified model. Yong and Jeong (2010) assumed that corporate default intensity would follow the jump diffusion process and combined "Poisson Jump" with their study, and finally built up a CDS pricing model based on the mixed process. Stephan and Rudi (2010), based on the empirical research and focused on the illustration of the default recovery process, studied the pricing of the credit derivatives from the perspective of default recovery rate. Guo Jun et al. (2003) built a CDS utility function model and made a game analysis of CDS risk trading under asymmetric information. Wang and Chen (2003) took the impact of unexpected events on the probability of default into consideration and built a CDS pricing model based on the jump-diffusion process. Wang Lele et al. (2010) studied the CDS pricing model of multiple credit levels, taking the fact into account that there generally exist many different credit-rating structures given to one bond by different rating agencies. Chen et al. (2010) constructed a pricing model of Basket Credit Default Swap based on distorted Copula function, which could perfectly solve the problem of inadequate reflection of tail dependence in the standard Gaussian Copula.

In recent years, more and more studies are devoted to structured credit derivatives instruments such as basket default swap and CDO. The most important problem in the pricing of these instruments is modeling the structure of dependency of the default times. In this paper, we analyze the impact of structure of dependency on the pricing of Basket Credit Default Swap such as Kth-to-default swap. According to the Kth-to-default swap, the protection buyer is compensated for loss amount of the kth defaulted asset but not for any subsequent defaulted assets, so its contingent claim depends on time to the kth defaulted event. Besides the default risk of each asset itself, default correlation of securities in the underlying portfolio influences the price of basket default swaps. To express dependencies between times of default, Gaussian and Archimedean copulas have been considered. To capture the richer and more realistic correlation structures in multiple default risks, we construct a mix copula which is a weighting linear combination of three kinds of Archimedean copulas (Gumbel, Clayton and Frank Copula).

86.2 Pricing Model of Basket Default Swap Based on Copula

86.2.1 Estimating the Marginal Distribution of Default Times

We consider a pricing procedure of a *k*th-to-default BDS relative to a portfolio of $n(n \geq k)$ underlying assets. Let τ_i denote the time until default, simply default time, for the underlying *i*-name asset for $1 \leq i \leq n$. The cumulative distribution of τ_i can be written as

$$F_i(t) = P(\tau_i \leq t) = 1 - \exp\left(-\int_0^t \lambda_i(u)d(u)\right) \tag{86.1}$$

where λ_i is a hazard rate, which is defined as the probability of default until time $(t + \Delta t)$, given the survival time t. λ_i can be extracted from the quoted market spreads between default-risky bonds and default-free bonds. When λ_i is in a constant level, the formula (86.1) can be written as:

$$F_i(t) = 1 - \exp(-\lambda_i t) \tag{86.2}$$

Credit Derivative Market in China is making a move in recent years. However, the data of credit default is not enough for studying the λ_i. So we applied the methods of Hu (2002) which can be written as:

$$\lambda_i = (r_i - r_f)/(1 - R_i) \tag{86.3}$$

where the r_i is the yield to maturity of default-risky bonds and r_f refer to default-free bonds. R_i denote the recovery rate for i-name security when default event happens.

86.2.2 Fair Price Estimation of kth-to-Default Basket Swap

The fair price of the *k*th-to-default basket swap is computed by equating the expected value of the discounted premium payment leg (fixed cash flow to be paid till contract expiration T or *k*th credit event occurs) with the expected value of the discounted default leg (contingent payment in case of default), under the risk-neutral measure P^*.

The premium legs are paid at regular intervals till contract expiration T or *k*th credit event occurs. The present value of the premium leg of the *k*th-to-default basket swap can be computed as follows:

$$SL = sM \sum_{j=1}^{m} \Delta(t_{j-1}, t_j) B(0, t_j) E^Q\left[1_{\{\tau^k > t_j\}}\right] \tag{86.4}$$

Here s denotes the annualized premium of a kth -to-default swap, $\Delta t_{j-1}, t_j = t_j - t_{j-1}$, where $0 = t_0 < t_1 \cdots < t_m = T$ are the m premium payment dates. τ^k denotes kth-to-default time among n reference securities, $n \geq k$. $B(0, t)$ denotes the risk free bond price with maturity date t. M_i denotes the notional amount for i-name security. Let R_i denote the recovery rate for i-name security when default event happens. And then we obtain the default leg as:

$$SC = \sum_{i=1}^{n} M_i(1 - R_i)E^Q\left[B\left(0, \tau^k\right)1_{\{\tau_i = \tau^k\}}\right] \tag{86.5}$$

Then let $SL = SC$, the fair price of the kth-to- default basket swap is computed by:

$$SC = \sum_{i=1}^{n} M_i(1 - R_i)E^Q\left[B\left(0, \tau^k\right)1_{\{\tau_i = \tau^k\}}\right] \tag{86.5}$$

$$s = \frac{\sum\limits_{i=1}^{n} M_i(1 - R_i)E^Q\left[B\left(0, \tau^k\right)1_{\{\tau_i = \tau^k\}}\right]}{M\sum\limits_{j=1}^{m} \Delta\left(t_{j-1}, t_j\right)B\left(0, t_j\right)E^Q\left[1_{\{\tau^k > t_j\}}\right]} \tag{86.6}$$

86.3 Mix Copula Function and Parametric Estimation

86.3.1 Default Correlation Measure Based on Mix Copula Function

In spite of being relatively new applied on financial analyses,copulas are already an object of frequent use by researchers. A copula is a joint distribution function of random variables, which was introduced by Sklar (1959). According to Sklar (1959), it is possible to split the joint distribution function into two basic components: the marginal variables function,following a uniform distribution in the interval [0, 1], and the function of dependence between these variables.

Li (2000) firstly applied a Gaussian copula function to build a multivariate distribution of survival times for the valuation of portfolio credit derivatives. Li's research proves that the measure methods through asset correlation derivation and connection function are essentially the same.

In order to choose an adequate copula to model the dependence structure of pairs of financial series, we need to consider two critical factors: Firstly, the characteristics of a certain Copula function meets the correlation characteristics of the distribution of target variables. Secondly, the parameter estimation of this Copula functions should be feasible.

The classical applied copula function (especially in finance modeling) is the Gaussian copula. But Gaussian copula assigns very little weight to the tails. However, tail events occur much more frequently within the financial markets. So, we prefer a joint distribution, which has fatter tails. The Archimedean copula has many families that are capable of presenting different structures of dependency, and different methods are developed to estimate the parameters. So, in order to study tail dependence of the underlying assets' default time, it is necessary to find a Copula that can best describe dependence structure. This article constructs a mix Copula function which is a weighting linear combination of three types of Copula (Gumbel, Clayton and Frank Copula). The combination of these three copulas is not only adequate in the analysis of the fat tail dependence structure in down market, but also for those situations of asymmetric shape.

86.3.2 Stylized Procedures to Estimate the Mix Copula Function

(1) *The functional form of this mix copula*

According to mix Copula theory in Hu (2006) a mix Copula is a weighting linear combination of some Copulas and can describe different dependence structures by adjusting weights. So, we consider the following mix Copula which is the weighting linear combination of Gumbel Copula, Clayton Copula and Frank Copula.

$$C_{Mix} = w_g C_g + w_c C_c + w_f C_f \tag{86.7}$$

$$C_g = C(u_1, u_2, \cdots, u_N) = \exp\{-[\sum_{i=1}^{N} (-\ln u_i)^{\theta}]^{1/\theta}\} \tag{86.8}$$

$$C_c = C(u_1, u_2, \cdots, u_N) = (\sum_{i=1}^{N} u_i^{-\alpha} - N + 1)^{-1/\alpha} \tag{86.9}$$

$$\begin{aligned} C_f &= C(u_1, u_2, \cdots, u_N) \\ &= -\frac{1}{\beta}\ln[1 + \prod_{i=1}^{N} (e^{-\beta u_N} - 1)/(e^{-\beta} - 1)^{N-1}] \end{aligned} \tag{86.10}$$

The Gumbel Copula Function captures the upper tail dependence well, and the Clayton copula captures the lower tail dependence well, and the Frank Copula is used to analyze the situations of symmetric shape. By adjusting weights, this mix Copula can describe the correlations in upper tail, in middle part and in lower tail at the same time, so it can describe dependence structure among the credit assets better than any single Copula.

(2) *Estimating the parameters of the mix Copula*

Because Copula Functions can separate joint distribution into two independent parts: marginal distribution and dependence structure, parameters of joint distribution t can be divided into two independent parts: the parameters of marginal distribution u_i, and the parameter of dependence structure (w_{g}, w_{c}, w_{f}, θ, α, β). This article uses the following three steps to estimate the parameters of the mix Copula.

Step 1: Estimating the parameters of marginal distributions

Firstly, this article uses nonparametric kernel density estimation to estimate empirical cumulative distribution function. The advantage of this procedure is the possibility of a priori testing the goodness of fit of the marginal distributions.

Step 2: Estimating the parameters of the single Copula

Secondly, the marginal distributions obtained in step 1 are used as inputs in the estimation of the three single copulas, by maximum likelihood.

Step 3: Estimating the parameters of the mix Copula

Finally, the parameters of the single Copula obtained in step 2 are used as a starting value as the θ, α, β of the mix Copula, while the starting weights are one-third and get empirical Copula(C_e) which is defined as Deheuvels (1979):

$$c_e\left(\frac{n_1}{n}, \frac{n_2}{n}, \ldots, \frac{n_d}{n}\right) = \frac{1}{n}\sum_{i=1}^{n}\prod_{j=1}^{d} 1_{\{r_j^i \le n_j\}} \tag{86.11}$$

where $0 \le n_1, \ldots, n_d \le n$, $\{x_1^{(t)}, \ldots, x_d^{(i)}\}$ is the order statistic and $\{r_1^{(t)}, \ldots, r_d^{(i)}\}$ is the rank statistic of the sample.

The best parameters are the ones which minimize the squares of deviations between the considered copula (C_t) and the empirical copula (C_e). Use the Ordinary Least Square method to calculate the best parameters of the considered copula (C_t).

86.4 Framework of the Valuation of Kth-to-Default Swaps

In this section, we give a brief framework of the valuation of kth-to-default swaps, the marginal default times of all credits in the basket must be known. And then the default times of different risky bonds are connected to each other by a mix copula which is estimated by the Sect. 86.3.

Pricing a kth-to-default basket default swap under mix copula using Monte Carlo simulations, can be presented in the following steps:

Step 1: Estimate the marginal distribution of default times τ_i, as described $F_i(t)$ in formula (86.2)

Step 2: Estimate the dependence structure model of the default times, as described C_{Mix} in formula (86.7). We use the assumption that dependence structure of the default times is equivalent to dependence structure of returns on assets.

Step 3: Determine the joint default time distribution of the baskets, as described $C(g)$ which uses the dependency parameters of Step 2 and the marginal distribution of Step 1.

Step 4: Simulate n-dimensional vector of correlated uniform random variables from the copula $C(g)$ obtained by step 3. Record it as $(u_1,u_2,\ldots,u_n)$.

Step 5: Translate the corresponding uniform variables into default time for each obligors, where $t_k = F^{-1}(u_k)$ $(k = 1,2,\ldots,n)$.

Step 6: Sort the credits with respect to their default time τ_i and then determine the kth default time τ_k.

Step 7: Based on specific realization of τ_k, determine the present value of the premium leg SL and the present value of the default leg SC.

Step 8: Repeat step 4 to step 7 until the required number of scenarios have been simulated and the sample average fair price of the kth to default basket swap, using formula (86.6).

86.5 Numerical Simulation Example

In this section, we consider 3 underlying credit bonds in china debenture market. Their Bond Code of Bond1, Bond2, Bond3 are 1122059, 112036, 112019. The maturity date $T = 5$, *a* deterministic recovery rate of 40 %, notional amount R_i for each security is 1 million yuan, $\Delta = 0.25$ for quarterly payment frequency. To determine the impact of the structure of dependency via mix copula on the kth-to-default basket swap spread, a simulation study was performed for different baskets of different a 10,000 Monte Carlo simulations. The following basket default swaps were considered, Basket Default Swap 1 (BDS 1): a baskets of Bond1 and Bond2; Basket Default Swap 2 (BDS 2): a baskets of Bond1 and Bond3; Basket Default Swap 3 (BDS 3):a baskets of Bond2 and Bond3.

We use Bond market data in 2011(the average yield of a bond to maturity) to obtain r_i, r_f. And then, constant default intensities λ_i can be calculated, which are shown in Table 86.1.

We use the method described in Sect. 86.2 to estimate the dependence structure model of the default time, and sample data include Daily stock return rate of the three Obligors from 1-04-2010 to 12-30-2011. The lengths of these samples are 449. Using the calculating formulas for estimating the parameters of the mix Copula, and let D^2 denotes the squares of deviations between C_t and C_e. The parameters of the mix Copula we estimated are shown in Table 86.2.

Table 86.1 Constant default intensities

	λ_i	$F(t)$
Bond 1	0.047884864	$F_1(t) = 1{-}exp(-0.0479t)$
Bond 2	0.069442035	$F_2(t) = 1{-}exp(-0.0694t)$
Bond 3	0.042449685	$F_3(t) = 1{-}exp(-0.0424t)$

Table 86.2 Estimation the parameters of the mix Copula

Parameters	BDS 1	BDS 2	BDS 3
θ	0.734769	0.703378	0.69035
α	0.776393	0.784932	0.804916
β	3.206533	3.467139	3.786194
w_g	0.291529	0.404349	0.410607
w_c	0.355104	0.541417	0.437875
w_f	0.353367	0.054234	0.151518
D^2-*Mix*	48.20277	51.35852	53.14395
D^2-*Gaussian*	48.54236	51.68848	53.55285
D^2-*Gumbel*	49.70596	52.95517	54.87726

From Table 86.2, we note that the value of D^2 simulated under Gaussian, *Gumbel* and mix copulas are different. We note that D^2-*Mix* copula is smaller than D^2-*graussian* copula and D^2-*Gumbel* copula. *So* the goodness of fit of the joint distributions simulated under mix copula is the best, and the Mix copula is then our optimal copula.

Use results from Tables 86.1 and 86.2. Then, we have the following results.

From Table 86.3, we notice that the fair price changes with the value of k, the fair price of the first-to-default swaps is higher than the second ones, that means the first-to-default swaps are much safer than the second ones.

We note that the fair price simulated under Mix copula, Gaussian copula and Gumbel copula are different. It means, the choice of copulas also govern the pricing of basket credit derivatives. Indeed, the lowest fair price is always under Mix Copula.

Table 86.3 Basket default swap (on basis points)

Fair price (on basis points)		Mix Copula	Gaussian Copula	Gumbel Copula
First-to-default (k = 1)	BDS-1	186.32	298.93	308.56
	BDS-2	79.89	207.69	214.16
	BDS-3	129.13	269.89	274.01
Second-to-default (k = 2)	BDS-1	27.48	61.00	55.71
	BDS-2	13.41	44.69	40.90
	BDS-3	19.86	63.53	52.78

86.6 Conclusion

In this paper, we introduce a mix Copula which is a linear combination of Gumbel Copula, Clayton Copula and Frank Copula for investigating the *k*th-to-default BDS. The simulation results show that the mix Copula can avoid the major disadvantage of the lack of tail dependence in normal Guassian Copula and present different structure of dependency. We illustrate the general framework of pricing the basket default swaps. Finally, we gave numerical simulation example of three *k*th-to-default swaps.

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Chapter 87
Influencing Factors, Countermeasures and Suggestions for Safety Assessment Quality of Dangerous Chemicals Production Enterprises

Lan Zhang, Jiang Xu and Yan-song Zhang

Abstract The compulsory implementation of safety assessment for dangerous chemicals production enterprises has been clearly stipulated in China's relevant laws and regulations due to the objective existence of the risks in these enterprises. This paper analyzed some major problems existing in these enterprises according to the working practice of safety assessment for dangerous chemicals production enterprises, and put forward some suggestions for the improvement of safety assessment quality for dangerous chemicals production projects.

Keywords Safety assessment · Quality · Quality control · Suggestion

87.1 Introduction

Safety assessment is stipulated by three provisions stated in the "Regulations on the Control over Safety of Dangerous Chemicals" (Decree No. 591 of the State Council of the Peoples' Republic of China). Article 12 stipulates that the safety assessment should be conducted for the new construction, reconstruction and extension of the dangerous chemical production facilities as well as for the new construction projects of storage of dangerous chemicals prior to the review and approval of these activities; Article 22 stipulates that the periodical safety assessment for the production of dangerous chemicals and the storage of devices being used; any enterprise that produces and stores dangerous chemicals shall

L. Zhang (✉) · J. Xu
State Key Laboratory of Coal Mine Disaster Dynamics and Control,
Chongqing University, Chongqing, China
e-mail: 51732534@qq.com

L. Zhang · Y. Zhang
Chongqing Research Institute of China Coal Technology and Engineering
Group Corporation, Chongqing, China

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entrust the qualified agencies according to the State rules to conduct a safety assessment on the production conditions of the enterprise every three years and the agency shall submit a safety assessment report Ref. Regulations on the Control over Safety of Dangerous Chemicals (2011) (Decree No. 591 of the State Council of the People's Republic of China). Article 30 stipulates that the safety assessment shall be conducted for the chemical production enterprises that apply for the license of safety use of dangerous chemicals.

With the determination of these management systems, safety assessment for dangerous chemicals was put on the agenda, and what's more, the social needs and legal driving force accelerated the development of China's safety assessment market. Due to the objective existence of the risks in the dangerous chemicals enterprises, safety assessment, as a necessary component of the safety production management, is an important means for predicting and preventing accidents. So the quality of safety assessment must be guaranteed to properly play its role in dangerous chemicals production enterprises. However, because of various differences between the safety assessment agencies, superadded some other objective reasons, the quality of safety assessment was unsatisfactory. Therefore, how to effectively ensure and improve the quality of safety assessment has important practical significance.

87.2 Objectives and Main Points of Safety Assessment for Dangerous Chemicals Production Enterprises

The materials used and the products, by-products and intermediate products manufactured by the dangerous chemicals enterprises are mostly flammable gas, flammable liquid and combustible solid, or even extremely toxic substance. Moreover, the production process of dangerous chemicals production enterprises is a dynamic process associated with various dangers, hazardous factors and risks, which are closely related to the production technology, equipments, environment, materials, operating personnel and other factors that more or less determine some certain harmful risks of fire disaster, explosion, poisoning, asphyxia, corrosion, chemical wounding, electric shock and so on (State Administration of Work Safety 2003). Therefore, the purpose of safety assessment for dangerous chemicals production enterprises is to find out the main risks and harmful factors during its production process, then qualitatively analyze and evaluate them, put forward corresponding safety countermeasures for reducing the occupational safety and health risks brought about by above dangers and harmful factors, and finally provide references for the construction units during their daily production operation and safety management and the basis for the governmental authorities during the safety supervision.

Before the safety assessment agencies undertake the safety assessment within their qualification, they should first organize an assessment team full of correlative professionals to analyze the potential risk according to the program's requirements. On the basis of current relative requirement of national laws, requirements and standards, the team shall choose an appropriate safety assessment approach to systematically carry out the qualitative and quantitative assessment with an objective and equitable attitude for the fundamental information of the evaluated units, such as the basic situation, project scale, equipment and facilities, production process, raw and auxiliary materials, products, by-products, intermediate products, geography, ambient environment, the characteristics of industrial risk and so on, and then the team shall, on the basis of the risk and the risk level, put forward some reasonable and operational safety countermeasures and suggestions, and come to a conclusion whether the enterprise or project possesses the qualification of safety production or not.

87.3 Quality Control for Dangerous Chemicals Production Enterprises

Quality is not a changeless concept, but a dynamic one which varies from time, locations and users. With the development of the society and the progress of technologies, the requirements to quality are becoming more updated and abundant. It has been gradually enriched, consummated and deepened with the development of social economy and scientific technique, and also, human beings have experienced a historic process to understand the concept of the quality. Dr. J.M Juran, a distinguished American quality control expert, pointed out from the view of customers that the quality of production is just the applicability of production, namely the degree of the product being used to meet the needs of customers. The fundamental requirement of users to the product is exactly applicability, which properly expressed the connotation of the quality (http://baike.baidu.com/view/290226.htm).

This definition has two meanings, which are use requirement and satisfaction. As a purposeful behavior, the safety assessment should reach a certain quality level. It is just like a product because people always put forward some requirements to the quality of a product. However, these requirements are often affected by the use time, location and users, the social environment and market competition. As these factors changes, people will raise different requirements to the quality of the same product. The quality of safety assessment means the virtues or defect degree, or whether the evaluation persons comply with the principle of legitimacy, science, justice and pertinence, evaluate carefully, and deeply, completely and really plays an instructive role during the subsequent safety production of the enterprises.

Prior to undertaking a safety assessment task from an enterprise producing dangerous chemicals, the safety assessment agency shall make a plan according to the client's demands and the specific project. In the mean time, the agency shall also submit a proposal on the establishment of a project-based safety assessment team and a list of members recommended. The risk analysis sheet for the safety assessment project shall be filled at large by the team leader along with the partial involvement of other team members, with information including the general information on the enterprise to be assessed, project production/design scale, the general information on the project, the qualification and aptitude, the risk of the project, feasibility and others. The safety assessment contract can be signed between the agency and the enterprise to be assessed only when both the project supervisor and the leader with the agency consider the risk level of the project to be acceptable. The team leader compiles the implementation proposal and submit it to the project supervisor and the senior leader of the agency for review and approval so that the agency can have a well-planned control over the contents of safety assessment, the progress of the project to be assessed, the assessment quality as well as the final completion after the contract has been signed and the scale of the whole project has been weighed. By following the rules and laws related to the safety assessment and in combination with the practical situation, the assessment agency where the drafter works also appoints the parson in charge of process control to organize related employees to work out the control procedures, with a purpose to develop and improve the safety assessment process control. A series of quality control manuals are submitted to the person in charge of process control and the technical supervisor for examination and approval, including the control procedures for safety assessment risk analysis, the process control procedure for safety assessment implementation, the control procedure for examining the safety assessment report, the control procedure for the safety assessment technical support, the control procedure for safety assessment operation documents, the control procedure for the internal management of safety assessment, the control procedure for the filing and management of safety assessment document and information, the control procedure for recording, management review procedure, the procedure for internal review and approval, the control procedure for correction and prevention measures and others. These manuals can be released after the final approval by the senior leader of the agency. By doing so, the safety assessment quality can be effectively controlled with the help of a well-established system. All the procedure documents mentioned above are issued in controlled and uncontrolled forms, the issuing scope of the controlled ones is subjected to the final decision of the technical supervisor.

87.4 Factors Influencing Safety Assessment for Dangerous Chemicals Production Enterprises

Since the beginning of safety assessment for dangerous chemicals production enterprises in 2002, it has played an important role in reducing and controlling the danger, harmful factors and safety risks in dangerous chemical production enterprise, and also in preventing accidents, and protecting the property of the construction units and coal mines as well as the personnel's health and life safety. Unfortunately, the safety assessment is not perfect and many problems still exist due to the lack of mature experience in safety assessment for dangerous chemicals production enterprises and some other reasons. In conclusion, the key reasons affecting the quality of safety assessment are as follows:

87.4.1 Perfectness and Effectiveness of Laws, Regulations and Technical Standards

All kinds of laws, regulations, technical standards and regulatory documents for safety assessment are the important basis for this work, so the correct quotation of them is a precondition for improving the quality of safety assessment. Whether an evaluated item is analyzed accurately and a scientific and reasonable evaluation conclusion is drawn greatly depend on whether the safety regulations and standards are accurately applied.

In the safety assessment for the dangerous chemicals production enterprise, if the laws, rules and standards quoted by the assessment persons are invalid after their specified data or has not been officially published and implemented, or the assessment persons did not pay attention to timeliness of laws, regulations and standards, they cannot make a right judgment for the safety of the materials, equipment and production process of the project to be assessed, the assessment conclusion may be unfair and not accurate.

87.4.2 Improvement of Evaluators' Quality

Actually, safety assessment is a work to find out faults, examine and solve the problems existing in enterprises and institutions, so the safety evaluators must have a certain quality. Since the safety science and technology is a strong practical science, the evaluators should often go to the actual production, learn from and consult to the productive workers and the technical personnel in charge of safety so as to enrich their practical experience and gain an overall understanding of the production process. Also, they should continuously emulate advanced assessment method and improve the accuracy of safety assessment. The poor professional quality of the evaluators, the fail to identify the potential risk factors of the project or the selection of inappropriate assessment method will result in assessment errors. At present, the many evaluators are not equipped with safety or chemical professional background, they are not familiar with the safety production target of the project, the technical measures against accidents, and the rules and regulations of safety production. All of these will directly influence the quality of safety assessment for dangerous chemical production enterprises.

87.4.3 Reasonability of Selection of Safety Assessment Methods

In general, safety assessment methods are commonly used and the safety assessment reports have a fixed writing criterion, but the targets of safety assessment are different, each project has its own specificity, even in the same industry, the same type of project is also different. Most of the safety assessment methods for dangerous chemical production enterprises were introduced from foreign countries, the personal risk and social risk assessments which were widespread adopted in industrialized countries were seldom used in China, and the acceptable qualitative risk index was not established. The failure of evaluation for key equipments and technology and the shortage of knowledge base and foundation data base for guiding safety assessment resulted in that the technical parameters of some assessment methods are not in accord with Chinese actual situation. At present, in order to establish an evaluation system suitable for Chinese actual situation as soon as possible, we must study on the foreign mature assessment systems, improve our assessment methods according to the actual situation and develop scientific and advanced assessment methods for dangerous chemical production enterprises so as to form our own assessment system. This is very necessary to improve the quality of the safety evaluation of the dangerous chemicals production enterprises.

87.4.4 Urgent Improvement of Enterprises' Recognition Degree for Safety Assessment

At present, some laymen believe that the safety assessment is a much profitable business. They believe that the money can be made by submitting assessment reports when a certificate is acquired with inviting several experts. Therefore, there is an easy start-up for such business with many people being engaged in safety assessment. Some use improper means to compete for the potential market, with others competing by directly lowering the price. All of these resulted in a consequence that many enterprises believe that the safety assessment is only a show business without any practical useful function. The enterprise under a safety assessment tends not to disclose true face of all the production stages, management stages to the safety assessment agency when it is for a field inspection. They tend not to allow the assessment executors to inspect the safety issues in much detail. Instead, they would try to avoid exposing some locations with higher level of risk. Due to the limited field inspection time and some other reasons, the assessment executors cannot have a well-round understanding of the enterprise, which subsequently leads to an incomplete assessment. Worse than that, some safety assessment agencies even make faked information and issue faked certificate and report in cooperation with the enterprise to realize their own targets. The direct consequence is lack of exact danger identification and the issue of uniform safety measures. Consequently, the assessment results tend to less specific and technically-conductive.

87.5 Countermeasures and Suggestions for Improving Safety Assessment of Dangerous Chemicals Production Enterprises

As a new work, the safety assessment for dangerous chemicals production enterprises develops rapidly. In order to provide a normative and high-quality service for the dangerous chemical production enterprises, the governments, industrial associations, safety assessment agencies, safety assessment persons and even safety assessment commission institution need to work together. Only continuously improving the quality management models and methods, basing on the real situation, it can all-round uplift the quality of safety assessment for dangerous chemicals production enterprises and promote the healthy development of safety assessment for dangerous chemicals production enterprises. In view of the problems existing in the safety assessment for dangerous chemicals production enterprises at present, from the actual situation and the angle of all-round management, this paper puts forward following suggestions on safety assessment quality:

87.5.1 Perfection of Laws, Regulations and Technical Standards

The current unsuitable regulations and technical standards for safety production must be modified so as to establish a perfect system of regulations and technical standards for safety production (Yin 2007). The regulatory system for occupational safety and health has been increasingly improved in developed countries, and it was effectively and dynamically modified, timely updated and perfected, for instance, more than 900 standards in the United States of America have been modified and consummated in recent 20 years; in Japan, the "Health and Safety Law at Work" has been modified for 15 times since it was promulgated in 1972, this means that it would be modified once for every 2 or 3 years (Hong 2007).

Although our legislative procedure is very complicated, we still suggest stipulating highly targeted and operable laws (Li 2005), regulations and technical standards for dangerous chemicals production so as to perfect our safety regulations and standards of dangerous chemical production (Wang and Shi 2005).

87.5.2 Strengthening Process Control

The reports of safety assessment for dangerous chemical production enterprises are the final product of all assessment agencies. The quality of their assessments directly reflects their technical level and inner management level, also the assessment results are the basis for the clients to make decisions and for the safety supervision department to execute the regulations (Qin 2007, Qin et al. 2009).

Therefore, it is necessary for the assessment agency to establish a sound safeguard mechanism for internal safety assessment quality (Dong 2007, Xi 2007), which includes the evidence collection from the beginning of safety assessment, the acquisition of test data, the preparation of assessment reports, the internal assessment and so on, for example, an assessment report should be checked and approved by the experts who have rich theoretical knowledge and practical experiences in this field, and the expert group should guard the last pass of the assessment reports. Evaluator should adjust and consummate the reports according to the suggestions from experts so as to insure the quality of the reports. The assessment agencies should do self-check, standardize the evaluators' behavior and control the assessment quality through audit procedure and system, the agencies should also adhere to the principle that "the evaluator who undertook the safety assessment should take the responsibility for his assessment and signature", and strictly control the quality of the safety assessment reports according to the examination procedures and system.

87.5.3 Paying Attention to Building-Up of Assessment Team

The evaluator's skill and quality will have direct influence on the assessment results of the project and the quality of the assessment report, so it is necessary to invite the authoritative experts in relevant fields to give evaluators regular or irregular training on safety knowledge and professional knowledge so as to improve their skill. The assessment agencies should actively cultivate evaluator's devotion and dedication spirit to enhance their sense of responsibility and sense of mission, to abandon negative working attitude, and to open up a new situation for the dangerous chemicals production and safety assessment with their enthusiastic, conscientious and responsible working attitude.

87.5.4 Selection of Correct Safety Assessment Method

The quality of the assessment report is good or not depends on whether it can give an objective, scientific and accurate assessment of the situation of safety production and construction project. Only using the correct safety assessment method can we achieve it (Fan 2003). At present, there are dozens of methods for safety assessment, but each has its feature and limitation, if we cannot choose a suitable method, it will lead to a wrong assessment result, and the quality of assessment report cannot be insured. So the evaluators should adopt suitable assessment method for different assessment targets according to actual safety production risks. For example, the assessment method for the hazard of the working condition can be applied for analyzing the hazard degree of potential dangerous working environment during safety assessment for the dangerous production enterprises. In addition, the safety assessment work is of the diversity and complexity, so if we use one method to evaluate different contents and different targets, we can not get an objective, scientific and accurate assessment result. Therefore, a better way is to apply different assessment methods for one target, which can consummate each other and check each other.

87.6 Summary

The safety assessment is an effective measure taken by our government in the new safety situation for seeking continuous improvement in safe production. In order to insure the safety assessment to develop smoothly, we should enhance the quality management of safety assessment. The quality assurance system for safety assessment is a systematic, scientific, open and developing system. In this paper, the authors analyzed some problems in the process of safety assessment in the light of the work practice in the safety assessment for the dangerous chemicals production enterprises, and put forward some suggestions and ideals for improving the safety assessment quality of the dangerous chemicals production projects based on the problems mentioned in order to provide some useful complements for the control of the safety assessment quality.

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Chapter 88
An Empirical Study on the Effect of Independent Directors on Firm Performance from the View of Regulation Environment

Shan-hui Wang and Qi-shen Zhou

Abstract This paper analyses the effect of legislation environment on the relation between independent director and firm performance in China, and provides the Chinese market evidence for the international company governance study. We mainly focus on the effect of The Guidance of establishing independent director system in listed company on the relation between independent director and firm performance. Using the Mixed cross-sectional data of listed companies in Shanghai and Shenzhen Stock Exchange from 1998 to 2005, we found a significant improvement of the proportion of independent director after publishing the guidance. The results conclude that the proportion of independent director is significantly negative related to the firm performance, however, the legislation did not seem to enhance or weaken the negative relationship between independent director and firm performance.

Keywords Firm performance · Independent director · Regulation environment · The guidance

88.1 Introduction

In 1990s, the importance of corporate governance has been recognized in world-wide, and a series of legislation and regulation are issued to guide firms' internal governance. O'Shea (2005) suggests that these regulations have a common requiring the specific number of independent director or specific ratio of independent director in board of directors. For example, the Cadbury reporting of England in 1992 ask for at least three independent directors in board of directors (Laing and Weir 1999);

S. Wang (✉) · Q. Zhou
School of Management, Huazhong University of Science and Technology, Wuhan, China
e-mail: shanhui323@yahoo.cn

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the VienotII Reporting of French in 1999 demand the ratio of independent director in board of directors should exceed 1/3; the Corporate governance regulation of Mexico in 1999 require at least twenty percent of independent director in board of directors, in 1999, Korea introduced the best corporate governance regulation which required companies to have no less than 25 % of the board composed of independent directors, especially financial institution and large listed companies to have at least half independent directors in board of directors or three independent directors. The independent directors' regime was introduced to china in 1997, and Chinese Securities and Exchange Commission issued The Guidance regarding to the development of independent regime in listed companies in 2001. The Guidance which is the signal of the implement of listed companies' independent directors regime require listed companies to have at least 1/3 in board composed of independent directors before 30 June 2003. Until now, The Guidance has been carried out over ten years, and researches in the effect of independent directors nerve cease in china. The independent directors regime was introduced from Anglo-Saxon countries of relative disperse shareholder, and its adaptability in china characterized as centralized shareholder was always a hot topic. However, few scholars concern about The Guidance's influence on the relation between independent and corporate performance (Petra 2005). Then, whether The Guidance has impact on the relation between independency and firm performance, and how extend? Does The Guidance improve the effect of corporate governance? We will try to answer these questions.

The remainder of the paper is organized as follows. Section 88.2 given the theory analysis and Sect. 88.3 develop our testable hypothesis. Section 88.4 describes the sample, the measures of variable and the econometric models in our empirical study. Section 88.5 presents the described statistics and the regression results. Section 88.6 concludes the paper.

88.2 Theory Analysis

88.2.1 The Role of Independent

The separate of ownership and control was appeared in the development of modern companies. Because the manager who was not the owner of the companies will scarify the interest of shareholders to pursue their own benefits and this will induce the agency problem between managers and owners. The independent director was introduced to the corporate governance structure based on two reasons. On one side, it can monitor the firm's management effectively, mitigating the conflict between firm's management and owners. On the other side, it also can prevent dominant shareholders from tunneling the benefit of the minority shareholders. Thus, the independent directors have three functions that were approved by scholars and laws. The first function is monitoring which is the original goal for establishing the independent regime, and also the basic function. Fama and Jensen (1983) argued that the establishment of an independent director's regime can prevent the internal control and make up for the lack of the absence of supervisor. Du et al. suggested that independent directors not only solve the agency problem from the conflict between managers and shareholders, but also constrain the tunnel of dominant shareholders to protect the benefit of minority shareholders. The Cardbury report of England in 1992 also approved the independent director's function including monitoring the board and management and relieve the agency problem. And The Guidance in china also has the same rules about the role of independent directors. The second function is about firms' strategy. The independent directors from listed companies usually have good education, good skill and abundant business experience background. Kong argued that independent director can bring new information, new idea and skill to companies. Yangmin Kim (2007) suggests that independent directors can provide advice and counsel for management. The OECD corporate governance code published by OECD in 1995 recognized the important contribution of independent directors in decision making. And The Guidance also pay attention to the strategy function of the independent directors, in particular, it demand the companies to have at least one accounting in independent directors, and all the independent directors should have at least 5 years job experience in law and economic filed. The third function of independent directors is function of political and communication. Aunp and Knoeber (1996) conclude that political factors also influent the independent directors. Companies tend to employ the independent directors with political background. When firm have more conflict with government about environment contaminate and monopoly question, the ratio of independent directors with law background will improve. They provide the insight advice to help firm anglicizing and forecasting the correlate behavior of government. The best practice code report of Initial in 1999 also agreed with the communication function of independent directors.

88.2.2 Independent Directors and Firm Performance

Scholars at home and abroad widely study the relation between independent directors and firm performance, but there is no consistent results achieved. Some researches show that there is a positive relation between independent directors and firm performance. Hossain et al. (2001), Dahya and McConnell (2005), Choi et al. (2007), for example, analysis the value effect of independent directors, and found that independent directors have a significant positive impact on firm performance. In china, Wu and Liu (2008), Tang et al. (2008) also have the same conclude using the listed companies of china stock market. Some found that there is a negative relation between independent directors and firm performance. Agrawal and Knoeber (1996) examine the relation between independent directors and firm performance based on the panel data of 383 American large companies, the result show there is a significantly positive relation between independent directors and firm performance. Bhagat and Black (1998) document that independent directors are ineffectiveness, moreover, they have adverse impact on the board's monitoring incentive. In china, Tan et al. (2003) find that independent directors show no positive influence on firm performance. Moreover, the existence of independent directors damage firms' value. In addition, some evidences show that there is no relation between independent directors and firm performance. Hermalin and Weisbach (1991) attempts to measure the influence of independent directors on firm performance using 134 listed companies in New York Stock Exchange from 1971 to 1983. And find that there appears to be no relation between independent directors and firm performance. Bhagat and Black survey the differences in firm performance caused by board composition and find that the firm with bad performance may appoint more independent directors, but the change in independent directors can't improve firm performance, in other words, there is no significant relation between the ration of independent directors in board and firm performance. In china, Hu et al., Gao et al. and Yu et al. also have the same conclusion based on the data of Chinese listed companies.

88.2.3 Independent Directors, Legislation Environment and Firm Performance

In 1940, Investment Companies Act was published by American required that the board of company should include independent directors. This is the first time to recognize the law position of independent directors' regime. After that, other countries in worldwide issue series of law, legislation, code and guidance to guide the board governance structure of companies one after another (Laing and Weir 1999). The independent directors regime was first introduced in china in 1997 and The Guidance of listed companies issued by Chinese Securities and Exchange Commission allow having independent directors if necessary. In 1998, H companies establish independent directors regime based on the requirement of Hong Kong Stock Exchange. In 1999, The Guidance of further improving the operation regulation of companies was issued by Chinese Economic and Trade Commission and Chinese Securities and Exchange Commission ask for increase the ratio of independent directors in external listed companies. The Guidance also demands that the ratio of independent directors should achieve more than fifty percentages in board, and at least two non-executive directors. In 2001, The Guidance of establishing independent directors' regime was published by Chinese Securities and Exchange Commission requires at least two independent directors in board of directors before 2002.6.30, and also demands that the ratio of independent directors should exceed more than 1/3. Thus far, the independent directors' regime in china has carried out officially.

At the same time, some researches survey the influence of legislation environment on the relation between independent directors and firm performance in the international market. Laing (1997) measures the different governance structure before and after adopting the Cadbury Committee's Code of Best Practice found that all the companies have adopted the recommended governance structure. However, there is no evidence show that independent directors recommended by Cadbury lead to improved performance or that moving towards them improves performance. Using the data of 633 listed companies in New Zealand stock exchange, Hossain et al. examines the impact of the Companies and Financial Reporting Acts in New Zealand on the relation between independent outside directors and firm performance, and the results show that the legislation doesn't seem to enhance or weaken the positive relationship between independent outside directors and firm performance after a series of regressions. Linck et al. (2009) survey the influence of the Sarbanes–Oxley Act (SOX) of 2002 and other contemporary reforms on directors and boards, guided by their impact on the supply and demand for directors using the data of 8,327 public companies in American. The directors' workload and risk and the demand by mandating that firms have more outside directors was increased because of SOX. Post-SOX boards are larger and more independent. Kim et al. (2010) examines the diversity of independent directors and the relation between independent directors and firm performance after the reform of corporate governance, and the results show that not only the quantity but also the quality of independent outside directors affects the valuation of Korean companies.

88.3 Research Hypothesis

88.3.1 Independent Directors and Firm Performance

Independent directors can monitor the internal managers effectively, hander value destroy action made by management, can stop dominant shareholders' abuse of right and monitor the decision made by management whether or not harm for the minority of shareholders' interest. Some independent directors usually are expertise in some special aspects, have abound business experience, can bring new information, idea and skill for firm, so they can help managers to capture the opportunities and forecast the underlying problems, they also can help to construe essential business strategies for firm. In addition, Independent directors open up the companies' access to communicate with the public, enhance the communication with external, and help to build well-deserved reputation of firm. Although independent directors regime was introduced in china are very late and the regulation environment was not mature, the independent directors have positive impact on firm performance due to these functions of monitoring, strategy, politician and communication effectively. Based on this theoretical framework, it is hypothesized that:

H1: the proportion of independent directors is positively associated with firm performance.

88.3.2 Legislation, Independent Directors and Firm Performance

In order to further complete the corporate governance structure in china, The Guidance of establishing independent director system in listed company was issued by Chinese Securities and Exchange Commission in 2001.8.16. The Guidance required that the board of company should contain at least 2 independent directors before 2002.6.30, and the proportion of independent directors should achieve more than 1/3 before 2003.6.30. The Guidance explicitly states the directors' duties: Independent directors should carry out their obligation sincerely; maintain the whole interest of the company especially the interest of the minority shareholders. Independent directors should implement their duties independently, and can not be influenced by the dominant shareholders and others.

The object of publishing The Guidance is to enhance the corporate governance in china and to improve the firm performance by the effect of independent directors. Therefore, the listed companies change their governance structure after the issue of The Guidance. The proportion of independent directors in healthy companies is larger than special treat companies. Based on the above analysis, it is hypothesized that:

The Guidance can enhance the positive relation between independent directors and firm performance.

88.4 Data, Variables and Methodology

88.4.1 Data

Data for this study is obtained for a sample of companies listed in Shanghai and Shenzhen Stock Exchange from 1998 to 2005. It doesn't contain financial companies because the difference of financial companies' debt. Some companies are excluded if the data was missing or incomplete. In total, 8,924 samples were obtained from 8 years of 1,527 companies. All the board and financial data was derived from CCER data base.

88.4.2 Variables

To evaluate the impact of independent directors on the firm performance, we use the ROA as dependent variable to measure the firm performance, and use the proportion of independent directors (OUTSIDE) as the independent variables. In order to survey the influence of The Guidance on the relation between independent directors and firm performance, we adopted the interaction terms between a dummy variable for the period following the passage of The Guidance and the proportion of independent directors (GUIANCE*OUTSIDE). To control for firm performance, we include the firm size (SIZE), leverage (LEVERAGE), liquidity (LIQUIDITY), and growth (GROWTH).

88.4.3 Research Methodology

We measure the effectiveness of independent directors by estimating the responsiveness of ROA to a change in independent directors. We estimate the coefficients of the following model to obtain such information:

$$\begin{aligned} ROA = {} & \alpha_0 + \alpha_1 OUTSIDE + \alpha_2 SIZE + \alpha_3 GROWTH \\ & + \alpha_4 LIQUIDITY + \alpha_5 LEVERAGE + \varepsilon \end{aligned} \tag{88.1}$$

To examine the impact of The Guidance on the relation between independent directors and firm performance, we extend Model (88.1) by including the interaction terms between a dummy variable for the period following the passage of The Guidance and the proportion of independent directors (GUIANCE*OUTSIDE). The revised model is therefore as follows:

$$\begin{aligned} ROA = {} & \alpha_0 + \alpha_1 OUTSIDE + \alpha_2 GUIDANCE * OUTSIDE \\ & + \alpha_3 SIZE + \alpha_4 GROWTH + \alpha_5 LIQUIDITY \\ & + \alpha_6 LEVERAGE + \varepsilon \end{aligned} \tag{88.2}$$

The coefficients of the above models are estimated by using the ordinary least square (OLS) method with standard errors adjusted for heteroscedasticity.

88.5 Results

88.5.1 Descriptive Statistics

Table 88.1 presents the descriptive statistics of the proportion of independent directors per year. From the Table 88.1, we can see that the maximum is go up from 0.6 in 1998 to 1. It means that the independent directors are concerned by some companies, and they choose independent directors to strength the independent of the board. However, the minimum of the proportion is 0, that's to say, some companies don't employ independent directors in accordance with The Guidance. Further, the average proportion of independent directors increased every year, and the range is from 0.004 in 1998 to 0.536 in 2005. Especially, the proportion obviously increased the after the announcement of The Guidance, the mean proportion is less than 0.1, but increased to 0.326 in 2002, and the standard

Table 88.1 Descriptive statistic of all variables

	Max	Min	Mean	Mode	Median	S.D
1998	0.6	0	0.004	0	0	0.001
1999	0.5	0	0.006	0	0	0.002
2000	0.571	0	0.013	0	0	0.002
2001	1	0	0.081	0	0	0.005
2002	1	0	0.326	0.286	0.286	0.004
2003	1	0	0.491	0.5	0.5	0.004
2004	1	0	0.522	0.5	0.5	0.003
2005	1	0	0.536	0.5	0.5	0.003

variance is lessened. The mode and median proportion improved obviously, which means the independent directors wasn't employed before the announcement of Guidance, but the case changed after issuing The Guidance. In particular, most board chooses to have half of independent directors after The Guidance requiring the ratio should achieve more than 1/3.

88.5.2 Correlation

Table 88.2 provides the pair wise correlation matrix of the independent variables and control variables. The ordinary least square regression demands that all the independent and control variables are not strongly correlated with each other. In Table 88.2, we can see that the absolute value of all the correlation all generally <0.2, therefore, there is no highly correlated variable in the same regression.

88.5.3 Regression Results

Notes: For each model, coefficients and the associated *t*-statistic (in parenthesis) for the significance of the coefficient are shown. The asterisks next to the *t*-statistic denote the significance level for a two-tailed test that the coefficient is different from zero: * denotes significance at the 10 % level, ** denotes significance at the

Table 88.2 Corrltation matrix

	OUT	SIZE	GRO	LIQ	LEV
OUT	1	0.186	−0.057	−0.092	0.07
SIZE	0.186	1	0.176	−0.102	−0.139
GRO	−0.057	0.176	1	−0.019	−0.122
LIQ	−0.092	−0.102	−0.019	1	−0.178
LEV	0.07	−0.139	−0.122	−0.178	1

Table 88.3 Regression results

	Model 1	Model 2
Intercept	0.334 (0.025)***	−0.336 (0.025)***
OUTSIDE	0.027 (0.004)***	−0.062 (0.016)***
OUTSIDE*GUIDANCE		0.035 (0.016)
SIZE	0.018 (0.001)***	0.018 (0.001)***
GROWTH	0.097 (0.003)***	0.097 (0.0030)***
LIQUIDITY	0.004 (0.001)***	0.004 (0.001)***
LEVERAGE	0.067 (0.001)***	−0.067 (0.001)***
Adjust R2	0.336	0.337
F-VALUE	905.853 (0.000)	756.054 (0.000)

5 % level, and *** denotes significance at the 1 % level. The F-value is the model F-value with the associated p value shown in parenthesis. Adj. R-square is the adjusted R-square of the model. N is the sample size used in the regression.

The data was handled by SPSS 13.0, and Table 88.3 provides the regression result. Model 1 presents the regression results of Eq. 88.1. It did not consider the impact of guidance on the relation between independent directors and firm performance. Model 2 provides the regression results of Eq. 88.2 with considering the influence of The Guidance. In these two models, OUTSIDE is negative and statistically significant at the 1 % level. It suggests that firms with more independent directors are more likely to have bad performance. Therefore, H1 was not supported by the regression results, and it can be explained by some reasons. Firstly, because the independent directors almost are recommend by large shareholders, and the phenomena of dominance shareholders in china was very popular, so, the independent of the independent directors was hard to sustain. While the independent directors play a role in business activities, they are likely to be restricted by large shareholders. Moreover, the effect of the convergence between independent directors and the shareholders was happened sometimes. Secondly, the independent directors in Chinese companies generally have more part time jobs, and have adequate time and energy to focus on the business. In addition, they have on profound understand on the companies issues, moreover, due to the complex of the complete environment, the independent directors judge only rely on the common experience. Therefore, the independent directors can not play a role in strategy and communication effectively. Thirdly, the independence do not have incentive to take their obligations due to the adequate of effective independent directors market in china, and employing the independent directors increases the firm's burden (Bhagat and Black 2002). So, that's why there is a negative relation between the proportion of independent directors and firm performance.

Model 2 reveals that the interaction of OUTSIDE with The Guidance dummy variables is positive but not significant. This implies that the enforcement of The Guidance neither enhanced nor weakened the relationship between the independent director's representation and firm performance. Therefore, we conclude that the issuing of The Guidance can not change the negative impact of independent director on the firm performance, and H2 was rejected. There also have three reasons to explain this conclusion. First, The Guidance was published very late, and just simulates the model of the external. The roles of the independent directors are not understood deeply. For example, the requirement of the education context of independent directors in The Guidance only is attending the training supplied by Chinese Securities and Exchange Commission, however, American regime emphasis on the context of management education. Therefore, The Guidance only make rules in model and it have no real function. Second, The Guidance only focuses on the number of the independent directors, and does not care about the quality of the independent directors. It may be result in the function was concealed by the burden. Third, because of the shortage of the sample, we only contain 4 years data after issuing The Guidance, so the impact of independent directors on the firm performance has not yet appeared completely.

88.6 Conclusion

The Guidance of establishing independent directors' regime was published by Chinese Securities and Exchange Commission in 2001, which was the signal of the official implement of independent directors in china. This paper surveys the impact of the policy regulation on Chinese firms, provide evidence for internal corporate governance study regarding to the influence of Chinese regulation environment. Using the Mixed cross-sectional data of listed companies in Shanghai and Shenzhen stock exchange from 1998 to 2005,we found a significant improvement of the ratio of independent director after publishing The Guidance, A Series of regression results that the ratio of independent director is significantly negatively related to the firm performance, however, The legislation did not seem to enhance or weaken the negative relationship between independent director and firm performance.

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Chapter 89
Research and Application of the Dangerous Point and Risk Management System for Earthquake

Qian-ru Wang and Qing-hui Dai

Abstract The earthquakes happen frequently that people pay more and more attention to earthquake warning work. In order to maximize reduce the damage from the earthquake, before the quake, need to consolidate defence,Therefore, in accordance with the seismic risk level of medium-sized cities, establishing the dangerous point and risk assessment system and emergency management system,as a matter of convenience, people can searching for their own region dangerous point online, to prepare for earthquake comes, we can choose the correct way of escape routes. It has great significance for reducing casualties and economic loss; Provide a reliable guarantee for doing the preparatory work and to ensure the earthquake emergency effective.

Keywords Earthquake dangerous point · MIS · Earthquake prevention and disaster mitigation introduction

89.1 Introduction

The human society is still in a disaster -prone era, which earthquake brought great losses to people's lives and property safety, so the efforts to reduce the losses caused by earthquake to people are very necessary. Emergency management capability is an important indicator of the level of urban disaster reduction; a higher emergency management capability can effectively reduce the loss of urban earthquake disaster (National disaster reduction committee office 2010). When earthquake happens, people rattled escape for lack of correct knowledge,

Q. Wang · Q. Dai (✉)
School of Energy Power and Mechanical Engineering, North China Electric Power University, Baoding, China
e-mail: dqh6789@126.com

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and causing casualties, so it is significant to make the correct hedge knowledge Popularization to people. Therefore, the establishment of the dangerous point pre-control system now becomes an urgent task (Li 2010; Zhang and Shuzhi 2011).

In the studies of dangerous point pre-control, the research is basically concentrated in the power plant. Scholars have elaborated concepts about the definition of dangerous point, features and how the dangerous point to be formed in power enterprises, and put forward precautions and general procedures in dangerous point pre-control (Sang 2009; Jin 2005). Some scholars have described the methods of dangerous point pre-control in detail with their own work experience (Du 2004). For the deficiencies of our management information system, Qin Jian has designed a devastating earthquake emergency management information system with effectiveness (Qin 2009). Lixin Jiang has provided a model for future technology system on the earthquake emergency (Jiang et al. 2003).

According to the phenomenon that earthquake-prone in recent years, with the basis of dangerous point pre-control theory, this article focus on the research of emergency management in medium-sized cities when earthquake happens. First, build an early warning mechanism, must have emergency measures to avoid the crisis which could be avoided. Second, study the characteristics when earthquake happens; provide countermeasures to the people who are in different locations when the crisis comes, thus, can effectively reduce the damage and casualties caused by the earthquake.

89.2 Dangerous Point Pre-Control

Dangerous point refer to the place, equipment or behavior which liable to have accidents in the job (Liu 2002). The dangerous point is a kind of induced accident risk, and it is likely to evolve into an accident under certain conditions without control and prevention, however, prior research and analysis to it will head off the danger.

The method of dangerous point analysis and pre-control is through certain channels, make a judgment, forecasting, and take the control measures to the various insecure factors in the job before operation, which is a way can effectively prevent the equipment accidents and personal injuries caused by human error. In general, it is an effective method to prevent accidents.

Dangerous point pre-control management information system is used to propose a viable means of escape,through collect, transmit, store, process and utilize the information about dangerous point and corresponding safety point in dangerous area.

89.3 Dangerous Point Management Information System

89.3.1 Dangerous Point Management Information System

(1) *The framework of Website information*

The establishment of the management information system can be very good to help us manage the dangerous points, and can make the five studied city regions defined their own advantages and disadvantages in dealing with earthquake disasters, make it realized the crisis and the challenges in the development and make it laid the foundation of people's self-rescue and mutual-aid-rescue in earthquakes.

The dangerous point management information system mainly includes dangerous point inquiry, administrator login, dangerous point knowledge test, etc. The website information form structure shown in Fig. 89.1.

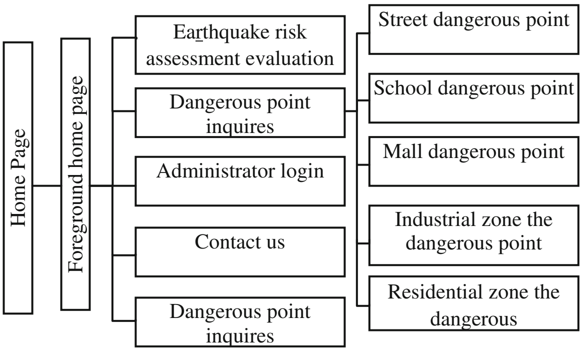
(2) *Flow of work of the dangerous point management information system*

We could realize the definition of the dangerous point after click into the homepage of earthquake dangerous point; it also could be realized by clicking into the each dangerous point homepage through the homepage. The general citizen need not to login for browsing the web, they could directly into the testing knowledge page test themselves. The administrator would make a series of management to the web site after login and judgments. The working progress of dangerous point pre-control information system was shown in Fig. 89.2.

(3) *Query dangerous point module*

The dangerous point inquiry module includes dangerous point classification inquiry, the list view of the dangerous point and the security point of each specific region, and measures inquiry what deal with earthquakes exactly. Figure 89.3 is the detailed information. People can find the relevant dangerous point when entering the page, and when we click the detailed information, the page turn to the detailed dangerous point page. Figure 89.4 is a dangerous point interface of schools.

Fig. 89.1 The website information form structure



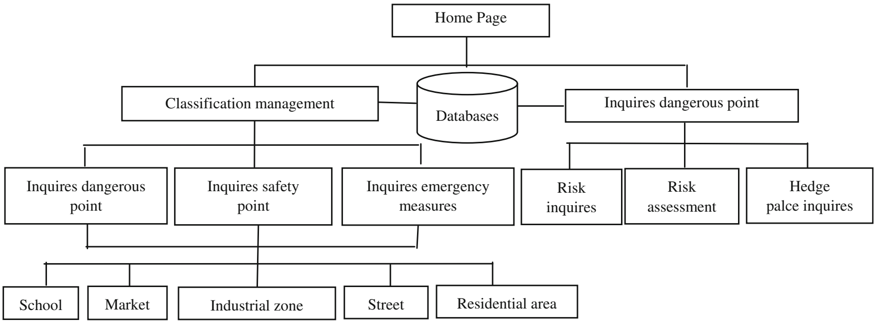


Fig. 89.2 Flow of work of the dangerous point management information system

Fig. 89.3 The dangerous point classification inquires

(4) *Dangerous point knowledge test*

The dangerous point knowledge test is aimed to the other people who browse the internet pages. Though testing the dangerous point knowledge, people can understand and master earthquake dangerous point knowledge. The administrator will regularly update the test content.

The dangerous point test system includes two aspects. One is the self-test article for adults, the other one is education article for children. Self-test article for adults has some questions to help them consolidate dangerous point knowledge. Education article for children has some vivid pictures to teach children dodge and escape exactly.

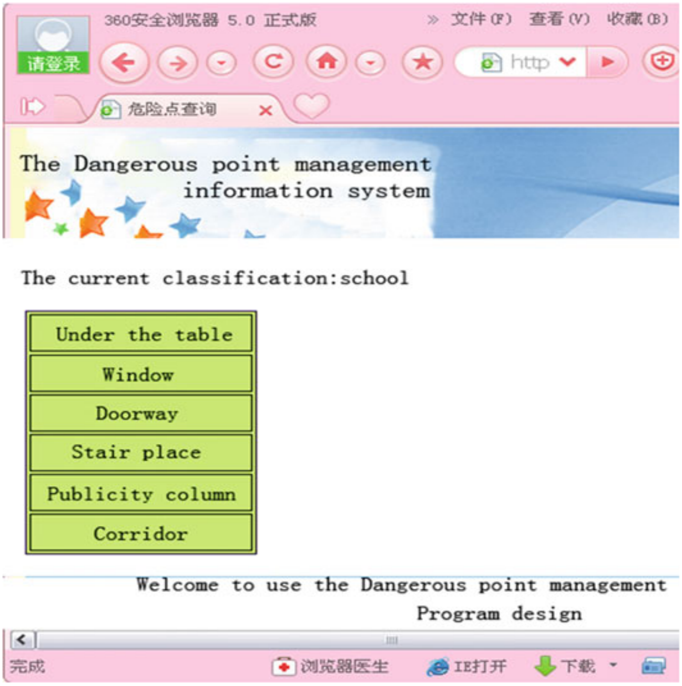


Fig. 89.4 School dangerous point interface

(5) *Administrator login module*

The administrator login module is an entrance which into the running in the background, administrator enter the background, he could modify, add and edit the information of foreground, could also to modify the login information.

(6) *Database design*

Database of this system is relatively simple, it include the dangerous point data tables, administrator login data table, Test database etc. (Tables 89.1, 89.2).

The data table above is just the two of them in the data table in the system, other data table here; I do not list one by one.

Table 89.1 The dangerous point data tables

Field description	Field types	Field name	Length	Explain
ID	Char	id	8	Don't allow for empty
Type	nvarchar	Point	500	Allow empty

Table 89.2 Test database

Field description	Field types	Field name	Length	Explain
ID	Char	id	8	Don't allow for empty
Test questions 1	nvarchar	Test1	200	Allow empty
Answer1	nvarchar	As-Test	200	Allow empty
……	……	……	……	……
Test questions n	nvarchar	Test1	200	Allow empty
Answer n	nvarchar	Test1	200	Allow empty

89.3.2 Urban Regional Earthquake Risk Assessment System

The interface of Urban regional earthquake risk assessment system has three links, the first one is the earthquake risk inquires, it links to the interface of earthquake risk inquires (Deng and Jiahan 2008); the second is the earthquake risk assessment (Cheng 1988; Zhong 2011), connected to the earthquake risk assessment interface, when people can not query the area which are we needed, they can click the link and do regional seismic risk assessment; The third is the emergency evacuation query (Xiugeng 2007; Dong 2011), link to the interface of emergency evacuation inquires (Jing 2011).

The interface of urban earthquake risk inquires, we use north district, Baoding, Hebei as an example, we enter the urban regional seismic risk assessment system, enter the north district, Baoding, Hebei, after submit, we can get earthquake risk of the main streets of north District.

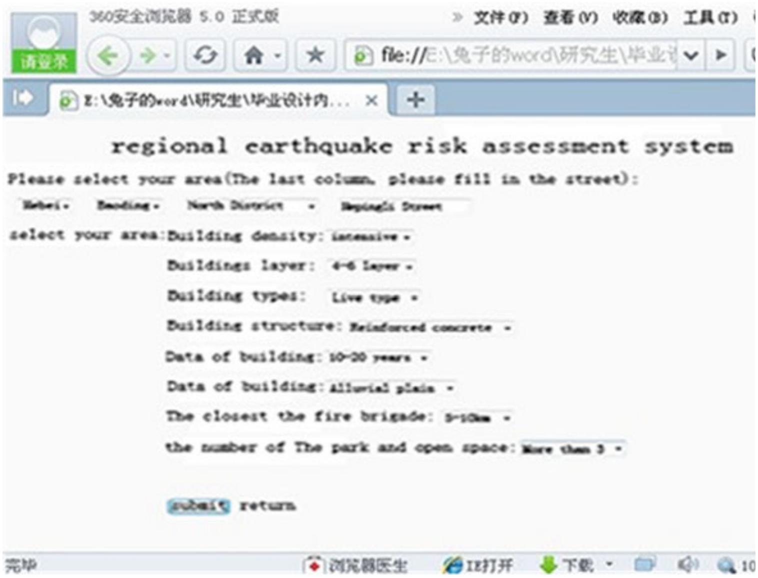


Fig. 89.5 The interface of urban regional earthquake risk assessment system

Enter the interface of the region earthquake risk assessment system; select the region which wants to be inquired. For example, select Hepingli street, north district, Baoding city, Hebei province, and then choose a evaluation index, click submit button (shown in Fig. 89.5), the system will jump to the interface of results inquire. Choose the inquire region again, the results will be acquired.

In addition, the system also provides a function of regional emergency escape query, inquirers select the emergency escape query in the main interface, then enter into the interface of emergency escape query, input the region need to be queried, will get the emergency escape sites in the queried region.

89.4 Conclusions

When earthquake happened, the characteristics and the way of refuge in different areas are different, so should be researched according to different regions. Thus, we divide the city into five main regions, with their characteristic, search the dangerous point separately. This paper lists the dangerous point and the way of refuge of all five regions, and builds an information system. So, people can inquire the dangerous information and how to refuge with the system.

The dangerous degree assessment system is to allow people to query the streets building density, construction type in their region; to understand the dangerous degree of their region and the locations of available refuge places nearby. This system helps people to choose a correct escape route after earthquake. However, the system has some shortages such as the data structure is single and data processing is complicated. In addition, the data need to be collected and entered into the database after assess by experts who organized by the national disaster emergency management agencies. To maintain the authenticity and reliability of the data, this database needs to be updated 3–5 times annually. In this way, the dangerous degree assessment system can be used efficiently in the most degree.

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Chapter 90
Research and Implementation of Tourism Satellite Account in China

Ming-xiu Chen and Qi Wang

Abstract Tourism satellite accounts (TSA) is a worldly adopted framework for integrating all the statistical data used to quantify the economic impacts of tourism. In reference of the TSA: Recommended Methodological Framework, the set-up of TSA is undertaken in China. Based on the reaches related, the authors analyze TSA development in China and point out the vital issues in the establishment of TSA in China.

Keywords China · Framework · Tourism satellite account · Vital issues

90.1 Introduction

Tourism Satellite Account (TSA) is a theoretical account within the system of national accounts. The account records the output of the industries related to tourism consumption within the national accounts so as to measure the contribution of tourism industry to Gross Domestic Product (GDP). It has become an international mainstream instrument of evaluating the tourism's economic effects on national economy (Jia et al. 2009).

TSA was initially put forward in the late of 1970s in France (Liu 2000). In 1982, the World Tourism Organization (UNWTO) firstly started the research on TSA. Successively, Commission of the European Communities Eurostat (EUROSTAT), Organization for Economic Co-operation and Development

M. Chen (✉)
International Business College, College of Humanities and Sciences of Northeast Normal University, Changchun, China
e-mail: 67625611@qq.com

Q. Wang
School of Management, Changchun University, Changchun, China

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(OECD) and United Nations Statistics Division (UNSD) have also developed the research, practice, and popularization of TSA. Special mention should be made of the approval of the Tourism Satellite Account: Recommended Methodological Framework 2000 (TSA: RMF 2000). TSA: RMF 2000 was finished based on the revised System of National Accounts, 1993 (SNA 93 rev.1). SNA 93 rev.1 is a conceptual framework that sets the international statistical standard for the measurement of the market economy. TSA: RMF 2000 provides a bridge to link tourism statistics and the standard tables of the SNA 1993 rev.1.

As an advanced measurement of tourism economic impacts, TSA has become a standard method in the world. There has been globally a big trend of development of TSAs after approved as an international standard by United Nations Statistical Commission (UNSC) in March of 2000 (Zhao and Wei 2001). Up to now, TSA has been set up in more than 30 countries and regions including Canada, Dominica, Norway, and many European countries (Liu 2006).

Specifically, the purpose of a tourism satellite account is to analyze in detail all the aspects of demand for goods and services associated with the activity of visitors; to observe the operational interface with the supply of such goods and services within the economy; and to describe how this supply interacts with other economic activities. The present International Recommendations provides an updated framework for constructing a Tourism Satellite Account. It should permit greater internal consistency of tourism statistics with the rest of the statistical system of a country as well as increased international comparability of these data (Commission of the European Communities Eurostat, Organization for Economic Cooperation211 and Development, World Tourism Organization, United Nations Statistics Division 2001).

In China TSA is also highly valued. Regional establishment of TSA has been undertaken in the economically advanced provinces and cities such as Jiangsu province, Zhejiang province, Shandong province, Xiamen city, Beijing city, etc. An accurate understanding of the meaning and characteristics of TSA is the foundation and antecedent of starting up TSA project in China (Chang et al. 2005).

90.2 Innovation of TSA: RMF 2000 and Its Location in China

In 2002, the Tourism Satellite Account: Recommended Methodological Framework (2000) was approved by the Statistical Commission at its thirty-first session and jointly presented by UNSD, EUROSTAT, OECD, and UNWTO. And in 2008, TSA: RMF 2000 was updated to TSA: RMF 2008.

Main differences between TSA: RMF 2000 and TSA: RMF 2008 include the incorporation of changes to reflect updated and new recommendations contained in IRTS 2008, the revised version of the 1993 system of national accounts and the sixth edition of the Balance of Payment Manual, as well as editorial amendments to the original text (Commission of the European Communities Eurostat, Organization for Economic Cooperation 211 and Development, World Tourism Organization, United Nations Statistics Division 2001).

In TSA: RMF 2008, the tourism products are classified in detail, according to characteristics of trips and visitors. Two concepts: tourism expenditure and tourism consumption are stressed. Tourism expenditure refers to the amount paid for the acquisition of consumption goods and services as well as valuables for own use or to give away, for and during tourism trips. It includes expenditures by visitors themselves as well as expenses that are paid for or reimbursed by others. The concept of tourism consumption used in the TSA goes beyond that of tourism expenditure. Besides tourism expenditure, it also includes services associated with vacation accommodation on own account, tourism social transfers in kind and other imputed consumption (Commission of the European Communities Eurostat, Organization for Economic Cooperation 211 and Development, World Tourism Organization, United Nations Statistics Division 2001).

Country-specific characteristic products and characteristic activities are added in the new framework. And time sharing arrangements and other innovative types of vacation home ownership and the meetings industry are recognized. The new framework also stresses the impact analysis of TSA to economy of reference.

In TSA: RMF 2008, country-specific characteristic products and characteristic activities are complemented, but country-specific connected industries are excluded conceptually.

The meetings industry is mentioned in TSA: RMF 2008, but as marginal. While in China, attending meetings and other business is an important component of Chinese inbound tourism, because in China's inbound tourism statistics, the foreign visitor arrivals are divided into five types by the government. There are as follows.

- Meetings/business
- Sightseeing/leisure
- Visiting relatives and friends
- Working and crew
- Others

Obviously, we can see the important linkage of inbound tourism and meetings industry.

The definition of outbound tourism is clearer. Outbound tourism comprises the activities of a resident visitor outside the country of reference, either as part of an outbound trip or as part of a domestic trip (Commission of the European Communities Eurostat, Organization for Economic Cooperation 211 and Development, World Tourism Organization, United Nations Statistics Division 2001).

90.3 TSA Development in China

Since the 1990s, tourism activities have been spreading rapidly and widely in China. As a new economic and social phenomenon, the tourism's impact on the economy has been drawn more attention from business and the central of local government. There is an urgent need for a new method to measure the importance of tourism economy. It is only TSA that could bare the task with a much better credibility and a systematical perspective (Zhao 2001).

90.3.1 TSA General Development in China

Since 2001, Jiangsu Province has begun to develop the establishment of Jiangsu Tourism Satellite Account (JSTSA) in China. Based on the relevant data regarding tourism of 2002, JSTSA was completed and approved by the government finally in 2004. Later in 2006, Manual on Regional Tourism Satellite Accounts was published by the research group, which definitely has become the fundamental instruction of TSA establishment in China (Li et al 2004). TSA of Xiamen (1998), Beijing (2002), Zhejiang (2004), Shandong, Guilin etc. are in succession.

Further more, useful theoretical researches have been undertaken by some scholars in China. These include the study on fundamental theories of TSA, tourism value added, tourism capital formation, and the usefulness of the TSA for the measurement of tourism economic impacts on employment.

Based on above works, the National Bureau of Statistics and National Tourism Administration of China have jointly started the set-up of national TSA. Up to now, the establishment has gotten breakthrough progress.

Table 90.1 Recommended framework and its types

Types	Tables
Internal tourism consumption	Inbound tourism expenditure by products and classes of visitors
	Domestic tourism expenditure by products, classes of visitors and types of trips
	Outbound tourism expenditure by products and classes of visitors
	Internal tourism consumption by products
Domestic supply	Production accounts of tourism industries and other industries
Contribution to economy	Total domestic supply and internal tourism consumption
	Employment in the tourism industries
	Tourism gross fixed capital formation of tourism industries and other industries
Government expenditure	Tourism collective consumption by products and levels of government
Other indicators	Non monetary indicators

Resource based on TSA: RMF 2008

Table 90.2 Recommended framework and its types

Types	Tables
Inbound and domestic tourism consumption	International tourism consumption by products
	Domestic tourism consumption by products
	Internal tourism consumption by products and types of tourism
Domestic supply	Comprehensive production accounts in terms of related (or not) to tourism industry
Contribution to economy	Output ratio of tourism industries: productive activities
	Production accounts of tourism industries

Resource As in Zhao (2001)

90.3.2 Tables in TSA

The result of TSA is mainly composed of series tables, which are derived from the tables or related in relation with the supply and usage of goods or services in SNA93.

The tables recommended and its types are shown in Table 90.1.

The tables adopted by China can be seen in Table 90.2, taking Xiamen-TSA as an example.

Compare the two tables above; we can see that the employment in tourism industry, the gross fixed capital formation of tourism industry, and tourism collective consumption are not listed in the frameworks of Xiamen-TSA. Most because of the data related are hard to obtain. But the employment has been studied in theory by a few scholars in their research.

90.3.3 Scope of Tourism Product

One of the aims of TSA is to separate the parts in associated with tourism consumption among each industry from input–output table theoretically and relatively and then put them into a new section, namely tourism industry (Stephen and Zhao 2004).

The classification of products has been developed in IRTS 2008. Besides consumption products, it includes all other products that circulate in the economy of reference and have some relationship with tourism. Of these products, two main subgroups are defined (Consumption products/Non consumption products). Consumption products include tourism characteristic products and other consumption products. Non consumption products include valuables and Other non consumption products (Commission of the European Communities Eurostat, Organization for Economic Cooperation 211 and Development, World Tourism Organization, United Nations Statistics Division 2001).

Table 90.3 Recommended framework and its types

Products	Tourism industries
Tourism characteristic products	Accommodation industry
	Food and beverage serving industry
	Transportation industries
	Travel agencies and other reservation services industry
	Cultural industry
	Sports and recreational industry
Tourism connected products	Retail trade of country-specific tourism characteristic goods

In reference of the studies of TSA in China and based on the System of National Accounts of China (2002), the authors establish the following scope of tourism industries in China (Table 90.3).

90.3.4 Data Resource

Reliable and sufficient data are needed to fill out the tables listed in the account. In China, most of the data used in the account are come from administrative departments, including statistics bureau and tourism bureau and statistic yearbook. However, in most of the national, regional, or local statistics, due to the lack of statistic method and standard, there are differences between the data gotten and the real quantities. Therefore, the regulations on statistic method and standard should be put out in the future so as to reinforce the establishment the TSA in China.

The tourism statistic system also needs perfection and completion.

90.4 Vital Issues on TSA Set-Up in China

90.4.1 Necessity of Feasibility Study

The national government urges the provinces, municipalities, cites, etc. to set up TSA. If they do not pay attention to the tourism development, data, and the economical status in quo, time and money will be wasted eventually. Therefore, a feasibility study is needed to establish the foundation of TSA.

In international practice, feasibility study is the first step in TSA set-up from the aspects of economy, technology, data, etc. Feasibility study includes the studies on tourism activities, national accounts system, tourism statistics, input–output table, etc.

Upon the feasibility study, government should lay heavy stress on regions with sound tourism statistic system and economically developed regions, where the motivation is strong, since most of the TSA set-up is funded by government.

90.4.2 Data Collection and Analysis

As mentioned above, the tourism statistic practice in China is not sound with irregular data resource and without regulations on data collection and processing methods, which make it difficult to compare between different regions. Therefore, the regional tourism statistic system should be reinforced so as to provide reliable and sufficient data, which is of vital foundation for TSA set-up.

Moreover, for tourism development initially regions, it is more important to complete and perfect the local tourism statistic system for future convenience.

90.4.3 Reinforcement of International Cooperation

TSA set-up in China needs to develop in reference of research and practices of TSA at home and abroad.

We could use other countries experience such as Canada, USA, Dominica, Norway, etc. for reference and cooperate with international organizations such as WTO, UNSD.

90.4.4 Perfection of Fundamental Theories of Tourism

In the theories of tourism in China, there are many definitions different from those of the world standard, for example, the definition of tourism, tourism product, tourism industries, tourism consumption, etc. Even in China, these definitions have different meanings. Therefore it's vital to perfect the fundamental theories of tourism in China firstly according to the international standard and our reality. Consequently, the localization of the framework in China is essential. Since the System of National Accounts is different from the SNA93 recommended by WTO and other world organization in some fields, the localization of the framework in China is more important. In TSA: RMF 2008, the specific division of the country is accepted.

90.4.5 Sharing of the Regional TSA

There isn't successful case of regional TSA set–up internationally (OECD 2000). But in China, there are several provinces and cities have established TSA. However, the final contents can not be found in public. They are kept in the government. The authors sincerely wish the contents can be shared publicly. The sharing of the regional TSA may speed the completion of the national TSA and then set national frame to instruct the regional establishment.

90.5 Conclusion

In brief, the research of TSA in China is undergoing rapidly in an important period. The research on fundamental theories and the perfection of tourism statistics are the two vital keys to open up a new era of international cooperation.

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Chapter 91
Research on Contractors' Strategies Dealing with Risks Reallocated by Owners Under Particular Contract Clause

Jie Bai and Hong Ke

Abstract With the reality that owners usually reallocate risks to contractors under special contract clause, this paper conducts a systematic analysis on contractors' dealing with the reallocated risks in four steps: Risk identification, risk assessment, risk response and risk control. Firstly, this paper identifies the list of reallocated risks based on comparative analysis between model contracts and actual contracts. Secondly, by means of questionnaire collection and analysis, the importance of each listed and reallocated risk to Contractors shall be greatly evaluated. Thirdly, this paper revealed the mechanism of contractors' risk response decisions by establishing the model of risk response decision to the reallocated risks. Finally, it described the contractors' risk control process during the construction process through the analysis on control process towards reallocated risks.

Keywords Reallocated risk · Risk assessment · Risk control · Risk identification · Risk response

91.1 Introduction

Construction is a complex system, there are many uncertain factors in the process, so construction risk is very common in its implementing (Pier 2007). Risk event is bound to bring losses to the project, therefore, a reasonable risk allocation between owners and contractors will arouse the enthusiasm of project management, and ensure the smooth implementation of project target (He 2003).

Nowadays, general terms of FIDIC contract series, 07 version standard bidding documents and 99 version construction textbook in China are considered to be a

J. Bai (✉) · H. Ke
Management School, Tianjin University of Technology, Tianjin, China
e-mail: woshiwo2081@163.com

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more detailed and reasonable risk allocation provisions between owners and contractors. But in practice, owners often take advantages of their information or time dominant position reallocate large amount of risks belong to them to contractors by assigning special contract(Zhang and He 2005; Xie 2006). In this paper, the risks which owners should undertake but reallocate to contractors through special contract clauses are called owners' reallocated risk. Due to the levels of contractors' risk management are relatively low, if they cannot deal well with the owners' reallocated risk, it should eventually lead to losses. And currently, domestic risk studies focused on how to reasonably allocate risk and how to prevent the risks on a macro level, there are fewer researches on how to deal with the owners' reallocated risk, when it actually occurs.

Based on the identification and assessment of owners' reallocated risk, this paper analyzed how to response owners' reallocated risk, so as to achieve contractors' effectively management.

91.2 Identification of Owners' Reallocated Risk

Risk identification is the first step of risk response, its purpose is to reduce uncertainties from project (Han and Wang 2007), through cognition, judgment, classification of the facing or potential risks. According to the definition of owners' reallocated risk in this paper, the best way to identify owners' reallocated risk is to compare actual contract with initial owners' reallocated risk list, then analyzed the risk sharing situation in actual contract through data analysis, finally get the final list of owners' reallocated risk.

91.2.1 Get the Initial List of Owners' Reallocated Risk

Currently, 07 version standard bidding documents and 99 version construction textbook are the domestic major construction contract, the clauses in general conditions about risk allocation between owners and contractors are very clear. Based on these clauses and combined with the rational principles of allocation risk, we made further detailed analysis, the results turned out that their risks division is more consistent. Finally, after induction and screening, the number of risk owners should undertake is 19, risk issues are shown in Table 91.1.

91.2.2 Get the Final List of Owners' Reallocated Risk

We collected 50 actual contracts from 8 large construction firms of different provinces and cities in China, which were signed based on 07 version standard

Table 91.1 The Initial List of owners' reallocated risk

Serial number	Risk issues	Undertake side	Undertake content
R1	Price fluctuation	O	C + P
R2	Delays of Prepayments, progress payment	O	T + C + P
R3	Drawing delays	O	T + C + P
R4	Owners supply materials and equipment	O	T + C + P
R5	Adverse physical conditions	O	T + C
R6	Owners' reason to suspend the construction	O	T + C + P
R7	An error from indicators	O	T + C
R8	Unusually bad weather	O	T
R9	Accuracy of benchmark data	O	T + C + P
R10	The change from Law	O	T + C + P
R11	Terminate contract by owners' default	O	T + C + P
R12	Quality problems caused by owners	O	T + C + P
R13	Construction safety responsibility to owners	O	Casualty and property loss
R14	Owner default lead to the failure of test runs	O	C + P
R15	Floods, earthquakes, typhoons and other	O + A	Respective losses
R16	War, embargo, strike, social unrest	O + A	Respective losses
R17	Temporary land occupation	O	C
R18	Infringement of patent technology supplied by owners	O	(third-party claims)
R19	Fossil, relics	O	T + C

Note the "O" as a landlord and a contractor; "T", "C", "P" represent durations, costs, profit

bidding documents or 99 version construction textbook after revising the special terms, therefore they had a certain breadth and could fully reflect the real content about owners' reallocated risk.

After analysis of risk reallocation in the actual contracts, we found that owners allocate risk in initial list through three different manners: risks are fully passed on to contractors, owners undertake part of the risks, the risks owners should undertake are not agreed in the contract, analysis results are shown in Table 91.2.

From the table above, ratios of 19 owners' reallocated risk are more than 36 %, relatively large, they are the risks contractors need to response. In addition, through contract investigation, we found that owners also bring three kinds of risk to contractors: risk (R20) that explaining order of contract files change, risk (R21) that advanced payment, risk (R22) that black-and-white contract, they are also belong to owners' reallocated risk, so there are 22 different types risk in the final list of owners' reallocated risk, as shown in Table 91.3.

Table 91.2 The situation of risk in the initial list reallocated

Serial number	Risk issues	Number of reallocated risk	Number of initiative to undertake	Proportion
R1	Price fluctuation	40	10	80 %
R2	Delays of Prepayments, progress payment	35	15	70 %
R3	Drawing delays	36	14	72 %
R4	Owners supply materials and equipment	41	9	82 %
R5	Adverse physical conditions	27	23	54 %
R6	Owners' reason to suspend the construction	34	16	68 %
R7	An error from indicators	26	34	52 %
R8	Unusually bad weather	39	11	78 %
R9	Accuracy of benchmark data	37	16	74 %
R10	The change from Law	39	11	78 %
R11	Terminate contract by owners' default	44	6	88 %
R12	Quality problems caused by owners	36	14	72 %
R13	Construction safety responsibility to owners	32	18	64 %
R14	Owner default lead to the failure of test runs	30	20	60 %
R15	Floods, earthquakes, typhoons and other	28	32	56 %
R16	War, embargo, strike, Social unrest	18	32	36 %
R17	Temporary land occupation	45	5	90 %
R18	Infringement of patent technology supplied by owners	34	16	68 %
R19	Fossil, relics	19	31	38 %

Table 91.3 The finial list of owners' reallocated risk

Serial number	Proportion of redistribution risk (%)	Risk factors
1	≥75	R1,R4,R8,R10,R11,R17,R22
2	50–75	R2,R3,R5,R6,R7,R9,R12,R13,R14,R15,R18,R20,R21
3	≤50	R16,R19

91.3 Assessment of Owners' Reallocated Risk

Risk assessment is the link of risk recognition and risk management, the foundation of risk response (Posner and Rosen field 1997), it needs to comprehensively considerate risk nature, risk management objectives and risk-bearing capacity of main body. The common method of risk assessment is qualitative and quantitative (Tah and Carr 2003).

Posner and Rosen committed to contract economics risk-sharing discussion, suggested that there were two important factors to judge the loss of stakeholders, including the extent of losses, and the possibly occurrence frequency (Xu and

Tiong 2000). Therefore, based on the risk identification results, this paper used the method of questionnaire to research and analysis the losses and the occurrence frequency of different risk factors to contractors, and accordingly drawing out risk quadrant map in order to make the priority of owners' reallocated risk clear.

91.3.1 The Design and Extension of Assessment Questionnaire About Owners' Reallocated Risk

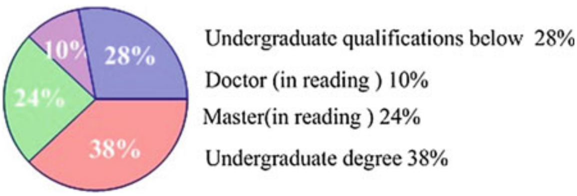
The surveyed made professional judgment about the loss and frequency of risk events in the final list of owners' reallocated risk, in order to achieve the assessment of owners' reallocated risk. The degree of risk loss is divided to five level:" Not serious (0,1), General serious (1,2), Serious(2,3),Very serious (3,4), and extremely serious (4,5)"; the frequency of risk occurrence is divided into four grades: occasionally occurrence or few occurrence (0,25 %), usually occurrence (25,50 %), frequently occurrence (50,75 %), inevitable occurrence (75,100 %), according to the knowledge and experience of the surveyed to evaluate the corresponding content.

The survey had hand out a total of 120 questionnaires, and regained 98, the surveyed' related circumstances are shown in Figs. 91.1, 91.2, 91.3.

The statistics in figures about the respondents' career position, academic qualifications, working years, and other aspects showed that the respondents have a wealth of knowledge and experience to make accurate judgments, so the data collected in the survey can accurately reflect the impact degree that owners' reallocated risk to contractors.

Fig. 91.1 Respondents' career position

Fig. 91.2 Respondents' academic qualifications



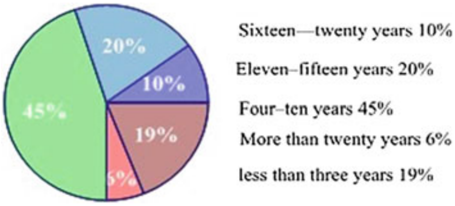


Fig. 91.3 Respondents' working years

91.3.2 The Output of Owners' Reallocated Risk Assessment Result

About the statistical results of the risk assessment questionnaire, in order to further clarify the impact of risk matters in the final list of owners' reallocated risk to contractors, we conducted a comprehensive analysis on the above survey results data, and drew out risks Quadrant, as Fig. 91.4, which horizontal side was loss degree, ordinate side was frequency of risk occurrence, they both had an effect on the degree of owners' reallocated risk.

In impact degree quadrant maps of owners' reallocated risk, the horizontal was taking 3.5, vertical as a division of quadrants centerline was taking 50 %. According to the principles of Quadrant, the risk factors in the first quadrant for contractors is the most important, followed is risk factors in second and fourth quadrant, risk factors in the third quadrant is the last. So risks in the First quadrant is the key response problem contractors should focus on; Second and Fourth

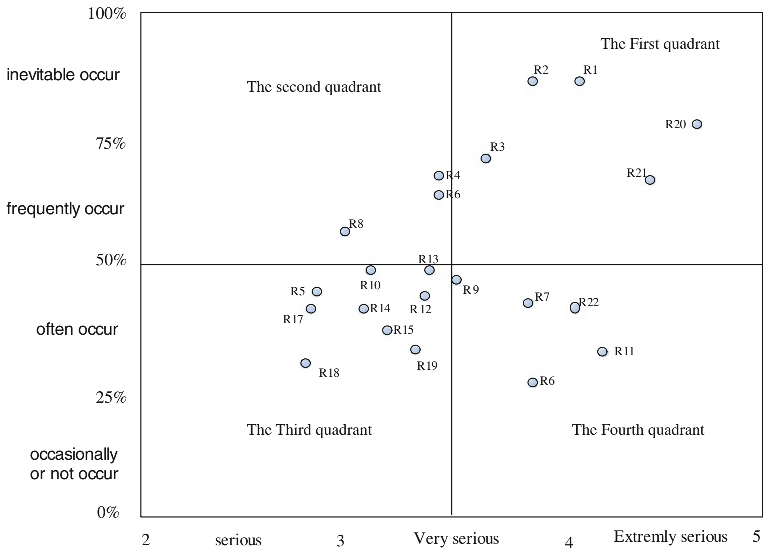


Fig. 91.4 Quadrant maps of impact degree about owners' reallocated risk

quadrant, as price volatility risk, risk of contract document explaining order change and so on, if the result is negative, it will cause serious damage to the contractors.

91.4 Responses of Owners' Reallocated Risk

Risk response means, according to finial list and assessment results of owners' reallocated risk above, combined with project specific situation, risk nature and undertake capability, contractors take corresponding countermeasures to upgrade engineering management target opportunities and reduce threat of owners' reallocated risk (Fig. 91.5).

91.4.1 Explanation of Model Input

Model input mainly take finial list of owners' reallocated risk and risk assessment results as an important reference, collect related factors of owners' reallocated risk in the tender documents as basic information for contractors to make response decision to owners' reallocated risk. It should include (Pate-Carnell and Regan 1998): the actual list of owners' reallocated risk in tender documents, risk nature, basic project conditions, optional risk response plans and so on.

91.4.2 Model Decision Process

First, contractors should make some related qualitative analysis combined with the enterprise internal reality of risk response decision, specific actual of engineering and the entered model signal (Huseby and Skogen 1992). Then, reassess the risk

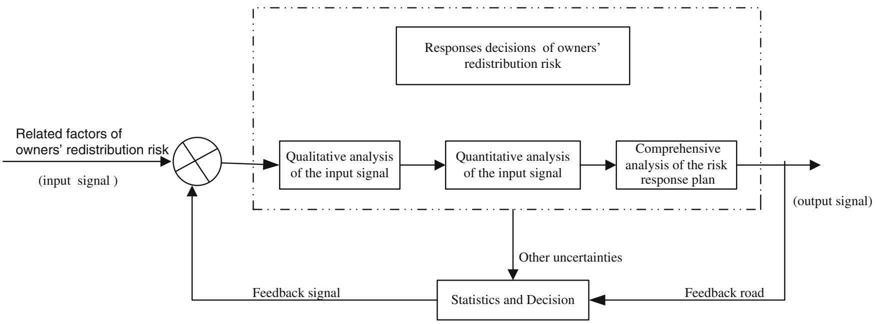


Fig. 91.5 Responses decision model of owners' reallocated risk

probability and impact by interviews or meetings, assess the usefulness of risk data for the risk management, classify risk according to the common root causes (Cano 1992),so as to form the register of the owners' redistribution risk.

Second, contractor should make quantitative analysis about entering signal on the base of qualitative analysis: quantitative analysis referring to risk probability and project target effect are made by contractors' experience and history data. According to the potential effect on cost and progress related expert judge, tornado figure for sensitivity analysis was drawn to determine which risk has maximum potential effect, and relevant data was formed for risk response plan integrated analysis.

Last, based on the work above, combined with viable risk response plan to conduct a comprehensive analysis; finally a comprehensive analysis report of owners' redistribution risk was formed to help make decisions about risk response.

91.4.3 Explanation of Model Output

Model output mainly reflected decision process, including update register of owners' redistribution risk, and add up quantitative risk report which contends quantitative method, results and recommendations. According to probability analysis about project, its cost and time target, level list of quantitative risk priority, and trend of quantitative risk analysis results, eventually decision program of owners' reallocated risk can be got, while accompanied with management plans.

91.5 The Control of Owners' Reallocated Risk

Contractors control method to owners' reallocated risk in the project life cycle is to deal with the risk which has taken risk retention and risk mitigation strategies, collect and analyze kinds of related information during the construction progress, forecast risks that may occur, then to monitor (Ren 1994).

The process of owners' reallocated risk control needs to be based on various information gathered in the construction process, and uses various technology such as deviation and trend analysis to determine the following matters (Lin 2003): (1) assumption conditions of owners' redistribution risk are still established or not; (2) risk has been assessed whether changed or disappeared or not; (3) risk management plans and response policy has implemented or not; (4) according to the current risk assessment, cost or progress emergency reserves whether need to adjust or not. In other ward, the process of owners' redistribution risk control can be expressed as shown in Fig. 91.6.

Conclude from Fig. 91.6, contractors' control for owners' redistribution risk is a process that continues to gather and deal with information during the

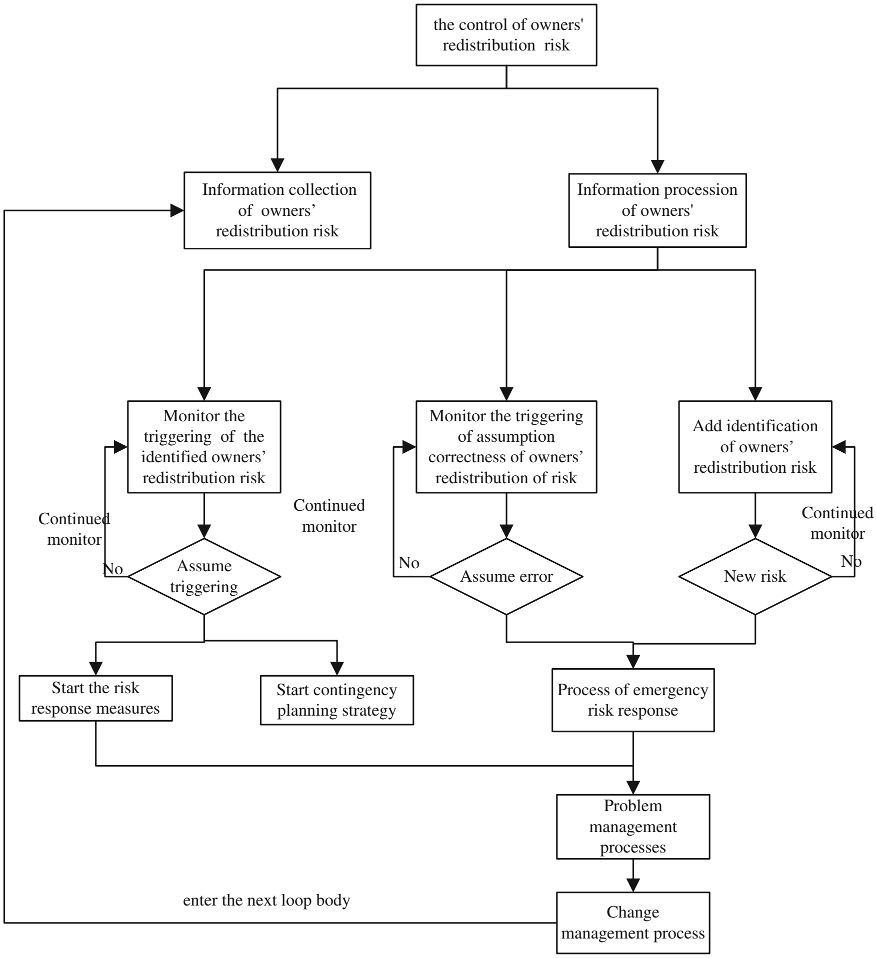


Fig. 91.6 The flow of owners' redistribution risk control

construction process, the process of dealing with information includes the following work:

91.5.1 *Monitor Identified Owners' Reallocated Risk Triggered or Not*

During the construction process, contractors should monitor owners' redistribution risk which has taken risk retention or risk reduction strategies, once the risk has been triggered, contractors should immediately carry out work in accordance with the pre-established risk response measures. If necessary, contractors should start risk management emergency plans to minimize the losses caused by owners' reallocated risk for contractors (Gu 2009).

91.5.2 Monitor the Assumption Analysis of Owners' Reallocated Risk Correct or Not

Contractors should appoint specialized staff to check the previous analysis assumption in the process of construction is correct or not (Chen 2010). If the assumption is fail, it will became the right risks, then need immediately get into emergency response process, and make a detailed response plan.

91.5.3 Identify the New Risks

Due to the complexity, uncertainty of the project, some accident will inevitably occur in the course of construction (Wang 2005)· In this way, contractors must monitor the newly appeared owners' reallocated risk as a result of the occurrence of fortuitous events, and once triggered, it should immediately get into the emergency risk response process.

91.5.4 The Emergency Risk Response

Risk emergency response refers to the process that contractors take response measures to solve newly appeared risk, according to the advanced risk management document, in order to minimize the risks loss.

91.5.5 Implement Problem Management Process

Regardless of the identified risks, the triggered risks assumed analysis, or a new identified risk, they are all the control issues of owners' reallocated risk that need to solve effectively, ensure notification had given to all affected individuals, and resources has been injected to solve the problem.

91.5.6 Implement the Changing Management Procedure

Unless a plan, budget, and resources has made, risk control solution to these problems is likely to change the scheme (Lei 2004), so contractors must ensure the impact that the management procedures change had made on the approval of project scope, resources and schedule changes.

This is a completed owner reallocated risk control processes, turning into the next process cycle, and ultimately ensures contractors have an effective control on owners' reallocated risk.

91.6 Conclusion

This paper focused on owners' reallocated risks under special conditions of contract, and studied in-depth on the contractors' response to owners' reallocated risk through four procedures: risk identification, risk assessment, risk response and risk control.

Through risk identification formed the list of owners' reallocated risk, then made response object clear; analyzed the effect degree that owners' reallocated risk had on contractors by risk assessment; through describing risk decision-making model for the contractors response, analyzed the principle that response decision contractors made for owners' reallocated risk; through describing the mechanism of risk control process in order to ensure the validity of contractors' risk control and reduce the loss. This article provided important support for contractors' risk management which from owners' reallocated risk under the special conditions of contract.

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Chapter 92
Research on the End Effect Experiment of New Type 18.4 mm Kinetic Energy Pain Block Bullet

Xiao-jun Zhai, Yong-jie Zhu and Shang-shun Wang

Abstract In order to make full use of the antiriot kinetic energy weapon and ammunition, it is necessary to make a scientific and systemic research on the end effect of antiriot kinetic energy weapon and ammunition. Take the new type 18.4 mm kinetic energy pain block bullet as an example, on the ground of establishing an experimental firing platform, we carried out the end effect experiment of the bullet in different shooting distance. By analyzing the experimental data and error correction, we obtained that the effective range of the bullet is 30–45 m, the ideal nonlethal end effect value of the kinetic energy pain block bullet is a ratio of kinetic energy of 8.2 J/cm^2, it is of great help of the scientific use of this type of antiriot weapons and ammunition.

Keywords Antiriot kinetic energy weapon · End effect · Kinetic energy pain block bullet · Ratio of kinetic energy

92.1 Introduction

In recent years, terrorism events have become a threat to the safety of the countries all over the world. In the process of disposing of those terrorism events, nonlethal antiriot weapons are widespread used as an effective means by the police, the existing problem that " excessive damage in short distance and harmless in distance" of such weapons is gradually exposed. In order to solve this problem, take

X. Zhai · Y. Zhu (✉)
Department of Equipment and Transportation Engineering,
University of CAPF, Xi'an, China
e-mail: wujingzhuyongjie@126.com

S. Wang
Department of Training Engineering, University of CAPF, Xi'an, China

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the new type 18.4 mm kinetic energy pain block bullet as an example, based on a large number of end effect experiments, we obtain the ideal end effect value of new type 18.4 mm kinetic energy pain block bullet, providing certain technical and tactical support to scientific use of the antiriot kinetic energy weapon and ammunition.

92.2 Injury Criterion of Kinetic Energy Pain Block Bullet

In present, there are two kinds of injury criterion of kinetic energy pain block bullet: taking kinetic energy as the standard and taking ratio of kinetic energy as the standard. In the former way, the data is very dispersive, we can hardly find a universal threshold (An et al. 2010), while in the later way, it is easy to find a universal threshold. So it is better to take ratio of kinetic energy as injury criterion (Ran et al. 2010). The ratio of bullet's kinetic energy and the maximum cross-sectional area (which is parallel to the contact target area when it hits target) is the ratio of kinetic energy E_d. That is:

$$E_d = \frac{1}{2}\,\mathrm{mv}^2 \Big/ \mathrm{A}$$

V bullet speed;
A maximum cross-sectional area which is parallel to the contact target area.

National Military Standard regulate that when hitting target, the injury caused by antiriot kinetic energy weapon can only achieve the mild injury (II) standard, namely : when hitting body, antiriot kinetic energy weapon can only cause redness and swelling of skin, or blood exudation, subcutaneous layer bleeding, superficial blood exudation (The Chinese People's Liberation Army General Staff Department 1995), while the range of ratio of kinetic energy is 4.0–12.0 J/cm^2 (when the bullet's diameter is larger than 10 mm, Shore Hardness is less than 90) and 4.0–28.9 J/cm^2 (when the bullet's diameter is less than 10 mm, Shore Hardness is less than 90).

When we use antiriot weapon hitting targets with new type 18.4 mm kinetic energy pain block bullet, it's bullet diameter is greater than 10 mm, Shore Hardness is less than 90. According to the National Military Standard, the range of ratio of kinetic energy of new type 18.4 mm kinetic energy pain block bullet should be 4.0–12.0 J/cm^2.

92.3 End Effect Experiment

92.3.1 Establishment of Experimental Firing Platform

As shown in Fig. 92.1, the ballistic experimental gun is designed and machined on the ground of new type 18.4 mm antiriot gun, remaining technical and tactical parameters of the original gun barrel unchanged.

There is a 70 mm long platform at the top of the barrel chamber, regulating firing muzzle angle and the whole gun posture. Firing mechanism is firing pin lever type.

Firing platform is built on the foundation of desk. The vise is bolted on desk while ballistic experimental gun is fixed on vise. Experimental firing platform is shown in Fig. 92.2.

Fig. 92.1 Three dimensional diagram of ballistic test gun

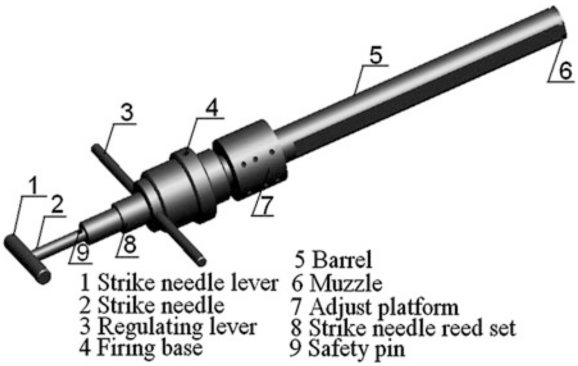

Fig. 92.2 Experimental firing platform

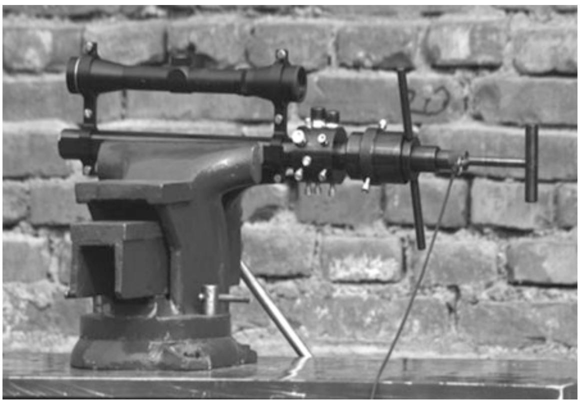

Fig. 92.3 High-speed photography and recording system

92.3.2 High-speed Photography and Recording System

As shown in Fig. 92.3, High-speed photography and recording system is used to observe and record the flying process and hitting target attitude of bullets, providing basis for the measurement and calculation of velocity and ratio of kinetic energy of hitting target. It is consist of a Miro3 type high speed camera, the image monitor, image processing software.

By analyzing experimental recording high-speed images with image processing software, we can get the flying velocity and ratio of kinetic energy of hitting target, provides reliable basis for the theoretical analysis of flying bullet.

92.3.3 Experimental Target Selection

The foreign scholars often use gelatin as a simulated target in studying kinetic energy pain block bullet end effect. It is economical and environmental and the bullet impact effect can be visually observed (Sheriock et al. 2005). The Swedish scholar Berlin have used gelatin target which contains 20 % content gelatin, 80 % content water to do kinetic energy pain block bullet end effect experiment (Zahler and Danino 2007). The drag coefficient of kinetic energy bullet measured in gelatin target is $C_x = 0.35$, slightly lower than the soft tissue of human body resistance coefficient ($C_x = 0.45$) (Liu et al. 1991), therefore this experiment choose gelatin target which contains 23 % content gelatin, at the same time since the new type of kinetic energy pain block bullet is too powerful within 30 m, in order to make the target as similar as possible with the tissue of the human body, we put a layer of thick 0.11 mm aluminum foil on the surface of gelatin block within 30 m to simulate human skin and choose 0.16 mm thick Kraft paper when out 30 m.

92.3.4 Ideal Nonlethal End Effect Value Criterion

Foreign researchers found that when bullet penetrating into subcutaneous tissue about 20–30 mm, it would cause severe contusion and obvious stopping effect without fatal injury, nonlethal effect will be ideal. When the bullet's penetration depth is larger than 40 mm, it is prone to bring fatal injury (Bedard and Pare 2003).

In this experiment, since the gelatin content is about 23 %, slightly higher than the foreign experiment's 20 %, and we cover gelatin target with aluminum foil or Kraft paper, the ideal penetration depth will be slightly larger than 20–30 mm, reaching 30–35 mm and it cannot larger than 40 mm. The National Military Standard of nonlethal blow provides that the range of ratio of kinetic energy value is 4.0–12.0 J/cm^2.

92.3.5 Experimental Schemes

1. Set up the experimental firing platform, put gelatin target up, debug high-speed photography and recording system, correct the experiment antiriot gun.
2. Conduct the initial velocity measuring experiment. Shoot 5 bullets. Use high-speed photography and recording system to record their flight attitude within the 150 cm distance off muzzle.
3. Take the experimental firing platform to the experimental point which is 10 m off the gelatin target, and shoot 5 bullets, record their flight attitude before hitting target, record the changes of target and bullets at the moment of hitting target.
4. Continue the experiment at the different target distance of 20, 30, 35, 40, 45 m in order.
5. Analyze experiments records and do data processing and numerical correction.

92.3.6 Experimental Data Analysis and Calculation

1. Numerical correction. Due to the effect of view angle, high-speed photography and recording system has amplification effect for bullet's flight distance, it needs data correction for experiment results (Schaefer and Grappethaus 2006).

As shown in Fig. 92.4 below, the lens focal length of high speed camera is 135 mm, the distance between the background score and lens is 37 cm, the distance between shooting plane and lens is 9.7 m, distance from shooting plane to reticle plane is 40 cm.

According to correction principle above, we can get that $\Delta L = 0.015$ m, when image records show that bullets fly over 75 cm, the actual distance is 72 cm, the real data is 96 % of the high-speed image recording data.

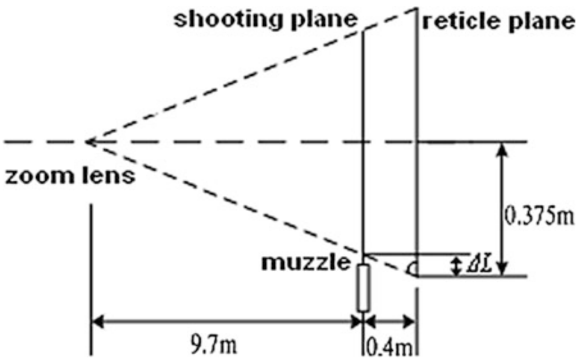

Fig. 92.4 Schematic diagram of data correction

Fig. 92.5 Target damage in 10 m shooting distance

2. Take the experimental firing platform to the experimental point which is 10 m off the gelatin target. Here, gelatin target volume is 30 × 30 × 10 cm, using 0.11 mm thick foil to simulate human skin. Conduct the experiment. The hitting effect is shown in Fig. 92.5.

Here, the bullets penetrate through gelatin target, break the supporting plastic box behind the target, rebound in gelatin. The kinetic energy of bullets is enough to penetrate human skin causing permanent penetrating wound, injury effect is too large. It is not the ideal nonlethal end effect (Zhang 1992).

By analyzing high-speed image records, we can get that the hitting target velocity of bullets is $v = 123$ m/s, it is $v = 118$ m/s after data correction, Ratio of kinetic energy is $E_d = 22.5$ J/cm^2 here, it is far beyond mild injury (II) standard range.

3. Continue the experiment at the target distance of 20 m. The hitting effect is shown in Fig. 92.6. The bullets penetrate through the foil and penetrate into gelatin target, the penetration depth is about 79 mm, gelatin target dehisces along ballistic trauma, resulting in severe penetrating wound. The injury effect is still too large (O' Dwyer and Lee 1999). It is not ideal nonlethal end effect.

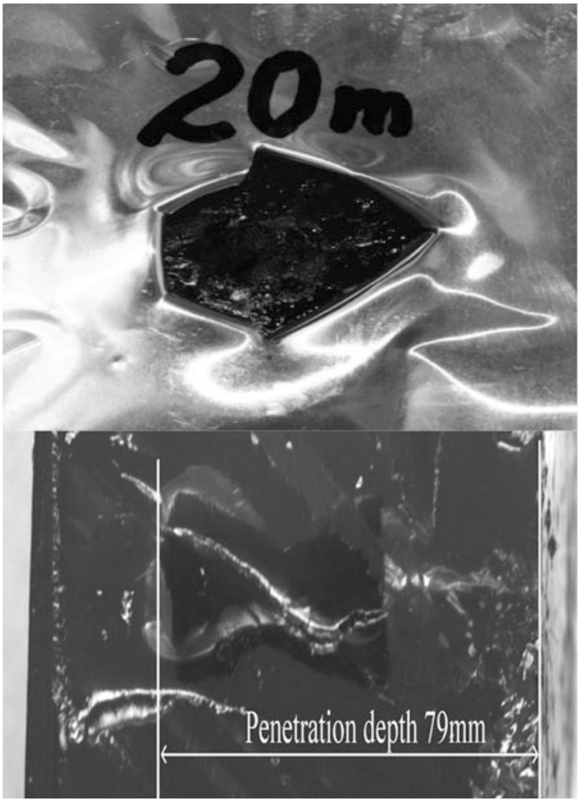

Fig. 92.6 Target damage in 20 m shooting distance

By analyzing of high-speed image records, we can get the hitting velocity of bullets is $v = 102$ m/s, it becomes $v = 98$ m/s after modifying, the ratio of kinetic energy of hitting target is $E_d = 15.5$ J/cm^2, it is beyond mild injury (II) standard range (Meta Storm Technology 2001).

4. Continue the experiment at the target distance of 30 m. The hitting effect is shown in Fig. 92.7.

Here, the gelatin target volume is $42 \times 34 \times 10$ cm, using 0.16 mm thick Kraft paper to simulate human skin. Here, bullet velocity of hitting target is $v = 89$ m/s, it becomes $v = 85.4$ m/s after modifying, the ratio of kinetic energy of hitting target is $E_d = 11.8$ J/cm^2. Bullet penetrate through the thick Kraft paper, the penetration depth is about 55 mm; there is local cavity appears near the internal ballistic trauma of gelatin block, resulting in apparent penetrating injury (O' Dwyer and Lee 1999), the killing effect is still too large, nonlethal end effect is still not ideal.

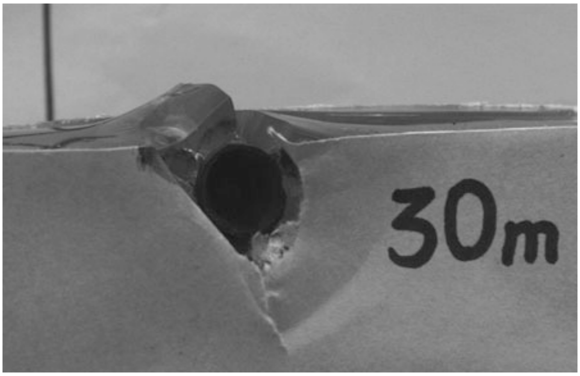

Fig. 92.7 Target damage in 30 m shooting distance

5. Continue the experiment at the target distance of 35 m. Here, the bullet velocity of hitting target is v = 80 m/s, it becomes v = 77 m/s after modifying, the ratio of kinetic energy of hitting target is $E_d = 9.6\ J/cm^2$. It is consistent with mild injury (II) standard range. The framing screenshots of high-speed image records is shown in Fig. 92.8. The 3 and 4 frame photo shows bullet completely penetrates into the gelatin target, and the 5–8 frame photo shows that bullet is bounced out of gelatin target. It flies a short distance before dropping to the ground. Penetration depth is about 42 mm. There are still some obvious penetrating wounds (Harten 1983). According to analysis of *D*, the hitting effect is still has certain lethality, it does not reach ideal nonlethal end effect.
6. Continue the experiment at the target distance of 40 m. Hitting effect as shown in Fig. 92.9, bullet penetrates through Kraft paper and penetrates into gelatin target. Penetration depth is about 35 mm. There is no obvious penetrating wound and it will not cause permanent damage (He 2004). The penetrating ability of bullet is weak, but the stop effect of bullet is obvious, the nonlethal end effect is ideal.

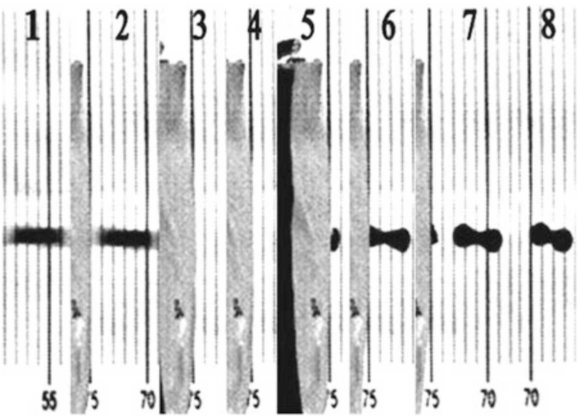

Fig. 92.8 Screenshots of hitting process in 35 m shooting distance

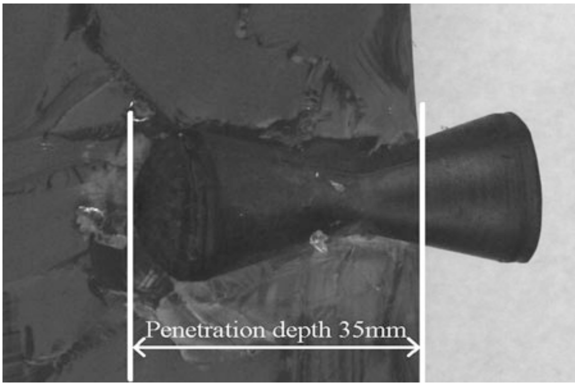

Fig. 92.9 Target damage in 40 m shooting distance

Here, bullet velocity of hitting target is v = 74 m/s, it becomes v = 71 m/s after modifying, the ratio of kinetic energy of hitting target is $E_d = 8.2$ J/cm^2. It is consistent with mild injury (II) standard range. The penetration depth is about 35 mm. According to analysis of *D*, it will not produce excessive damage. Stopping effect here is very obvious. Basically, it reaches the ideal nonlethal end effect and meets the requirement of experiment.

7. Continue the experiment at the target distance of 45 m. Hitting effect is shown in Fig. 92.10. The bullet tumbles in gelatin target after partial penetrating through Kraft paper. The penetration depth of bullet is not enough. The stopping effect is not obvious.

Here, bullet velocity of hitting target is v = 66 m/s and it becomes v = 63.4 m/s after modifying, the ratio of kinetic energy of hitting target is $E_d = 6.5$ J/cm^2. It is consistent with mild injury (II) standard range, but the penetration depth is about 26 mm. The stop effect here is not obvious. It does not satisfy the requirements of ideal nonlethal end effect.

When the shooting distance continues to increase, the hitting effect goes further down. It cannot meet requirements of nonlethal end effect any more. The end effect experiment ends here (Heiser 1987).

Make a conclusion of the experiment, we can get the experimental data which is shown in the Table 92.1.

92.3.7 *Error Analysis*

The experimental errors are mainly caused by following aspects:

1. The minor difference of propellant and bullet-shape lead to the difference of bullets' muzzle velocity. This error can't be avoided (Ray and Tezduyar 2000).

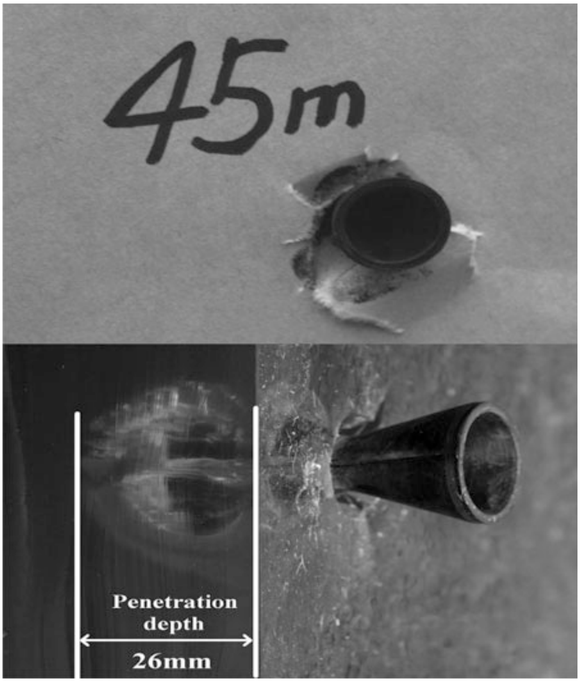

Fig. 92.10 Target damage in 45 m shooting distance

Table 92.1 Experimental data

Target distance (m)	Bullet velocity of hitting target (m/s)	Ratio of kinetic energy of hitting target (J/cm^2)
10	118	22.5
20	98	15.5
30	85.4	11.8
35	77	9.6
40	71	8.2
45	63.4	6.5

2. The measurement method of bullet velocity in this experiment is measuring average velocity. Data got in this way is a little different with the actual bullet velocity. It belongs to the system error and cannot be eliminated, but the error is so small that it can be neglected (Nusca and Conroy 2002).

92.3.8 Analysis of experiment results

According to the experiment analysis above, we can be see that at the experimental point which is 40 m off the target, the penetration depth of new type 18.4 mm kinetic energy pain block bullet is about 35 mm, the nonlethal effect is ideal, the ratio of kinetic energy of hitting target here is 8.2 J/cm^2.

92.4 Conclusions

On the basis of end effect experiment, we can draw following conclusions:

1. The effective action range of new type 18.4 mm kinetic energy pain block bullet is about 30–45 m. Its effective range is a little short. It is necessary and pressing to study on the new type 18.4 mm kinetic energy pain block bullet and expand its scope.
2. At the experimental point which is 40 m off the target, the bullet velocity of hitting target is 71 m/s, the ratio of kinetic energy of hitting target here is 8.2 J/cm^2, the nonlethal end effect is ideal. It provides reference for the ballistic trajectory optimization of new type 18.4 mm kinetic energy pain block bullet.

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Chapter 93
Research on Mode of Facility Operation and Management in Tianjin Station Hub Based on Facility Management Theory

Song Yang

Abstract The research based on the theory of facilities management theory, and it puts forward the scientific and rational large centralized management model of Tianjin Station Facilities Project. The model solves the problem of Tianjin Railway Station Project that investors are not clear and unclear property rights, and making the equipment system achieves the desired function, and the hub project gets efficient operation, and it achieved win–win social and economic benefits.

Keywords Facilities management · Hub project · Large centralized model

93.1 Theory Review of Facility Management

At present, the international has not yet formed a unified consensus on definition of facility management. Industry associations or institutes make the definition in Table 93.1.

Comprehensive analysis of the associations for the definition of facility management, facility management is a comprehensive, systematic management system (Quah 1998), it integrates three key organizational resources: personnel, facilities and technology, as shown in Fig. 93.1 (Cao and Miu 2008). Facility management in the strategic integration of personnel, facilities and technology to maintain the high quality of work and living space, improving investment returns; in order to achieve the purpose of improving the company's operational capabilities. In this study, the definition of facility management based on the international facility management association is defined as the contents of the facility management, facilities management is a specialized industry contains a variety of disciplines, people, place, process and technology to ensure the functionality of the built environment.

S. Yang (✉)
Management School, Tianjin University of Technology, Tianjin, China
e-mail: yangsong598@163.com

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Table 93.1 Comparative study on definition of facilities management

Association	Definition	Emphasis
International Facility Management Association (IFMA) (International facility management association 2007)	Facility management is a specialized industry contains a variety of disciplines, people, place, process and technology to ensure the functionality of the built environment	Establish facility quality management code of conduct based on the operation of the whole life cycle
British Institute of Facility Management (BIFM) (British institute of Facility Management 2007)	Facility management can be integrated parts of the building for the management of its people and places	All activities are based on clients' core business needs
Hong Kong Institute of Facility Management (HKIFM) (Gilleard 2007)	Facility management is the process of comprehensive people, process and the advantages of the tenement in order to achieve long-term strategic objectives	Effective integration in the daily operations and strategic level to promote the organization's competitiveness

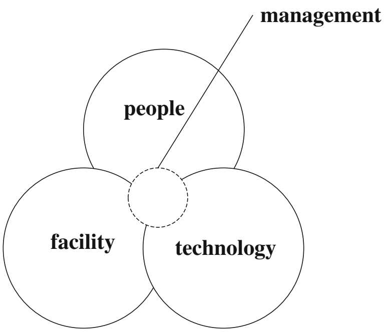


Fig. 93.1 Integration of facilities management system

93.2 Tianjin Station Project Equipment Operation and Management Model Comparison and Selection

Tianjin station project subkey of up to 19, pre-estimate the total investment more than 8 billion yuan, investors involved in the Beijing-Tianjin intercity railway corporation, the Beijing railway bureau, Tianjin metro company, Jinbin light railway company, city investment corporation, and other investment entities, as shown in Fig. 93.2. Tianjin Station transport hub project's complexity needed introducing advanced management models and concepts. Tianjin station based on facility management theory and practical recommendations to take ownership of the assets owned by the investment parties, Tianjin city investment corporation unified operation of the project management model to achieve the integrated management of the project life cycle.

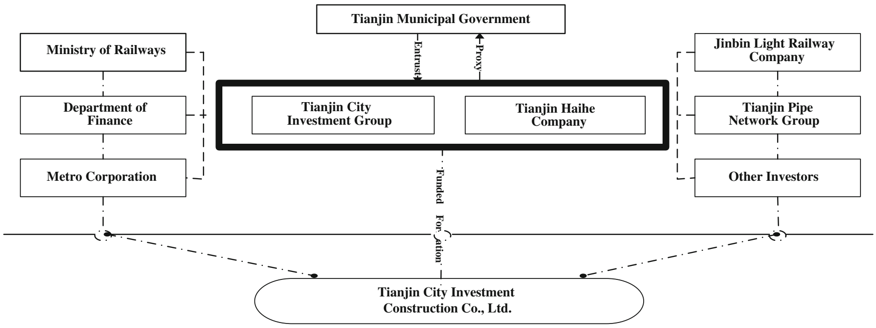


Fig. 93.2 Tianjin railway station project operation and management company formation mode

Tianjin station transport hub project equipment, included power supply and power monitoring system, air-conditioning system, drainage and fire fighting system, comprehensive monitoring system, electric escalators and other equipment systems, specific equipment system constitute shown in Fig. 93.3.

93.2.1 Tianjin Railway Station Transport Hub Project Equipment System Constitutes

Tianjin Station transport hub project facility system needed in the different conditions functional as well as two aspects to research. Equipment system features are summarized in Table 93.2.

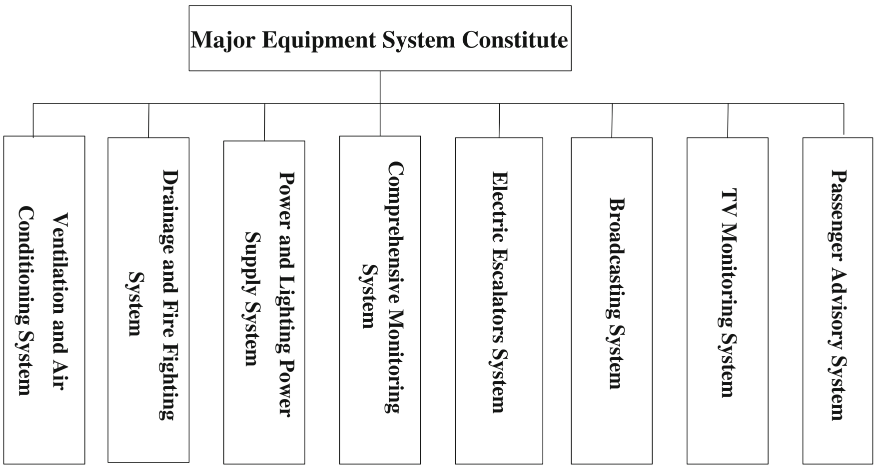


Fig. 93.3 Transport hub equipment system constitute

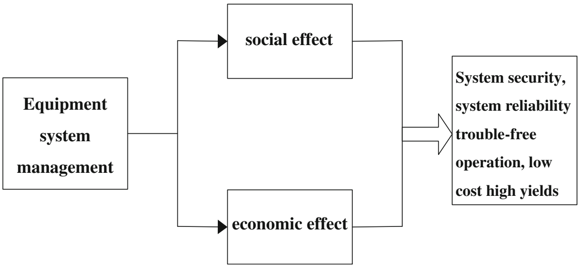
Table 93.2 Summarizing of equipment system constitutes

Equipment system	Basic functions	Functional requirements of different operating conditions
Ventilation and air conditioning system	Meet the air environment quality standard	Normal operating conditions: meet the different moments and seasons ventilation Fault conditions: mechanical ventilation, air cooling and fresh air Disaster conditions: take effective ventilation, the exhaust gas on the site of the incident
Drainage and fire fighting system	Meet the water quality, water pressure, water requirements	Normal operating conditions: provide a reliable water, fire-fighting equipment in a normal state Fault conditions: standby equipment can be enabled Disaster conditions: fire-fighting equipment open normally, effectively control the fire and eliminate fire
Power and lighting power supply system	Introduction of city electricity grid; measurement; system automation management	Normal operating conditions: ensure electricity reliable security Fault Conditions: multiple power backup each other Disaster conditions: the alarm signal is issued in a timely manner to provide electricity to the fire-fighting equipment
Comprehensive monitoring system	Fire alarm equipment monitoring, power monitoring	Normal operating conditions: monitoring related equipment Disaster conditions: automatic alarm monitoring fire; to assist the evacuation, control and extinguish fires

93.2.2 Tianjin Station Transport Hub Engineering Facility System Operation Management Goals

Tianjin transportation hub station in architectural structures includes PuSu railway, admiral inter-city railway, the city rail transit, and the peripheral municipal facilities effective combination as a whole. The whole project involves multiple investment subjects. All items building are large scale, with various kinds of equipment system and different nature multifarious. Orderly and efficient operation of the facility system will benefit the integrated hub operational management. As quasi-public project, Tianjin integrated transportation hub station facility system

Fig. 93.4 Equipment system management goals



operational management should follow the social effect and the principle of equal importance to economic effect, to ensure of system security with the minimum cost to meet the needs of the largest. It is shown in Fig. 93.4.

93.2.3 Tianjin Station Transport Hub Engineering Equipment Operation Management Content and the Choice of the Ways of Management

Tianjin Station Hub Project's facility system is numerous, and the intended use of the system, operation time and operation modes are not the same. However, analyzing from the equipment system management factor, the project operation management company main job includes facility system planning management, the facility system under different working conditions control, facility maintenance and management system, interface management and management position setting a few parts content.

1. Alternative

According to Tianjin station facility system of sophistication, and the construction of the equipment system of the diversity of the investment main body concrete circumstance, based on the theory of property rights, the paper puts forward two kinds equipment system operation management way: centralized operation management mode and decentralized operation management mode (Yang 2008). Among them, centralized operation management mode is to ensure the smooth implementation of the project, Tianjin city investment construction Co., Ltd. is responsible for construction, unified and harmonious arrangement, procurement, installation and commissioning of the facility system, and the owners' share construction cost. At operational stage, hub operations management company determines the range of facility system monitoring and control system of unified facility operation, and to determine the range of facility maintenance management system. Decentralized operation management mode is to orbit transfer center facility system of procurement, construction, installation and debugging and facility operation management system by each related investment main body

Table 93.3 Options for Large Centralized and Decentralized Mode of the Equipment System Operation and Management Mode Factor Analysis Summary

Optional element	Centralization operation management mode	Centralization operation management mode
Investment cost-sharing	City voted to build the cost of individual owners sharing	The Chengtou responsible for public areas: building an independent part of owners to build
The Chengtou responsible for public areas: building an independent part of owners to build	Hub management in different conditions, unified control scheduling	Under normal working conditions of local take unified control, fire control, under the condition of unified dispatching
Maintenance management mode	Hub operations management company to maintain a unified management, outsourcing or self-study	Hub operations management company is responsible for the maintenance and management of public areas, self-built part of the investment entities own maintenance and management
Interface management	Track transfer center, B4F equipment general considerations, centralized management, considered independently of the rest of the individual engineering equipment systems	Rail transfer center basement equipment separate systems, decentralized management

responsible for their own, hub operations management company only change to the center of the underground layer facility system of unified management. At the operation stage, the company controls the operation of the facility system in public areas. Other related project of main body is responsible for their own management.

2. Options selected elements

For these two different operational management models, this paper proposed the following scenario elements: investment-sharing mode, the system control mode, maintenance mode, the interface management. According to the comparison and selection of elements, the two modes of operation and management are summarized in Table 93.3.

3. Conclusion of options selected

Based on analysis of Equipment systems two types of operation and management mode, we can conclude that in large centralized management mode, property rights are clear, and use of the equipment system is reasonable. The desired functional goals; facility system compatibility and reliability contribute to the efficient operation of the hub, and achieve win–win of social effects and economic effects. Therefore, the Tianjin station facility operation and management mode used the large centralized mode.

93.3 Scheme of Managing Facility in Tianjin Station Hub

93.3.1 Organization for Managing Facility in Tianjin Station Hub

According to the LCC theory and principle for organization establishment, hub operation Management Company set up facility department which was directed by hub operation Management Company. In the department, there are facility programming section, integrated operation maintenance sector and facility overhaul agency, while other sectors were established in accordance with characters of different facility system. Figure 93.5 is design of organizations for managing the operation of facility system.

93.3.2 Facility Operation and Management Mode Under Large Centralized Mode

According to the specific circumstances and characteristics of each facility in Tianjin Integrated Transport Hub, the hub facility system operation is divided into

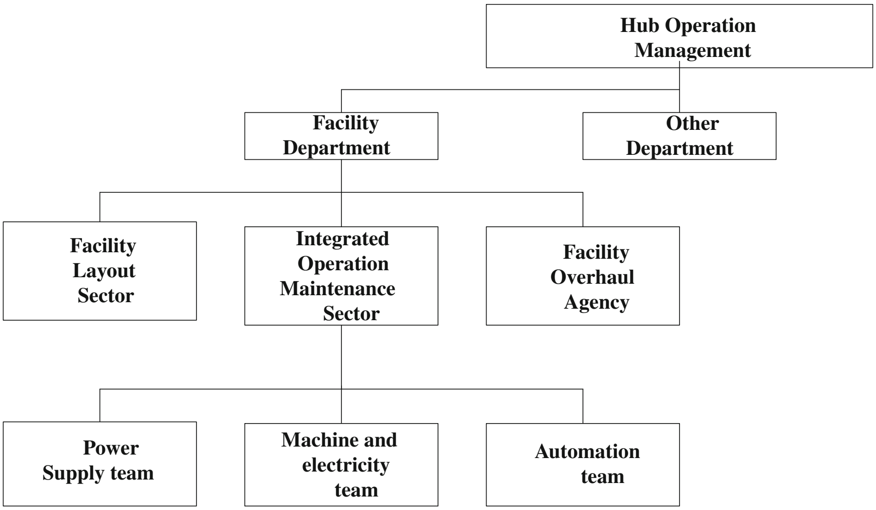


Fig. 93.5 Design of organizations for managing the operation of facility system

the normal operating conditions, malfunction conditions and disaster conditions. Thus, the operational control of the facility system should also be the corresponding divided into facility operational control in the normal conditions and facility operational control in the disaster conditions. Table 93.4 describes part of facility system operation control mode.

93.3.3 Mode of Operation and Maintenance of Facility System under Integrated Mode

The maintenance management of facility system in Tianjin Integrated Transport Hub has 4 traits which are high-tech, integrated managing, high randomicity and all staff participation. (1) High-tech: The facility system in Tianjin Integrated Transport Hub is high-tech which includes engineering, electron, hydraulic pressure, optics, computer and other aspects of professional elements. Mastering related aspects of professional elements is necessary for operating and maintaining the facility system correctly. (2) Integration: The facility system contains a variety of specialized technical knowledge, which is application of various science and technology (Qiu and Zhou 2010).

Operation and maintenance of facility system needs considering LCC which embodies technique, finance and organization management (Song 2006) (3) Randomicity: Many malfunctions of facility system are random which lead to the maintenance management of facility system having the trait of randomicity. In order to reduce the loss and interference brought by the sudden malfunction of facility system, the maintenance management must have the ability of providing the service at any moment and the ability of coping with the sudden failure of facility system. (4) All staff participation: Modern maintenance management of facility system stressed the role of behavioral science and promoted the mobilization of the masses of workers to participate in the management and people-centered management.

According to the different degree of market and the different main body of maintenance, the mode of maintenance could be divided into complete outsourcing maintenance, joint maintenance and independent maintenance (Zhang 2002; Hua et al. 2004). From complete outsourcing maintenance to independent maintenance, the degree of market is gradually decreasing. Combining the trait of Tianjin Integrated Transport Hub, trait of maintenance management of facility system and the principles of satisfying integrated management of regional maintenance, resource sharing, cost efficiency, emergency response, fast and efficient, Tianjin Integrated Transport Hub adopted the mode that part of the facility system is independently maintained and other part is maintained by social company. It is a selective outsourcing of maintenance management mode.

Table 93.4 Part of facility system operation control mode

Facility system	Facility operation and management mode under large centralized mode
Ventilation and air conditioning systems	1. Normal operating conditions: (1) orbital transfer center: unified control on air conditioning and ventilation and facility in public areas within the platform screen doors in rail transfer center, (2) sub project: air conditioning and ventilation are set up independently and controlled by integrated control room 2. Malfunction conditions: when the subway train is blocked in the tunnel, the ventilation facility set at every line executes aeration, and other ventilation conditioning system works as usual 3. Disarter condition: (1) Fire in the public area: turning off inner inhaling and exhausting air in the smoke partition area, and opening exhausting air outside; fire in buildings for facility and management: switching the inhaling and exhausting air system to preventing and exhausting smoke condition. (2) Fire in inter-zone: when the subway train is blocked in the inter-zone, the ventilation facility set at every line executes aeration; when there is fire in the hub, the hub control center directs the work of fire fighting and sends the information to every line
Drainage and fire fighting system	1. Normal operating conditions: fire and sewage pump are at auto control situation. The implementation of fire pump is displayed in hub integrated direct center 2. Malfunction conditions: (1) malfunction of facility system: fire and sewage pump are used and prepared; (2) malfunction of auto system: when the auto system fails, fire and sewage pump are at manual control state, and the valve of corresponding associated piping is open 3. Disarter condition: (1) fire hydrant system directly supplied by the city pipe: staff in station push the fire alarm, and signal will transfer to the corresponding integrated control room, while the fire is being extinguished. (2) Automatic sprinkler system: when the temperature reaches the prescribed temperature, the nozzle will sprinkles and the fire pump will start working. (3) Drainage system: waste water pumps which will drain the water for extinguishing fire in time are auto control or controlled by integrated control room
Power and lighting supply system	1. Normal operating conditions: 35/10 kV the main substation in the hub uses three-way power which are mutual backup operation mode; the step-down substations in hub generally use two-way power 2. Disarter condition: receiving control of FAS system, removing non-fire power in the relevant regional, and turning on emergency lighting and intelligent evacuation signage system

(continued)

Table 93.4 (continued)

Facility system	Facility operation and management mode under large centralized mode
Integrated monitoring system	1. Normal operating conditions: there are there-level control and two-level management. Two-node integrated monitoring sub system is established in every sub project, and the two-node integrated monitoring sub system is linked to monitoring system in hub which is monitored and managed by the hub of the integrated command center 2. FAS system adopts token ring and BAS system uses redundant ethernet. The system interface uses a redundant configuration to ensure communication through the subnet and spare equipment when the network disconnection and multiple points of failure happen 3. Disarter condition: (1) fire in hub: FAS subsystem monitors the fire. When it is affirmed, FAS will control the start and pause of the special fire-fighting facility and display its condition. FAS will cut non-fire power in related region and switch on emergency power; after receiving fire instructions, BAS subsystem controls the operation of the smoke control facility, and links to network of the city's emergency command center, as well as sends an alarm signal; (2) fire in inter-zone: the tunnel ventilation system is monitored by each line, and FAS and BAS subsystem will be set up in orbit transfer center. When the fire breaks out, tunnel ventilation system at each line will become inter-zone fire model

93.4 Conclusion

Facilities management in recent years in the international community has received a great development, but facilities management in China is still in the early stages of development. From the year of 2005, some scholars in the theoretical circles have gradually begun to attach importance to facilities management, while facilities management companies in China are rare. At present, study of project in life cycle management has already begun, however, the study of facility management at operation and management phase is still rather crude, and the same study is rare in China. This paper studied the application of facilities management in the operational management in Tianjin Integrated Transport Hub. Concerning of public facilities management, as the value of its operational phase includes not only the economic benefits, it is more important to consider the social benefits of public goods properties.

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Chapter 94
Safety Evaluation Method of Oil Depot Based on Improved Dow Chemical Method

Yi Yang, Gong-hui Ping and Zhi-wei Huang

Abstract To overcome the drawback that human and environment factors are entirely ignored in Dow's fire and explosion index method, this paper improved Dow's method to quantificationally compute and evaluate the fire and explosion hazard of oil depot. Safety compensation factor is put forward to remedy the defect of the traditional algorithm. F&EI, exposure radius, DF, MPPD of the fuel depot is analyzed and computed by the improved Dow's method.

Keywords Dow chemical method · Oil depot · Safety evaluation · Safety compensation factor

94.1 Introduction

Gasoline, diesel and kerosene stored in oil depot have flammable, explosive, volatile and diffusing characteristics. According to GB 1821 (2009), if the storage capacity of gasoline is more than 10 tons or kerosene is more than 200 tons, then the oil depot should be considered as major hazard installation. So, great majority of oil depots generally belong to major hazard installation and have high risk. Evaluating dangerous degree and adopting suitable preventive measures to reduce the risk of fire and explosion become the significant methods to prevent heavy accidents in oil depot. There are several methods of safety evaluation in the field of safety system engineering, such as Causal Factor Analysis (CFA), Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Dow's fire and explosion index method, and so on (State Administration of work safety 2005; Wu Zongzhi et al. 2001). CFA and FEMA are qualitative

Y. Yang (✉) · G. Ping · Z. Huang
Aviation Fuel and POL Equipment Test Center, Beijing, China
e-mail: jzliu7209@sina.com

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analysis methods, FTA and ETA are also used as qualitative analysis because the probabilities of basic events are hard to collect. According to past accidents' statistical data, potential energy of storage materials, and equipments' protective measures, fire and explosion hazard of process unit can be quantificationally calculated by Dow chemical method (Meiqing 2006; China chemical industry safety and Health Technology Association 1997). Many scholars used this method to evaluate the safety status of industrial equipment and dangerous site stored plenty of hazardous material (Hongjin 2011; Yang et al. 2010; Yinan and Baishun 2011; Yan et al. 2011; Limin et al. 2012; Ruibing et al. 2005; Wei et al. 2008; Xinglong and Liang 2007; Guiying 2009; Wenhua et al. 2008). In these articles Dow chemical method had been used to evaluate the safety level of the inflammable and explosive places stored plenty of hazardous chemical materials. But these articles only described the inner effect of the equipments' safety conditions on evaluation unit, and ignored the external effects of human factor, management factor and external environment on unit. Reviewed past heavy industrial accidents, we can find that human errors and management defects have an important effect on system safety. In this paper Dow's fire and explosion index method is improved to comprehensively evaluate the system safety degree.

94.2 Improved Evaluation Procedure of Dow's Fire and Explosion Index Method

94.2.1 Improved Evaluation Procedure

The improved evaluation procedure of Dow's fire and explosion index method is shown in Fig. 94.1.

94.2.2 Parameter Calculation Method

1. *Material factor* (*MF*)

   MF is the basic data to describe the chemical activity and flammability of storage materials in evaluation unit. The value of MF can be calculated by flammability rating N_f and chemical activity level N of hazardous materials stored in unit.

2. *General process hazard factor* (*F*1)

   F_1 is the main factor to define the accident loss degree. The value of F1 is the sum of 6 hazard factors, the factors mainly reflect the performance of chemical reaction, material storage and delivery, unit structure, discharge and leakage of unit.

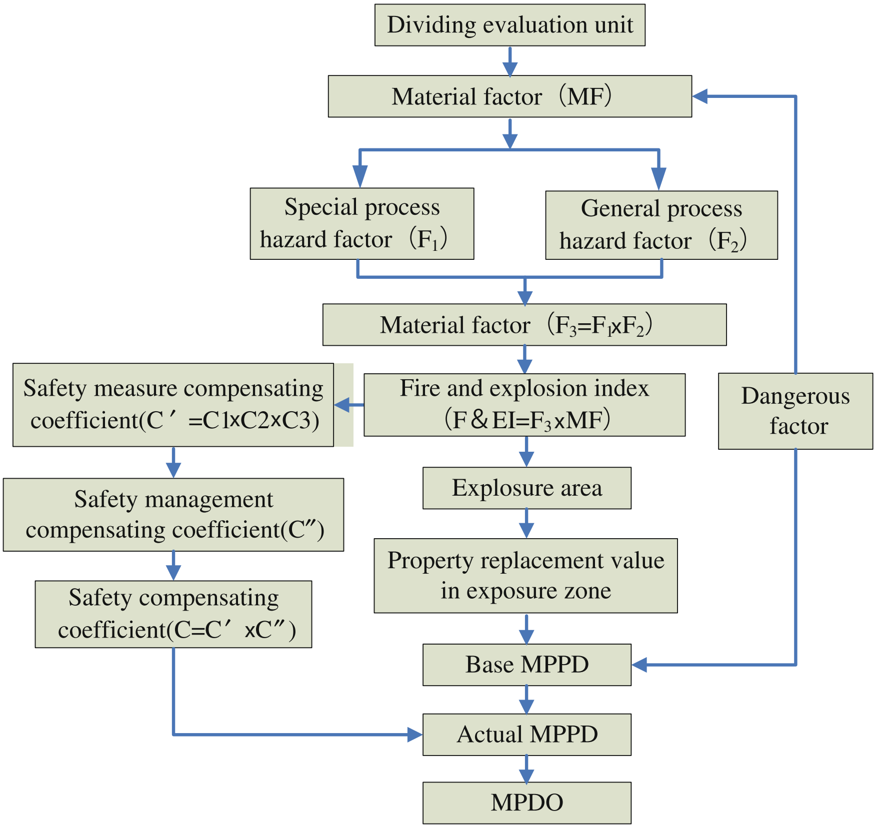

Fig. 94.1 Improved evaluation procedure of Dow's fire and explosion index method

3. *Special process hazard factor* (F_2)

   F_2 is the main factor to effect accident probability, its value is the sum of 12 hazard factors, it mainly reflect the risk degree of toxic substances, negative pressure, materiel combustion range, dust explosion, and the pressure of unit.

4. *Unit hazard factor* (F_3)

   F_3 reflects the potential risk of unit. It is the product of F_1 and F_2.

$$F_3 = F_1 \times F_2 \tag{94.1}$$

5. *Fire and explosion index* (*F&EI*)

   F&EI reflects the damage degree by fire and explosion.

$$F\&EI = F_3 \times MF \tag{94.2}$$

6. *Damage factor of unit* (*DF*)

DF reflects the comprehensive effect of energy release on unit. It is the non-linear function of F_3 and MF.

7. *Exposure radius* (*R*)

Explosion zone is commonly described as a cylinder, its height is same as exposure radius.

$$R = 0.256 \times F\&EI \text{ (m)} \quad (94.3)$$

8. *Safety compensating coefficient* (*C*)

C is the product of process control compensating coefficient C_1, materiel isolation compensating coefficient C_2, fire prevention measures compensating coefficient C_3 and safety management compensating coefficient C''.

9. *Maximum possible property damage* (*MPPD*)

Base MPPD reflects the whole property loss without any protective measure. Actual MPPD reflects the loss adopting some protective measures.

$$\text{Base MPPD} = \text{Property value} \times \text{DF} \quad (94.4)$$

$$\text{Actual MPPD} = \text{Base MPPD} \times \text{C} \quad (94.5)$$

10. *Maximum possible damage of operation* (*MPDO*)

MPDO can be estimated by MPPD.

94.3 Safety Evaluation of Storage Area

94.3.1 Fuel Depot Introduction

Fuel depot storages gasoline and diesel, it has 43,000 m^3 ground vertical gasoline tanks and 85,000 m^3 ground vertical diesel tank. Each fuel tank installs liquid foam fire control system and water spray and cooling system.

94.3.2 Calculating Evaluation Factors

1. *Material factor* (*MF*)

According to the principle that MF is defined by the dangerous materiel in unit, MF is selected on the basis of gasoline, its value is 16.

2. *Fire and explosion index* (*F&EI*)

On the basis of the Process and storage characteristics of fuel depot, F_1, F_2, F_3 and F&EI can be calculated by the corresponding parameters, shown as

Table 94.1 Fire and explosion index (F&EI)

Item	Dangerous factor range	Dangerous factor
1 General process hazard		
Base factor	1.00	1.00
A Exothermic reaction	0.30–1.25	
B Endothermic reaction	0.20–0.40	
C Material handling and delivery	0.25–1.05	0.85
D Closed or indoor process units	0.25–0.90	
E Channel	0.20–0.35	
F Emissions and leakage control	0.20–0.50	0.5
General process hazard factor F_1		**2.35**
2 Special process hazard		
Base factor	1.00	1.00
A Toxic substances	0.20–0.80	0.40
B Negative pressure	0.50	
C Inserting		
a. Flammable liquid in tank	0.50	0.50
b. Process disorders or purging fault	0.30	
c. Been burning range	0.80	
D Dust explosion	0.25–2.00	
E Pressure		
F Low temperature	0.86	
G Flammable and unstable physical energy	0.10–0.75	1.20
H Corrosion and abrasion	0.10–1.50	0.20
I Leak-joint and packing	0.10–1.15	0.10
J Using fire equipment		
K Heat oil, heat exchanging system		
L Rotating equipment	0.50	
Special process hazard factor F_2		**3.40**
3 Unit hazard factor ($F_3 = F_1 \times F_2$)		7.99
4 Fire and explosion index ($F\&EI = F_3 \times MF$)		128 (critical safety)
5 Exposure radius ($R = F\&EI \times 0.256$)		32.73

Table 94.1, F&EI = 128. According to the interrelation of F&EI and dangerous degree ruled by Dow's index method, it can be judged that the dangerous degree of fire and explosion of this unit is belonged to Critical safety.

3. *Safety compensating coefficient (C)*

According to the protective measures and safety management level of fuel depot, safety measures compensating coefficient $C' = 0.64$, safety management compensating coefficient $C'' = 0.90$, and the compensating coefficient of evaluation unit $C = C' \times C'' = 0.58$.

From Table 94.2 we can see that compensated F&EI of fuel tank area is dropped from 128 (belong to Critical safety level) to 78 (belong to safety level). It shows that system safety degree has been greatly improved by adopting safety protection measures and improving the level of safety management at the same time.

Table 94.2 Safety compensating coefficient

Item	Compensated factor range	Compensated factor
1 Process control		
a. Emergency power	0.98	
b. Cooling device	0.97–0.99	0.97
c. Explosion suppression device	0.84–0.98	
d. Emergency switching-off device	0.96–0.99	0.96
e. Computer control	0.93–0.99	
f. Inert gas protection	0.94–0.96	
g. Procedures/procedures	0.91–0.99	0.95
h. Chemical lively material inspection	0.91–0.98	
i. Other process risk analysis	0.91–0.98	
Process control safety compensating coefficient C1		**0.88**
2 Physical isolation		
a. Remote-controlled valve	0.96–0.98	0.98
b. Unloading/emptying devices	0.96–0.98	
c. Emission system	0.91–0.97	
d. Chain device	0.98	
Physical isolation safety compensating coefficient C2		**0.98**
3 Fire prevention facilities		
a. Leakage detection equipment	0.94–0.98	0.98
b. Steel structure	0.95–0.98	
c. Fire water supply system	0.94–0.97	0.94
d. Special fire-fighting system	0.91	
e. Spray and cooling system	0.74–0.97	
f. water curtain	0.97–0.98	
g. Foam fire extinguishing devices	0.92–0.97	0.92
h. Portable fire extinguisher and squirt gun	0.93–0.98	0.93
i. Cable protection	0.94–0.98	0.94
Fire prevention safety facilities compensation factor C3		**0.74**
Safety measures compensation factor $C'=C1 \times C2 \times C3$		0.64
Safety management compensation factor C''	0.85–0.98	0.90
Compensated fire and explosion index (F&EI) = F&EI $\times$ C' $\times$ C''		73.73

4. *Dangerous factor* (*DF*)

DF can be inquired in the correlation curves on the basis of unit hazard factor (F_3) and material factor (MF). In Table 94.1, F_3 = 7.99, MF = 16, according to the correlation curves the value of DF can be gained, DF = 0.68.

Table 94.3 Summary of unit hazard analysis of storage area

Item	Computing results
1. F&EI	128
2. Hazard level	Critical safety
3. Exposure radius	32.73 m
4. Dangerous factor	0.68
5. Safety compensating coefficient	0.58
6. Compensated F&EI	73.73
7. Compensated Dangerous factor	Safety
8. Base MPPD	5,353,000
9 .Actual MPPD	3,104,700
10. MPDO	50d

5. *Loss*

(a) *Affected area and property replacement value*

$$\begin{aligned}\text{Exposure radius}: \mathrm{R} &= 0.256 \times \mathrm{F\&EI} \\ &= 0.256 \times 128 = 32.77\mathrm{m}.\end{aligned}$$

Exposure zone: because fuel tanks are all located in fire dike, the leaked fuel will flow and scatter in fire dike, it should be taken fire dike as a starting point to calculate the effected area of radius R.

Property replacement value in exposure zone: Replacement value = Original cost × 0.82 × Growth factor. Growth factor is defined by engineering budget experts. If original cost is 8,000,000 Yuan, growth factor is 1.2, replacement value is 7,820,000 Yuan.

(b) *Property loss*

$$\begin{aligned}\text{Base MPPD} &= \mathrm{DF} \times \text{Replacement value} \\ &= 0.68 \times 7,820,000 = 5,353,000 \text{ Yuan}\end{aligned}$$

Actual MPPD = Base MPPD × Safety compensating coefficient C = 5,353,000 × 0.58 = 3,104,700 Yuan

(c) *MPDO*

According to actual MPPD, MPDO can be gained by inquiring relevant chart. In this example, MPDO value is about 50d.

Summarized results of unit hazard analysis are list in Table 94.3.

94.4 Conclusion

Because fuel stored in tank has significant risk for its flammable, explosive and toxic characteristics, people must to strength safety protective measures to reduce dangerous factor. Reviewing the history of fire and explosion accidents of fuel depot, the accidents caused by human errors and management drawbacks were the main reason. It is very necessary to take safety management factors into Dow's fire and explosion index method. By the improved Dow's method it can be avoided that only take facilities factors into account to evaluate the risk of fuel depot. Meanwhile in the process of safety evaluation people should pay enough attention to external factors, such as storage environment, meteorological condition, geological structure, surrounding facilities, and so on. If the external environments have some differences, accident consequences and property losses caused by fuel tank fire and explosion is also different. The state of facilities and its service time also should be taken into account. Based on the improved Dow's fire and explosion index method, other qualitative or quantitative safety evaluation methods can been used to comprehensive evaluate the system safety degree.

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Chapter 95
Study on Green Safety Degree in Construction Project Under Energy Conservation Idea

Dan-feng Xie and Su-lei Li

Abstract Under the guidance of energy conservation idea, combining measures of emission reduction within construction project, the article brings up the concept of green safety and green safety degrees and sets up an evaluation system composed of two levels, two indexes, 4 three-leveled indexes and 23 four-level ed indexes as well as establishes the two-leveled evaluation model in order to give a quantitative analysis of green safety in construction project, so that we can get the point that the green safety degrees and these degrees, which can judge the degree of safety in green construction. The calculated result is credible, providing reliable basis for the green construction safety management.

Keywords Construction project · Energy conservation idea · Green safety · Green safety degree

95.1 Introduction

The implementation of green construction take quality and safety as preconditions, with the goal of achieving four saving projects and one environmental protection (Energy-saving, Land-saving, Water-saving, Material-saving and Environmental protection),which belongs to the thought of "process cognitive" of the theory of sustainable construction thought (Hong et al. 2010). The focus of green construction are concentrated on how to achieve four saving projects and one

D. Xie (✉) · S. Li
Department of Engineering Management, Shandong University of Technology, Zibo, China
e-mail: xiedanfeng2001@126.com

S. Li
e-mail: lsulei@163.com

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environmental protection, however, the safety of the achieve measures (so called "green measures") is rarely mentioned. Taking green measures into the process of implementation of green construction is certainly important; however, "security" is also an inevitable question, just as there are safety factors in traditional construction, "green safety" throughout the whole process of the green construction.

95.2 The Meaning of Green Safety

Drawing on the definition of green construction, as well as current theoretical research, green safety and green safety degree are defined as follows:

Green safety, it is to point to in the green construction process, under the premise of achieve "four saving projects and an environmental protection ", to take the green construction of special programs to ensure the health and safety of construction workers, so that the project can be smoothly carried out in a green and safe condition, meets the safety requirements and with green construction principle.

Green safety degree, that is a quantitative index of the green safety evaluation of construction projects, it is used to measure the green degree of safety. The specific calculation method described below.

95.3 Establishment of Construction Project's Green Safety Degree Evaluation System

The establishment of the evaluation system considers two aspects, which are the green construction program and the green safety program. Green construction program indicators established to ensure that green construction's four saving projects and one environmental protection goals to be achieved, and to make sure that the implementation process of the construction project is green, low carbon, including the technology program indicators of green construction and the organization indicators of green construction; Green safety program indicators are considered from the perspective of the construction safety. When green measures are to be taken, whether there is adequate security measures to protect the personal safety of construction site or not. According to statistics, very year, there are about 50 % of injuries are caused by falls, electric shock, against objects and other reasons(Xijing et al. 2010). The implementation of green construction does not mean you can ignore the occupational health and safety, therefore, the article put green safety management program and green construction occupational health and safety program as green safety program assessment indicators. Specific indicators are shown in Fig 95.1.

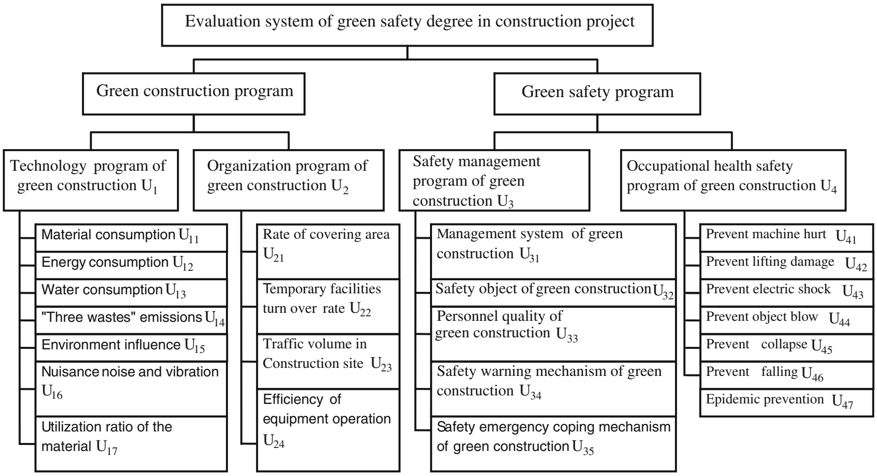

Fig. 95.1 Evaluation system of green safety degree in construction project

95.4 Establishment of the Green Safety Degree's Evaluation Model in Construction Project

As to the evaluation of green safety degree, the article combined with the case of the construction of a residential area in Shandong Province, to build two evaluation models, with the combination of the analytic hierarchy process and fuzzy comprehensive evaluation method to assess the green safety degree in construction projects.

A residential area in Shandong Province, architectural design uses outer wall insulation, hollow glass, ceramic cushion, and a series of new materials, new technologies, residential energy efficiency is expected to more than 50 %; construction process is required to take low-carbon emission reduction measures, and to take "energy-saving land-saving, water-saving, materials-saving, environmental protection" as green goals.

According to <Green construction guidelines>, the construction enterprise draws up the green construction program. In order to both achieve four environmental goals, but also to ensure the safety and reliability of the green measures, the construction enterprise sets up "the green safety degree 's evaluation system of construction project", it is shown in Fig. 95.1, and takes it as a basis to measure the green safety degree construction project.

95.4.1 Level Model—The Use of AHP to Determine the Grade of Green Safety Index of Construction Projects

AHP, that is Analytic Hierarchy Process, it is a decision-making method which can combine qualitative analysis with quantitative analysis together (Danfeng and Yutian 2011), its principle and method of calculation can be found in the literature (Danfeng and Yutian 2011).Article uses the AHP method, takes "green safety degree of construction project" in Fig. 95.1 as a target layer, takes the "technology program of green construction, organization program of green construction, safety management program of green construction, and occupational health and safety program of green construction" as principle layer, takes their respective lower-level indicators as sub-principle layer, then can calculate green safety indicators' weight of the residential area construction project. The article omits the judgment matrix and the calculation process, given Index weight of ordering in single level directly, on this basis, calculates the weight of ordering in total level, and then the grade of green safety indicators are determined.

(1) Index weight of ordering in single level and consistency check

In Table 95.1, R means the judgment matrix, the $R^{U\text{-}Ui}$ means the judgment matrix of principle layer to target layer, $R^{Ui\text{-}Uij}$ (i = 1,2,3,4,5) means the judgment matrix of sub-principle layer to principle layer. The row of judgment matrix is n, it is the number of index, the maximum eigenvalue is λ_{max}, the weighting vector is W, the consistency index is CI, CI = $(\lambda_{max}-n)/(n-1)$,. The random consistency ratio is CR, CR = CI/RI, RI is the average random consistency index, its value is shown in literature (Danfeng and Yutian 2011). Because CR $\leq$ 0.1, so the judgment matrix has satisfied consistency.

(2) The weight of ordering in total level and consistency check

Calculate the weight of basic indicators to total indicators, see formula (95.1).

Table 95.1 Index weight of ordering in single level and consistency check

R	Weight (W)	λ_{max}	CI	CR
$R^{U\text{-}Ui}$ (n = 4)	$W^{U\text{-}Ui} = [0.44, 0.16, 0.08, 0.32]^T$	4.1471	0.0490	0.0551
$R^{U1\text{-}U1j}$ (n = 7)	$W^{U1\text{-}U1j} = [0.17,0.10,0.30,0.06,0.04,0.03,0.30]^T$	7.7453	0.1242	0.0941
$R^{U2\text{-}U2j}$ (n = 4)	$W^{U2\text{-}U2j} = [0.07,0.54,0.15,0.24]^T$	4.1179	0.0393	0.4416
$R^{U3\text{-}U3j}$ (n = 5)	$W^{U3\text{-}U3j} = [0.29,0.37,0.18,0.06,0.11]^T$	5.0994	0.0249	0.0222
$R^{U4\text{-}U4j}$ (n = 7)	$W^{U5\text{-}U5j} = [0.07,0.05,0.10,0.16,0.24,0.36,0.03]^T$	7.2085	0.0348	0.0263

$$W^{U-Uij} = W^{Ui-Uij} \times W^{U-Ui} = \begin{bmatrix} W^{U1-U1j} & & & \\ & W^{U2-U2j} & & \\ & & W^{U3-U3j} & \\ & & & W^{U4-U4j} \end{bmatrix} \times \begin{bmatrix} 0.44 \\ 0.16 \\ 0.08 \\ 0.32 \end{bmatrix}$$
$$= [0.0741 \quad 0.0438 \quad 0.1338 \quad 0.0261 \quad 0.0194 \quad 0.0126 \quad 0.1031 \quad 0.0112 \quad 0.0860$$
$$0.0389 \quad 0.0456 \quad 0.0269 \quad 0.0823 \quad 0.0161 \quad 0.0119 \quad 0.0221 \quad 0.0146$$
$$0.0500 \quad 0.0759 \quad 0.1139 \quad 0.0112^{T} \tag{95.1}$$

Due to the non-consistency of the accumulation of all levels may lead to more serious non-consistency of ordering in total level, so it need to consistency check for the total ranking (Ruijun et al. 2009). The random consistency ratio CR of total ranking are shown in formula (95.2)

CR_i is the lower layer's random consistency ratio of ordering in single level, RI_i is the corresponding average random consistency index, W_i is the weight of higher layer's index. From formula (95.2), it is shown that the CR $\le$ 0.1, that is satisfactory consistency in total ranking. The results of formula (95.1) are shown in Table 95.2

$$CR = \sum_{i=1}^{4} CR_i \times W_i \Big/ \sum_{i=1}^{4} RI_i \times W_i = \frac{0.0941 \times 0.44 + 0.4416 \times 0.16 + 0.222 \times 0.08 + 0.0263 \times 0.32}{1.32 \times 0.44 + 0.89 \times 0.16 + 1.12 \times 0.08 + 1.32 \times 0.32} = 0.1 \tag{95.2}$$

(3) Determine the level of the green safety indicators. In the total ranking, define the primary level index as weight $\ge$0.1, it is the most important indicators, and take it as the focus in controlling; Define the secondary level index as 0.05 $\le$ weight < 0.1, it also should be brought to the forefront; Define the third level index as 0.02 $\le$ weight < 0.05, it should be given to the attention

Table 95.2 Index weight of ordering in total level

W^{U-U1j}	W^{U-U2j}	W^{U-U3j}	W^{U-U4j}
$U-U_{11}$:0.0741	$U-U_{21}$:0.0112	$U-U_{31}$:0.0456	$U-U_{41}$:0.0221
$U-U_{12}$:0.0438	$U-U_{22}$:0.0860	$U-U_{32}$:0.0269	$U-U_{42}$:0.146
$U-U_{13}$:0.1338	$U-U_{23}$:0.0239	$U-U_{33}$:0.0823	$U-U_{43}$:0.0323
$U-U_{14}$:0.0261	$U-U_{24}$:0.0389	$U-U_{34}$:0.0161	$U-U_{44}$:0.0500
$U-U_{15}$:0.0194		$U-U_{35}$:0.0119	$U-U_{45}$:0.0759
$U-U_{16}$:0.0126			$U-U_{46}$:0.1139
$U-U_{17}$:0.1301			$U-U_{47}$:0.0112

of the appropriate; Define the fourth level index as weights <0.02, it should be given to little attention.

From Table 95.2, U13, U17, U46 are the primary level index, U11, U22, U33, U44, U45 are the secondary index. These index should be taken as key control indicators in the green construction, because they determine whether the project can achieve green construction or not, as well as possible to ensure the security status of the green construction.

95.4.2 Level Model—Determine the Project's Green Safety Degree with the Use of Fuzzy Comprehensive Evaluation Model

Fuzzy Comprehensive Evaluation (FCE) is an evaluation and decision-making method of multifactor, the evaluation results are expressed as fuzzy sets, within the given scope, the membership grade of an element is not necessarily only "yes" or "No", there is intermediate state, with the real numbers between 0 and 1 to represent the membership grade. The article uses FCE to measure green safety degree of construction of a residential area. Its calculation steps are as follows:

1. Determine the object set, factor set and evaluation set

Take the construction of a residential area as the object set; The rank of green risk index is obtained by level model, it contains four levels, take green safety index of primary level and secondary level as the key index controlled in the construction process as well as the factor set of evaluating green safety degree, the factor set is shown as U, U = {U11,U13,U17, U22, U33, U44,U45,U46}; The green safety circumstances of the factors are evaluated according to actual conditions, evaluation set of green safety degree is established, it is shown as V, V = {higher, high, generally, lower, low}, the 5 grades is assigned as V = {5,4,3,2,1}.

2. Determine weight set as W, W is composed by index weight of ordering in total level. From Table 95.2, W = {0.0741, 0.1338, 0.1301, 0.0860, 0.0823, 0.0500, 0.0759, 0.1139}.
3. Create fuzzy evaluation matrix. According to the practical experience in construction or expert evaluation, a fuzzy mapping can be obtained from factor set to evaluation set, it expresses the membership grade of a factor to an evaluation degree (Hong et al. 2009), it is shown in Table 95.3

From Table 95.3, a membership grade matrix R_0 is obtained as a fuzzy matrix for evaluating green safety. R_0 is composed by fuzzy transform R_i, $R_0 = [R_5\ R_4\ R_3\ R_2\ R_1]^T$, see in formula (95.3)

Table 95.3 Table of fuzzy mapping

Evaluation set (Green safety rank)	Fuzzy mapping (Membership grade)					Describe	R_i (Fuzzy transform)
	Rank 5	Rank 4	Rank 3	Rank 2	Rank 1		
Higher	0.8	0.2	0	0	0	Mostly belongs to higher green safety Rank 5	R_5
High	0.2	0.6	0.2	0	0	Mostly belongs to high green safety Rank 4	R_4
General	0	0.2	0.6	0.2	0	Mostly belongs to general green safety Rank 3	R_3
Low	0	0	0.2	0.6	0.2	Mostly belongs to low green safety Rank 2	R_2
Lower	0	0	0	0.2	0.8	Mostly belongs to lower green safety Rank 1	R_1

$$R_0 = \begin{bmatrix} R_5 \\ R_4 \\ R_3 \\ R_2 \\ R_1 \end{bmatrix} = \begin{bmatrix} 0.8 & 0.2 & 0 & 0 & 0 \\ 0.2 & 0.6 & 0.2 & 0 & 0 \\ 0 & 0.2 & 0.6 & 0.2 & 0 \\ 0 & 0 & 0.2 & 0.6 & 0.2 \\ 0 & 0 & 0 & 0.2 & 0.8 \end{bmatrix} \tag{95.3}$$

4. Fuzzy evaluation of the green safety degree in the construction project: ("×" indicates that the matrix multiplication)

Green safety index are evaluated by experts, factor set U is obtained, it is shown in Table 95.4.

From Table 95.4, fuzzy evaluation matrix R is obtained, $R = [R_4R_2R_3R_1R_3R_4R_3R_5]^T$

Make P as the green safety fuzzy evaluation sets in construction project, then

$$P = W \times R = [0.1159 \quad 0.1549 \quad 0.2246 \quad 0.1551 \quad 0.0956] \tag{95.4}$$

Table 95.4 Fuzzy mapping of green safety for construction project

Fact-or set	W	Evaluation	Higher	High	General	Low	Lower	Transform R_i
U_{11}	0.0741	High	0.2	0.6	0.2	0	0	R_4
U_{13}	0.1338	Low	0	0	0.2	0.6	0.2	R_2
U_{17}	0.1301	General	0	0.2	0.6	0.2	0	R_3
U_{22}	0.0860	Lower	0	0	0	0.2	0.8	R_1
U_{33}	0.0823	General	0	0.2	0.6	0.2	0	R_3
U_{44}	0.0500	High	0.2	0.6	0.2	0	0	R_4
U_{45}	0.0759	General	0	0.2	0.6	0.2	0	R_3
U_{46}	0.1139	Higher	0.8	0.2	0	0	0	R_5

Normalize P, P' is obtained, P' = [0.1554 0.2076 0.3010 0.2079 0.1281], its meaning is: in this construction project, the membership grade of green safety to higher green safety rank 5 is 15.54 %, while it is20.76 % to high green safety rank 4, 30.10 % to general green safety rank 3, 20.79 % to low green safety rank 2 and 12.81 % to lower green safety rank 1.

Confirm the rank of green safety according to According to the principle of maximum membership grade. Take the maximum index, its corresponding evaluation set is the result. Since max{0.1554 0.2076 0.3010 0.2079 0.1281} = 0.3010, so the maximum value is the membership grade of high green safety rank 3, that is in this construction project, its green safety rank is high green safety rank 3. Because the green safety rank is general, it should be paid attention, and should strengthen the control measures of green safety further.

5. To calculate the green safety degree

Make v as the green safety degree, that is, quantized the green safety rank further; it is shown in formula (95.5)

$$v = P' \times V^T = [0.1159 \quad 0.1549 \quad 0.2246 \quad 0.1551 \quad 0.0956] \times [5 \quad 4 \quad 3 \quad 2 \quad 1]^T = 3.0543 \tag{95.5}$$

It means in this residential area's construction process, its green safety degree is 3.0543. According to the evaluation result, green safety degree is general, it is shown that the construction project realizes green construction in a certain extent, also can consider the safety measures in green construction process.

95.5 Conclusions

The article presents the definition of green safety and safety degree, and set up a corresponding evaluation index system, gives two level evaluation models. First, analyze the grade of green safety index of construction projects with the use of the Analytic Hierarchy Process (AHP), determine the focus of 1,2 index as the most important index in controlling; Second, determine the project's green safety degree with the use of fuzzy comprehensive evaluation model, and to measure the degree of green safety in construction project. As the two level evaluation methods both use the relevant data to conduct an objective evaluation, the result is credible, and can provide a reliable theoretical basis for the green construction's safety management.

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Chapter 96
Study on the Classification of Performance Shaping Factors in Digital Control System of Nuclear Power Plants

Peng-cheng Li, Li Zhang, Guo-hua Chen, Li-cao Dai and Ming Zhao

Abstract In order to identify the performance shaping factors (PSFs) which influencing operator's reliability in digital control system of nuclear power plants (NPPs), the comparative analysis of the representative contextual characteristics between traditional analog control system and digital control system is carried out by means of literature research, field observation and interviews in this paper, and identify the typical PSFs in terms of technical system, human–computer interface, procedure system, task, and team communication and cooperation. The classification of PSFs has been collected from existing PSF taxonomies of human reliability analysis (HRA), human error analysis (HEA), and organizational factors classification and performance evaluation methods, and based on the established classification criterion and classification framework (the conceptual causal model of human error), the relative comprehensive classification system of PSFs is built to provide the reference to HEA and HRA in digital control systems of NPPs.

Keywords Digital control system · Human reliability · Nuclear power plant · Performance shaping factors

P. Li · L. Zhang · L. Dai · M. Zhao
Human Factor Institute, University of South China, Hengyang, China

P. Li (✉) · G. Chen
Institute of Safety Science and Engineering, South China University of Technology, Guangzhou, China
e-mail: lipengcheng0615@163.com

L. Zhang
Hunan Institute of Technology, Hengyang, China

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96.1 Introduction

All human action is performed under a specific context, i.e., conditions that are situational (such as cues from plant instrumentation) or environmental (such as the time available in which to perform an action) (Dougherty 1993). Therefore, the contextual factors are the main factors that affect operator's reliability, and a lot of research work related above has done by the relevant researchers, such as performance shaping factors (PSFs) has been classified into subjective goals and intentions, mental load and resources, affective factors, task characteristics, physical environment and work time characteristics by the NEA Committee on the Safety of Nuclear Installations (CSNI). Swain and Guttman (1983) divide PSFs into three categories including external PSFs, stressor PSFs, and internal PSFs, and Hollnagel (1998) classifies PSFs into nine common performance conditions (CPCs) and so on. However, there is overlap, abstract, crossed and non-orthogonal in the classification systems, which makes the results of human error analysis lack consistency, and the possibility of double-counting PSFs effects when quantifying the HEP. Furthermore, with the rapid development of computer, control, and information technology, the instrumentation and control (I&C) system of nuclear power plants is transformed from traditional analog control to digital control, the man–machine interface (MMI) in control room is transformed from the traditional monitor and control board to the computer-based workstation, thus the very differences between operating environment in advanced digital main control room and the environment in traditional analog control room makes the PSFs influencing human reliability change, such as technology system, human-system interface, procedure system et al. Therefore, the classification of PSFs in digital control system of NPPs is developed, which is conducive to human error analysis and HRA.

96.2 The Contextual Characteristics in Digital Control System

Although digital I&C system offers many advantages when compared to the traditional analog I&C system, such as carrying out correction and compensation under a variety of disturbances, not set-point drift, a number of improvement of functions including fault tolerance, self test, automatic calibration, etc., from the viewpoint of human error and reliability, the occurrence of new characteristics of digital control system makes the contextual factors influencing human reliability change, it is possible to produce new effects. Specifically, there are overt differences in term of technical system, human–machine interface, procedures systems and so on between digital systems and analog systems (Committee on Application of Digital Instrumentation and Control Systems to Nuclear Power Plant Operations and Safety, National Research Council 1997; Hara et al. 2002, 2000; Dusic 1997; Lee and Seong 2009), as shown in Table 96.1. In addition, 5 operation teams of 20

Table 96.1 The comparison of contextual characteristics between conventional analogy control system and advanced digital control system in nuclear power plants

Dimensions		Analogy control system	Digital control system	Typical PSFs in digital system
Technical system		Insufficient function, poorer performance, lower hardware reliability, Single indicator, single parameter, and single target control	High level of automation, high system reliability, multi-parameters, the multi-objective control	Level of automation; Complexity; Available time; Response speed/delay; Reliability
Human-Machine interface	Information display	Analogy display, the information displayed largely is the underlying, concrete parameters (component layer)	Computer-based digital display, large screen display the overview of system, no set-point drift, more and more detailed information are displayed, a lot of information are the integrated abstract information (system layer)	Structure relationship of the screens; Information display format; Information understandability; Amount of information displayed; Consistency of information in different displays
	User Interface Interaction and Management	Shift supervisor authorizes operator to carry out user interface management, to get information back and forth in control room, to implement operation tasks back and forth, frequently communication between team members	The authority of shift supervisor is relatively reduced because of information sharing, information is obtained by sitting position on computer-based workstations, and add interface management tasks, the control activities are implemented by clicking the mouse with sitting position on computer-based workstations, the communication between team is relatively reduced	Keyhole effect; Interface management tasks
	Operation control	Hard control (physical)	Soft Control (virtual icon)	Cognizability of Software control icon; Location of the soft control icon on the display; Ease of operation of soft controller; Type of soft control; Data input and state feedback of controller
	Alarm system	The tile-style alarm system, alarm is identified through alarm light plate. The presence of alarm is more intuitive and clear, but there are too much interference alarm and condition information	With alarm processing functions, including alarm classification, filtering, suppression and priority discrimination.	Ease of discrimination of alarm; Easy of search of alarm

(continued)

Table 96.1 (continued)

Dimensions	Analogy control system	Digital control system	Typical PSFs in digital system
Procedure system	Paper-based procedures	Computer-based digital procedures	Display format; Function/usability/validity; Complexity; Understandability
Task	The tasks of operators are characterized by monitor and operation, and operation is predominant	The tasks of operators are characterized by monitor, identify, diagnose, and operation, the cognitive tasks are predominant, and add interface management tasks (the secondary task)	Type of task; Complexity of task
Team communication and cooperation	Information is not shared, the board operators need timely to patrol board, from which the results about parameter are reported the shift supervisor, and communication and cooperation are frequent between operators	Information sharing, communication and cooperation are carried out between operators according to the requirements of digital or electronical procedure, and communication is more convenient because of the closer stations. In addition, the role of coordinator is wardship, and the role of safety engineer is correct and restore functions	Team structure and the level of personnel allocation; Role and responsibility of team members; Team communication; Team cooperation and coordination

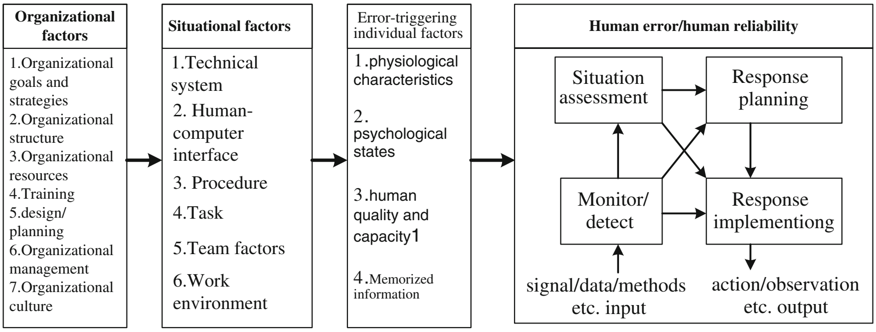

Fig. 96.1 The conceptual causal model of human error

people are interviewed and investigated (semi-structured questionnaire) to identify the typical PSFs impacting human reliability, each operator has more than 6 months of digital simulator training experience. 20 valid questionnaires are received runs a total of 20 team members were surveyed, the results of investigation are shown in Table 96.1, the more specific and major PSFs are identified according to the various dimensions, for example, the factor of technical system is divided into various sub-factors including automation level of technical system, complexity, available time to complete the task determined by technical system, system response speed/delay, and system reliability, as shown in Table 96.1. Operator's performance is differently influenced by these main and specific sub-factors, for example, Kaber and Endsley (2003) studied the effects level of automation and adaptive automation on human performance, workload and situation awareness. The results show that operators can not get some important information accurately and timely because of the increase of the level of automation, which leads to wrong cognition, wrong operation, and ultimately gives rise to serious consequences, this is so-called "out-of-the-loop". Out-of-the-loop performance problems are characterized by a decreased ability of the human operator to intervene in system control loops and assume manual control when needed in overseeing automated systems.

96.3 The Classification of PSFs

Human reliability is influenced not only by situational factors, but also by other factors, such as individual and organizational factors. Therefore, on the premise of the identified typical classifications of situational factors related above in digital control systems, and recollect the classification of PSFs in the first generation (THERP, HCR, SLIM, HEART), the second generation (CREAM, ATHEANA, CAHR) and third generation HRA (OPSIM, IDAC). And also consider the classification of PSFs in the CSNI classification, SPAR-H and the HRA good

Table 96.2 The classification of individual, situational and organizational factors

Influencing factors	Subclass	Specific factors
Individual factors	Psychological state	Cognitive modes and tendencies: alertness, attention to current task, attention to surrounding environment, cognitive bias, Stress: frustration, conflict, pressure, uncertainty. Strains and feelings: time-constraint load, task-related load, non-task related load, passive information, confidence in performance. Perception and appraisal: perceived severity of consequence associated with current diagnosis/decision, perceived criticality of system condition, perceived family with situation, perceived system confirmatory/contradictory responses, perception of alarms (quantity, intensity, importance), perceived decision responsibility, perceived complexity of strategy, perceived task complexity, perception of problem-solving resource, awareness of role/responsibility, done quickly psychology, habit psychology. Intrinsic characteristics: motivation (desire, demand), attitude, morale, character and personality, self confidence, problem solving style
	Physiological state	Suddenness of onset, pain or discomfort, fatigue, hunger or thirst, physical movement constriction, lack of physical exercise, disruption of circadian rhythm, sensory loss, individual size/body condition
	Memorized information	None or incorrect of Recall perceptual information, none or incorrect of memory of previous execution action, none or incorrect of memory of current execution action (diagnosis, action and results), none or incorrect of memory of prospective execution action sequence, none or incorrect of memory of the stored information (procedural and declarative knowledge)
	Quality and capability	Knowledge, experience, skills/capacity, social roles, and level of moral
Situational factors	System	Degree of automation, the complexity of system, redundancy of system, system reliability, software reliability, compatibility and coupling degree of system configuration, inspection and test of output of system, system feedback, response speed/delay of system, number and speed of information presentation, information interference, number of simultaneous goals, required judgment beyond level of skill and experience, time stress/available time determined by system design
	Human–computer interface	Monitor and controller reliability, structure relationship of screens, range of display, display precision, display information cognizability, display information understandability, accessibility of control equipment, operability/availability of control equipment, accuracy of controlled location, requirement of special tools, complexity of interface management tasks, information display format, amount of information displayed, consistency of information in different displays, cognizability of software control icon, location of soft control icon on display, ease of operation of soft controller, type of soft control, data input and state feedback of controller, ease of discrimination of alarm, easy of search of alarm, keyhole effect

(continued)

Table 96.2 (continued)

Influencing factors	Subclass	Specific factors
	Task	Perceptual requirements, motor requirements (speed, strength, precision), anticipatory requirements, interpretation of task, task complexity, narrowness of task, frequency and repetitiveness of tasks, task criticality, required long-term and short-term memory, calculation requirements, results feedback (knowledge of results), task type (dynamic VS step-by-step activities), task novelty, task speed requirements, high jeopardy risk, threats (failure, loss of job), nature of task (monotonous, degrading or meaningless work)
	Procedure	Format or type of procedure, logic structure, forms of presentation, function/availability/validity of procedure, complexity, level of detail, accuracy requirement to activity, adequacy and integrity of description of warnings and cautions, activity criterion, understandability of procedure, interpretation margin, number of steps, required time for completion, clarity of instruction and terminology, level of standardization in use of terminology, decision making criterion, number of logical conditions (branches), number of simultaneous tasks
	Environment	Physical access, temperature, humidity, air quality, radiation, lighting, color, noise, vibration, degree of general cleanliness, G-force extremes, atmospheric pressure extremes, oxygen insufficiency, external interference/distraction events
	Team factors	Team structure and level of personnel allocation, type of team communication, quality and validity of communication, team cohesion, team leadership, team cooperation and coordination, dynamic characteristics of team, role and responsibility of team
Organizational factors	Organizational goals and strategies	Organizational objective (safety, performance): lack of objective, integrity objective system, consistency of objective system, priority of objective system, objective specificity, contradiction between current objective and long-term objective,
		Strategy: organizational policies/systems, formulation of high level plans, work methods/strategies, centralization of organizational decision-making, priority of management, problem identification and solution, determination of organizational structure, responsibilities, authority, organization/workshop practices
	Organizational structure	Number of staff, control range, number of organizational level, location of decision/authority, roles and responsibilities, authorization, communication paths
	Organizational resources	Information resources: superior instruction, information of analysis method, information of process, manual of activities, methods, tools
		Material resources: equipment, tools, parts, materials
		Human resources: employee selection, performance evaluation, reward/incentive
		Economic resources: available funds. Time resources: effective time, available time
		Other resources: such as space resources

(continued)

Table 96.2 (continued)

Influencing factors	Subclass	Specific factors
	Organizational Management	Organization: task allocation, personnel allocation, resource allocation, time arrangement, shift organization, work preparation, staff placement
		Management: level of management such as human resources management
		Control: supervision, control (such as quality control), verification and evaluation
		Leadership: Leadership
		Coordination: cooperation and coordination
	Education/Training	Way of training, training programs, training tools, required resources allocation of training, special education support, supervision of the training process, evaluation of training effectiveness, quality assurance of training
	Organizational culture	Organizational climate: organizational cohesion, organizational knowledge, organizational learning, information sharing, sense of belonging of employees, group identity
		Safety culture: tradeoff between safety and economy, safety standards and rules, safety attitudes, safety practices, safety measures, experience feedback, violations, documentation
	Organizational plan/design	Strategic planning, safety planning, objective design, system design, work process design, programming/procedure design, work design

practices, and combine with the study results of classification of organizational factors from the previous studies (Li et al. 2009) in order to extend the classification of PSFs in digital control system of NPPs. The classification follows five principles of classification: (1) concrete, (2) assessable and measurable, (3) non-repetitive and non-cross, (4) consistency, (5) comprehensive, and according to the established conceptual framework developed on the basis of the organization-oriented causal model of human error (see Fig. 96.1) to determine the detailed classification of organizational factors (the specific classification of organizational factors may be a process, such as planning formulation, task allocation, it may indicate a state, such as lack of goals, the number of personnel, and it may indicate the certain property of upper-layer factors, such as the style of training, etc.), situational factors, and individual factors, as shown in Table 96.2.

96.4 Conclusions

After digital technology is drawn into high-risk systems, the situational conditions where operators work have been changed, so that the classification of PSFs has also been changed. The authors analyze the contextual characteristics of digital control system of NPPs, then the classification of PSFs of digital control system is analyzed in detail based on the collected data of PSFs, classification principles and the established conceptual causal framework of human error in order to provide a reference to human error analysis and human reliability analysis in digital control system of NPPs. However, the interactive relationships, relative importance, and degree of relatedness between PSFs are to be resolved in the future study.

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Chapter 97
Study on the Risks of Mining Logistics System Based on System Dynamics Model

Li-jun Liu and Xiao-ji Guan

Abstract There exist various risks in the operating process of mining logistics system. The main aim of constructing risk system dynamic model of mining logistics system is to recognize the risk structure of the logistics system, to study the operating mechanism of risk system from a combination of qualitative and quantitative perspectives, to analyze the operating characteristics of the system, to discover the dominant factors which play in the changes of risk system, and to predict future behavior to provide valuable references for the improvement of system behavior and the enaction of proper control strategy of system risk.

Keywords Logistics system · Risk · System dynamic model · Third-party logistics

97.1 Introduction

As a collection of node enterprises which depend on each other and cooperate closely, building around core enterprises (such as coal enterprises) to meet users' needs, mining logistics system is a community of the same interest which has dynamic alliance characteristics. During the operation of logistics system any problem of any link will cause instability of the entire system resulting in the risk of the logistics system, which led to the loss of node enterprises, such as supply disruptions of coal materials needed, coal products not being timely served to the users. As a result, it can improve the efficiency of mining logistics system, reduce the costs of it, realize the maximize benefits of coal enterprises, protect the environment, promote the completion of the emission reduction targets and ensure the

L. Liu (✉) · X. Guan
College of Management Science and Engineering, Shandong Institute of Business and Technology, Yantai, China
e-mail: llj2002-1@163.com

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healthy development of coal mining industry by analyzing the risk factors of mining logistics system systematically, identifying those factors that influences the sustained and stable operation and performance of the logistics system and even causes the risk of it, and by taking effective control measures to reduce the probability of risk occurring (Dan 2006; Tao and Fang 2007; WU 2005; Feng 2005).

From the perspective of system analysis, mining logistics system is a complex network system made of multiple nodes enterprises, such as coal, ore material suppliers, third-party logistics service providers, users, etc. Therefore, in carrying out system analysis, the risk characteristics of the logistics system should be analyzed first and then system risk factors and risk consequences identified which can put forwards the main risk of the mining area logistics system, and the mechanism of risk occurrence explained (Zhao et al. 2008; Wang 2009).

There exists risk in mining logistics system, including cost risk, quality risk, collaborative risk, and mechanism risk (Liu 2006; Wong 2009; Qiu 2007; Juan 2007):

1. Cost Risk: It refers to the possibility of the actual cost of logistics outsourcing higher than expected costs of coal enterprises due to the opportunism of the third-party logistics service providers, poor supervision and management of the coal enterprises or asymmetric information in the course of the operation of the mine logistics system.
2. Quality Risk: It refers to the possibility of mass loss to the coal enterprises due to capacity constraints of third-party logistics service providers, or a lack of coordination and communication that causes the quality of logistics service cannot reach the requirements of coal enterprises.
3. Collaborative Risk: It refers to the possibility that coal enterprises rely on third-party logistics service providers or even are under the control of them in the logistics operation due to the resource monopoly, small number or the complexity of logistics system structure of third-party logistics service providers.
4. Mechanism Risk: It refers to the possibility that the interests of node business cannot be met due to goal conflicts of node business, lack of effective mechanism of coordination and communication and constraints and incentives and the unfair distribution of profits of node enterprises in the logistics system.

The paper divides the risk model structure of mining logistics system into four subsystems: risk factors subsystem, risk subsystem, performance subsystem, and risk control strategy subsystem.

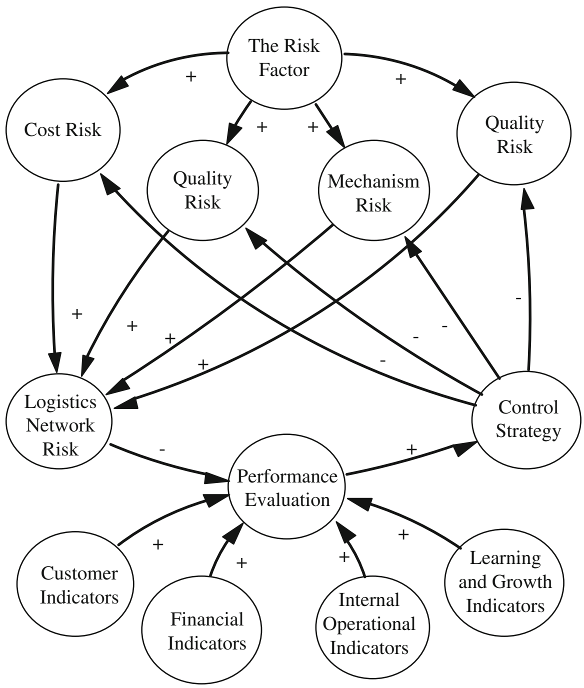
1. Risk factors subsystem: The risk of mining logistics system comes from the internal of the system, including three aspects: the risk of the enterprise itself (coal, a third-party logistics service providers and users or suppliers), between enterprises and between system network.
2. Risk subsystem: The goal of the coal logistics system is to reduce costs and improve logistics performance and enhance business efficiency. When outsourcing logistics to third-party logistics service providers, the coal enterprises are most worried about the possibility of not achieving the desired effects, that

is, risk—the likelihood of loss. Risk subsystem is mainly composed of cost risk, quality risk, collaboration risk and mechanism risk.

3. Performance subsystem: Through the evaluation of the performance of logistics service providers, it enables the coal enterprises to better analyzes the problems in the mining logistics system, comprehensively judge the logistics level of third-party logistics service providers so that they can detect problems in time, identify risk and ensure the effective operation of the logistics system. The paper constructs performance subsystem from the aspects of finance, users, internal business and learning and growth by drawing on the balanced scorecard performance measurement system.
4. Risk control strategy subsystem: In this paper, four kinds of risk control strategies are put forward: process management of the system, contract management, performance management and relationship management. The main purpose is to strengthen the control of logistics and information flow within the system through process management and performance management to increase the responsiveness to the needs of users, reduce logistics costs, and improve the quality of logistics services; and to strengthen the communication and coordination between the internal node enterprises through contract management and relationship management to reduce the conflicts between the enterprises and cut down the dependence on third-party logistics service providers.

Mining logistics system risk model structure is shown in Fig. 97.1.

Fig. 97.1 Mining logistics system risk model system structure



97.2 The Risk System Dynamics Model of the Mining Logistics System

97.2.1 Causal Relationship of Mining Logistics Risk Model

Causal feedback effects in the risk system dynamics model of the mining logistics system will be mainly reflected in the interaction of risk system and performance system. When the system risk is controlled within the acceptable range, the increase of system performance will enable each node enterprise in the system to get profits; while when the risk is in the state of continually increase, system performance will decline and continue to decrease the interests of enterprises. The system will be in a vicious cycle at this time (Sun 2006a, 2006b; Liang 2004; Zheng 2006; Dai 2000).

Risk system of logistics system is a negative feedback system, whose feedback loop can be described as: risk factors–risk–performance–the gap to the expected system interests–risk control strategy–risk factors. It contains four basic modules: the system state, the desired goal, bias and correction. When risk factors increases, the risk must increase, which will reduce system performance, thereby enlarge the gap between the desired goals; the greater the gap is, the more incentive the coal enterprises will have to further strengthen risk control strategies to reduce risk factors and cut down risk. It will circulate all the time until it reaches the desired goals of the coal enterprises. At this time the system will be in a stable state (Shown in Fig. 97.2).

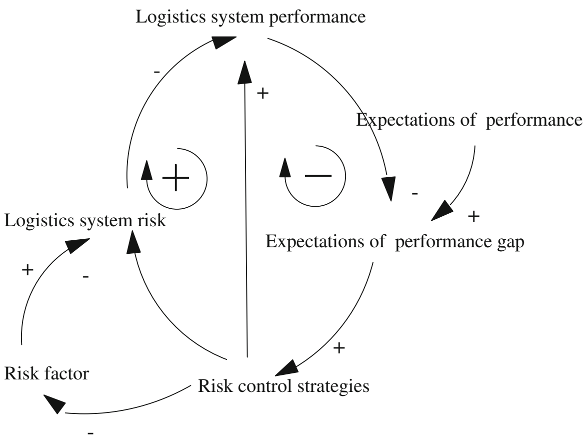


Fig. 97.2 Risk model of causality

97.2.2 The Dynamics Model of Risk System

Based on the above analysis of the causal relationship of the mining area logistics system risk system, the risk system dynamics model of mining logistics system is established.

97.3 Model Simulation and Analysis

97.3.1 Parameter Determining

1. Risk factors: In this paper, eight kinds of risk factors are considered: opportunism, the degree of information sharing, service capabilities, resource monopolies, changes in needs of users, coordination and communication, the number of service providers and network complexity. Four kinds of risk will be given simulation analysis by making use of the above factors.
2. Logistics system performance: Logistics system performance includes four aspects of evaluation: users, learning and growth, internal management and finance. If their initial state values are assumed to be 0.7, the expected performance value of outsourcing companies is 1. Since the initial value is only a reference value, there is little effect on the run of model.
3. Other parameters: The basic structure of the system dynamics model is the feedback whose behavior is not sensitive to initial parameter values, mainly depending on the model structure rather than the magnitude of the parameter. Therefore, the requirement of the accuracy of its model parameters is not very strict. It just can meet the modeling requirements. So the data that cannot be obtained in the model can be given a reasonable estimation by taking effective parameter estimation and ensuring the confidence of the model data and simulation results.

97.3.2 Model Equation

The main model equations are as follows:

$$\begin{aligned}\text{Opportunism} = {} & \text{Information Asymmetry}^{*}2/3 + \text{Decision Unilateralism}/6 \\ & + \text{Lack of Supervision}/6;\end{aligned} \tag{97.1}$$

$$\text{Cost Risk} = \text{INTEG (happen1} - \text{loss1} - \text{reset1, 30);} \tag{97.2}$$

$$\text{Quality Risk} = \text{INTEG (happen2} - \text{loss2} - \text{reset2, 40);} \tag{97.3}$$

$$\text{Mechanism Risk} = \text{INTEG (happen3} - \text{loss3} - \text{reset3, 15);} \tag{97.4}$$

$$\text{Collaborative Risk} = \text{INTEG}\ (\text{happen4} - \text{loss4} - \text{reset4},\ 40); \tag{97.5}$$

$$\begin{aligned}&\text{Logistics Network Operation Risk}\\&= \text{ZIDZ}\ (\text{Cost Risk} + \text{Mechanism Risk} + \text{Collaborative Risk} + \text{Quality Risk},\ 3);\end{aligned} \tag{97.6}$$

$$\begin{aligned}&\text{Operation Performance}\\&\quad = (\text{Finance} + \text{Internal Operation} + \text{Users} + \text{Learning and Growth})/\\&\quad 4 - \text{IF THEN ELSE}\ (\text{Logistics Network Operation Risk} \geq 40,\\&\text{Logistics NetworkOperation Risk}/400, -0.15);\end{aligned} \tag{97.7}$$

$$\text{Expected Performance Gap} = \text{Expected Performance} - \text{Operation Performance}; \tag{97.8}$$

$$\begin{aligned}&\text{Contract Management}\\&\qquad = \text{IF THEN ELSE}\ (\text{Expected Performance Gap} \leq 0.1, 0.9,\\&\qquad \text{IF THEN ELSE}\ (\text{Expected Performance Gap} \leq 0.3,\ 0.6,\ 0.1));\end{aligned} \tag{97.9}$$

$$\begin{aligned}&\text{Process Management}\\&= \text{WITH LOOKUP}\ (\text{Expected Performance Gap},\\&([(0,0) - (1,1)], (0, 0.98), (0.05, 0.975), (0.1, 0.965),\\&(0.15, 0.95), (0.2, 0.88), (0.25, 0.8), (0.3, 0.7), (0.35, 0.57), (0.4, 0.42),\\&(0.45, 0.22), (0.5, 0.03), (1, 0));\end{aligned} \tag{9.10}$$

$$\begin{aligned}&\text{Performance Management}\\&= \text{WITH LOOKUP}\ (\text{Expected Performance Gap}, ([(0,0) - (1,1)],\\&(0, 0.98), (0.05, 0.97), (0.1, 0.95), (0.15, 0.9), (0.2, 0.82), (0.25, 0.72),\\&(0.3, 0.58), (0.35, 0.42), (0.4, 0.28), (0.45, 0.12), (0.5, 0.03), (1, 0));\end{aligned} \tag{9.11}$$

$$\begin{aligned}&\text{Relationship Management}\\&= \text{WITH LOOKUP}\ (\text{Expected Performance Gap},\\&([(0,0) - (1,1)], (0, 0.98), (0.05, 0.95), (0.1, 0.92), (0.15, 0.89), (0.2, 0.85),\\&(0.25, 0.8), (0.3, 0.72), (0.35, 0.62), (0.4, 0.5), (0.45, 0.32),\\&(0.5, 0.1), (0.6, 0.02), (1, 0));\end{aligned} \tag{9.12}$$

$$\begin{aligned}\text{User} = {} & (\text{New users get} + \text{User Retention Rate} + \text{User Satisfaction}\\& + \text{User Profitability})/4;\end{aligned} \tag{9.13}$$

$$\begin{aligned}\text{Financial} = {} & (\text{Net Assets Yield} + \text{Cash Turnover} + \text{Return on Capital}\\& + \text{Total Assets Turnover})/4;\end{aligned} \tag{9.14}$$

$$\text{Internal Operation} = (\text{Innovation} + \text{Production Process} + \text{After} - \text{Sales Service})/3; \tag{97.15}$$

$$\begin{aligned}\text{Learning and Growth} = (&\text{Process Improvement Rate} + \text{Information Sharing Rate} \\ &+ \text{New Knowledge and Technology Utilization Rate})/3;\end{aligned} \tag{97.16}$$

97.3.3 Results and Analysis of Model Runs

Risk system dynamics model of mining logistics system is simulated in application of Vensim software. And the simulation time is three years, total 36 units.

1. Performance Analysis. At the beginning of the system operation, operational performance is not satisfactory due to lack of experience and the just beginning of the operation of the coal mining enterprises with third-party logistics service providers. It can be seen from Fig. 97.3 that operational performance plummets from the fourth month and shoots up from the eighth month, which mainly results from the delay of the existing time of risk control. From the first to the fourth month, the system performance was in flat trend. There are small changes. In about the seventh month, it bottoms out. In the eighth month, performance presents a gradually rising trend and the risk control mechanisms begin to work, inhibiting the occurrence of various risks and promoting the growth of the performance.
2. Risk Analysis. Figure 97.4 is the chart of the system risk trends. It can be seen from the figure that the risk is in the downward trend in the first and second months, because the cooperation of all parties has just begun and all kinds of contradictions don't appear. From the second month to the fifth month, the risk rises and fluctuates sharply which is the combined result of various risk factors.

Fig. 97.3 Performance trend chart

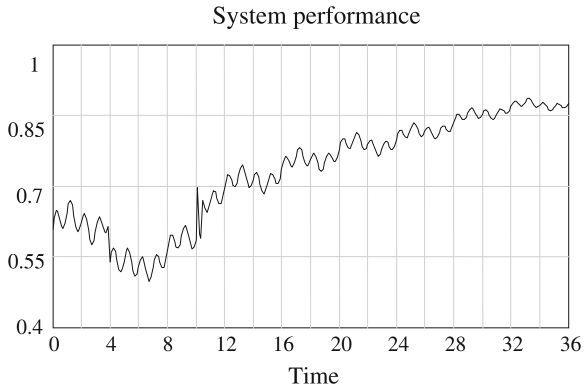
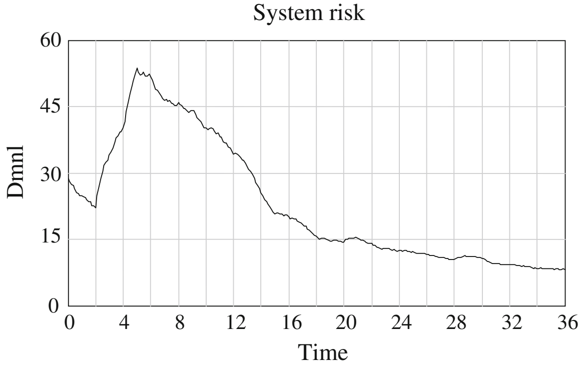


Fig. 97.4 Risk trend chart



After the sixth month, the risk trend declines gradually. It is a variety of risk control strategies that work. The overall system risk appears to goes downward smoothly.

The development trend of four kinds of risk is similar to that of system risk substantially, but differences exist between volatility and time.

The cost risk mainly comes from opportunism of third-party logistics service providers, service capabilities, as well as the demand fluctuations of coal enterprises. It can be seen from the figure that its incidence has four larger fluctuations, resulting in the fluctuations of cost risk over the same period. The change of the control rate is related to the gap of the system operation performance. During the beginning of the system operation, the level of risk control is low, resulting in the increased performance gaps. With the increase of control degree, the control rate also increases. It can be seen from the figure, the control rate of cost risk declines from the eighth month, and rises during the remaining periods. The cost risk and control rate go into a reverse trend. The cost risk presents a downward trend in the first two months and an upward trend from the second to the sixth month which is caused by the time delay of the control effect. After that, the cost risk is in a volatile decline trend.

Quality risk mainly comes from the service capability of logistics service providers, opportunism, communication and coordination and information sharing degree. After the system operates for a period of time, the communication and coordination ability between the coal enterprises and third-party logistics service providers and information sharing degree enhance, which suppresses the opportunistic behavior of logistics service providers to a certain extent. The incidence of the quality risk declines gradually, which shows a gentle downward trend in the latter period in addition to an increase from the second to the sixth month. It is mainly controlled through contract management, process management and performance management. Due to the delay of time, the control rate has an oscillation with a large volatility near the eighth month, followed by an upward trend.

Mechanism risk mainly comes from the fluctuations of users' demand, the service capability of logistics service providers and the complexity of network.

Because of the characteristic that the fluctuations of users' demand are unexpected, the incidence of mechanism risk has four large volatilities. Control rate is reflected mainly through process management, performance management and relationship management. Because of the time delay, it reduces to a minimum in the seventh month and then begins to grow after the reflection of the effect of various control measures. The variation trend of mechanism risk and the control rate go into a reverse shock downward trend.

Collaboration risk mainly comes from the fluctuations of users' demand, the resources monopoly, network complexity and the number of third-party logistics service providers. The incidence of collaborative risk has a big fluctuation. The control rate is mainly reflected through contract management and relationship management, becoming flat gradually after a shock rise in the initial period of the incidence. With the growth of the control rate, the variation trend of collaboration risk shows a gradual downward trend.

3. Risk control. Enterprises should strengthen risk management before, during, and after the operation of logistics system, due to the various risk factors existing in mining logistics system.

Control in advance refers to setting performance standards and risk early warning system before the operation of the logistics system. The control program runs before the risk occurs, taking the hedge against possible future risk as the orientation, also known as feed-forward control.

Control in the process refers to the control of taking appropriate measures immediately to eliminate risk when risk occurs, also known as real-time control, on- site control.

Control after the event refers to taking control procedures and correcting the problem after the risk occurs, also called feedback control.

It is generally believed that the pre-control > things in control > post-control.

Control in advance is the best, but needs timely and accurate information and a reasonable estimate of future risk; control in the process allows the standardization of network operational procedures, but needs rapid action and accurate judgment; control after the event can measure whether the plan is reasonable, enhance the consciousness of network risk control and find out the gap, but it is too late to remedy the situation.

97.4 Conclusion

Through the simulation analysis of the risk system dynamics model of the mining logistics system, it can be found that the variation trend of cost risk, quality risk mechanism risk and collaborative risk is not continued to decrease, but shows some volatility. Due to the gap between the actual operational performance and the expected performance of coal enterprises, coal enterprises can be encouraged to adopt a variety of control measures, including strengthening contract management, performance management, process management and relationship management. Because of the time delay, these measures can not become effective immediately, which leads to the risk volatility. Overall, the various risks show a shock downward trend and the gap between the system performance and the expected performance of coal enterprises continues to lessen. It can be seen that the effectiveness of risk control is the key factor in suppressing the happening of risk. Meanwhile, the time delay of the implementation of control measures is an important factor that affects the system risk control.

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Chapter 98
The Causes and Consequences Analysis of Fire and Explosion Accident Happened in Buried Oil Tank of Gas Station

Xu-dong Ding, Wen-hua Song and Zhen Chen

Abstract This paper has used the means of accident tree analysis and Dow chemical analysis to discuss the causes and consequences of fire and explosion accidents happened in buried oil tanks of gas station qualitatively and quantitatively. The conclusion is that using the accident tree analysis has got 85 minimum cut sets which can lead to the explosion of gas station. The gas station should focus on strengthening the safety management to ensure operating safely. Using Dow chemical analysis can get the danger level, exposure radius, hazard area and the actual maximum possible loss of property of the fire and explosion accident happened in buried oil tanks of gas station. These analysis results cover the accident causes, accident scope and the influence degree, and they have great significance for the safety construction of the gas station.

Keywords Explosion · Fire · Gas station · Risk analysis

98.1 Introduction

Today, as the main energy provider for urban transportation, Gas stations play an important role in the development of the national economy. The reserve of gas station is large. The characteristics of gas are low flash point, volatile, flammable and explosive (GB 1226 2002). Gas stations are usually located in traffic hub or relatively dense place. Consequence is unimaginable once the fire and explosion accidents happened. This paper has analysis the causes and consequences of the fire and explosion accident happened in a certain gas station in a qualitative and quantitative way (Xiangchen and Bingshu 2011). Analysis results have great significance for the safety operation and management of the gas station.

X. Ding (✉) · W. Song · Z. Chen
College of Environment and Chemical Engineering,
Tianjin Polytechnic University, Tianjin, China
e-mail: dingxudong11@163.com

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98.2 Choosing Analysis Methods

98.2.1 Accident Tree Analysis

The accident tree analysis is one of the important analysis methods in safety system engineering. It identifies and evaluates the hazards of all kinds of systems. Not only can analysis the direct reason for the accidents, but also can deeply reveal the underlying causes of the accidents. To describe the causality of the accidents, accident tree analysis has the advantages of intuitive, clear and logical. Most of the time is used for qualitative analysis.

98.2.2 Dow Chemical Analysis

Dow chemical analysis is based on the past accident statistics, the potential energy of the material and the current safety measures, to evaluate the potential fire and explosion hazards from the processing installations and the related materials. Using this analysis method can achieve the following purposes. (1), to make the expected losses of potential fire, explosion and reaction accident quantitative. (2), to find the device which may cause accidents or make accidents expand. (3), to notice the administrative department about the potential fire and explosion danger (Zhou 2005).

98.3 Case Analysis

98.3.1 Introduction to the Gas Station

This paper will take the buried oil tanks of a certain gas station in Tianjin for example to analysis. The gas station consists of six buried oil tanks. Two of them are gasoline tanks which volume is forty cubic meters. The rest four of them are diesel tanks which volume is 50 m^3.

According to the *design and construction standard for car refueling station* (GB50156- 2002) which is issued in 2006, the buried storage tanks of this gas station have set the following safety facilities and the corresponding safety measures.

(a) the high level alarming device installed in oil tank.
(b) quick joint installation installed in oil discharge interface.
(c) static electricity grounding device installed near the oil discharge interface.
(d) flame arrester installed in top of breathing tube.
(e) using the explosion-proof type of potential oil pump.

(f) gas collection device.
(g) lightning-proof grounding device installed in oil tank which according to the standard.
(h) the flange which have less than five bolts in oil and gas transmission pipeline have installed the static electricity remove device.
(i) electric cable are buried underground.
(j) formulate the perfect operation procedures.
(k) find related institutions to do safety evaluation regularly.
(l) for staff configuration for anti-static work clothes.
(m) tank field equipped with 135 kg cart type powder fire extinguisher
(n) five pieces of fire blanket and two cubic meters fire sand.

98.3.2 Accident Tree Analysis About Fire and Explosion Accident Happened in Gas Station Buried Oil Tanks

1. *Build Accident Tree*

When the concentration of the steam because of the leakage or volatile from the gas station buried tanks meet the explosion limit, explosion accident happened when the ignition energy is enough at the same time. If saves is not in time, it will cause catastrophic consequences. So use fire and explosion accident happened in oil tanks and diesel tanks as the top event to do the accident tree analysis (Joulain 1996; GB50156- 2002; Zhang and Yunpeng 2008; Cozzani et al. 2005; Zhu 2012; He and Yue 2007; Dang et al. 2007; Pang 2001; Maokui et al. 2010; Lin 2010; Jiang and Li 2006; Zhixue 2002). The picture of the accident tree is as Fig. 98.1 (Table 98.1).

2. *Minimum Cut Set and the Path Set Computing*

According to the Fig. 98.1 accident tree analysis can clearly and intuitively see the reasons of the fire and explosion accident happened in oil tanks and diesel tanks. Through calculation, there are 85 minimum cut sets in this accident tree.

By using Boolean algebra method can get four minimum path sets. They are, $J_1 = \{X_1, X_2, X_4, X_5, X_6\}$, $J_2 = \{X_1, X_3, X_4, X_5, X_6\}$, $J_3 = \{X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17}, X_{18}, X_{19}, X_{20}\}$, $J_4 = \{X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17}, X_{21}, X_{22}\}$.

3. *Structural Importance of Basic Events*

The accident tree structure importance and important degree sequence are as follows:

$I_{\Phi(1)} = I_{\Phi(4)} = I_{\Phi(5)} = I_{\Phi(6)} > I_{\Phi(2)} = I_{\Phi(3)} > I_{\Phi(7)} = I_{\Phi(8)} = I_{\Phi(9)} = I_{\Phi(10)} = I_{\Phi(11)} = I_{\Phi(12)} = I_{\Phi(13)} = I_{\Phi(14)} = I_{\Phi(15)} = I_{\Phi(16)} = I_{\Phi(17)} > I_{\Phi(21)} = I_{\Phi(22)} > I_{\Phi(18)} = I_{\Phi(19)} = I_{\Phi(20)}$.

Table 98.1 The meanings of the symbols

Symbol	Meaning	Symbol	Meaning
T	Gasoline and diesel tanks fire and explosion accidents	M_1	Oil and gas leaks to the explosion limit
M_2	Ignition sources	M_3	Oil spill
M_4	Oil tank overflow	M_5	Fail to find
M_6	Electric sparks	M_7	Lightning sparks
M_8	Strike sparks	M_9	Flame
M_{10}	Static sparks	M_{11}	Electrostatic discharge of oil tank
M_{12}	Electrostatic accumulated	M_{13}	Grounding failed
X_1	Operating mistake	X_2	Level gauge damage
X_3	No one monitoring	X_4	Line and valve leakage
X_5	Tank leakage	X_6	Tank maintenance and cleaning not qualified
X_7	Electric machine leakage	X_8	Call in tank farm
X_9	Insulation damage	X_{10}	Joint bad
X_{11}	Grounding damage	X_{12}	Grounding resistance of lightning proof device is too large
X_{13}	Doesn't use explosion-proof tools	X_{14}	Metal equipment crash
X_{15}	Illegal igniting	X_{16}	Illegal smoking
X_{17}	Wear chemical fiber clothes	X_{18}	Flow velocity is too fast
X_{19}	Conduit inside is rough	X_{20}	Oil hit containers
X_{21}	Grounding resistance is too high	X_{22}	Electrical connections damage

98.3.3 *Dow Chemical Analysis About Fire and Explosion Accident Happened in Gas Station Buried Oil Tank*

1. *Fire and explosion index analysis*

Now take the whole buried oil tank system as the risk analysis unit. The main components in the tank are gasoline and diesel. Look-up the table of buried storage tanks fire, explosion index (F&EI) in "Dow chemical company fire and explosion danger index evaluation method", gasoline, MF = 16, diesel, MF = 10.

According to the index chosen principles of the seventh edition, combined with the actual situation of the gas station device, table of buried storage tanks F&EI is as follow (Table 98.2).

According to the league table for F&EI and risk level, the risk level of gas station buried oil tank is less seriously, diesel tank is the least serious (Table 98.3).

2. *Safety measures compensation coefficient analysis* (Table 98.4).
3. *Process unit risk analysis summary*: (Table 98.5).

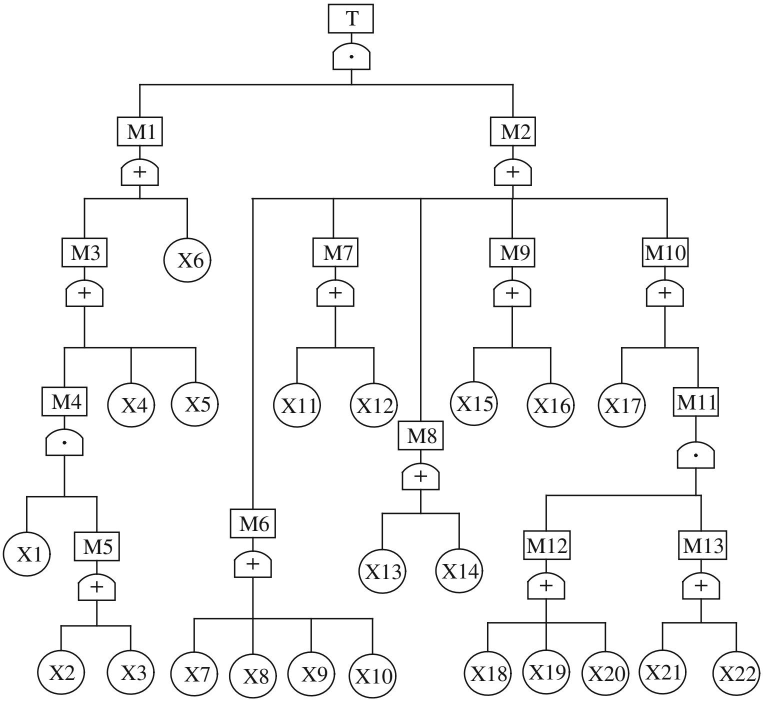

Fig. 98.1 The accident tree of oil tanks and diesel tanks in a certain gas station

Table 98.2 Table of buried storage tanks fire and explosion index (F&EI)

Material needed to determine the MF		Oil	Diesel
1. material factors (MF)		16	10
2. general process risk	Risk factors range	Risk factors chosen	Risk factors chosen
Basic factors	1.00	1.00	1.00
A. materials handling and transportation	0.25–1.05	0.50	0.25
General process risk factors(F_1)		1.50	1.25
3. special process risk factors			
Basic factors	1.00	1.00	1.00
A. toxic substances	0.20–0.80	0.20	0.00
B. the operation within combustible ranges and close to the combustible ranges	0.30–0.80	0.50	0.00
C. pressure	Look up the figure	0.18	0.18
D. flammable and not stable material quality	Look up the figure	0.46	0.39
E. corrosion and abrasion	0.10–0.75	0.20	0.20
F. leakage, connectors and packing	0.10–1.50	0.10	0.10
Special process risk factors (F_2)		2.64	1.87
Process risk factors ($F_3 = F_1 \times F_2$)		3.96	2.34
Fire and explosion index ($F_3 \times MF = F\&EI$)		63.36	23.4

Table 98.3 League table for F&EI and risk level

F&EI	1–60	61–96	97–127	128–158	>159
Risk level	The least	Less	General	More	The most

Table 98.4 Safety measures compensation coefficient

No.	Project	Compensation coefficients range	Compensation coefficients
1	Operation procedures	$0.91 \sim 0.99$	0.97
	Risk analysis of other processes	$0.91 \sim 0.98$	0.98
	Process control security compensation coefficients $C_1 = a \times b$		0.95
2	Physical isolation security compensation coefficients C_2		1.00
3	Portable fire fighting equipment/squirt gun	$0.93 \sim 0.98$	0.98
	Cable protection	$0.94 \sim 0.98$	0.94
	Fire prevention safety facilities compensation coefficients $C_3 = a \times b$		0.92
4	Security measures compensation system $C = C_1 \times C_2 \times C_3$		0.87

Table 98.5 Process unit risk analysis summary

Item	Oil	Diesel	Statement of calculation
Fire and explosion index (F&EI)	63.36	23.4	$F_3 \times MF$
Exposure radius	15.97 m	5.90 m	$R = 0.252 \times$ F&EI
Exposure area	800.83 m^2	109.30 m^2	$S = \pi R^2$
The property value within the exposure area (A)	A yuan	A yuan	Suppose to A yuan
Risk factors	0.52	0.14	According to the value of MF and F_3 to check charts
The most possible basic loss of operty (A_1,basic MPPD)	0.43 A	0.11A	$A_1 = A \times$ unit damage factor $\times$ 0.82
Safety measures compensation factors (C)	0.87	0.87	$C = C_1\ C_2\ C_3$
The most possible actual loss of property (actual MPPD)	0.37 A	0.10A	$A_2 = A_1 \times C$

98.4 Conclusion

98.4.1 Result of Accident Tree Analysis

We should strengthen the safety management mainly from the following several aspects, in order to preventing the fire and explosion accidents happened in gas station buried oil tanks.

1. Execute discharge and overhaul safety operation procedures strictly, ensure that someone is monitoring.
2. Check the tanks, safety equipment and the pipe valves regularly. And do daily maintenance.
3. Check the electrical machine and the electrical lines regularly, to avoid insulation damage, leakage of electricity and joint loose.
4. No smoking, make a phone call, illegal hot in tank farm.
5. Do lightning protection and anti-static detection periodically, ensure the validity of the grounding device.

98.4.2 Result of Dow Chemical Analysis

1. Oil tank risk is less important, diesel tanks basically have no dangerous.
2. Exposure radius of oil tanks is 15.97 m, risk area is 800.83 m^2. Suppose the property value within the exposure area is A yuan, the most possible actual loss of property is 0.37 A yuan.
3. Exposure radius of diesel tanks is 5.9 m, risk area is 109.3 m^2. The most possible actual loss of property is 0.1 A yuan.

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Chapter 99
The Correlation Between Risk and Return: The Empirical Evidence from Chinese Listed Companies

Jin Zeng and Yang Li

Abstract The Paper examined the correlation between risk and return of China's listed companies. The paper found that there existed a negative correlation both across and within industries for China's listed companies during 1996–2000, 2001–2005 and 1996–2005 time periods. The paper further studied the industrial and dynamic characteristics of this relationship and discussed the reason caused this abnormal phenomena. Finally, the paper offered several suggestions on further study.

Keywords Bowman paradox · Chinese listed companies · Negative correlation · Risk-return

99.1 Introduction

Bowman's creative work (Bowman 1980), known as Bowman's Paradox, caused a large shock to classical economic and financial theory in which correlation between risk and return is considered positive, and sparked a new stream for strategy management research. This stream has contributed to some curious and interesting ideas in past more than 30 years (Andersen et al. 2007; Bettis 1981; Baird and Thomas 1985; Bromiley 1991; Fiegenbaum 1986; Fiegenbaum and

J. Zeng (✉)
College of Application Technology, Kunming University of Science and Technology, Kunming, China
e-mail: zj86118@163.com

Y. Li
Department of Humanity and Creativity, Xiamen Huaxia Vocational College, Xiamen, China
e-mail: sangyuruomu@gmail.com

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Thomas 1988; Fiegenbaum 2004; Miller and Bromiley 1990; Miller and Chen 2003; Miller and Chen 2004; Ruefli et al. 1999).

While present researches did not concern with developing country, especially emerging market countries, this paper will examine risk-return correlation of China's listed companies and try to find managers' and firms' behavior difference between China and US. The paper is organized as follow. The first section is literature review. The second section is methodology introduction, including sample and data, variable definition and measurement. The third and forth sections contain empirical results and discussion. Final section is conclusion and suggestion on further study.

99.2 Literature Review

The risk and return are two key elements in strategic decisions. However, before the Bowman put forward his famous paradox what scholars concerned was mainly the risk of finance management and investment. During 1950–1960s, the focus of academic research was how to measure the risk of stock portfolio and price capital asset. The investment portfolio theory (Markowitz 1952) and the capital asset price mode (CAPM) (Sharpe 1964) were the most representative academic achievement in this time period. According to financial theory, the correlation between risk and return is positive. This relationship arises mainly from a risk-averse reasoning: people will not support higher risk for the same level of return; they will only accept higher risk if they get a higher return (Arrow 1965; Pratt 1964). However, Bowman (1980) discovered that within most industries, risk and return were negatively correlated. He described that research outcome as a paradox for strategic management, since the findings ran counter to the conventional wisdom that argued for a positive association. He also argued that firms' risk attitudes may influence risk-return profiles and that more troubled firms may take greater risks (Bowman 1982, 1984).

Bowman's finding caused a series of research which included: The new risk measurements (Ruefli et al. 1999), management goal choice (Fiegenbaum and Thomas 1988; Jegers 1991; March and Shapira 1987), reaction to organization decline (Wiseman and Bromiley 1996), risk-return of diversification (Bettis 1981; Amit and Livnat 1988; Bettis 1982; Chang and Thomas 1989) and the behavior risk of agent (Wiseman and Gomez-Mejia 1998; Palmer and Wiseman 1999) etc. Researchers tried to find the reason caused risk-return negative related and how to solve relative problems.

Chinese scholars did not pay enough attention to Bowman's work in passed decades. One of possible reason is they lack cognition toward risk due to they are under planning economy for a long term. While, risk is an objective existence and it has to be considered in decision. With economy transform and rapidly growth in China, more and more people begin to concern this issue.

99.3 Methodology

99.3.1 Sample and Data

In this study sampling was restricted to non-financial A share listed companies in Shanghai and Shenzhen stock exchange. The CSMAR data base was used to develop a research data set of firms and industries for the 1996–2005. We chose that time period because it represented a wide range of economic and environmental conditions. Separate analyses were then performed for the non overlapping 5 year periods 1996–2000, 2001–2005, for the 10 year periods 1996–2005. We analyzed different time periods in order to examine the possibility that time period influences risk-return results.

According to the selection principle mentioned above, we got 509 effective samples for 1996–2000 period, 1091 for 2001–2005 period and 428 for 1996–2005 periods.

99.3.2 Variable and Measurement

For each period, we calculated the average ROA and variance of ROA as accounting-based measures of firm return and risk. Many researchers have used the variance of a firm's return over time as a proxy for risk (Bowman 1980; Fiegenbaum and Thomas 1988; Jegers 1991; Armour and Teece 1978; Christensen and Montgomery 1981). ROA was chosen because it reflects a return more directly under the control of management and is widely employed by managers, analysts and researchers.

99.3.3 Analytical Method

Analytical method we adopted includes negative association ratio, binomial test and spearman correlation analysis (Bowman 1980; Fiegenbaum and Thomas 1988).

99.4 Results

Applying the analytical methods above, we got the empirical results presented in Tables 99.1, 99.2, 99.3, 99.4, 99.5, which included general characteristic, industrial characteristic and dynamic characteristic of risk-return correlation of China's listed companies.

99.4.1 General Characteristic

The above tables presented that during 1996–2000, 2001–2005 and 1996–2005 periods, both total level and industry level, the risk-return correlation of China's listed company all were negative. Wherein 10 industries were negative at 1996-2000 period, taking up 76.92 % of the total amount; 28 industries were negative at 2001–2005 period, taking up 82.35 % of the total amount; 11 industries were negative at 1996-2005 period, taking up 84.62 % of the total amount. Binomial test were significant at the 0.05 or 0.01 level.

99.4.2 Industry Characteristic

The above tables also presented that the industries which had the highest negative related degree of risk-return are competitive industries, such as agriculture, textile, clothing, food and computer etc. But for monopoly industries or capital-intensive industries like petroleum, electric power and metallurgy negative related degree of risk-return are lower or positive.

99.4.3 Dynamic Characteristic

By carefully observing tables above we further found that, at 1996–2000 and 2001–2005 periods, regardless at total level or industry level, the degree of risk-return negative correlation of the latter is higher than the former. In addition, some

Table 99.1 Risk-return correlation across industries

	Negative association rate	Spearman correlation analysis	Number of companies
1996–2000	1.61	−0.359[a]	509
2001–2005	2.07	−0.501[a]	1091
1996–2005	2.66	−0.575[a]	476

[a] Correlation is significant at the 0.01 level (2-tailed)

Table 99.2 Risk-return correlation within industries during 1996–2000

Industry name	Negative association rate	Spearman correlation analysis	Number of companies	Industry name	Negative association rate	Spearman correlation analysis	Number of companies
C73 Special equipment manufacture	5.33	−0.678[b]	19	C43 Chemical raw material and product	1.45	−0.248	27
M Synthesis	5.33	−0.693[b]	76	H11 Retail	1.41	−0.379[a]	41
G81 Telecom equipment	3.33	−0.648[a]	13	C75 Transport equipment	1.25	−0.313	18
C81 Medicine	3.00	−0.396	24	D01 Electricity	0.67	0.129	20
C76 Electrical appliance machine	2.67	−0.610[b]	22	C47 Chemical fiber	0.57	0.355	11
C61 Nonmetal mine	2.00	−0.383	18	C71 General machine	0.50	0.154	12
J01 Real estate	1.50	−0.360[a]	40				

[a] Correlation is significant at the 0.05 level
[b] Correlation is significant at the 0.01 level

Table 99.3 Risk-return correlation within industries during 2001–2005

Industry name	Negative association rate	Spearman correlation analysis	Number of companies	Industry name	Negative association rate	Spearman correlation analysis	Number of companies
C31 Paper making	18.0	−0.813[b]	19	M Synthesis	2.48	−0.594[b]	101
A01 Agriculture	14.0	−0.845[b]	15	C51 Electronic component	2.40	−0.501[a]	17
C13 Apparel	8.00	−0.884[b]	18	C75 Transport equipment	2.00	−0.568[b]	54
C76 Electrical utility machine	8.00	−0.790[b]	36	C81 Medicine	2.00	−0.536[b]	60
C11 Textile	5.50	−0.740[b]	26	G81 Telecom equipment	2.00	−0.589[b]	24
C01 Food	5.33	−0.901[b]	19	J01 Real estate	2.00	−0.414[b]	51
C61 Nonmetal mine	4.86	−0.723[b]	41	K34 Tourism	2.00	−0.312	12
G87 Computer software	4.50	−0.810[b]	22	E01 Construction	1.60	−0.358	13
C05 Soft drink	3.60	−0.564[b]	23	C43 Chemical raw material and product	1.52	−0.351[b]	73
H11 Retail	3.45	−0.584[b]	49	C41 Petroleum refining	1.33	−0.143	14
C71 General machine	3.33	−0.643[b]	26	C73 Special equipment manufacture	1.29	−0.463[b]	39
C85 Biological product	3.33	−0.560[a]	13	C55 Home appliance	1.00	−0.056	12
C47 Chemical fiber	2.80	−0.559[a]	19	F11 Transport assistance	1.00	0.017	24
C49 Plastic manufacture	2.67	−0.401	11	H21 Business agency	1.00	−0.089	16
G83 Computer manufacture	2.67	−0.445	11	D01 Electricity	0.95	−0.115	41
K01 Public service	2.67	−0.266	11	C67 Non-ferrous metal metallurgy	0.60	0.389	16
C78 Apparatus and office machine	2.50	−0.579[a]	14	C65 Ferrous metal metallurgy	0.53	0.361	29

[a] Correlation is significant at the 0.05 level
[b] Correlation is significant at the 0.01 level

Table 99.4 Risk-return correlation within industries during 1996–2005

Industry name	Negative association rate	Spearman correlation analysis	Number of companies	Industry name	Negative association rate	Spearman correlation analysis	Number of companies
H11 Retail	9	−0.859[b]	40	J01 Real estate	2.55	−0.507[b]	39
C75 Transport equipment	8	−0.802[b]	18	C71 General machine	2	−0.371	12
G81 Telecom equipment	5	−0.874[b]	12	C47 Chemical fiber	1.5	−0.485	10
M Synthesis	4.67	−0.719[b]	68	C61 Nonmetal mine	1.25	−0.550[a]	18
C76 Electrical appliance machine	4	−0.795[b]	20	D01 Electricity	1	−0.235	20
C81 Medicine	3.6	−0.668[b]	23	C43 Chemical raw material and product	0.67	−0.234	25
C73 Special equipment manufacture	3.5	−0.743[b]	18				

[a] Correlation is significant at the 0.05 level
[b] Correlation is significant at the 0.01 level

Table 99.5 Bowman binomial test

1996–2000		Category	N	Observed prop.	Test prop.	Exact sig.
Negative association rate	Group 1	<=1	3	0.23	0.5	0.046
	Group 2	>1	10	0.77		
	Total		13	1		
2001–2005		Category	N	Observed Prop.	Test Prop.	Asymp. Sig.
Negative association rate	Group 1	<=1	6	0.18	0.5	0.000[a]
	Group 2	>1	28	0.82		
	Total		34	1		
1996–2005		Category	N	Observed Prop.	Test Prop.	Exact Sig.
Negative association rate	Group 1	<=1	2	0.15	0.5	0.011
	Group 2	>1	11	0.85		
	Total		13	1		

[a] Based on Z Approximation

industries which risk-return correlation is positive at 1996–2000 periods changed into negative at 2001–2005 periods, such as general machine manufacture, paper making and chemical fiber.

99.5 Discussion

Why does risk-return negative correlation across firms appear? What issue is hidden behind this phenomenon which is contrary to traditional theory? Bowman (1980) pointed out that the risk-return paradox deal with the behavior of the firm and its managers. We further argue this phenomenon that disobeys traditional economics theories and finance theories come from firms' difference in strategy decision and risk control, and the difference in managers risk propensity and investment behavior. It is exactly this difference to make one part of firms carried out low risk and high return simultaneously, but the other part of firms then went to the other pole.

We know that the firms have to undertake risk to make profit (Knight 1921), which is to say if a firm wants to acquire benefit it has to be exposed to risk in advance. While what risk the firm exposed to is decided by what kind of strategy it chosen. For example, diversification firm will be exposed to different market risk, multinational firm will be exposed to the risk of exchange rate, law system and cultural difference, and parties of strategic alliance will be exposed to the risk of relationship and performance (Das and Teng 1999) etc. Therefore, the most important factor which influences firm's risk-return is strategy. Theories and practice of strategic management tell us, the correct strategy can not only bring firm huge income but also avoid the risk of endangering the firm development. As Porter stated 'Risk is a function of how poorly a strategy will perform if the "wrong" scenario occurs' (Porter 1985).

Strategy decision is closely related with manager's risk propensity (Bettis and Mahajan 1985) because manager's personal characteristics determine his preference to alternative. According to Bowman (Bowman 1982), risk-return negative correlation implied some troubled firms' managers had greater risky tendency which would result in abnormal or wrong firms' behavior. Due to China being placed in period of transformation and rapid growth, this tendency would be more serious.

Why troubled firm managers inclined to take more risk? The possible answers are: (1) Managers' impractical subjective wishes; (2) Managers' moral hazard.

The impractical subjective wishes imply personal judgment is inconsistent with objective risk, it derive from limited rationality and asymmetric or incomplete information which cause people to misunderstand the environment and his personal ability. When managers underestimate risk and try to outstrip objective constraint they usually expect to enter new industry to achieve an abnormal growth or to get away from current predicament through further adventure. However, because of original defect in strategy decision the result usually is contrary to manager's desire. In addition, this problem can be enlarged by economic environment change or fluctuation. At expanding stage, prosperous demand and relaxed financial environment will lead to managers' subjective wishes inflation; their decision will become more impractical. That is the reason why more China's listed companies inclined to the adventure during 2001–2005.

The moral hazard derives from the benefit conflict and asymmetric risk bearing between managers and shareholder. It may cause managers (as agent) to make a decision that is contrary to normal principles. Bahrain bank, Enron and MCI Worldcom are classical cases in this aspect. Most of individuals usually think that risk means a loss, and always adopt various ways to avoid it. But Kahneman and Tversky (Kahneman and Tversky 1979) found that individuals are not uniformly risk averse but adopt a mixture of risk-seeking and risk-averse behaviors. Their evidence suggests that when returns have been below target, most individuals are risk seeking and that when returns have been above target, most are risk averse. However, when firm's ownership and control power is mutually separated individual's attitude toward risk then is difficult to predict, especially their sensitive degree to possible loss would appear very great difference. Furthermore, individual is not always more sensitive to loss than to gain, their attitude toward risk is finally subjected to whose loss and whose gain but loss and gain itself. That is to say, individual risk propensity will change according to his role and position. For example, as private investor an individual is usually very careful, but as agent he usually inclines to an adventure. The reason is that individual's investment exposes his private property to the risk, the loss caused from it will be undertaken by himself; but, as agent, managers' investment decisions expose firm's property to the risk, the loss caused from it will be undertaken by shareholders or stakeholders.

Among above-mentioned two factors which caused troubled firms' managers take greater risk, moral hazard is more important because it is more dangerous for a firm. Further, we argue that manager's moral hazard is the most important risk for a firm. In order to cope with manager's moral hazard corporate governance has been already developed and it is at heart of enterprise institution. "Mistake" of strategic decision usually connects with the failure of corporate governance and troubled firms usually exist some defaults in incentive and monitory system. Therefore, establishing perfect governance mechanism is an effective guarantee to align managers' decision with shareholder interest and avoid strategic risk.

99.6 Conclusion and Suggestion on Further Study

99.6.1 Basic Conclusion

Through empirical research above, we got the basic conclusion as follows:

(1) There existed risk-return negative correlation, an abnormal phenomenon to traditional theory, among China's listed companies' regardless total or industry level. Risk-return paradox derived from firms' difference in strategy decision and risk control, and the difference in manager risk propensity and investment behavior. This difference between excellent firm and worst firm is most obvious.
(2) At 1996–2000 and 2001–2005 periods, regardless at total level or industry level, the degree of risk-return negative correlation of the latter was higher than the former. In addition, some industries which risk-return correlation was positive at 1996–2000 periods changed into negative at 2001–2005 periods. That implied economy cycle could influence firms' risk-return relationship. So supervision institution have to strengthen control at expand stage to confine troubled firm because more risk they take usually result in further poor performance (Bromiley 1991).
(3) The higher competition intensity in an industry is, the more obvious its risk-return negative correlation is.
(4) Considering the benefit conflict between manager and shareholder, we suggest corporate governance is a core mechanism to control strategic risk.

99.6.2 Further Research Suggest

Our findings offer an important empirical evidence for the research of strategic risk management in China. On these findings following research can be continued: (1) the impact of manager's risk propensity on firm's performance; (2) the influence of industry concentrated degree on risk-return correlation; (3) the firm's risk–return performance in different stage of the industry life cycle; (4) the impact of corporate governance on firms' risk-return; (5) further testing prospect theory (Kahneman and Tversky 1979) and behavioral theory of the firm (Cyert and March 1963) by using China's data etc.

In general, when facing risk-return paradox, we should return to the most original meaning of paradox—"to think more" ("para + dokein" in Greek).

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Chapter 100
The Relationship Between Financial Resource Allocation Efficiency and Growth in Different Areas of China

Hong-bo Zhang and Qing Xia

Abstract The aim of this paper is to analyze empirically the relationship between financial resource allocation efficiency and economic growth in China. This paper examines the economic performance of financial resources in China's 31 regions for the period 1978–2010. Based on the analysis of Wurgler, the empirical results indicate that different regions' financial resources allocation have different impacts on the economic growth. In short, the East performs much better than the Middle and West areas. Besides, the result of our study shows that there is a positive and significant association between financial resource allocation efficiency and economic growth. Meanwhile, financial department plays an important role in financial allocation efficiency and economic growth. So the government should make full use of the financial markets to achieve a better performance.

Keywords Allocation efficiency · Economic growth · Financial source

100.1 Introduction

Since the beginning of economic reform in 1978, China's performance in economic growth and the financial sector expansion has been impressive. Over the period 1978–2010, the Chinese economy saw an annual growth rate of 9.8 % in real terms. Some individual years are even over 11 %, which is the world-shaking fact. However, the high growth rates at the national level also leave our country

H. Zhang (✉)
Economics and Management School, Wuhan University,
Wuhan, China
e-mail: casa2005@sina.com

Q. Xia
Department of Basic Education, Military Economics Academy, Wuhan, China

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some problems that could not be ignored. The regional disparity in economic growth has been widening, due to a series of preferable development policies in the mid-1990s which encouraged investments to go to the eastern coastal area. Chinese government expects the development of eastern coastal areas can bring along that of the inland areas, however, this has not yet been realized so far. On the contrary, the phenomenon of the continuous regional disparity in China is still aggravating. The coastal regions absorbed most investments while the economic performance of the interior regions remained stagnant.

The imbalance of economic growth among regions in China has attracted much attention of economists since a long time. Although different scholars attach different degrees of importance to the allocation of financial resources, its role in economic growth can be theoretically postulated and has been supported by more and more empirical evidence.

Theoretically, economists have long been interested in the role of resource allocation in financial development. The hypothesis that the efficient allocation of resources facilitates financial development dates back to at least Schumpeter (1912), who conjectured that reallocating resources to their most productive uses, and therefore help the banks and entrepreneurs to get good growth prospects. Subsequently, many scholars have done researches on the relationship between the resource allocation and economic growth in different respective. Some economists analyzed the resource allocation and economic growth from the perspective of financial intermediation like Ross et al. (1999). Besides, some other scholars devoted to study the reasons of regional disparity from the viewpoints of history, culture, geography and the outside policy such as Kanbur and Zhang (2005). More recently, there are other people involved this subject both in the short- and long-run. Beck and Levine (2002) suggest that the resource allocation plays a different role in the economic growth in the short run compared with what in the long run. In summary, the examination of the theoretical literature founded on the relationship between the efficient resource allocation and the economic growth show a positive association.

As for the empirical research on the resource allocation and economic growth, scholars also did a lot of researches. On the basis of a data relating to 65 non-socialist countries, Wurgler (2000) designed an indicator of the effectiveness of the financial market which measure the degree of the financial development. Furthermore, Wenqin and Wei (2003) used this method applying the Chinese's 28 provinces panel data to analyze the efficiency of capital allocation and the economic development. More recently, a number of other researchers have used other approach to study this subject empirical. For example, Ling and Jigang (2010) apply the DEA techniques developed for dynamic panels, and provide more evidence that the efficient resource allocation has a strong and causal effect on economic growth (Beck et al. 2000).

The articulation of this paper is organized as follows. Section 100.2 introduces the empirical approach and our econometric model. Based on the 31 regions' data from 1978 to 2010, we find the main empirical results. Section 100.3, we analysis the relationship between allocation efficiency and the economic growth. While Sect. 100.4, we conclude.

100.2 Efficiency of Financial Resource Allocation: Evidence from China's Provincial Data

100.2.1 Methodology

The objective of this article is to empirically check the existing relation between financial resource allocation and economic development. The basic estimation model employed in this study is similar with Wurgler (2000).

In Wurgler's model:

$$In\frac{I_{ict}}{I_{ct-1}} = \alpha_c + \eta_c In\frac{V_{ict}}{V_{ct-1}} + \varepsilon_{ict} \tag{100.1}$$

where I is the formation of fixed capital, V represents its increased value, i stands for different industry sectors, ε is the error term, with the subscripts c and t representing country and time, respectively. The regression coefficient η is the flexibility.

Here we just analyze the total amount, so the subscripts of i can be ignored, and the c in this essay stands for different regions. The logarithm of the above equation can be written as the following form:

$$InI_{ct} = In\alpha_c + \eta_c InV_{ct} + In\varepsilon_{ct}$$

Therefore, we can obtain:

$$\eta_c = \frac{V_{ct}}{I_{ct}}\frac{dI_{ct}}{dV_{ct}} \tag{100.2}$$

In the article, by means of analyzing the η in different regions, we can do a comparison to the efficiency of the financial resource allocation.

100.2.2 Data and Indicators, Model

The panel consists of data from 31 Chinese regions over the period 1978–2010. The data come from the China Statistical Yearbook (various years), the Comprehensive Statistical Data and Materials on 50 Years of New China (1999), the Almanac of China Finance and Banking (various years) and the China Regional Economy: A Profile of 17 Years of Reform and Opening-up (1996). To assess the impact of the financial resource allocation on economic growth, our analysis consists in estimating the following growth equation (Calderón and Liu 2003):

$$InI_{ct} = In\alpha_c + \eta_c InV_{ct} + In\varepsilon_{ct} \tag{100.3}$$

100.2.3 Results

On the basis of the provincial data, making a regression to the Eq. (100.3), Table 100.1 presents the results.

From the Table 100.1, the results are basically good as we expect. The elasticity coefficient are positive, which confirms the funds indeed flow to the higher value added, in other words to the good performance of economic growth areas. In

Table 100.1 Efficiency of financial resource allocation

Region	α	η	R^2	F
Bejing	−0.7646(0.1953)**	1.2649(0.045)***	0.9891	2856.3***
Tianjin	0.0798(0.215)	1.132(0.028)***	0.9921	3421.4***
Hebei	0.3989(0.172)	1.0239(0.021)***	0.9942	4655.6***
Shanxi	0.9921(0.144)***	0.9668(0.027)***	0.9918	3089.9***
Neimeng	−0.1206(0.1584)	0.8929(0.025)***	0.9953	5640.3***
Liaoning	−0.0365(0.1712)	1.1907(0.043)***	0.9894	3710.2***
Jilin	−0.0985(0.2410)	1.1178(0.044)***	0.9897	2689.6***
Heilongjiang	−0.2867(0.143)*	1.1146(0.020)***	0.9938	4978.4***
Shanghai	−1.345(0.377)***	1.2335(0.048)***	0.9868	2128.9***
Jiangsu	−0.6901(0.152)***	1.1571(0.017)***	0.9974	9601.8***
Zhejiang	−0.7898(0.267)***	1.1912(0.034)***	0.9926	3503.7***
Anhui	−0.0962(0.153)	1.0765(0.019)***	0.9889	4829.1***
Fujian	−0.3551(0.134)**	1.1315(0.026)***	0.9936	5096.7***
Jiangxi	−0.5114 (0.168)***	1.0699(0.025)***	0.9965	5195.8***
Shandong	−0.4743(0.162)***	1.1891(0.014)***	0.9971	6880.4***
Henan	−0.3457(0.238)	1.1198(0.033)***	0.9894	3754.5***
Hubei	−0.3008(0.1963)	1.1269(0.027)***	0.9896	4521.2***
Hunan	0.4667(0.171)**	1.1198(0.022)***	0.9933	7164.9***
Guandong	−0.6125(0.171)***	1.2099(0.028)***	0.9962	1152.4***
Guanxi	0.5859(0.209)**	1.0052(0.046)***	0.9981	1922.8***
Hainan	−0.7327(0.282)***	1.0109(0.043)***	0.9850	2078.1***
Chongqin	−1.1563(0.241)***	1.1623(0.036)***	0.9914	2352.9***
Sichuan	−0.7629(0.091)***	1.1125(0.014)***	0.9980	14221.7***
Guizhou	1.0801(0.348)***	0.9652(0.059)***	0.9743	2154.4***
Yunnan	1.7986(0.170)***	0.9795(0.031)***	0.9931	4120.8***
Tibet	1.9945(0.244)***	0.7846(0.089)***	0.9145	322.01***
Shanxi	−0.9821(0.261)***	1.0371(0.027)***	0.9964	6179.1***
Gansu	2.3465(0.659)***	0.7387(0.061)***	0.9582	675.87***
Qinghai	−0.9695(0.281)***	0.9532(0.032)***	0.9892	2548.3***
Ningxia	0.0937(0.226)	0.7474(0.019)***	0.9974	9500.6***
Sinkiang	−0.3362(0.247)***	0.8915(0.011)***	0.9996	3152.7***

Sources A Profile of 17 Years of Reform and Opening Up, State Statistical Bureau; China Statistical Yearbook, 1986–1999; China Statistical Yearbook on Investment in Fixed Assets 1997; and Comprehensive Statistical Data and Materials on 50 Years of New China, China Statistical Press, October 1999

Note In the regression, the number in the bracket is the standard deviation, (***), (**) and (*) indicate significance at the 1, 5 and 10 % levels respectively

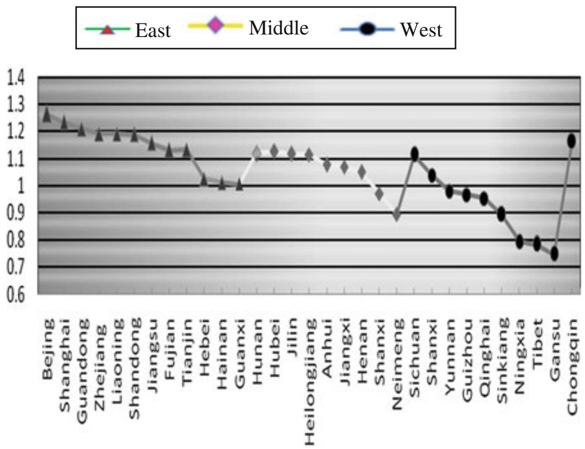

Fig. 100.1 Efficiency of financial resource allocation of East, Middle and West Area (η). *Source* Author's classification from the Table 100.1

view of this, the financial resource allocation is efficient (Calderón and Liu 2003). However, the coefficient among provinces varies a lot. All in all, the coefficient in most eastern provinces and coastal areas are bigger than that of in the inland provinces with the η over one (Rengin and Kara 2011). The western province, in contrast, the coefficient is less than one except the Sichuan, Chongqing, Shaanxi (see Fig. 100.1).

As shown in Fig. 100.1, from the east to middle and to West areas, the curve goes downward orderly basically. With capturing a relatively larger proportion of financial resources, some eastern regions have a higher economic growth rate. In contrast, most of the west areas are poor for the geographic, historical, economic disadvantages. The result is to some extent in accordance with the real economic performance (Liu and Li 2001).

100.3 The Relationship Between Efficiency of Financial Resource Allocation and Growth

After discussing the efficiency of the financial resource allocation, we can't help but wonder the relationship with the region's economic growth. We assume that the flow of capital largely depends on the financial markets (Shan and Morris 2002).

Let's mark Fin for the ration of added value of the financial industry to GDP, Loan for the credit of bank to GDP. Here we take Fin and Loan as indicators for the financial development (Arestis et al. 2008). Make a regression with Fin and Loan respectively. Table 100.2 represents the result.

According to Table 100.2, the regression results were satisfactory. The development of financial markets and the credit of bank both are positively and significantly correlated with the efficiency of financial resource allocation at the 5 and 10 % levels respectively. In other words, the efficiency is closely related to the financial development and economic growth.

Table 100.2 The regression result between efficiency of financial resource allocation and financial development

	Fin	Loan
Intercept	0.9413(0.082)***	0.9526(0.087)***
η	0.03768(0.0125)***	0.1194(0.079)*
R^2	0.1651	0.0524
F-Statistic	5.3117***	3.328***
Observations	31	31

Source Various provincial statistical yearbooks
Note In the regression, the number in the bracket is the standard deviation, (***), (**) and (*) indicate significance at the 1, 5 and 10 % levels respectively

100.4 Conclusion

To study the relationship between financial resource allocation efficiency and economic growth, we have served of a data base of 31 regions over the period 1978–2010 and the panel data analysis. Several conclusions can be drawn from these findings.

First of all, since the onset of economic reform in 1978, a series of changes have taken place in Chinese economy. In summary, the resource allocation is efficient. Among the 31 regions, the coefficient of resource allocation efficiency is mainly over 1. Funds flow to the place where have a higher economic output or productivity.

Secondly, the efficiency of different regions varies a lot. As the development of different regional economic growth, the disparity of regional resource allocation is widening. As we discussed previously, the eastern coastal regions' financial resource allocation is catholically higher than the middle and west areas.

Finally, well-developed financial sector exerts a positive, causal and economically important impact on China's economic growth. The efficiency improvement of China's financial intermediation has great potential. Deep reform needs to be implemented for transforming China's financial department into a more efficient engine of growth.

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Chapter 101
The Relationship of the Operational Risk with Other Types of Risks: Concept and Analysis

Shao-qiang Qu and Yu-zhong Zhang

Abstract Operational risk is the second major risk faced by the commercial banking of China and is inherent in all banking products, activities, processes and systems. So, how to manage it effectively has always been a fundamental task for commercial banking of China. We must deal with it seriously. According to the principles of risk management, it is important for us to understand operational risk. In this paper, based on qualitative analysis, the main financial risks including operational risk have at first been listed, and then the relationship and difference between operational risk and other risks such as credit risk, market risk, liquidity risk and compliance risk have been analyzed. At last, we think that the operational risk is a kind of comprehensive risk and has very close relations with other risks and is often the cause of other risks. Therefore, we should pay special attention to it.

Keywords Analysis · Compliance risk · Credit risk · Liquidity risk · Market risk · Operational risk · Relationship

101.1 Introduction

According to the China Banking Regulation Commission (CBRC, the regulatory authority of the commercial banking of China) in its "Guidelines on Operational Risk Management of Commercial Banks" issued on 14 May 2007 and "Regulation Governing Capital of Commercial Banks (Provisional)" issued on 7 June 2012, operational risk is the risk of loss resulting from inadequate or failed internal processes, people and IT system, or from external events. It includes legal risk but excludes strategic and reputational risk. The issuing of above documents has

S. Qu (✉) · Y. Zhang
School of accounting, Shandong Institute of Business and Technology, Yantai, China
e-mail: qushaoqiang@163.com

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indicated that the regulatory authority of China banking has attached great importance to the operational risks encountered by the commercial banks of China.

From the development viewpoint of commercial banking, a consensus relating to banks had been reached that the representation of the business operations of a modern commercial bank is money, but the essence of it is risk. A modern commercial bank is a "risk machine". It takes risks, transfers risks and embeds risks in its banking products, activities, processes and systems. The intention of it is to obtain returns through managing risks timely and effectively. Hence, only various risks are being managed efficiently and effectively can the business operations of the commercial banks of China be sound, can they make progress really and truly. Otherwise, they will be devoured by various risks. According to the successful operational risk management practices of the internationally active banks, the effective operational risk management depended upon the establishment of the operational risk management framework. The definition of operational risk, the understanding of the relationship between operational risk and other financial risks are two key factors in the construction of such framework about operational risk management. The level of understanding the risk decides the level of managing it. Therefore, to define the operational risk accurately and reasonably, especially to make relationship analysis precisely about the operational risk with other financial risks will be the premise and foundation of the effective operational risk management for the commercial banks in China. The commercial banks of China, as special institutions, should attach importance to the formulations of them.

In this paper, the concept and comprehending relating to the relationship between operational risk and other financial risks in China's commercial banking have been probed into by utilizing qualitative analysis. The intention of it is to enhance the levels of the effective and sound operational risk management of the commercial banks of China.

101.2 Financial Risk and Its Major Types

For the English word *risk*, the Oxford English Dictionary cites the earliest use of the word in English (in the spelling of *risque*) as from 1621, and the spelling as *risk* from 1655. It defines *risk* as: (Exposure to) the possibility of loss, injury, or other adverse or unwelcome circumstance; a chance or situation involving such a possibility (Simpson and Weiner 1989). The ISO 31000:2009 also gives that the definition of the risk is the "effect of uncertainty on objectives". In this definition, uncertainties include events (which may or not happen) and uncertainties caused by ambiguity or a lack of information. It also includes both negative and positive impacts on objectives (International Organization for Standardization 2009). Many definitions of risk exist in common usage, however this definition was developed by an international committee representing over 30 countries and is based on the input of several thousand subject matter experts. For risk versus uncertainty, Frank H. Knight, an American economist, established the distinction between risk and uncertainty. "…Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated. The term 'risk', as loosely used in everyday speech and in economic discussion, really covers two things which, functionally at least, in their causal relations to the phenomena of economic organization, are categorically different…. The essential fact is that 'risk' means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomenon depending on which of the two is really present and operating. …It will appear that a measurable uncertainty, or 'risk' proper, as we shall use the term, is so far different from an unmeasurable one that it is not in effect an uncertainty at all. We …accordingly restrict the term 'uncertainty' to cases of non-quantitive type" (Knight 1921). Hence, for the sake of the demanding of risk management, risk can be seen as relating to the probability of uncertain future events, or the probable frequency and probable magnitude of future loss (Jones 2006).

101.2.1 Financial Risk

In finance, there is no one unified definition for risk. It can be defined as the unexpected variability or volatility of returns and thus includes both potential worse-than-expected as well as better-than-expected returns. It can also be defined as the probability that an investment's actual return will be different than expected. This includes the possibility of losing some or all of the original investment. In a view advocated by Damodaran, risk includes not only "downside risk" but also "upside risk" (returns that exceed expectations) (Damodaran 2003). Broadly speaking, risk is a condition in which there is a possibility of an adverse deviation from a desired outcome that is expected or hoped for and an expression of the danger that the effective future outcome will deviate from the expected or planned outcome in a negative way (Chernobai et al. 2007).

101.2.2 Major Types of Financial Risk

In finance risk is the fundamental element that affects financial behavior and has been recognized as persistent features of the economic system. In order to manage risk effectively and efficiently, it is important for commercial banking of China to summarize the major types of financial risk. At present, there is different classification of risk in finance. According to the CBRC, the major types of financial risks include market risk, credit risk, operational risk, compliance risk, and liquidity risk.

1. *Operational risk*: operational risk is the risk of loss resulting from inadequate or failed internal processes, people and IT system, or from external events. It includes legal risk but excludes strategic and reputational risk. This definition is given by the CBRC and the BCBS.

   It is the operational risk that is the focus of this paper.

2. *Credit risk*: we know that credit is an economic obligation to an "outsider," an entity that doesn't own equity in the firm. So, credit risk is most simply defined as the potential that a bank borrower or counterparty will fail to meet its obligations in accordance with agreed terms (Basel Committee on Banking Supervision 2000). It includes default risk, credit migration risk, counterparty risk, clearing and settlement risk.
3. *Market risk*: according to CBRC, market risk refers to the risks of incurring loss in the on- and off-balance-sheet businesses of banks as a result of adverse change in market prices (interest rates, exchange rates, share prices and commodity prices). Market risks exist in trading and non-trading businesses of banks. Market risks may be divided into interest rate risks, exchange rate risks (including gold), share price risks and commodity price risks, which refer to, respectively, the risks created by any adverse change in interest rates, exchange rates, share prices and commodity prices. Depending on the source of risks, interest rate risks may be divided into repricing risks, yield curve risks, basis risks and optionality risks (China Banking Regulatory Commission 2004).
4. *Liquidity risk*: liquidity risk means that a solvent commercial bank fails to duly acquire adequate funds or fails to do so at a reasonable cost to deal with the risk of asset increase or repayment of debts at maturity. Liquidity risks may be divided into financing liquidity risks and market liquidity risks. The term "financing liquidity risk" herein means a risk that commercial banks cannot meet the fund demands in a timely and effective manner with its routine business or financial situation being unaffected. The term "market liquidity risk" herein refers to a risk that commercial banks cannot dispose of its assets at the reasonable market price to obtain funds due to its lack of market depth or market fluctuations (China Banking Regulatory Commission 2009).
5. *Compliance risk*: The CBRC indicated that the term "compliance" refers to the consistence between the business operations of commercial banks and the related laws, rules and standards. The term "compliance risks" herein refers to the risks of a commercial bank suffering from legal sanction, supervision punishment, great financial losses or reputation losses when it violates any law, rule or standard. The term "laws, rules or standards" mentioned above refers to the laws, administrative regulations, departmental rules as well as other regulatory documents, business rules and industrial standards of self-disciplinary organizations, behavioral code and occupation ethnics (China Banking Regulatory Commission 2006).

101.3 The Relationship of the Operational Risk with Other Financial Risks

Up to now, for every commercial bank of China, the operational risk management is always its core risk management. In order to manage operational risk soundly and effectively based on the successful practical activities of the international commercial banking about operational risk management, the commercial banks of China shall establish their sound and reliable operational risk management systems commensurate with the nature, scale and complexity of their business. The bank's operational risk management system shall include the effective oversight and control by the bank's board of directors and senior management, sound policies and procedures for the operational risk management, sound procedures for identifying, measuring, monitoring and controlling operational risks, sound internal control and independent external audit and appropriate mechanism for their operational risk capital allocation. In carrying out the operational risk management, a commercial bank shall give due consideration to the correlation of operational risks with other types of financial risks such as credit risks, liquidity risks, market risks and compliance risks, and coordinate the policies and procedures of the management of operational risks with those for the management of other types of risks so as to ensure the consistence between all the policies and formalities for bank's risk management. Hence, it is important for every commercial bank of China to consider the relevance correctly between operational risks and credit risks, market risks, liquidity risks, compliance risks and other risks.

101.3.1 The Relationship Between Operational Risk and Credit Risk

For international commercial banking, credit risk is a traditional risk accompanying with the history of it. Credit risk is the first of all risks in terms of importance for banks of China. In carrying out operational risk management effectively, a commercial bank of China shall give due considerations to the correlation of operational risk with credit risk. For example, for the default risk, which is one of the credit risks and means that the customers of bank default or fail to comply with their obligations to service debt, triggering a total or partial loss of any amount lent to the counterparty, it is important to analyze its causes correctly. If a customer fails to repay the loan, is it a 'normal' credit risk caused by customer, or is it a 'non-normal' credit risk attributed to bad behaviors or errors of the bank's employees in charge of the loan? If the employees in charge of the loans take bribes, or understand wrongly the information relating to the loans, or violate the loan policies in the process of making loans, the risk coming from the making loans is in essence the operational risk although the presentation of it is credit risk. If the credit risk is resulted from the malfunctioning of the bank information system, non-perfecting of the internal control mechanism, insufficient of the risk assessment, dereliction of duties, corruption or fraud, then it is also in essence a kind of operation risk.

Especially, in China's commercial banking, there is a more close relationship between the operational risk and the credit risk due to some things handed down from the planned economy era. For example, although most of the state-owned commercial banks of China and state-owned enterprises have to a certain extent partial rights to make their own decisions, they haven't so far become the unadulterated economic entities of standing on their own, operating independently, assuming sole responsibility for their own profits or losses, having ability for self-development. In such circumstances, a commercial bank is easy to make loans that should not be lent to its customers under the pressure of some administrative factors. If the loans are not repayable at maturity, the risk resulting from the lending should be categorized into operational risk instead of credit risk. Under the interest-driven, some of managers and employees in the state-owned commercial banks exploit the mixing of operational risks and credit risks and the disadvantage of the regulatory authorities in supervisory information so as to gain for themselves through a variety of bad ways. These behaviors are negative. These behaviors can lead directly to financial corruption and internal fraud, which is one type of the operational risk. For commercial banks of China, combined actions of above behaviors and factors lead eventually to a pooling and coexisting situation of the operational risk and credit risk. In such a situation, managers and employees in the state-owned commercial banks are easy to ignore the credit rating of the borrower, and in the process of lending to ignore the identification, measurement or assessment, warning and controlling of the risk, which are operational risks, at last, to increase credit risks of the banks. Operational risk has a close correlation with credit risk. Just as Shuang-ning Tang, the former Vice Chairman of the China Banking Regulatory Commission, had said that the credit risk is the main 'form' of the risks and the operational risk is the important source of risks for the commercial banking of China.

101.3.2 The Relationship Between Operational Risk and Market Risk

Based on the definitions of the operational risk and market risk, we can see that operational risk has a direct impact on market risk. For example, the exposure degrees of the operational risks a commercial bank is presenting would influence directly on the positions of the securities and derivative products of this commercial bank is willing to hold. Just look at the collapse case of the Barings Bank (1762–1995) will we understand this impact. Barings Bank was the oldest merchant bank in London until its collapse in 1995 after one of the bank's employees, Nick Leeson, lost £827 million ($1.3 billion) due to speculative investing, primarily in futures contracts, at the bank's Singapore office. At last, a Dutch bank purchased Barings Bank in 1995 for the nominal sum of £1 and assumed all of Barings' liabilities, forming the subsidiary ING Barings. Post hoc analysis of this event has found that although the direct cause was the continuous falling of the prices of Nikkei 225 futures contracts listed on the Osaka Securities Exchange and the Singapore International Monetary Exchange in 1995, resulting in the damage of the bank derivatives trading positions, the deeper causes were the Kobe earthquake in 1995, which had close relation with the continuous falling of the prices of Nikkei 225, and the bank's own deficient internal auditing and risk management practices, which exposed the Barings Bank at great risk. The former belongs to external events, while the latter is the failure of the internal control mechanism. Two are operational risk events.

The risks relating to the transactions of securities and derivatives come mainly from the 'trading book'. The 'trading book' groups all market transactions tradable in the market. The major difference between the trading book and banking book is that the 'buy and hold' philosophy prevails for the banking book, contrasting with the trading philosophy of capital markets. The purpose of utilizing 'trading book' is obtain capital gains by bearing the various types of market risks taken in transactions. In order to gain profit from the 'trading book', a commercial bank needs to have sustained competitive advantage, and this advantage may come from the bank's advantage of specialization, scale of operations, skilled employees and so on. However, the more efficient a market is, the less profit a person can gain. Only a small number of people, in any market and at any point of time in the logic, can profit from the 'trading book'. In such unstable and changeable environment, if you don't pay more attentions to the business specifications and the code of conducting of the bank in the course of pursuing profit, the market risks resulting from operational risks may occur. Hence, it is important for the banks to adhere to the most basic principle in risk management relating 'trading book': if you don't understand a transaction, business and its risk, don't do it. That is to pay more attentions to the relationship between the operational risk and the market risk in the processes of market risk management.

101.3.3 The Relationship Between Operational Risk and Compliance Risk

Operational risk is financial risk. It also tends to compound other risks, for example, liquidity risk. An operational risk event might occur if a bank experiences sudden unexpected cash outflows. Also, a commercial bank might lose its liquidity if an operational risk event occurs, such as computer problem. One well-known instance occurred on Thursday, November 21, 1985, when a computer outage at The Bank of New York (a predecessor of The Bank of New York Mellon) prevented that bank from effecting deliveries of Treasury securities.

The bank was unable to resolve the problem until the following day, and had to finance overnight (at its own expense) the customer securities that it was unable to deliver. It borrowed in excess of $20 billion from the Federal Reserve Bank of New York and incurred interest expenses of $5 million (Garbade et al. 2010).

Serious operational risk events can trigger the customer's distrust and panic to bank, and even lead to run on the bank. In China, the result is, over a long period of time, that the customers would be lost and the profits would be affected substantially, whereas, in a short-term, the result may be a fatal liquidity crisis. We know that the commercial banks confront natively liquidity problems. If a great number of depositors draw money from their saving accounts in the bank at the same time, the banks will have to face liquidity risk. So the liquidity of the bank relies heavily on the confidence of customers to banks. In order to maintain enough liquidity of the banks, it is important for the commercial banks of China to avoid the occurring of serious operational risk event which can shake the confidence of customers to banks, at last resulting in liquidity risk. Insurance can cover some operational risks. But, due to the immediacy of liquidity risk, insurance company can not avoid liquidity risk. The reason is that only the losses have been occurred and a detailed investigation has been made can the insurance company determine whether to compensate and how much money should to be paid. Insurance can cover some operation risks. But, due to the immediacy of liquidity risk, insurance company can but can not avoid liquidity risk. The reason is that only the losses have been occurred and a detailed investigation has been made can the insurance company determine whether to compensate and how much money should to pay. This indicates that the process of compensating is long. Hence, how to avoid operational risk so as to control liquidity risk, that is to analyze correctly the relationship between the operational risk and the liquidity risk, is of great urgency for the commercial banks of China.

101.3.4 The Relationship Between Operational Risk and Liquidity Risk

In simplicity, compliance risk is the current and prospective risk to earnings or capital arising from violations of, or nonconformance with, laws, rules, regulations, prescribed practices, internal policies, and procedures, or ethical standards. The CBRC indicates, in the Article 4 of its "Guidelines for the Compliance Risk Management of Commercial Banks", compliance risk management is a core risk management of commercial banks. Commercial banks shall take overall consideration of the relevance between compliance risks and credit risks, market risks, operation risks and other risks so as to ensure the consistence between all the policies and formalities for risk management. Hence, the analysis of the relationship between operational risk and compliance risk is necessary for banks whether from the point of view of operational risk management or compliance risk management.

The final objective of compliance risk management of a commercial bank in China is to ensure its operation based on compliance of laws and regulations. So the emphasis of it should focus on the degree of 'complying with', that is to see the consistence between the business operations of commercial banks and the related laws, rules and standards. In details, the first, the business operations of commercial banks must comply with the national laws and regulations, including administrative regulations issued by related regulatory authorities; the second, the business operations must conform to the business rules and industrial standards of self-disciplinary organizations including usual practices; the third, the department business operations must be consistent with departmental rules as well as other regulatory documents in their daily operations; at last, the bank's business operations must comply with the principle of good faith, with the behavioral code and occupation ethnics, reflecting the bank's compliance culture. According to the definition of the operational risk, all above in this section indicate that there is a close relevance between the compliance risk and the operational risk.

Operational risk management and compliance risk management are important parts of the integrate risk management system of a commercial bank. From their definitions, we can see that the difference and the close contact always exist side by side. For example, analyzing from the perspective of characteristics of operational risk and compliance risk, the keynote of compliance risk management is 'compliance', so the subjectivity of bank itself behaviors in compliance risk is obvious because internal factors are in most case in a dominant positions. While for operational risk, the objectivity of risks is more obvious than it in the compliance risk because the losses triggered by external environment factors are a large proportion of all losses resulting from operational risk events, although the misconduct of bank itself behaviors is also existent. Analyzing from the consequences of operational risk and compliance risk, there is a close linkage between operational risk and compliance risk. The manifestation of compliance risk is the 'non-compliance'. In fact, the compliance risk is an important cause for a lot of many operational risk events, whereas, some operational risks are also the causes of compliance risk. The existence of operational risk makes the compliance risk too complicated and difficult to control. At the same, the existence of compliance risk also makes the operation risk management become very complex. At the last, they have the same consequence, which is the commercial bank's economic loss and reputational loss.

101.4 Conclusion

From above analyses and comparisons, we can see that the operational risk is a kind of comprehensive risk, the relationships between operational risk and several other risks are very close, and the operational risk is often the causes of other types of risk. At present, although the portions relating to operational risks are small in most of the financial reporting and relevant research reporting in commercial banks of China, but the importance of the operational risk is far more than its proportion in the reporting. Therefore, it is worth for us to study seriously if it can be considered that, for the commercial banks of China, the credit risk is the main type of risks, the market risk is the new expression of risks and the operational risk is the main risk source. If you knew it clearly, it will certainly be helpful to the effective operational risk management for the commercial banks of China.

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Chapter 102
The Research of Banking Capital Resources Deployment Based on the Financial Ecological Environment and Credit Risk

Ling Zhang and Zhuo Peng

Abstract This paper makes an empirical analysis of the influence of the credit risks which the bank faced on its capital resources deployment and uses 2002–2010's data of China's 16 listed bank as a basis of sample, and further analyzes the influence of the credit risk on its capital resources deployment whether to have the difference under the different finance ecological environment. The results indicate that the bank effectively controlling the credit risk and reducing the non-performing loan rate will have a more beautiful condition of capital resources deployment, and good financial ecological environment can weaken the negative correlation between the credit risk and capital resources deployment.

Keywords Capital resources deployment · Credit risk · Financial ecological environment

102.1 Introduction

Since resources with scarcity, the society of the government, enterprises or people have to make choices. Allocation of resources related to banks' cost control, output capital optimization, scale expansion and the implementation of a number of effects. The bank's capital resources are the basic resources of the bank. That its capital allocation of resources is good or bad directly determines the bank's competitiveness and development.

December 2004, the People's Bank of China Governor Zhou Xiao Chuan introduced system of ecological concepts into the financial sector in China, and stressed the ecological approach to examine the financial development. In the November 5, 2005, Chinese Academy of Social Sciences Finance announced *Urban Financial Ecological Environment Report*, which again raised the concern of the

L. Zhang · Z. Peng (✉)
Business School Hunan University, Changsha, Hunan, China
e-mail: pengzhuo410@126.com

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financial environment. This article intends to study the impact of banks' credit risk faced to its capital resource allocation, and further investigates the impact of the financial environment to the bank credit risk and their capital resources.

102.2 Literature Review

102.2.1 Credit Risk

Shujun (2006) put forward from the perspective of the bank, credit risk is the uncertainty factor of safety of credit funds. In China, whether in commercial banks' internal or in the field of academic research, the study of credit risk management in the commercial banks is still also in its infancy. At present, the domestic credit risk is mainly concentrated in the following areas:

The first area is the credit risk of the formation of the reasons for the study, such as Xiliang and Dezhi (2001). The second area is the research of bank credit risk management, such as Chungen and Ying (2008).

Regarding of measure of credit risk, many international institutions and scholars proposed the applicability of the model, such as Credit Portfolio View model (referred to as CPV) (Wilson 1997), KMV model rate (KMV Corporation 1993) and Credit Risk + Model (Credit Suisse First Boston 1997).

102.2.2 Capital Allocation of Resources

Resources allocation and utilization is the core issues of economic and social development. Resources allocation refers to the distribution of resources in the economy (including manpower, material and financial resources) in a variety different orientation (Yining 1990). In the country, many scholars have studied the allocation of resources. Microscopic point of resources is mainly carried out from the industry and enterprise levels. From a macro perspective, the study of the allocation of resources is carried out mainly from the national perspective.

At present, the foreign enterprise resource allocation problem is more concentrated in the resource allocation methods, and has appeared in the matrix analysis methods and other resource planning approach, such as the Boston Matrix (BCG Matrix) (Erming 1998), the General Matrix on the basis of the Boston Matrix (Mengfan 1994), the Product Market Evolution Matrix (Huide and Weimin 1998), and SWTO analysis method (Thompson and Strickland 1998).

102.2.3 Financial Ecological Environment

Professor Qinxian (1995) in 2001 first proposed the concept of the financial ecological environment. The earliest systematic explanation of theory of financial ecological environment in the domestic is Xiaochuan (2004). Since then, many scholars began to study the financial ecological environment evaluation system. Yang et al. (2005) and Taifeng (2006) proposed indications to measure the financial ecological environment from a different angle.

The research about financial ecological environment in the domestic is mostly concentrated in theoretical analysis; suggestions for improvement and construction of evaluation, only a small amount of literature study the impact of the financial ecological environment for financial institution operating efficiency as well as the efficiency of resource allocation, such as Deren and Gaoju (2007) and Xu (2011).

102.3 Hypothesis

The bank's operational risk is mainly from the lender's credit risk. If the credit risk faced by bank is different, it in the allocation of resources is also significantly different. Therefore, this paper presents the hypothesis 1 and hypothesis 2:

Hypothesis 1: Credit risks faced by bank and capital resource allocation are a negative correlation.
Hypothesis 2: Compared with the bank faced the lager credit risk, in the bank faced the smaller credit risk, credit risk and capital resource allocation are a more negative correlation.

Li Yang believes behavior of bank credit and corporate finance is subject to its financial ecological environment. Therefore, this paper presents the hypothesis 3:

Hypothesis 3: In the poorer financial ecological environment, the correlation between bank credit risk and its capital resource allocation is more negative; in the area of the better financial ecological environment, financial ecological environment weaken the role of negative correlation between credit risk and bank capital allocation of resources.

102.4 Study Design

102.4.1 Sample Selection and Data Sources

This paper selects 16 listed banks in China from 2002 to 2010 as the research sample. Taking into account the lack of financial reporting data integrity and availability, we actually get to 77 samples. The data of financial ecological environment is from the study of Yuhui (2007), and other data is from the CSM database and the bank annual report. Data analysis uses SPSS 16.0 and Eviews6.0.

102.4.2 Research Model and Variable Declaration

102.4.2.1 Capital Allocation of Resources

This paper selects six indicators to reflect the situation of bank's capital allocation of resources, that is, loan ration of assets per capita, per capita assets, the proportion of loans (bank loans/total bank assets), the proportion of fixed assets (bank of the original value of fixed assets/total bank assets), the ration of fee per income and the amount of branch assets (total assets of bank/total number of bank branch) (Xiufeng and Guotai 2010). To obtain the composite score of the situation of the capital allocation of resource must make the factor analysis to six factors, and do standardized treatment to two indications of per capita assets and the amount of branch assets.

1. KMO and Spherical Bartlett Inspection

Through adjusting and standardizing the original data to carry on the factor analysis, the inspection results show that in Table 102.1. KMO value more close to 1 means that the correlation between variables is stronger and the original variable is suitable for factor analysis; and vice versa. KMO value is 0.676 in this paper is suitable for factor analysis. Observation value of Bartlett' ball degrees inspection is 516.514 and the corresponding probability (p) is 0, which reject the null hypothesis, so we think the correlation coefficient matrix and unit array have significant difference and the value of each index is associated.

2. Explanation of Sample Variance

Using SPSS 16.0 to make the factor analysis, we obtain the Eigenvalue and the contribution rate.

As shown in Table 102.2, we obtain the eigenvalue, the variance contribution rate and accumulated variance contribution Rate according to the correlation coefficient matrix. It can be seen that the first two factors of the cumulated

Table 102.1 Kmo and Bartlett' Ball degrees inspection result

KMO statistics		0.676
Bartlett' Ball degrees inspection	Chi square value	516.514
	Freedom	15
	P Value	0.000

Table 102.2 Sitution of factor explaining the total variance of the original variance

Factor	The original eigenvalue			Rotating square load sum		
	Eigenvalue	Variance contribution rate %	Accumulated variance contribution rate %	Eigenvalue	Variance contribution rate %	Accumulated variance contribution rate %
F_1	2.967	49.453	49.453	2.551	42.515	42.525
F_2	1.864	31.068	80.520	2.280	38.005	80.520
F_3	0.500	8.339	88.859			
F_4	0.396	6.593	95.452			
F_5	0.267	4.450	99.902			
F_6	0.006	0.098	100.000			

variance accounted for 80.520 %, so we choose the first two factors enough to describe the bank's capital resources

3. Rotating of the Factor Loading Matrix

The factor loading matrix, calculated with the principal component analysis, can explain the impact of each factor on the each variable. Because the initial factor loading matrix coefficient is not very obvious and the factor analysis require that extracted male factor has a practical meaning, to make factor loading matrix of the more significant coefficient, we make the initial factor loading matrix to the maximum variance orthogonal rotating, which makes the relationship between factors and he original variables to be re-allocated and the correlation coefficient to 0-1 differentiation.

4. Factor Expression

Analysis and comprehensive evaluation of six indicators, we use the factor score coefficient matrix and calculate the factor score function. According to the Table 102.3 factor score coefficient matrix, two common factors can be expressed a linear form of six indicators, and we can get the following factors score function.

$$F_1 = 0.377x_1 - 0.041x_2 + 0.351x_3 - 0.056x_4 - 0.374x_5 - 0.042x_6$$
$$F_2 = -0.017x_1 + 0.402x_2 - 0.098x_3 + 0.380x_4 + 0.006x_5 + 0.380x_6$$

Common factors corresponding to the variance contribution as weights, we can obtain the comprehensive statistics of bank capital allocation of resources situation by the weighted.

$$CAR = 0.614F_1 + 0.386F_2$$

The composite score calculated from the above-mentioned various types are as the article of empirical research model of the dependent variable—capital allocation of resources.

Table 102.3 Rotating of the factor loading matrix

	Factor	
	F_1	F_2
Loan ration of assets per capita (x_1)	0.377	−0.017
Per capita assets (x_2)	−0.041	0.402
The proportion of loans (x_3)	0.351	−0.098
The proportion of fixed assets (x_4)	−0.056	0.380
The ration of fee per income (x_5)	−0.374	0.006
The amount of branch assets (x_6)	−0.042	0.380

102.4.2.2 Research Model

In this paper, model (102.1) is to illustrate hypothesis 1 and 2 hypothesis, and the model (102.2) is to illustrate hypothesis 3.

$$CAR = \beta_0 + \beta_1 * Risk + \beta_2 * Growth + \beta_3 * Size \tag{102.1}$$

$$CAR = \beta_0 + \beta_1 * Risk + \beta_2 * Dindex + \beta_3 * Dindex * Risk + \beta_4 * Growth + \beta_5 * Size \tag{102.2}$$

Related variables in the model are defined as follows: *CAR*: The bank's capital allocation of resources situation. CAR is the composite score obtained based on factor analysis of proceeding. *Risk*: The credit risk faced by bank. The NPL ration is to represent the credit risk in this paper. According to the credit risk in the value of this paper, all the samples are divided into higher risk group and lower risk group than the median. *Index*: Financial ecological environment index. In this paper, the financial ecological environment in an area is represented by financial ecological environment index established by LiuYuhui. Index is a range of between 0 and 1. Higher number indicates the better financial ecological environment. *Dindex*: Financial ecological environment index virtual variable. Greater than the median of all samples value (0.694) in the sample, Dindex definition is 1, otherwise 0. *Growth*: The company growth, taking the growth rate of net return on assets. *Size*: The bank size, equal to the total assets of the natural logarithm.

102.5 Empirtcal Results and Analysis

102.5.1 Descriptive Statistics

Table 102.4 shows the descriptive statistics of each variables grouping. In the lower risk group, the mean of capital allocations of resources is 0.107 and the median is 0.1115, which are significantly greater than the higher risk group. Means

Table 102.4 Variance descriptive statistics

	Variable	CAR	Risk	Index	Growth	Size
Lower risk group N = 39	Mena	0.107	0.010	0.742	−0.340	0.080
	Median	0.115	0.010	0.694	−0.254	0.060
	Maximum	0.838	0.015	0.831	1.714	1.985
	Minimum	−0.455	0.004	0.613	−1.795	−1.932
Higher risk group N = 38	Mena	−0.289	0.035	0.760	0.313	−0.082
	Median	−0.325	0.024	0.788	0.550	−0.369
	Maximum	0.327	0.114	0.831	16.781	1.884
	Minimum	−0.655	0.015	0.613	−2.330	−1.926
D-value	Mean difference	0.396	−0.025	−0.018	−0.653	0.162
	Median difference	0.44	−0.014	−0.094	−0.804	0.429

of credit risk faced by the two groups of banks respectively were 0.010 and 0.035; medians respectively were 0.010 and 0.024. Relative to the lower credit risk group, the value of financial ecological environment and growth in the higher credit risk group is bigger, but the value of scale is smaller.

102.5.2 Regression Analysis

The regression result (Table 102.5) shows the significant negative correlation for all the sample banks, the bank's capital allocation of resources situation with the credit risk faced by the bank, which is consistent with hypothesis 1. This suggests that when the bank has a higher rate of bad loans, the bank for its loan will be careful consideration and may make a decision for non-loan. Meanwhile, to recover the bank non-performing loans, bank will further increase bank charges. This series of reflects will change the bank's capital allocation of resources situation.

Table 102.5 Regression results

Variable	The full sample	Lower	Higher	The full sample	Lower	Higher
Risk	−8.7297***	−4.8142***	−46.3658***	−27.6864***	−19.6107***	−67.3672***
Dindex*risk				21.1462***	15.7647***	49.5919*
Dindex				−0.4385***	−0.4909***	−0.6344**
Growth	−0.0166	−0.0048	−0.7739	−0.0127	−0.0031	−0.0022
Size	−0.1182***	−0.1357***	−0.0005	−0.1217***	−0.1622***	−0.0865*
c	0.1040**	−0.1318**	−1.1374**	0.4483***	0.2736*	0.8598***
R^2	0.3556	0.4098	0.2406	0.5071	0.5496	0.3388
Prob(F)	0.000000	0.000404	0.02066	0.000000	0.000068	0.0014158

Note *, **, *** are said in respectively 10, 5, and 1 % significance level

However, the bank of any business activities would have certain risk. If the credit risk of size faced by the bank is not the same, the extent of the negative correlation will be different. Therefore, all samples are divided into two groups to respectively regress. It can be seen, from the regression results, that the allocation of resources and the credit risk are a negative correlation for the bank having lower credit risk; the coefficient of the risk is −46.366, and in 1 % of significance level it is different from zero. The allocation of resources and the credit risk are also a negative correlation for the bank having higher credit risk; the coefficient of the risk is −4.814, and in 1 % of significance level it is different from zero. This indicates that, compared to banks facing the higher credit risk, banks having lower credit risk can achieve a better state of capital allocation of resources. When making decision of capital resources allocation, banks can effectively analyze their exposure to credit risk and make the right allocation decisions. These are consistent with hypothesis 2.

This paper further studies the impact of the regional financial ecological environment on the bank's capital allocation of resources. Empirical results show that:

1. For all sample banks, the coefficient of Dindex*Risk is positive and is significantly different from 0 in the 1 % level. When in area having the good financial ecological environment (namely Dindex = 1), the coefficients of the Risk is 6.54 and a negative correlation between credit risk and bank capital resources allocation has been weakened, which is consistent with the latter part of hypothesis 3. This is because when the environment changes the bank according to the change of environment re-configure and use of resources.
2. For the bank facing lower credit risk, risk coefficient of bank in the poor financial ecological environment is −67.367. For the bank in the good financial ecological environment, risk coefficient is positive but not significant in the statistical sense. The reason may lie in: The area having good financial ecological environment may attract more investors. In order to strive for the customers and achieve maximum benefit, the bank will be more cautious for capital allocation of resources.
3. For the bank facing higher credit risk, risk coefficient of bank in the poor financial ecological environment is −19.611. For the bank in the good financial ecological environment, risk coefficient is significantly positive and risk coefficient is −3.846 (=−19.611 + 15.765) which is significantly different from 0 in the 1 % level. These results show that the regional financial ecological environment as the basis of banks to survive and effectively operate helps to make the right decisions about capital resources allocation when banks face the greater credit risk.

102.6 Conclusions and Discussion

With Chinese listed banks in 2002 and 2010 as the samples, the paper studies the relationship between credit risk and capital allocation of resources, and further investigates the impact of financial ecological environment to them. The research finds there is a negative correlation between credit risk and bank capital allocation of resources, so the bank in capital resources allocation should take full account of the credit risk they face. At the same time, it is seen that the worse financial ecological environment of the region is, the higher credit risk bank facing is. Compared with in the poor financial ecological environment, banks in the good financial ecological environment have a weaker negative relationship between the credit risk and capital allocation of resources. In this regard, it is considered in this paper that the development of China's banking industry need to improve the financial ecological environment, reduce local government intervention in the economy and business activities, improve the bank operational independence and credit risk control capability, strengthen the integrity of culture construction and effectively improve the financial ecological environment.

The study not only is a useful reference for China's commercial bank capital resources allocation optimization and the effective supervision of banking regulators, but also point out the direction for future improvement of the financial ecological environment. But in this paper there are some limitations. Due to the limitations and complexity of the financial ecological environment index, we only won the 2006 regional financial ecological environment index. This paper assumes that there is the same financial ecological environment index from 2002 to 2010, which would have some impact to the conclusion of this paper.

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Chapter 103
Uncertain Investment Models for an Insurer with Ruin Constraint

Qing-feng Song and Kai Shi

Abstract This paper focuses on the optimal investment proportion problem of insurance premium for an insurer in uncertain environments. Two uncertain investment models with ruin constraint are investigated, namely, an investment model with ruin constraint and constant per unit time premium (CPRCIM) and an investment model with ruin constraint and variable premium (VPRCIM), where the individual claim amounts are assumed as uncertain variables and the claim numerical processes are characterized as uncertain renewal processes. The equivalent forms of the above investment models are investigated, particularly, the expressions are given for normal distributed uncertain investment interest rate and lognormal distributed uncertain individual claim amount.

Keywords Investment · Ruin · Insurance · Uncertain variable

103.1 Introduction

In uncertain environments, how to get the optimal allocation of resources, to achieve the optimal effectiveness goal, and to gain more effective and practical investment strategy, are very important for both individual and institutional investors. Since the pioneering work of Markowitz (1952), modern portfolio theory has been studied by many researches. Tobin (1958), Sharpe (1963, 1964) perfected the portfolio theory by building mathematical modellings. On the other

Q. Song (✉)
School of Science, Tianjin Institute of Urban Construction, Tianjin, China
e-mail: qfsong@tju.edu.cn

K. Shi
School of Computer Science and Communication Engineering, Tianjin University of Technology, Tianjin, China
e-mail: shikai0229@tju.edu.cn

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hand, in modern society, a combination of global economic integration, increasing complexity of insurance market and rising sorts of investment assets leads to a significance of theory and reality for the insurance companies to do portfolio investment with premium. Kahane and Nye (1975), Doherty (1980), Hipp and Plum (2000), and Kostadinova (2005) researched the problem of optimal investment of premium surplus based on portfolio theory, and explained that the investment return could not only cover the loss of interest, but also enhance economic strength of the whole insurer.

The above researches are all not considered the ruin risk of the insurance companies. As financial institutions whose principal business are spreading risk and recovering losses, the insurance companies face various risks: market risk, management risk, default risk and loan risk, among which the first and most risk is insolvency, bankruptcy, which is ruin risk. Ruin theory is an important research of insurance theory (Gerber 1979), since the pioneering works of Lundberg and Cramer, the classical compound Poisson risk model has been the focus of both theory and practice, and has been generalized in varied ways. Ammeter (1948) expended the claim number process to Cox process, inhomogeneous Poisson process and mixed Poisson process, respectively. Borovkov (2008) provided an alternative method, which enables us to obtain the explicit risk formula with arbitrary distribution of claim amounts.

The classical investment model, risk model and their generalizations focused mainly on the investment process and the claim number process, respectively. Moreover, the rate of investment return and the individual claim amount were described as random variables. However, the probability distribution may be neither easily acquired in practice nor estimated from limited data. Under this scenario, the rates of investment return and even the claim amounts should be approximately reckoned by managers' judgments and experience, and should be characterized as uncertain variables (Zimmermann 2000). The theory of fuzzy set initiated by Zadeh (1965) provides an alternative method to solve this kind of uncertainty. Based on the fuzzy set theory, Liu (2012) presented an uncertain measure, and established the uncertain theory, which provides a reasonable and effective method to solve uncertain optimization problem described above.

Moreover, owing to imprecise human knowledge and subjective judgment, statistic data may also contain uncertainty, where uncertain renewal process was an appropriate and effective implement technique to research this kind of statistical analysis. Liu (2012) studied an uncertain renewal process and presented a renewal reward theorem. Popova and Wu (1999) discussed a fuzzy random renewal reward process and interpreted why the fuzzy random inter arrival times were introduced. Song et al. (2010) studied the insurance risk analysis with investment in uncertain environments. Huang et al. (2009) designed a risk model with uncertain parameters and no investment, while investment is an important influence factor for insurance companies.

This paper studies the optimal investment proportion problem of insurance premium for an insurer in uncertain environments, where the rates of investment return and the claim amount are characterized as uncertain variables, and the inter arrival time process as an uncertain renewal process. Two uncertain investment models with ruin constraint are investigated, namely, an investment model with ruin constraint and constant per unit time premium and an investment model with ruin constraint and variable premium, particularly, the equivalent models are provided by investigating the distributions of the uncertain surplus and the mean beliefs of ultimate ruin.

The remainder of this paper proceeds as follows. Some necessary preliminary knowledge is presented in Sect. 103.2. Section 103.3 builds uncertain investment models with ruin constraint. A numerical example is proposed in Sect. 103.4. Finally, conclusions are given.

103.2 Preliminaries

A collection L of the subsets of a nonempty set Γ is called a σ algebra if

(a) $\Gamma \in L$;
(b) If $\Lambda \in L$ then $\Lambda^c \in L$;
(c) If $\Lambda_1, \Lambda_2, \ldots, \Lambda_n \in L$, then $\Lambda_1 \cup \Lambda_2 \cup \ldots \cup \Lambda_n \in L$.

Uncertain measure is a function from L to $[0, 1]$. Let $M\{\Lambda\}$ be the belief degree that event Λ will occur. Liu (Liu 2012) proposed the following four axioms:

(1) $M\{\Gamma\} = 1$ for the universal set Γ;
(2) $M\{\Lambda_1\} \le M\{\Lambda_2\}$ whenever $\Lambda_1 \le \Lambda_2$;
(3) $M\{\Lambda\} + M\{\Lambda^c\} = 1$ for any event Λ;
(4) For each countable sequence of events $\{\Lambda_i\}, M\left\{\bigcup_{i=1}^{\infty} \Lambda_i\right\} \le \sum_{i=1}^{\infty} M\{\Lambda_i\}$.

Definition 1 (Liu 2012) A measurable function ξ is defined as an uncertain variable from uncertain space (Γ, L, M) to the set of real numbers, i.e., the set

$$\{\xi \in B\} = \{\gamma \in \Gamma | \xi(\gamma) \in B\} \tag{103.1}$$

is an event, for any Borel set B of real numbers.

Definition 2 (Liu 2012) For any real number x, the uncertain distribution Φ of uncertain variable ξ is defined as

$$\Phi(x) = M\{\xi \le x\}. \tag{103.2}$$

Lemma 1 (Liu 2008) *Assume that $\xi_1, \xi_2, \ldots, \xi_n$ are independent uncertain variable with uncertain distribution $\Phi_1, \Phi_2, \ldots, \Phi_n$, respectively. If $f(x_1, x_2, \ldots, x_n)$ is increasing with respect to $x_1, x_2, \ldots, x_m$ strictly, and decreasing with respect to*

$x_{m+1}, x_{m+2}, \ldots, x_n$ *strictly, then* $\xi = f(\xi_1, \xi_2, \ldots, \xi_n)$ *is an uncertain variable, whose uncertain distribution is*

$$\Phi(x) = \sup_{f(x_1,x_2,\ldots,x_n)=x} \left(\min_{1 \le i \le m} \Phi_i(x_i) \Lambda \min_{m+1 \le i \le n} (1 - \Phi_i(x_i)) \right) \tag{103.3}$$

Definition 3 Liu (2008) Let (Γ, L, M) be an uncertain space and T an index set. An uncertain process is a measurable function from $T \times (\Gamma, L, M)$ to a real number set, i.e., the set

$$\{X_t \in B\} = M\{\gamma \in \Gamma | X_t(\gamma) \in B\}, \tag{103.4}$$

is an event, for any Borel set B of real numbers and each $t \in T$.

103.3 Uncertain Investment Models With Ruin Constraint

In this section, the problem of how to maximize the expected utility of an insurer is investigated by building uncertain investment models, when a part of the initial surplus is used for investment and ruin constraint is considered. By assuming that the insurer adopts a current investment strategy, and the individual claim amounts are uncertain variables, an investment model with ruin constraint and constant per unit time premium (CPRCIM), and an investment model with ruin constraint and variable premium (VPRCIM) are established.

103.3.1 Model Building of CPRCIM

Let r_{tm} be the m-th risk invest return rate, r_{t0} the risk free return rate, w_{tm} the m-th risk invest proportion, and w_{t0} the risk free invest proportion at time t. Then, the total invest return rate at time t is

$$I_t = \sum_{m=0}^{M} w_{tm} r_{tm}, \tag{103.5}$$

With $\sum_{m=0}^{M} w_{tm} = 1$.

Let u be the insurer's initial surplus, g_t $(0 \le g_t < 1)$ the investable proportion of u and W_t the capital and interest at time t. Then, W_t can be obtained as

$$W_t = u(1 + g_t I_t). \tag{103.6}$$

For the reason that the insurer do investment activity at the same time also charge premium through claims activity, the insurer's capital source has both investment return and premium income.

Let $Y_j\,(j = 1, 2, \ldots)$ be the amount of the j-th claim, which is a positive uncertain variable, $\{Y_j, j \geq 1\}$ be a sequence of independently identically distributed (i.i.d.) positive uncertain variables; $T_j\ (j = 1, 2, \ldots)$ be the inter arrival time between the $(j-1)$-th and j-th claim, $\{T_j, j \geq 1\}$ be a sequence of i.i.d. exponentially distributed uncertain variables with parameter λ, and independent with $\{Y_j, j \geq 1\}$. Then, the arrive time of the n-th claim is

$$Q_n = T_1 + T_2 + \ldots + T_n, n = 1, 2, \ldots, \tag{103.7}$$

where $Q_0 = 0$.

The number of claims at time t is

$$N(t) = \max_{n \geq 0}\{n | 0 < Q_n \leq t\}. \tag{103.8}$$

It is obvious that $\{N(t), t \geq 0\}$ is a renewal process with parameter λt (Liu 2008).

The aggregate claims at time t, denoted by $C(t)$, can be obtained as

$$C(t) = \sum_{j=1}^{N(t)} Y_j. \tag{103.9}$$

Since Y_j is an uncertain variable, $C(t)$ is an uncertain variable. The process $\{C(t), t \geq 0\}$ is called an uncertain aggregate claim process.

Let c be the claim amount of the insurer per unit time. The capital surplus of the insurer at time t contains initial surplus, investment return, premium; the capital payout is the claim amount until time t, i.e., the surplus at time t can be derived as

$$R_1(t) = W_t + ct - C(t), \tag{103.10}$$

The process $\{R_1(t), t \geq 0\}$ is called an uncertain insurer's surplus process with an investment.

The first time when the surplus becomes negative is

$$T = \inf\{t | R_1(t) < 0\}. \tag{103.11}$$

(103.11) is called the time of ruin ($T = +\infty$ denotes that ruin would not occur). Since $R_1(t)$ is an uncertain variable, T is also an uncertain variable.

The mean belief of the ultimate ruin can be denoted by

$$M\{T < \infty\} = M\left\{\bigcup_{t>0}^{\infty} R_1(t) < 0\right\}. \tag{103.12}$$

The optimal strategy of the insurer in the case of constant pre unit premium is to maximize the expected utility and at the same time the mean ruin belief $M\{T < \infty\}$ is no more than a given levelc_0, which can be formulated as

$$\begin{cases} \max\limits_{w_{t0},w_{t1},\ldots,w_{tM}} [U(W_t)] \\ \text{s.t.} \\ \qquad M\{T < \infty\} \le c_0 \\ \qquad \sum\limits_{m=0}^{M} w_{tm} = 1 \\ \qquad 0 \le w_{tm} < 1, m = 0, 1, \ldots, M, \end{cases} \tag{103.13}$$

where $U(\cdot)$ is an utility function. The model (103.13) is called an investment model with ruin constraint and constant per unit time premium (CPRCIM).

103.3.2 Model Building of VPRCIM

The process $\{R_1(t), t \ge 0\}$ defined in (103.10) assumes that the premium amount pre unit time is a constant c. In fact, the premium amounts are discrete and have different uncertain values. Therefore, we defined a surplus process $\{R_2(t), t \ge 0\}$ as

$$R_2(t) = W_t + S_t - C(t), \tag{103.14}$$

with

$$S_t = \sum_{i=1}^{M_t} X_i, \tag{103.15}$$

$M_t = \max\limits_{n \ge 0}\{n|0 < Q_n \le t\}$, $Q_n = T_{11} + T_{12} + \ldots T_{1n}$, T_{1i} is the interarrival time between the $(i-1)$-th and i-th premium, X_i is the amount of the i-th premium, which is an uncertain variable. The first time that surplus (103.14) becomes negative can be defined as

$$T' = \inf\{t|R_2(t) < 0\}. \tag{103.16}$$

Equation (103.16) is called the time of ruin ($T' = +\infty$ denotes that ruin would not happen). Since $R_2(t)$is an uncertain variable, T' is also an uncertain variable. The mean belief of the ultimate ruin is

$$M\{T' < \infty\} = M\left\{\bigcup_{t>0}^{\infty} R_2(t) < 0\right\}. \tag{103.17}$$

The optimal strategy of the insurer in the case of variable premium is also to maximize the expected utility and meanwhile the mean ruin belief $M\{T' < \infty\}$ is no more than a given level c_0, which can be formulated as

$$\begin{cases} \max\limits_{w_{t0},w_{t1},\ldots,w_{tM}} [U(W_t)] \\ \text{s.t.} \\ \qquad M\{T' < \infty\} \le c_0 \\ \qquad \sum\limits_{m=0}^{M} w_{tm} = 1 \\ \qquad 0 \le w_{tm} < 1, m = 0, 1, \ldots, M, \end{cases} \tag{103.18}$$

Model (103.18) is called an investment model with ruin constraint and variable premium (VPRCIM).

103.3.3 Model Analysis

Models (103.13) and (103.18) involve so many uncertain variables and are not explicit expressions of decision variables $w_{t0}, w_{t1}, \ldots, w_{tM}$. Therefore, their equivalent forms are studied, particularly, the situation of normal distributed uncertain investment interest rate and lognormal distributed uncertain individual claim amount are considered to calculate the uncertainty distribution of the surplus process, and to obtain the mean belief of the ultimate ruin of the insurer.

Let $\{T_j, j \ge 1\}$ be a sequence of i.i.d uncertain variables with an uncertainty distribution Φ, $\{Y_j, j \ge 1\}$ a sequence of i.i.d uncertain variables whose uncertainty distribution is Υ, and r_{tm} an uncertain variable with uncertainty distribution $\Phi_{rm}, m = 1, 2, \ldots, M$. Considering the case of constant per unit time premium, we have the following Theorems 1 and 2.

Theorem 1 *The uncertain distribution of the uncertain surplus process (103.10) satisfies*

$$\Psi_1(x) = \sup_{y-z=x} \left(\Phi_{W_t}(y) \Lambda \left(1 - \Phi_{C(t)-ct}(z)\right)\right), \tag{103.19}$$

where

$$\Phi_{W_t}(y) = \sup_{\sum_{i=1}^{M} w_{ti} y_i = y} \min_{1 \le i \le M} \Phi_{ri}\left(\frac{y_i}{ugt} - \frac{1}{gt}\right) \tag{103.20}$$

and

$$\Phi_{C(t)-ct}(z) = \max_{k \ge 0} \left(1 - \Phi\left(\frac{t}{k+1}\right)\right) \Lambda \Upsilon\left(\frac{z + ct}{k}\right). \tag{103.21}$$

Proof Since W_t and $C(t) - ct$ are independent uncertain variables, it follows from Lemma 1 that

$$\begin{aligned}\Psi_1(x) &= M\{W_t - (C(t) - ct) \le x\} \\ &= \sup_{y-z=x} \left(\Phi_{W_t}(y)\Lambda\left(1 - \Phi_{C(t)-ct}(z)\right)\right).\end{aligned} \tag{103.22}$$

Moreover, it follows from the independence of $r_{tm},\ m = 1, 2, \ldots, M$ and Lemma 1 that

$$\begin{aligned}\Phi_{W_t}(y) &= M\{u(1 + g_t I_t) \le y\} \\ &= M\left\{I_t \le \frac{y}{ugt} - \frac{1}{gt}\right\} \\ &= M\left\{\sum_{i=1}^{M} w_{ti} r_{ti} \le \frac{y}{ugt} - \frac{1}{gt}\right\} \\ &= \sup_{\sum_{i=1}^{M} w_{ti} y_i = y} \min_{1 \le i \le M} \Phi_{ri}\left(\frac{y_i}{ugt} - \frac{1}{gt}\right),\end{aligned} \tag{103.23}$$

and

$$\begin{aligned}&\Phi_{C(t)-ct}(z) \\ &\quad = M\{C(t) - ct \le z\} = M\{C(t) \le z + ct\} \\ &\quad = M\left\{\sum_{j=1}^{N_t} Y_j \le z + ct\right\} \\ &\quad = M\left\{\bigcup_{k=0}^{\infty} (N_t = k) \cap \sum_{j=1}^{k} Y_j + ct\right\} \\ &\quad = M\left\{\bigcup_{k=0}^{\infty} (N_t = k) \cap \left(Y_1 \le \tfrac{z+ct}{k}\right)\right\} \\ &\quad = \max_{k \ge 0} M\left\{(N_t = k) \cap \left(Y_1 \le \tfrac{z+ct}{k}\right)\right\} \\ &\quad = \max_{k \ge 0} M\{N_t = k\} \Lambda M\left\{Y_1 \le \tfrac{z+ct}{k}\right\} \\ &\quad = \max_{k \ge 0}\left(1 - \Phi\left(\tfrac{1}{k+1}\right)\right)\Lambda \Upsilon\left(\tfrac{z+ct}{k}\right).\end{aligned} \tag{103.24}$$

Theorem 103.2 *The mean ruin belief of the ultimate ruin of uncertain surplus process (103.10) can be denoted by*

$$M\{T < \infty\} = \max_{t \ge 0} \Psi_1(0). \tag{103.25}$$

where $\Psi(x)$ *is defined as* (103.19).

Proof It follows from (103.2) and (103.12) that

$$\begin{aligned} M\{T<\infty\} &= M\left\{\bigcup_{t>0}^{\infty} R_1(t)<0\right\} \\ &= \max_{t\geq 0} M\{R_1(t)<0\} \\ &= \max_{t\geq 0} \Psi_1(0). \end{aligned}$$

Thus, (103.25) holds. In the following the case of variable premium is considered. Let $\{T_{1j}, j\geq 1\}$ be a sequence of i.i.d uncertain variables whose uncertainty distribution are Φ, $\{X_i, i\geq 1\}$ a sequence of i.i.d uncertain variables whose uncertainty distribution are Υ_X, $\{Y_j, j\geq 1\}$ a sequence of i.i.d uncertain variables whose uncertainty distribution are Υ_Y, and r_{tm} an uncertain variable whose uncertainty distributions are Φ_{rm}, $m=1,2,\ldots,M$. Similarly as Theorems 1 and 2, the results can be obtained as follows.

Theorem 103.3 *The uncertainty distribution of the uncertain surplus process (103.14) satisfies*

$$\Psi_2(x) = \sup_{y+s-z=x} \min(\Phi_{W_t}(y), \Phi_{S_t}(s))\Lambda\big(1-\Phi_{C(t)}(z)\big), \tag{103.26}$$

where Φ_{W_t} is defined as (103.23),

$$\Phi_{S_t}(s) = \max_{k\geq 0}\left(1-\Phi\left(\frac{t}{k-1}\right)\right)\Lambda\Upsilon_X\left(\frac{s}{k}\right) \tag{103.27}$$

and

$$\Phi_{C(t)}(z) = \max_{k\geq 0}\left(1-\Phi\left(\frac{t}{k+1}\right)\right)\Lambda\Upsilon_Y\left(\frac{z}{k}\right). \tag{103.28}$$

Moreover, the mean belief of the ultimate ruin of the uncertain surplus process (103.14) is

$$M\{T'<\infty\} = \max_{t\geq 0} \Psi_2(0). \tag{103.29}$$

where $\Psi_2(x)$ is defined by (103.26).

Proof Since W_t, $C(t)$ and S_t are independent uncertain variables, it follows from Lemma 1 that

$$\begin{aligned} \Psi_2(x) &= M\{W_t+S_t-C(t)\leq x\} \\ &= \sup_{y+s-z=x} \min(\Phi_{W_t}(y), \Phi_{S_t}(s))\Lambda\big(1-\Phi_{C(t)}(z)\big), \end{aligned} \tag{103.30}$$

thus (103.26) holds.

Moreover, since $X_i, i \geq 1$ are i.i.d uncertain variables, $Y_j, j \geq 1$ are i.i.d uncertain variables, following from Theorem 2 and Theorem 3, we have (103.27), (103.28) and (103.29) hold.

Based on Theorem 1, 2 and 3, Models (103.13) and (103.18) are equivalent to

$$\begin{cases} \max\limits_{w_{t0}, w_{t1}, \ldots, w_{tM}} [U(W_t)] \\ \text{s.t.} \\ \qquad \max\limits_{t \geq 0} \Psi(0) \leq c_0 \\ \qquad \sum\limits_{m=0}^{M} w_{tm} = 1 \\ \qquad 0 \leq w_{tm} < 1, m = 0, 1, \ldots, M, \end{cases} \tag{103.31}$$

where $\Psi(x) = \Psi_1(x)$ if premium amount pre unit time is a constant c, and $\Psi(x) = \Psi_2(x)$ if premium is a variable.

103.4 Numerical Example

In this section, a numerical example is afforded to illustrate the effectiveness of the proposed investment model with ruin constraint (103.31) derived in the above Sections.

It is assumed that the utility function of the insurer is

$$U(x) = -\frac{1}{\rho}(1 - \exp(-\rho x)),$$

where $\rho > 0$ is the insurer's risk tolerance factor, the interarrival time sequence $\{T_j, j \geq 1\}$ has a linear uncertainty distribution $\Phi(t) = \frac{t}{T}, 0 \leq t \leq T$, the claim amount sequence $\{Y_j, j \geq 1\}$ has a lognormal uncertain distribution

$$\Upsilon(z) = \left(1 + \exp\left(\frac{\pi(\mu - \ln z)}{3^{\frac{1}{2}}\sigma_z}\right)\right)^{-1}, z \geq 0,$$

where μ and σ_z are real numbers with $\sigma_z > 0$, and the investment interest rate has a normal uncertainty distribution $\Phi_{ri}(y_i) = \left(1 + \exp\left(\frac{\pi(\mu_i - y_i)}{3^{\frac{1}{2}}\sigma_{ri}}\right)\right)^{-1}$, $y_i \in \Re$, where μ_i and σ_{ri} are real numbers with $\sigma_{ri} > 0$.

Then the uncertain distribution of the surplus process is

$$\begin{aligned}\Psi(x) = \sup_{y-z=x} & \left(\sup_{\sum_{i=1}^{M} w_{ti} y_i = y} \min_{1\le i\le M} \left(1+\exp\left(\frac{\pi\left(\mu_i - \frac{y_i}{ugt} + \frac{1}{gt}\right)}{3^{\frac{1}{2}}\sigma_{r_i}}\right)\right)^{-1} \right. \\ & \wedge\left[1-\max_{k\ge 0}\left(\left(1-\frac{t}{(k+1)T}\right)\right.\right. \\ & \left.\left.\left.\wedge\left[1+\exp\left(\frac{\pi\left(\mu-\ln\left(\frac{z+ct}{k}\right)\right)}{3^{\frac{1}{2}}\sigma_z}\right)\right]^{-1}\right)\right]\right),\end{aligned} \tag{103.32}$$

and the mean belief of the ultimate ruin is

$$M\{T<\infty\} = \max_{t\ge 0}\Psi(0), \tag{103.33}$$

where $\Psi(x)$ is defined in (103.32).

Assume that the initial surplus $u = 100$, the constant per unit time premium $c = 2$, the number of risk investment $M = 2$, the time of ultimate ruin $T = 100$, the investable proportion $g_t = 0.8$, the claim amount has an expected value $\mu = 10$ and a variance $\sigma = 5$, the risk return rates r_1, r_2 have the expected values $\mu_1 = 0.2$, $\mu_2 = 0.5$, and variances $\sigma_{r1} = 0.008$, $\sigma_{r2} = 0.018$, and the optimal investment proportion $\left(w_{t0}^*, w_{t1}^*, w_{t2}^*\right)^T = (0.2703, 0.3067, 0.4230)^T$ then the expected utility of the insurer can be maximized.

103.5 Conclusion

This paper built two investment models with ruin constraint for an insurer with uncertain claim amounts and uncertain return rates, i.e. an uncertain investment model with ruin constraint and constant per unit time premium (CPRCIM), and an uncertain investment model with ruin constraint and variable premium (VPRCIM). The equivalent model was obtained by investigating the expression of uncertain distribution of the surplus process and the mean ruin beliefs. A numerical example illustrated the effectiveness of the proposed model, and the results showed that the ruin constraint plays an indispensable role on the optimal investment strategy of the insurer, and should not be neglected in both theory and practical application.

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Chapter 104
Using Network Security Index System to Evaluate Network Security

Jian-feng Zhang, Fei Liu, Li-ming Zheng, Yan Jia and Peng Zou

Abstract Fast Internet growth and increase in number of network attack make network security essential in recent years. This paper proposes a novel approach to evaluate the network security situation using Network Security Index System (NSIS). The NSIS is composed of Foundational Index, Vulnerable Index, Risk Index and Comprehensive Index. Each index focuses on some specific aspect of network security, and the detailed methods of how to calculate the index are given. Experimental results show that the NSIS can assess the network security situation objectively and comprehensively.

Keywords Network security index system · Network security · Situation evaluation · Multi-criteria decision making

104.1 Introduction

With the development of human society, the network has been integrated into all aspects of people's lives. Along with the convenience, network also brings many security problems, the global Internet attack happens frequently, and makes a highly severe impact on the global network. At the same time, in our county a variety of network security incidents have become inevitable, such as network economic crimes, large-scale network attacks, network stolen and so on. All these have became a constraint to our economic development, especially became the key

J. Zhang (✉) · F. Liu · L. Zheng · Y. Jia
College of Computer, National University of Defense Technology,
Changsha, Hunan, China
e-mail: jfzhang@nudt.edu.cn

P. Zou
Academy of Equipment Command and Technology,
Beijing, China

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factors that threaten social stability and national security. So that how to evaluate the situation of network security comprehensively and objectively has became a challenging issue. In this paper we use Network Security Index System (NSIS) to solve this problem perfectly. NSIS choose the objective and subjective attributions to quantify and compute network security situation, and it is designed to assist managers to discover the main elements that influence network security. So the managers can focus on the primary to defense the attack and protect the network.

NSIS is implemented in our system named YHSAS, this system is to analyze and predict the larger-scale network security situation. In this system, sensors like IDS, firewall, et al. are distributed deployed to detect and monitor the abnormal events in the network, all the threaten events generated by these sensors are send to server to be analyzed. Base on these information NSIS is used to evaluate the network situation in our system.

The rest of this paper is organized as follows. In Sect. 104.2, related theories of network security index system are explained. Section 104.3 explains the design of this system. Section 104.4 presents an experimental evaluation. Finally, the conclusion is given in sect. 104.5.

104.2 Related Works

Tim Bass (2000) proposes a distributed intrusion detection system using multi-sensor data to assess computer network security through data fusion and data mining methods. Meanwhile, Han et al. (2004) use qualitative analysis methods to assess network vulnerability. Kamara et al. (2003) propose Internet firewall vulnerability assessment, Hariri et al. (2003) propose a large-scale network attack assessment using quantitative analysis, The OCTAVE (Alberts et al. 2003) and ISO 13335 (2001) standards combined qualitative and quantitative methods to evaluate network security.

Shi and Zhuang (2007) propose a model of network security risk assessment system both with quantitative evaluation theory, and risk is defined as the product of asset, threat and vulnerability. Chen Xiuzhen et al. (2004) develop a quantitative hierarchical threat evaluation model to evaluate security threat status of a computer network system, the computational method in this model is based on the structure of the network and it focus on the threat situation. The threat indexes of services, hosts and local networks are calculated by weighting the importance of services and hosts. Yong and Yifeng (2009) proposes a network security situational awareness model based on log audit and performance correlation algorithm. The value of network security situation is computed using service information.

The existing researches on evaluate network security situation are mainly focus on a single security attribute such as threat, vulnerability and so on, lack of the evaluation on integrated network security situation. This paper prose a novel approach that use NSIS to evaluate the network security situation objectively and comprehensively.

104.3 Design of Network Security Index System

In order to reasonably assess the situation of network security, the index of network security must satisfy the following properties:

1) *Objectivity:* The indexes choose from network information should be representative and authentic. Meanwhile, these indexes can also indicate the network security comprehensively.
2) *Computability:* As can be applied to practice, the raw data used for Network Security Index System could be convenient to quantify and calculate, and the method of quantification and calculation must be reasonable.
3) *Sensitivity:* The values of each index in Network Security Index System should be changed sensitively when network security changes. And the trend of this change must be consistent with the network situation.

Based on the above characteristics, this paper designs our own Network Security Index System. As shown in Fig. 104.1, the NSIS is composed of Foundational Index, Vulnerable Index, Risk index and Comprehensive Index. All these indexes are introduced in following sections, the sections is organized by three parts: firstly, the attributes are selected to each index; Then the methods of quantify these attributes are given; and finally based on the qualified values, we use the aggregation algorithms to calculate the indexes. The functions in this paper are implemented in our YHSAS, and can also be replaced by others in different situation.

In order to indicate the relationship between the situation and the values that calculated by NSIS, we provide a rating from 1 to 5 using the scale in Table 104.1. Values in this table are the upper bound of each situation.

104.3.1 Foundational Index

Foundational Index is mainly focus on the capability of the hardware and the situation of the services, and is used to reflect whether the devices and the services work well. The resources of hardware and software are consumed when the network is under attacking. In this situation the utilization rate of CPU and Memory of these equipments will be high away from the normal level, and the network flow will increase seriously. So the Foundational Index is assessed by the properties as follows:

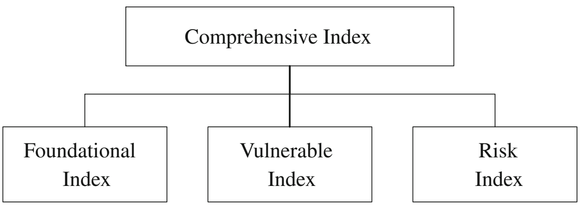

Fig. 104.1 Structure of network security index system

Table 104.1 Relationship between security situation and index values

Value	Situation
1	The situation of the network is very good. All the network devices are performing very well, almost no vulnerabilities and attacks are existed in the network
2	The situation of the netwok is good. All the network devices are working well, few vulnerabilities and attacks are existed in the network. The impact of all these vulnerabilities and attacks can be ignored
3	The situation of the network is medium. Some network devices are working near its threshold, some vulnerabilities and attacks are existed in the network. These vulnerabilities and attacks impact the security of the network
4	The situation of the network is dangerous. Some network devices are overloading. A few vulnerabilities and attacks are existed in the network. These vulnerabilities are serious, and the existed attacks used these vulnerabilities make an impact on the confidentially, integrity and availability of the network
5	The situation of the network is severe. Many network devices are severe overloading. Many vulnerabilities and attacks are existed in the network. These vulnerabilities are severe, and the existed attacks used these vulnerabilities make a severe impact on the confidentially, integrity and availability of the network

1) *Peak flow:* Peak flow is the max flow that received by a host and device in the fixed time period. Max flow can show the most threaten situation of the hosts and devices confronted.
2) *Bandwidth utilization:* High bandwidth utilization by one or more computers or network devices, either transient or sustained, which degrades network performance and effectively prevents or inhibits legitimate activities.
3) *CPU utilization:* CPU utilization is important to measure the performance of a host or device, and the higher the percentage of the CPU used, the less power the CPU can devote to other tasks. Here CPU utilization is considered as average percentage of the CPU used in the fixed time period.
4) *Memory utilization:* As the CPU utilization, we consider the memory utilization to asses the real-time performance of the devices. Many denials of services attacks have the aim to exhaust the CPU and memory resources, so this property is as important as CPU utilization to assess the running performance of a host or device.

Based on the defined the properties, the Foundational Index is calculated by the following steps:

Firstly, we use the overload of each property to qualify the severe scale in every time period. Suppose that a network has N nodes, and the overload of the property is defined as in

$$o_{ji} = \begin{cases} \frac{l_{ji}}{L_{ji}}, if l_{ji} > L_{ji} \\ 1 \end{cases} \tag{104.1}$$

where $i = 1, 2, 3, 4$ respectively stands for peak flow, bandwidth utilization, CPU utilization and memory utilization, j is the node number from 1 to N, L_{ji} represents the threshold for property i at node j, and its values are meeting specific statistical laws in a certain time period, l_{ji} represents the actual value for property i at node j. o_{ji} is the overload of the property i at node j.

Secondly, the o is normalized to a severity rating from 1 to 5. Let s_{ji} be the normalized result of O_{ji}. S is assigned as follows: if $o = 1$ then $s = 1$, if $1 < o \leq 1.25$ then $s = 2$, if $1.25 < o \leq 2$ then $s = 3$, if $2 < o \leq 3$ then $s = 4$and if $o > 3$ then $s = 5$. We can also define the different transfer function to normalize the overload according to the real situation.

Thirdly, we calculate the Foundational Index for every node as in

$$I_j = f(o_{j1}, o_{j2}, o_{j3}, o_{j4}) = \underset{1 \leq i \leq 4}{Max}(o_{ji}) \tag{104.2}$$

Finally, based on the Foundational Index of each node, we get the Foundational Index as in

$$I_F = f(o_1, o_2, \cdots o_N) = \sum\nolimits_{j=1}^{N} u_j o_j \tag{104.3}$$

where u_j is the weight of the node in the network, and$\sum\nolimits_{j=1}^{N} u_j = 1$. The function used to calculate the Foundational Index can be different in different situations.

104.3.2 Vulnerable Index

In computer security, vulnerability is a weakness which allows an attacker to reduce a system's information assurance. If a computer or system has much vulnerability, it may be easy to be exploited, and the asset on it may confront serious threat, so it is important to assess the harmful of the vulnerabilities exist in the network. In this paper we use Vulnerable Index to measure the self-security of equipment without any external attacks. We assess the vulnerabilities by three important attributes:

(1) *Asset:* In ISO/IEC (2001), anything that has value to the organization is defined as asset. In network system, we mainly defined asset as hardware, software, information. Vulnerabilities can be related to properties or attributes of the asset. The vulnerability of some import asset has higher threat, once this vulnerability is exploited, it may bring wide influence.

We use the definition of asset in international standards ISO/IEC 13335 (2001) to quantify the importance of network equipment, we assign 1 to "Negligible" level, 2 to "Low" level, 3 to "Medium" level, 4 to "High" level and 5 to "Critical" level. To complete this procedure, firstly we should identity the assets on each host and network device, then the values should be assigned to these assets by owners or users, and finally the asset of each host or network device is given by all assets on it.

(2) *Inherent threaten:* This attribute is used to consider what you can obtain through the vulnerability. For example, the vulnerability to get root privileges may be greater threat than the vulnerability to misuse of resources.

The inherent threaten of vulnerability is defined as in Anderson (2004), "Hole", "Warning" and "Note" are used to describe the threaten of vulnerability, we assign 1 to "Note" level, 3 to "Warning" level and 5 to "Hole" level.

(3) *Usability:* Usability is used to show that how easily the vulnerability may be exploited. Some vulnerability can only be exploited by experts, but some can be implemented by script kiddies (Rubin 2002).

The usability of vulnerability is defined as follows: "Easy" give a description of the vulnerability that can be exploited by script kiddies, and value 5 is assigned to this level; "Possible" means that the vulnerability may be exploited by some skillful persons, value 3 is assigned to this level; Vulnerability with "Difficult" level shows that the vulnerability can only be exploited by experts.

The Vulnerable Index is calculated by two steps:

Firstly we evaluate the vulnerabilities on every host or network device. Vulnerability on a host or device may be exploited by each other. For example, by some weak vulnerability attackers can only obtain remote access privilege, but based on this remote privilege, attackers may get root privileges by other vulnerability. So we consider each host and device as a whole to be evaluated. Suppose that there are N vulnerabilities on a host, let M_i be the Vulnerable Index of this host, and M_i can be expressed as in

$$\mathrm{M}_i = f(T_j, U_j) = T_j * U_j/5 \tag{104.4}$$

where i is used to identity different host or network device in the network, T_j is the inherent threaten value of specific vulnerability j and U_j is the usability value of specific vulnerability j.

After getting all values of Vulnerability Index for each host and network device, we use aggressive algorithm to get the Vulnerable Index for this network as:

$$\mathrm{I}_V = f(M_i, A_i) = Max(u_1 M_i + u_2 A_i) \tag{104.5}$$

where i is used to identity different host in specific network, A_i is the asset value of the host, u_1, u_2 are the weight of M_i andA_i, the max value of all the host is specified to Vulnerable Index of the network.

104.3.3 Risk Index

Risk is defined as a function of the values of the assets, the likelihood of threats, the ease of exploitation of the vulnerabilities by the identified threats, and any existing or planned safe guards (ISO/IEC 2001).

In this paper, we use Risk Index to evaluate the impact of the network attacks. Here the network attacks exist as alarms, and the alarms are generated from the threaten events collected by IDS and other security tools using correlate algorithm. In order to evaluate the situation of network attack, we cluster the alarms by the attack category, destination IP and the using vulnerability. After that we consider the attributes of these clusters as follows:

1) *Reliability:* Reliability is used to assess the likelihood of threats and the ease of exploitation of vulnerabilities by the identified threats. An alarm may have a high reliability if the vulnerability used by the threat exists truly at the target host, otherwise the reliability may be low.

The value of reliability is initialized according to the performance of each security tools, and then the value is modified in our YHSAS by correlation rules. In this paper we quantify the reliability as the number from 1 to 5, the bigger the more reliable.

2) *Scale:* We use scale to express the size of cluster. This attribute is very important to evaluate the impact of attack, for example, DDOS attack with high packet sending rate is more threat than the one with low packet sending rate. The scale is normalized as in

$$S = \begin{cases} 1, & x > MaxValue \\ \frac{x - MinValue}{MaxValue - MinValue}, & MinValue \le x \le MaxValue \\ 0, & x < MaxValue \end{cases} \tag{104.6}$$

Where x is the number of alarms in each cluster, $MaxValue$ and $MinValue$ are the biggest and smallest values in history, of course these two values can also specific by users.

3) *Asset:* Asset here is the same meaning as the asset in Vulnerable Index.
4) *Threatening:* Threatening is the self-attribute of an attack, some attacks such as DDOS is threaten to the availability of host or service, some attacks such as worms may be destructed to system. So we define the threatening as four levels: "Disclosure", "Modification", "Non-availability", and "Destruction". "Disclosure" is used to describe the attacks that have the aim to steal users' information, such as port scans. "Modification" describes the attacks that destroy data integrity, such as some virus. "Non-availability" means that the attacks ruin the availability of the data like DDOS. The severe threaten is

expressed as “Destruction”, meaning that the system is ruined by this attack, such as CIH (Ren 2001).

The level of all the attacks should be defined by experts, and the definition may be different in different application scene. In this paper we assign 2 to “Disclosure”, 3 to “Modification”, 4 to “Non-availability”, and 5 to “Destruction”.

After discussing the risk attributions, we use these attributions to assess the risk of the network situation. Let I_R be the Risk Index, I_R can be expressed as in

$$\mathrm{I}_R = f(S_i, A_i, R_i, T_i) = u_1 S_i + u_2 A_i + u_3 R_i + u_4 T_i \tag{104.7}$$

Where we suppose that C is the number of clusters, $i = 1, 2, \cdots C$, To cluster i, N_i is the scale of this cluster, A_i is the asset of destination IP, R_i is the reliability of the alarm, T_i is the inherent risk about this alarm, u is the weight of the attributes, and $\sum u = 1$.

104.3.4 Comprehensive Index

The Comprehensive Index is decided by Foundational Index, Vulnerable Index and Risk index. It is used to reflect the whole situation of the network. The Comprehensive Index is calculated as

$$I_c = u_F * I_F + u_{\mathrm{V}} * I_{\mathrm{V}} + u_{\mathrm{R}} * I_{\mathrm{R}} \tag{104.8}$$

where u is the weight for each index, and $\sum u = 1$, Its value can be assigned according to the role of corresponding index in the whole network.

104.4 Experimental Results

104.4.1 Introduce the Experimental Environment

We evaluate the effectiveness of the NSIS in the real environment. Before the experiment, a brief introduction about the environment is statement. The NSIS is deployed in an enterprise network as shown in Fig. 104.2. This enterprise network contains fifty PCs, twenty servers and a core switch, Snort (Roesch and Green 2003) is used as an IDS tool, Ntop (Pras 2000) is used to monitor the network flow and vulnerabilities are collected by Anderson (2004). Our NSIS is implemented in YHSAS server, and the web server is used to show the results of NSIS to users. All the values in NSIS are calculated every six seconds in our system.

The statement of YHSAS is initialized as follows: we sign 2 as the asset to all PCs, 3 to the servers and 5 to the switch. The optimal parameters of all equations in this paper are determined by training. Suppose all the devices have no severe vulnerabilities, and not be under attacking.

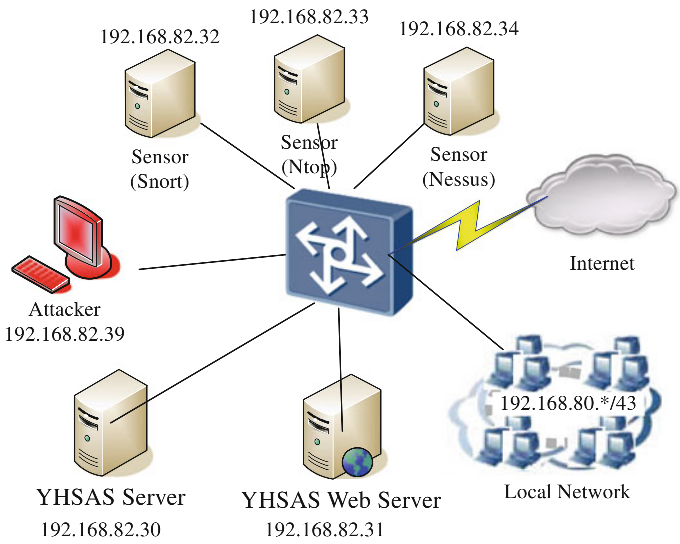

Fig. 104.2 Experiment environment

104.4.2 Validate the NSIS by Simulation

In this experiment, we simulate a DDOS attack to validate whether the values of index can reflect the situation of the network when the network is under attacking. In this scene, we launch the DDOS attack using TFN2K (Center 1999) to attack the server in our environment. The TFN2K daemons are capable of a larger variety of attacks, including ICMP flooding, SYN flooding, and smurf attacks. In our typical scenario, we use ICMP flooding to consume the resource at the target server. This attack last for twenty minutes. In the first 10 min, we increase the attack intensity from 10 per min to 300 per min, and in next 10 min, we decrease the attack intensity until to stop the attack.

Figure 104.3 shows all the index values in NSIS from the beginning of attack to the end, and the values are calculated every 6 s. We can find that the value of Foundational Index increases suddenly after 8 min which illustrates that the performance of the victim may meet its bottleneck when the attack intensity achieves 250 per min. When the intensity of DDOS decreases to 150 per min, the Foundational Index decreases suddenly. The values of Risk Index increase and decrease along with the attack intensity. Because of unchanged vulnerabilities in network, Vulnerable Index is also unchanged during the times.

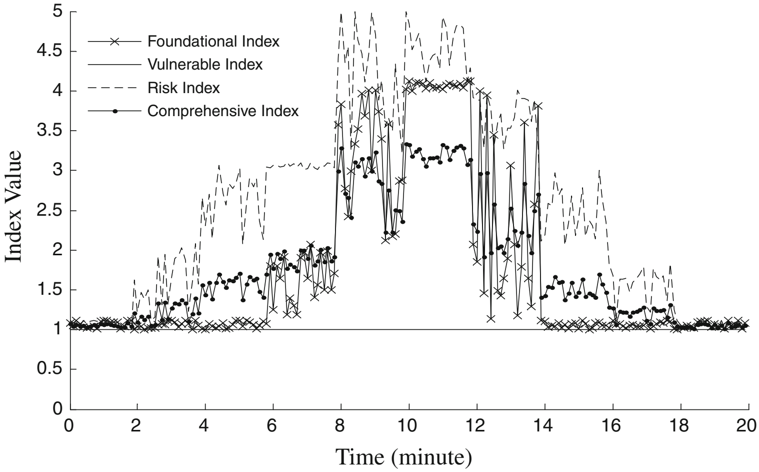

Fig. 104.3 The index curve under simulated attack

104.4.3 Monitor the Situation by NSIS

This experiment is to illuminate the usability of our NSIS. According the curve of NSIS we can get the security situation of the monitored network. Our system is deployed at enterprise network and running all the times. On April 6 we find that the curve of Risk Index is ascending rapidly as shown in Fig. 104.4.

Figure 104.4 shows that the situation of this network becomes severely, the network may be under attacking. After anglicizing the alarm data, we find that a

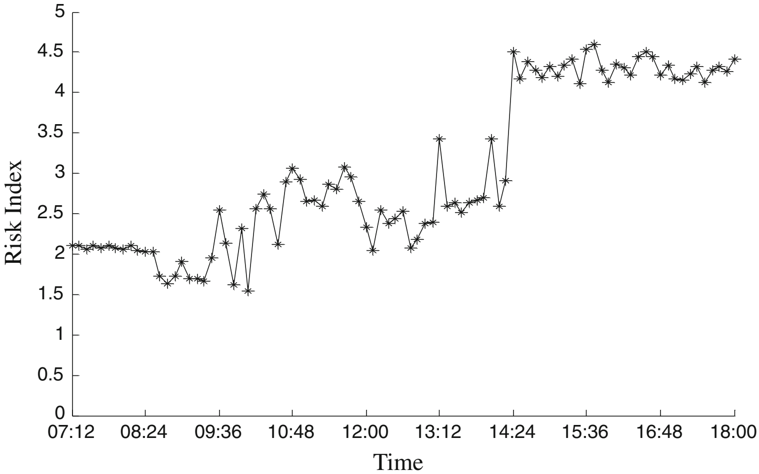

Fig. 104.4 The Risk Index on April 6

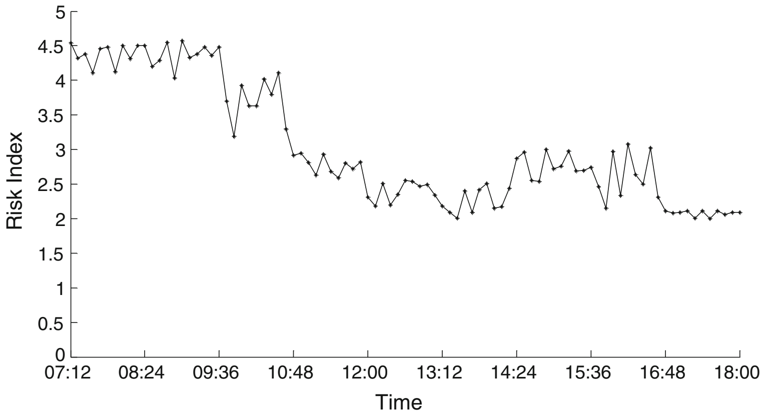

Fig. 104.5 The risk index on April 10

host in this enterprise is exploited, and it uses vulnerability named CVE-2001-0876 (http://web.nvd.nist.gov/view/vuln/detail?vulnId=CVE-2001-0876) to infect other computers. These abnormal behaviors are detected by IDS and some other tools in our system. This type of attack is named as "MISC UPnP malformed advertisement" by snort. After taking some security measures, the Risk Index returns to normal level as shown in Fig. 104.5.

104.5 Conclusion

In this paper, Network Security Index System is proposed to assess the network security situation. The NSIS is composed of Foundational Index, Vulnerable Index, Risk Index and Comprehensive Index, and used to evaluate the network security situation comprehensively and objectively. Then the detailed methods of how to calculate the indexes are given. The experiments illuminate that the NSIS can reflect the situation of the network security reasonability.

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Chapter 105
Research on Battlefield Awareness System Based on Internet of Things Technology

Zhao-fu Sun, De-xiang Sun and Zhi-liang Li

Abstract As a newly-developed and important technology in recent years, the Internet of Things (IOT) technology was regarded as "a gold mine of unknown reserves" by military experts, its kernel ideal of "connecting things" has a significant influence on information-based war. The concept of the Internet of Things and its military application are introduced, also the framework of battlefield awareness is analyzed, meanwhile the application system of the Internet of Things technology in battlefield awareness is proposed. Finally some related key problems are discussed.

Keywords Internet of things technology (IOT) · Battlefield awareness · System structure · Sensor

105.1 Introduction

The IOT's fast development has brought a significant influence on the society from all sides. Its wide application has begun in physical distribution management, intelligent transportation, environment monitoring, intelligent index, remote medical treatment, intelligent housing and military defense (Du et al. 2011). The breakthrough in the technique is more probably first applied to military, and promotes the military innovation forward. The IOT's creative logos has broken the traditional military thought, also will pound at the existing military operation

Z. Sun
Flight Training Base of Air Force Aviation University,
Changchun, China

D. Sun (✉) · Z. Li
Training Department of Air Force Aviation University,
Changchun, China
e-mail: sdx58964@gmail.com; iott1230@163.com

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system. Its integration into the battlefield awareness system is an effective way to improve the information-based war.

The IOT's concept is first proposed in America mobile computer and network conference in 1999, its English name is "The Internet of Things", based on computer and internet, according to promissory protocol, it connects things with the internet using the facilities such as RFID, infrared sensor, GPS and laser scanner, to realize intelligent recognition, location, tracking, monitoring and management, which constructs a real internet covering all things in the world. (Wu 2010a; Li 2011; Liu and Xiong 2011) The IOT is composed of three layers. First is the sense layer, which means obtaining all kinds of information with RFID, sensor, and two-dimension bar code. Second is the network layer, which means transmitting the obtained information with the integration of telecommunication and internet. Third is application layer, which processes the information obtained from the sense layer, to realize practical application. (Zhang 2010; Yin et al. 2011; Wu 2010b).

105.2 The Formation and Development of Battle Awareness System

The information-based war in the twenty-first century is regarded as "the success of the sense", in the background of modern military competition, the control of "transparent battlefield" is the inevitable result of information development, and the focused point of all powerful and strong countries.

105.2.1 Basic Concept

The concept of battlefield awareness forms with the development of information technology, especially the detection technology, and the further study of new military theories. Battlefield Awareness (BA), means the fight and support troops can grasp the real-time information of the enemy, the friend and our troop deploy, weapon allocation, and battlefield environment (such as terrain, meteorology and hydrology). Besides traditional reconnaissance, surveillance, intelligence, targeting and damage evaluation, battlefield awareness's biggest character is the management and control of information resource. In order to improve the army's ability of battlefield awareness, many countries are investing related systems. (Jinzhuo and Guo 2000; Albert 2005).

105.2.2 Framework

Nowadays, many countries are paying much attention to the study the battlefield awareness system, aiming to find out related targets timely, distinguish correctly and process rapidly. In 2002, the US military science consultation committee advised the army to improve their organization and technology to train better "prior battlefield awareness" ability. Recent years, the US army attached much importance to "network-centered war", "action-centered war" and "sensor to shooter" operation methods, give prominence to the ability of awareness by wireless sensor network. The framework of battlefield awareness system proposed by Cui Xunxue is shown as Fig. 105.1.

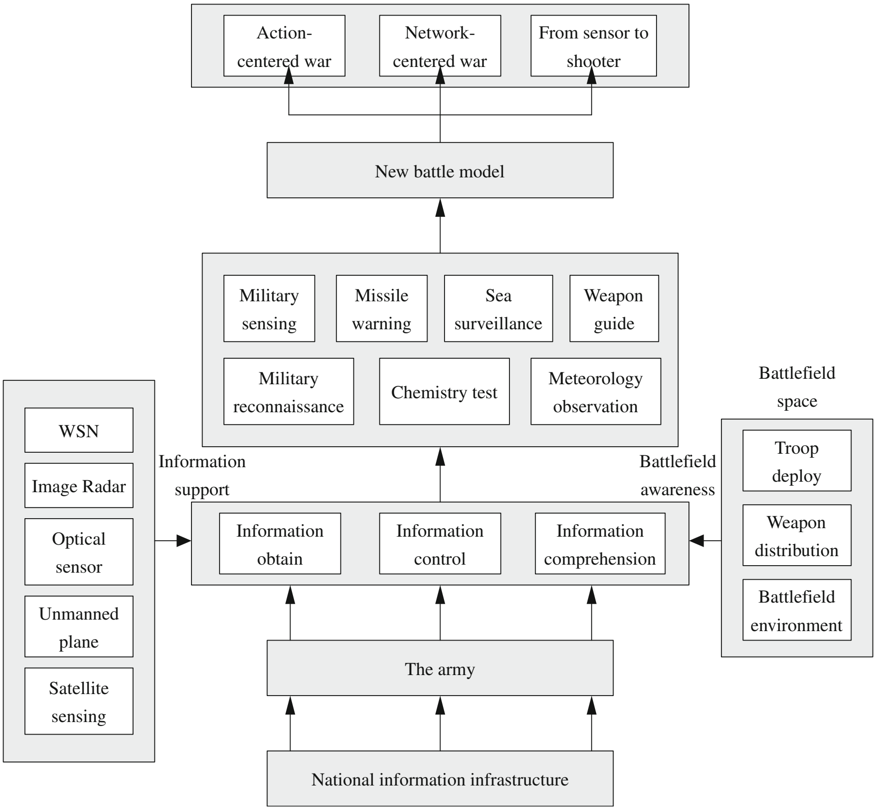

Fig. 105.1 Framework of battlefield awareness system

105.3 The Iot Technology's Application in Battlefield Awareness

The IOT technology's application in battlefield awareness is a totally new notion of intelligent sense, location, tracking, monitoring and management, which promotes the integrated operation.

105.3.1 Framework

The infrastructure of IOT is to construct the "connecting all things" sense network, all the sensor nodes are the feelers in the battlefield environment. With the feelers, the IOT can sense the time and space information accurately, so as to monitor the real-time battlefield environment, transmit the active fight information and control the intelligent terminal. (Chen et al. 2011).

To build the battlefield awareness information network supported by IOT technology, unmanned plane and artillery are used to cast the micro-sensor (such as sound, light, electromagnetic, shake, acceleration sensors) to the target area, so the sensors can detect and sense the equipment and track of the troops. At the same, these information are integrated with that obtained from the satellite, aircraft and ship sensors, then transmitted to the information technology center via the internet and mobile communication network, after process and analysis, an all-inclusive, all-spectrum, all-time reconnaissance and surveillance system is formed, which provides accurate target location and effect evaluation information, and improves joint battlefield awareness ability. Therefore, the IOT system can be a significant part of command, control, communication, computer, intelligence, surveillance reconnaissance and targeting system (C^4ISRT). The framework of battlefield awareness system based on the IOT technology is shown as Fig. 105.2.

105.3.1.1 Sense Layer

The sense layer is the foundation of the IOT, and the link layer of the physical and information world. It works by connecting all kinds of information, and using network communication, information process, physical security reliability, middleware and gateway technology etc. for the purpose of realizing the sense and communication between the physical and information world. In the battlefield awareness system, the sensors play a very important role.

The spatial sensing equipment especially sensing satellite is a significant power to provide real-time and accurate intelligence for the battlefield dynamic awareness. For example, the US army used seven optical imaging reconnaissance satellites such as the "Keyhole", "Hong hockey" to take photos in Iraq, and operate

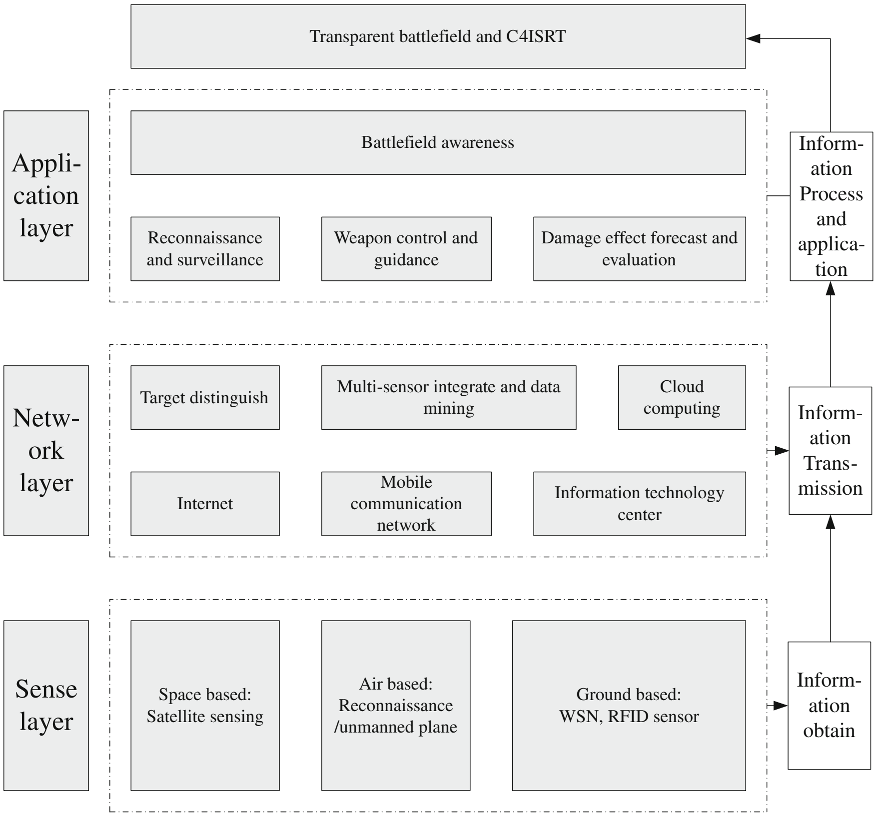

Fig. 105.2 The framework of battlefield awareness system based on the IOT technology

full-scale target reconnaissance and battlefield surveillance, which greatly improves the battlefield awareness ability.

Aviation reconnaissance force such as the reconnaissance plane can take carry out all-weather, all-time and all-orientation surveillance in the battlefield, while the unmanned plane can take its advantages of long-range and high-resolution, which is also very important in obtaining information. In the Iraq battlefield, the US army put ten kinds, more than ninety unmanned planes into the operation, including “Predator”, “Global hawk”, which became the largest action time in all previous battlefields (Lin 2009).

Micro sensor nodes can be sent to the target area.In this case intensive, random distributed and low-cost wireless sensor network is formed. It collects all kinds of sensing information such as shock, press, sound, speed, temperature, humidity, light, magnetic field, radiation, and operates in hidden position to sense all-around battlefield information. For example, when the vehicles go through, the sensors attached to the ground can collect and integrate shock, sound signals, and send them to the headquarter. Traditional sensor nodes are limited to the computing ability and electrical energy, so they can only collect and transmit small data. Nowadays, new generation of sensors which are able to collect and transmit video signals have emerged. Simultaneously, given that the sensors are large and distributed randomly, when a part of sensors encounter attack, the whole network system would carry on by its high fault-tolerance ability. For this reason, wireless sensor network can adapt to terrible surroundings, and undertake tasks such as detecting the enemy's troop deploy, equipment transmission, nuclear pollution, biochemistry, target positioning attack and battlefield evaluation.

105.3.1.2 Network Layer

The middle layer of IOT is network layer, it works by transmitting all kinds of information obtained from the physical world by the internet, mobile communication network and virtual private network to the application layer effectively, reliably and safely, to realize the interact between man and machine, machine and machine. The information transmitted by the communication network contains not only text, sound, video multimedia and so on, but also all information such as location data from the sensors.

Due to the information gathered from the sense layer consists of satellite remote sensing, reconnaissance plane and wireless sensor network data, the network layer is required to integrate multi-sensor data to mine as much battlefield information as possible. When it comes to how to process and distribute large quantity of sensor information quickly and effectively, "cloud computing" platform works, it may complete a certain task in dozens of minutes, while several hours before. It shows a new concept of computing.

105.3.1.3 Application Layer

Application is the driver of the whole IOT, application layer combines IOT technology with the professional system, encapsulates the sensing data, and realizes the solution of extensive "connect all things". In the connection with the decision maker, IOT needs to provide a customizing model under mass of information, and realizes a friendly, convenient, low consumption interactive system. The application layer's key algorithms and software system are the major of IOT computing environment, which ensure the security and reliability of IOT system.

The application layer combines strategic with tactic reconnaissance, dynamic and static surveillance, brings a all-weather, all-time battlefield sensing drawing, the formed "transparent" battlefield environment has a significant influence on reconnaissance and surveillance, weapon control and guide, damage effect forecast and evaluation. The intelligent, automatic and networking battlefield awareness system under IOT technology provides a better platform for the C^4ISR.

105.3.2 Key Problems

As a large and complicated information system, IOT technology still has some key problems to solve when applied to battlefield awareness. Among them are sensing system, cloud computing and information security.

105.3.2.1 Intelligence of Sensing System

The sense layer is based on data and information obtained by sensor. The battlefield awareness is becoming more and more automatic and complicated, so the sensors are required to have high accuracy, reliability, stability, and the ability data process, self-check, self-adjust, self-compensation. While traditional sensors cannot meet the demand, new generation of sensors are needed. High function sensor needs not only improved materials, but also chips to storage and process data. Therefore, the result of sensor combined with micro-processor is the merge of intelligent sensor. The intelligence of sensing system requires some functions as following. First, micro-processor should be embedded system, so it is possible to storage, distribute, process and transmit large information in a small sensor, then high technology and low-cost material are needed; Second, the intelligent sensor should have strong survival ability, including supplying energy for itself, self-networking and self-positioning; Third, the battlefield complicated magnetic environment has a serious impact on the sensors, once these sensors are damaged or used by the enemy, they should have the ability of self-destruction, at the same time, the quit of partial sensor nodes do not affect the whole network.

105.3.2.2 Cloud Computing and Share Platform

Cloud computing is a new technology just as IOT, while different people have different opinion about it. IBM cooperation holds that: “Cloud computing is new kind of IT service, in which application data and computing resources can be provide to the clients quickly via network.” Cloud computing has some advantages such as integrated resources, service according to requirement, high-flexibility and low-cost. While applied to battlefield awareness, private or combined cloud will be built. It can provide an efficient, high-speed, accurate transmission and process platform. There are also some problems, on one hand, it needs a large cost when diverting the traditional exploit, deploy, maintain model to the those based on clouding computing, the cost is decided by the battlefield complexity and request. On the other hand, currently the reliability and security of cloud computing is not high, especially the security. Due to the lack of mature security support technology and related legal rules, cloud computing still has a long way to go when applied to battlefield awareness.

105.3.2.3 Information Transmission Security and Management

Information transmission security and management is the premise of IOT application, also an significant symbol of the mature IOT system. The target of information transmission security and management is to ensure the obtained intelligence is secret, rounded and practicable. This request runs through the whole process of information collection, integration, transmission and decision. It has some problems like network system (Li et al. 2012). First, in data gather, transmission and security, sensing nodes are to simple to support complicated security function; there are some many kinds of sensing nodes and networks, while related standards are incomplete, so uniform security system is to be built urgently. Second, in the application security, the platform supporting IOT has different security strategies, the IOT application is facing challenges like large-scale, multi-platform and multi-type. Third, there also exists security protection problems in data process, access control of information gather, transmission and share should be established. In short, data-centered IOT is close to its application, its security target consists of privacy, data distinguish, integrity, usability, timeliness and so on.

105.4 Conclusion

Battlefield awareness attracts more and more attention in the world. As a new technology, IOT plays an important role in battlefield awareness with its special advantages. Through comprehension about IOT and its military application, the thesis proposed the IOT framework of battlefield awareness, studied some related key problems, and settled the foundation of further studies. Simultaneously, because some key technologies remains unsolved, its military application is still in theory analysis and experiment period, there is still a long distance before practical application. With the breakthrough of key technologies, IOT is to bring revolution in information-based war.

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Chapter 106
Regulations Construction and Implementation Difficulties of China's Internal Control over Financial Reporting

Jing Wang, Mei-yun Wang, Zhi-ping Xiang and Si-yu Chen

Abstract Facing the substantial losses to investors and the capital market caused by fraudulent accounting information disclosed by listed companies, China's regulators also pay more and more attention to the construction of regulations on enterprise internal control, thus constantly improving the legal system of internal control. The authors present the legal system's establishment of internal control and its improvement in China, then analyze the potential problems of internal control over financial reporting during the process of execution, and further put forward improving comments and suggestions.

Keywords Internal control · Internal control over financial reporting · Supporting guidance for basic code of enterprise internal control · The opinion on implementation of internal control's audit guideline

106.1 Introduction

Faced with the sequential accounting scandals Enron, WorldCom, Sanyo, and Kane boo, the United States and Japan took similar measures to cut down the complaints on the government supervision from the investors. One responded quickly and issued the Sarbanes–Oxley Act (Sentity Ecurites and Exchange Commission 2002), the other also introduced the Financial Commodity Exchange Act (FenLing 2009) which called a Sarbanes–Oxley of Japanese version. In order to avoid the appearance of such scandals, strengthen the supervision to the capital market and protect the interests of investors (Yu Ting Liu and Wang 2010),

J. Wang (✉) · M. Wang · Z. Xiang · S. Chen
Department of Economic and Management, North China Electric Power University, Beijing, China
e-mail: smilewlm@sina.com

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China's regulators also pay more and more attention to the internal control, and constantly improve the legal system of the internal control.

In 2008, the Ministry of Finance, Securities and Futures Commission, the National Audit Office the Banking Regulation Commission jointly issued the Enterprise Internal Control Basic Code (hereafter Basic Code). On April 26, 2010, the ministry of finance, etc. issued the Supporting Guidance for Basic Code of Enterprise Internal Control (hereafter Supporting Guidance), which is required to put into practice from 2011 on listed companies which appear simultaneously in domestic and foreign market. It will come to reality in Shanghai Stock Exchange and Shenzhen Stock Exchange's main board listed companies in 2012, and the large and medium-sized enterprises are encouraged to practice in advance. On October 11, 2011, in order to match the Basic Code and Supporting Guidance, the Chinese Institute of Certified Public Accountants (hereafter CICPA) issued the Opinion on Implement of Internal control Audit Guidelines (hereafter Opinion).

The authors present the legal system's establishment of internal control and its improvement in China, then analyze the potential problems of internal control over financial reporting during the process of execution, and further put forward improving comments and suggestions.

106.2 Establishment of Standard System

In 2006, Shanghai Stock Exchange and Shenzhen Stock Exchange respectively released Listed Company's Internal Control Guidelines of Shanghai Stock Exchange (hereafter Shanghai Guidelines) and Listed company's Internal Control Guidelines of Shenzhen Stock Exchange (hereafter Shenzhen Guidelines), which require two main board listed companies to establish internal control according to these two kinds of guidelines. When disclosing the annual report, the board of directors should disclose the report of management's assessment of the effectiveness of internal control, and disclose accounting firm's opinions on the management's assessment report. These two early files, having no legal effectiveness, just acting as the standard of guiding document, and its implementation is limited to the two main board listed company.

In 2008, the Ministry of Finance, and other four ministries, together released Basic Code, which have to be carried out from July 1, 2009 within the listed companies. Large and medium-sized enterprises are encouraged to practice. The listed companies' implementation of the Basic Code ought to evaluate the internal control's effectiveness by themselves, and disclose annual self-assessment report; they can also employ the accounting firm having qualification for securities, and future business to audit the validity of internal control (The Ministry of Finance 2008a).

On April 26, 2010, the ministry of finance, etc. issued the Supporting Guidance, which is put into practice starting from 2011 in listed companies that appear on both at home and aboard market at the same time. Since 2012, it will come to reality in Shanghai Stock Exchange and Shenzhen Stock Exchange's main board listed company, then the small and medium-sized and pioneering plate at right time. Large and medium-sized enterprises are encouraged to practice in advance (The Ministry of Finance 2008b).

On October 11, 2011 the CICPA issued Opinion, which provided a concrete standard for registered accountant to audit internal control, in which the internal control specific refer to internal control over financial reporting.

106.3 Consummation of Standard System

The Basic Code established the framework of internal control, made the internal control target and essential elements clear as well. According to Basic Code the goal of internal control is to provide reasonable assurance of achieving objectives relating to the enterprise management as legal compliance, assets safety, the reliability of reporting and efficiency and effect, finally to promote the enterprise to realize development strategy. At the same time, Basic Code requires enterprises to establish the internal control, which shall include the following factors: internal environment, risk assessment, control activities, information and communication, internal monitoring (Zhang and Chen 2008).

On April 26, 2011, in order to coordinate the execution of Basic Code, the ministry of finance, released the Supporting Guidelines for internal control, including three supporting guidance—Enterprise Internal Control Application Guidelines (18 items), Enterprise Internal Control Evaluation Guideline (1 item), Enterprise Internal Control Audit Guideline (1 item).

106.3.1 The Internal Control Application Guidelines

The Enterprise Internal Control Application Guidelines play a key role in guiding and regulating internal control construction and operation.

Of it the main executive body is listed companies and non-listed large and medium-sized enterprises. The enterprises are asked to establish an internal control framework in accordance with the principle of internal control. The 18 major application guidelines released in 2008 (a total of 21, three guidelines involving the banking, securities and insurance business have not released) (Yuan 2009), can be divided into three parts, namely "internal control environment guidelines", "internal control active guidelines", and "means of internal control guidelines", basically covering enterprise cash flow, material flow, human flow and information flow, and other business and matters.

"Internal Control Environment Guidelines", is a well-designed guideline for building and running the control environment. It comprises five sections, including organizational structure, development strategy, human resources, enterprise culture and social responsibility. They are pyramid base for establishing and maintaining the internal control, if we regard the internal control as pyramid.

"Internal Control Active Guidelines" is corresponding control activity for the specific business, including capital activities, purchasing business, assets management, sales business, research and development, engineering project, guarantee business, business outsourcing, and financial report. These nine guidelines are the main body of internal control, and the middle of the pyramid of internal control.

"Means of Internal Control Guideline" is control guidelines for implementation of the overall business and management, including overall budget, contract management, and internal information transfer and information system. These four parts are tools for implementing internal control, and they are upper part in pyramid for the internal control.

106.3.2 Enterprise Internal Control Evaluation Guidelines

The Internal Control Evaluation is essential to the Enterprise Internal Control (Bryan 2005). It regulates the enterprise internal control evaluation procedures and report, which provides a commonly-followed standard to launch the internal control self-assessment, and to improve the confidence of investors.

As the enterprise internal control evaluation guidelines state, the board of directors or the similar decision institutions are responsible for assessment. They are asked to evaluate the effectiveness of internal control overall, form evaluation conclusion, and disclose evaluation report. Accordingly, the procedures of internal control evaluation for the managers shall generally include: make evaluation work plan, composite assessment working group, implement site test, affirm control flaw, summarize evaluation result, and draw up evaluation report and so on. Enterprise may authorize the internal auditing department or special agencies to be responsible for internal control evaluation of the specific organization and implementation work. It also demands management eventually to disclose an internal control evaluation report, which shall reveal the design and the implementation status of internal environment, risk assessment, control activities, information and communication, internal supervision and other elements; and disclose the process of internal control evaluation, determination and rectification, internal control flaw, internal control effectiveness conclusion and other related content.

106.3.3 Internal Control Audit Guidelines

The Enterprise Internal Control Audit Guideline is used for regulating the internal control audit business (Li and zhang 2010). As it says, the principal body of responsibility of internal control audit is the public accounting firm which are entrusted to undertake the internal control audit. They audit the design and operation of the availability of internal control on the due date, usually at the end of year. Further, it is the responsibility for the registered accountant to air their opinion on the design and operation of the effectiveness of internal control, based on the implementation of audit work.

When the certified public accountants audit the internal control, the general process is: properly plan internal control audit work, identify risk preliminary with the method of top-down implement audit (Krishnan and Visvanathan 2005); evaluate the defects of enterprise internal control in its design and running; finally offer full audit evidence on the basis of the audit work completed, and issue the enterprise internal control audit report. When certified accountants plan the internal control audit work, they should evaluate the influence of risk issues on internal control, financial statements and audit work. Basked on risk assessment, they make a choice whether control procedures should be tested, determining the evidence required to collect; and based on the evaluation, the auditors shall judge whether to use the others' work or not.

When implementing audit work, the certified public accountants should adopt the top-down method. First, test the control risk on entity-level and grasp the important risk areas, and work down to significant business, mainly testing important business matters and control activities. Certified public accountants shall pay particular attention to major defects, and they ought to communicate all identified defects of internal control with management. Finally certified public accountants shall evaluate evidence already obtained, and form opinion on the validity of the internal control. For the internal control over financial reporting, the certified public accountant shall voice their audit opinion, but major defects of non-internal control over financial reporting found during auditing process should be disclosed in the internal control audit report as an increased section, which is called "description program about non-internal control over financial reporting".

106.3.4 The Opinion on Implementation of Internal Control Audit Guideline

In order to regulate audit business of internal control over financial reporting and improve service quality, CICPA issued the Opinion.

In many ways, the Opinion provides detailed operating methods for internal control over financial reporting audit (Chinese Institute 2011). For example, as for the scope of the test for control, it clearly presents the minimum testing ample size for the artificial control, automatic control and deviation. Specially, it gives the main points of final financial reporting audit process. Opinion further clarifies some of the controversial issues of the internal control over financial reporting audit. For example, as for the effectiveness of internal control over financial reporting auditing, some personages inbounds are disputing whether it is a period or a point auditing. Opinion claims, if just auditing internal control over financial reporting, certified public accountants shall obtain evidence about the effectiveness of internal control over financial reporting within a long enough period before the due date; if the internal control over financial reporting is integrated with an audit of financial statements, control testing shall cover the period as far as possible remain consistent with financial statement audit during which is to trust.

At the same time, the Opinion gives judgment for some special matters of the audit of internal control over financial reporting. Like investment, whether purchase entities should be included in the evaluation or not, when the entity emerge modification about internal control, how accountants change audit correctively, how to use the top-down method and other special item of audit, Opinion also gives explanations.

106.4 Problem Ananlysis of It's Execution

Relevant regulations of internal control over financial reporting produced from scratch, and gradually establish and perfect, but in the practical implementation process, it inevitably meets with some difficulties (YouHong 2009). These difficulties mainly come from two aspects, on the one hand, enterprise management level; on the other hand, system level.

106.4.1 Enterprise Management Level

In the implementation of the internal control over financial reporting, enterprise management encounter two problems. One is the weak consciousness of internal control; the other is the lack of certain means. However, typical representation is that the enterprise can not make good use of the information management.

To some domestic management, their understanding of the internal control is intuitive. They regards the internal control as the regulations deemed to formulate and implement, neglecting the construction of the internal control environment, which results in an phenomenon that management overrides internal control. To change this situation, and improve the management's consciousness of internal control, the author maintains that it needs to pay close attention to the following respects.

First of all, setting up a business values that management ought to maximize shareholders' benefits. At the same time, the management should improve the following fields: organization structure, social responsibility orientation, enterprise culture construction, and so on. And a sound internal control environment is eagerly needed in the enterprise. Internal control environment is the foundation of the effective implementation of internal control. Without good control environment, the other company's control elements will become the castles in the air.

Next, helping managers develop a profound understanding for the concept of internal control on account that some managers negatively think of internal control as red tape, which increases the management cost, worse reduces the management efficiency. Widely knowing the internal control is the escort which helps enterprise to realize their development goals. The core of internal control is pining to each other, and its realization way is not the "people over a man'' (Xiao 2010). What's more, it depends on its control system of institutionalization, streamline, process, and finally consciously implement internal mutual contain, and ensure the safety of the assets and financial reporting reliability.

Finally, pay attention to the effective system of risk monitoring and evaluation. Many domestic enterprises lack risk management mechanism (Zhang 2009), and deficiency in recognizing and dealing with the risk matters. As the internal control is designed for risk, enterprises need to have a correct grasp risk factors and its importance degree which they face, to establish and consummate the risk management mechanism, so can make the recognition and evaluation to all sorts of risk after effectively monitoring.

The information has brought great convenience for the execution of the internal control over financial reporting, and provided a broad platform for the information exchange and effective transfer of internal control, thus making some means of internal control realizable which couldn't complete before.

Some domestic enterprise managers' understanding of internal control remains on the artificial control level; some enterprises have a phenomenon that internal control information system does exist, but a set of perfect information system has not been established to reduce the risks when using the key information. To make full use of the convenience which well information system bring for internal control, enterprises do need some changes as the following two aspects.

First of all, the domestic enterprise should strength the effective information communication between technology sectors and the information technology sector and the business departments. Establish clear channel of communication, making the information internal control means fitted in the management of enterprise, ensuring that information technology department can completely meet the needs of the internal control.

And to establish an effective internal audit system for information technology which is to supervise the operation of information technology department. Correspondingly, it need build safety control measures for the development, operation and change of information system, then reducing risks of information system's design and operation.

106.4.2 The System Level

The Internal Control Audit Guideline puts forward the concept of internal control over financial reporting and the non internal control over financial reporting, this is considered to be an innovation of china's internal control (Yang et al. 2010). But regulators didn't explain and define, there was a little explain about internal control over financial reporting and non internal control over financial reporting in the file called Interpretation of Enterprise Internal Control Supporting Guidelines by Ministry of Finance and CICPA, however, for the practice of certified public accountants it is not enough and lack of clear guidance.

The "internal control audit guide" and "opinions" lack of cohesion. The Internal Control Audit Guidelines report that the internal control over financial reporting and non internal control over financial reporting should be treated differently by certified public accountants. But the Opinion was only for the internal control over financial reporting, and did not explain how to found the defects of the non internal control over financial reporting during auditing, and how to reflect of both in the audit report.

The Internal Control Audit Guidelines proposes two concepts of internal control over financial reporting and non internal control over financial reporting, it deems that in the audit report the certified public accountants should shown them separately, for the former issue audit opinion, for the latter's major defects need to disclose, the idea originally is to reduce the certified public accountants' audit risk through this system arrangement, remind the management responsible for internal control. But without clearing the difference between them, diminishing the responsibility of the registered accountant is impossibility in practice. When faced with the financial report litigation arising from the internal control, shareholders and creditors will not discriminate them because of the nature of audit opinions are different.

106.5 Look into the Future

As a starting point, the Shanghai Guidelines and Shenzhen Guidelines released, after the Basic Code and Supporting Guidance, and recently Opinions released, China's the framework of legal system on internal control over financial reporting has become increasingly perfect, especially the Opinion just issued by the CICPA, it is workable on level of concrete internal control over financial reporting audit operation.

There are many difficulties in the implementation of those regulations, as above mentioned difficulties on the execution of the internal control over financial reporting. The author thinks that it can be improved and perfected from the following several aspects. First, construct legislation. A detailed and complete implementation plan is needed, to coordinate the relevant supporting documents of internal control over financial reporting, establish a unified and coherent legal system and a standard system. Second, for regulators it would be best to strengthen the supervision of the capital market, strict supervision the execution of the Basic Code and Supporting Guidance (Zhang and Chen 2009). Third, for the managers, it is necessary to establish training mechanism on internal control, to help them to comprehend the concept that the internal control should be institutionalization and streamline, abandon the idea of "rule by man", pay more attention to the construction of enterprise culture environment. Finally in practice certified public accountants should pay attention to the accumulation of experience, continuously explore better way for the establishment, operation, evaluation and audit of the internal control over financial reporting.

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Chapter 107
The Management of Political Risk in the Overseas Mergers and Acquisitions of General Aviation Aircraft Company Limited of China

Xi-yu Han and Wei-li Xia

Abstract In this paper, at the background of the General Aviation Aircraft Co., Ltd. of China (GAAC) mergers successfully the Cirrus Corporation of American (CCA), by analyzing political risks which existing in the overseas mergers and acquisitions (M&A), other aviation or defense companies can draw on what preventive measures the GAAC takes to avoid risks. These mature experiences as a reference help other aviation companies of China to take effective measures preventing the political risk in the process of overseas M&A.

Keywords The GAAC · Overseas M&A · The political risk · Preventive measures

107.1 The Political Risk of Overseas M&A for Aviation Industry

Direct foreign investment is an important way of overseas M&A. By which multinational companies can avoid under the influence of the restrictions of investment and trade barriers form the host country. Overseas M&A is helpful for multinational companies to enter and occupy the market, achieve the integration of resources among global, implement the rapid expansion of business scale and achieve economies of scale eventually. In addition, they are serviceable for multinational companies to maintain the growth of earnings and to implement the diversification etc. (Gong 2009). Therefore, overseas M&A become the main way

X. Han (✉) · W. Xia
School of Management, Northwestern Polytechnical University, Xi'an, China
e-mail: rubyhan1008@yahoo.com.cn

W. Xia
e-mail: xiaweili@nwpu.edu.cn

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and inevitable choice for Chinese enterprises to expand into overseas markets rapidly and to adapt to the economic globalization. Especially the outbreak of financial crisis, Chinese companies ushered a rare for overseas acquisitions, by overseas M&A a growing number of enterprise enter into the foreign market, but the successful cases are few Chatterjee (2009). There are still existing risks in the process of overseas M&A. Because business strategy is at the beginning of turning form domestic to international, companies are lack of experience, strategic planning and management has not yet reached the international advanced standard. Companies have to face the shortage of information, legal risks and cultural conflicts in the process of acquisition. These negative factors lead to the fail and unsatisfactory result. Even if M&A is successful, the companies will still face the adjustment of corporate strategy, restructuring, product planning, and cultural re-plastic, labor relations, liabilities, integration of competitiveness and a series of major business issues. The research data of McKinsey shows that over the past 20 years, less than 50 % of the largest enterprise M&A in the world achieve the desired effect, and 67 % of overseas M&A are not successful in China (Zhou 2010).

With the deepening of globalization of economic and the liberalization of international air transport, Chinese aviation industry is facing increasingly fierce international competition. Therefore, it is necessary for domestic aviation companies to enhance the competitiveness and take the large-scale and intensive way. Allusion to the current situation of decentralized management and less competitiveness in Chinese Airlines, overseas M&A will result in significant economies of scale. However, as a system engineering, there are all kinds of hidden risks in the process of M&A, including political risks, foreign exchange risks, operational risks, management risks and project risks. Among them, the political risk is unfamiliar to Chinese enterprises. Because of the specificity of aviation industry, the limitations of understanding and the restrictions in the aspects of policies and regulations from the host country, making the political risk is particularly prominent in the process of overseas M&A: Firstly, the particularity of industry. Aviation industry is a strategic industry playing a major leading role. It is a leader and high-tech industry in enhancing national competitiveness. It is competitiveness reflects the competitiveness of advanced manufacturing (Cui 2008). Through overseas M&A, aviation companies can promote the increasing of manufacturing capabilities and economies of scale, achieve the complementary of product structure, technology and advantage. In addition by bringing the significant economies of scale, overseas M&A improves the competitiveness in the domestic and international market, expand the market share, consolidate and strengthen its dominant position further. Because of historical reasons, the U.S. and other Western developed countries are holding a contradictory state of mind for the M&A in China: For one hand, they hope the stable development of Chinese economic, which can promote the world's economic; for the other hand, they fear that rapid development will beyond their control and pose a threat to their national interests. Therefore, aviation companies which carrying on the overseas M&A with developed countries will have to face many complex procedures: they not only need to obtain the approvals of corporate shareholders and general regulatory, but also should through the review of high-level government agencies including the Foreign Investment Committee in the U.S. In addition, they have to face the pressure come from the media. Secondly, the particularity of the market does. What the international market which aviation industry facing is not perfectly competitive market. Paulo Krugaacan said that, “Aircraft manufacturing need large economies of scale, so that the world market can only accommodate a small number of producers, and there must be only a few of aircraft manufacturing center in the world.” Currently, in the international civil aircraft market, the route aircraft is dominated by Boeing and Airbus. So aviation industry is in the oligopoly market. In such a market structure, with the expansion of aviation industry of one country, the interests of the others will be damaged (Xu 2007). In this case cited in this article, after the GAAC making a successful acquisition with the CCA and achieving the layout of a global strategy, it must make changes to the existing pattern of interests in the international market of aviation industry, and then play an impact on the aviation industry of U.S. Thirdly, the restrictions of policies and regulations from the host country. The government plays an important role in overseas M&A. The attitude of government is reflected in the formulation of relevant policies and regulations (Guan 2009). For such strategic industry, once the objectives of the operation of company are different from the host country’s national interests, the host will use the policies of foreign trade, finance, balance of international payments exchange rate and economic protectionism, even by changing legal to limit corporations of transnational. Fourth, at the beginning of overseas M&A, the understanding to the political risk is not sufficient. Western countries increasingly thought China as a powerful competitor and protect themselves to limit its development. The enterprises in China do not have deep understanding in this regard, they thought naively that these countries of long-running market economy will not have strong political color (Li and Guo 2007). Playing less attention on political risks leads to the huge losses for the enterprises.

In this paper, at the background of the GAAC mergers successfully the CCA, by analyzing political risks which existing in the overseas M&A, other aviation or defense companies can draw on what preventive measures the GAAC takes to avoid risks. These mature experiences as a reference help other aviation companies of China to take effective measures preventing the political risk in the process of overseas M&A.

107.2 The Dynamic Analysis of Overseas M&A in the GAAC

The GAAC has acquired the largest manufacturer of piston type general aviation aircraft in the world—the CCA. It is the first time for the Chinese aviation company to acquire the aircraft machine manufacturers in developed country. The

GAAC is the core business of Aviation Industry Group. Its main models are researched, developed and manufactured by our own. The CCA as a leading global manufacturer of aircraft is the second largest general-purpose aircraft manufacturing company and also is the largest piston type general aviation aircraft manufacturers in the world. This successful acquisition lays a solid foundation for the GAAC to become a multinational company Chatterjee (2009). In the following, I will analyze the dynamic analysis of overseas M&A in the GAAC from the two aspects of the business growth and global competitive pressures (Zhang 2010).

107.2.1 Driving Force of the Business Growth

Today, the international general aviation industry has a very broad market prospects, the potential of development is very enormous. In order to develop general aviation industry, the GAAC should make use of their own advantages, adhere to the concept of "only partners, not rivals", trough the worldwide cooperation in a wide range to meet the demand of market better and achieve win–win cooperation and common development. Recently the State Council, Central Military Commission issued "deepening reform of China's low-altitude airspace management view", determine that by overall construction and reform deepening, to develop fully and use effectively the resources of low-altitude airspace in the next 5–10 years. In order to grasp the opportunity of the reform, the GAAC proposed' a leading development strategy to achieve this goal. It began to look for resources from the global, co-ordinate and use resources, changed from the simple use of their own resources to integrate and use the global resources, and actively explored the approach of international acquisition. The M&A activity is driven just basing on this strategic objective. As a leading global manufacturer of aircraft, the CCA produced the high-performance ultra-light full composite piston aircrafts which are complementary products with the products of the GAAC. Successful acquisition not only provides products with high performance and low-cost foe the national, but also lays a solid foundation for the GAAC to become a multinational company Cheng (2008).

107.2.2 Driving Force of Internationalization

The GAAC has been working to become a leader supplier in the products and services of international common aircraft, and the light piston aircraft is one of the areas which the GAAC focus on. Because of the stable performance, safe and reliable design, excellent management team, excellent staff and skills, advanced production equipment and expanding global networks and international business in the CCA, it is favored by GAAC. The success of M&A makes the CCA to expand production further to consolidate its own leadership position in the global generic industry and to serve Chinese general aviation market better with quality products and services on the basis of maintaining of excellent performance and stability. After the acquisition, the CCA will become a part of the GAAC, which will promote rapidly the R&D, manufacturing, marketing and level of sales, and help the GAAC enter into the mainstream of the global market. In addition, this acquisition plays a direct role in promoting changes from manufacturing to the whole chain. Acquiring the CCA as the first step of implementing the international strategy, facing to the distribution of Internationalization and building a multinational, lays a solid foundation for the GAAC to open up the aircraft market in worldwide.

107.3 Precautions to the Political Risks Which the GAAC Carried on

Less than a month after the GAAC announced the acquisition and made agreement with the CCA, the acquisition was suffered a strong opposition from the U.S. government which intervene this activity with an excuse of endangering the national security. After the signing of the agreement, some officials thought that selling CCA to Chinese means American will have to face the enormous national security risk. The M&A will enable Chinese to obtain sensitive technology of aircraft manufacturing, and also make hundreds of Americans lose their jobs. Facing to the interference, the GAAC drew on fully the mature experience of collaboration and communication with international companies, especially the ways they used to avoid the risk and communicate with the host country, the GAAC took effective preventive measures by reference to avoid risks occurring.

On the one hand, the GAAC made a timely communication with the U.S. government. The two sides carried on a rational negotiation between each other. Firstly, the GAAC clarify to the U.S. that the smooth progress of the acquisition will help the two sides utilize their own strengths fully, overall and make use of the resources better, promote the two sides to change from simply using their own resources to integrating and using the global resources finally. In terms of both companies, it is an activity purpose for achieving a win–win and common development. Secondly, with regard to the worrying about technology transfer and unemployment of employees, the GAAC and the spokesman of CCA made a timely response respectively: the GAAC stated that after the success of acquisition, the main production of the CCA is still in the U.S. and the existing management team will be remain, therefore there will be not have a phenomenon that hundreds of American lose their jobs; the spokesman of the CCA indicated that the technology which is worried by the U.S., because of the possibility of transfer has been widely used in China, and it do not have any relationship with national defense. Because the production certification and quality control of the aircraft are all in the U.S., it will take a high cost to transfer them aboard, the cost will increase $35,000 for each one. Therefore, taking into account the factor of cost, the production will not be transferred. Thirdly, the GAAC clarified to the U.S. that if the M&A fails, both of the companies will face to serious damage, even many companies which are in the same interest chain with the CCA will face negative influence by that, and thus damp down the U.S. economy.

On the other hand, in order to ensure the smooth progress of the M&A, at the same time of making negotiation and communication with the U.S., the GAAC carried on timely feedback to convey the information containing the political risks to Chinese government, by diplomatic channels pressured to U.S. Public opinion play a guiding role in the social mood of a country. By making full use of public opinion's effect, the GAAC propagandized vehemently in the aspects of catalytic role to the U.S. economy, increasing to the opportunities of employment and contributions to the community by doing the GAAC pressure to the government.

107.4 Enlightenment of this Case

By analyzing and summarizing the political risks and the preventive measures in this case, other aviation and defense enterprises in our country obtain the following Enlightenment in the process of overseas M&A:

107.4.1 Establishing an Efficient and Sensitive Mechanisms in the Parts of Communication and Coordination with Government of the Host Country

It is easy for the aviation industry to meet the political risks when they are in the process of overseas M&A because of the particularly of it. In many aspects of political factors, the power of government from the host country has an obvious influence. For the one hand, the resistance from the government will directly lead to the failure of M&A. In June 2005, when the China National Offshore Oil Corporation acquired Unocal Corporation (CNOOC), the members of Congress required the department of the treasury to review the role of Chinese government strictly in this acquisition as the excuses of "energy threat", "national security" and "deep-sea technology to master the core" and so on. The high-level U.S. politicians also made some handicaps to the CNOOC as the excuses of "energy security" and "economic security", which lead to the failure of the M&A (Liu 2008). For the other hand, by analyzing of the successful case in many foreign airlines, we can conclude that the government plays an important role in guiding and promoting the success of the M&A. The behavior of German Aerospace Corporations, Aerospace Matra France, and Aerospace Spain Corporations is belonging to the behavior of market, but they are closely connective with the attitudes of government. In the acquisition of European airline, the relevant national government's attitude is to encourage, guided and promote, which lead to the success of acquisition. Therefore, the companies should pay more attention to the attitudes of the host government in the process of overseas M&A, and draw on the mature experience of the GAAC fully. When they perceived resistance from the host government, they should take a rational negotiations, communication and coordination with the host government timely, clarify to them that the evils if the failure take place and make an explanation on what they confused in order to eliminate concerns of the host government. At the same time, aviation enterprises can seek to the protection from diplomacy and public opinion by the Chinese government and the media. By which, pressure to the U.S. government and ensure the smooth progress of M&A activity.

107.4.2 Establishing a Comprehensive System of Risk Management Mechanism to Enhance the Level Assessment of Political Risk

Overseas M&A of aviation industry is a long and arduous project. Obtaining the control power of the target company is just the completion of trading, which is far from to the end of the behavior of the M&A. Completing the integration of financial, human resources, technology, culture and other aspects are need to go through a long period. The period of capital payback is more than 5–10 years. Therefore, we should not only to analyze the assessment of political stability recently, but also to predict it in the future. The prediction of the process has a great of difficulty. Before the GAAC carried on the acquisition, they collected a full investigation and analysis of data in the aspects of the direct foreign investment, the level of economic development and balance of payments situation, political stability, the relationship between the goals of investment and economic development and so on. Then they analyzed and evaluated the relevant data concluding the sort of national political risks which are published by "The European monetary" magazine. The GAAC not only made an assessment to the level of macro risks, but also studied the micro risks, such as the risks which are caused by the extreme specificity of aviation industry (Gao 2005). The GAAC nipped the potential risks in the bud as much as possible by a comprehensive assessment of political risks. Therefore, before the M&A, the aviation enterprises need to establish systems of risk management mechanisms, in addition to make the assessment of political risks from the macro and micro aspects and to avoid the risks and carry on effective prevention timely.

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Chapter 108
Research on Dynamic Correlation Between A&B Stock Index of Shanghai and Shenzhen Exchange Based on DCC-MGARCH Model

Jin-fang Tian and Wen-jing Wang

Abstract The paper dynamically investigates the correlation of A and B-share in Shanghai and Shenzhen Stock Exchange using their daily trading data based on the Dynamic Conditional Correlation Multivariate Generalized Autoregressive Conditional Hetero skedasticity (DCC-MGARCH) model. We show that the A and B-share market have reflected a certain degree of consistency characteristics since 2001. However, since China's stock market isn't mature, the dynamic correlation between A and B-share stock index in both Shanghai and Shenzhen is still volatile and their segmentation feature is still evident.

Keywords DCC-MGARCH · A&B stock index · Dynamic correlation

108.1 Introduction

Correlation analysis in the financial asset or financial markets is an important foundation of modern finance, which also has been playing an important role in building the investment portfolio and risk management in multi-asset and multi-market, especially. Therefore, seeking a reliable estimate of the correlation coefficient has become the hot issue that many researchers concerned about. In order to study conveniently, they often set the indicators of the correlation among assets to a constant. Whereas this assumption divorced from reality, in which the correlation between most financial assets are dynamically changing. Therefore, close attention must be paid to analyze the dynamic evolution process of the correlation among assets.

The researches into the dynamic correlation between the financial assets originated in the promotion/generalization of the univariate GARCH model.

J. Tian (✉) · W. Wang
Department of Statistics, Shandong University of Finance and Economics,
Jinan, China
e-mail: 20038029@sdufe.edu.cn

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Engle (2000, 2007), Hafner and Franses (2003) and Engle and Colacito (2006) extends GARCH model to the case of multivariate, proposing the multivariate GARCH model. Since the evolution path of all the individual elements of the covariance matrix of the model have been made a GARCH-like description, the indicators of the correlation between the variables obey a dynamic process. The model quite comprehensively considers the fluctuation process of the random vector; as well brings problems about parameters excessive and make estimation difficulty. Furthermore, if we do not further setting the coefficient matrix in the model, we cannot guarantee the positive definiteness of the estimated covariance matrix. To solve this problem, Engle (2000) proposed the BEKK model, which makes a useful constraint on the coefficient matrix of the covariance matrix's evolution path, and makes it possible to guarantee the positive definiteness of the covariance matrix. Although the BEKK model solved the problem of positive definiteness, since all the parameters need to be put together to estimate, it brings the estimation problem in the case of multivariable. From the perspective of estimation, Guarda and Rouabah (2011), Zhang and Luo (2009), Gourierroux and Jasiak (2001) and Su and Ullah (2009) proposed the assumption of constant correlation coefficient, namely Constant Conditional Correlation (CCC) model. In the CCC model, the correlation coefficient is set to fixed, although this assumption has made a huge advantage on estimation, it is always difficult to satisfied in reality. On the basis of predecessors' achievements, Pagan (1996) and Yang (2005) expanded the CCC model and proposed the Dynamic Conditional Correlation (DCC) model.

This paper focuses on the introduction and the application of the Dynamic Conditional Correlation multivariate GARCH model (DCC-MGARCH Model) proposed by Engle. The advantages of the model lie in: (1) obvious computational advantage, even the large correlation coefficient matrix can be estimated. The DCC model limits the long-term variance-covariance matrix for the sample variance-covariance matrix; this restriction can reduce the number of parameters to be estimated and is well supported by the empirical data. (2) The two-step estimation method adopted by DCC makes the parameters to be estimated in related processes independent of the number of related sequences, the method can easily estimate the large correlation matrix with more variables.

In order to have a more comprehensive understanding of the dynamic relationship between A and B-share in both China's Shanghai and Shenzhen Stock Exchange, this paper studies the time-varying correlation between them based on the DCC-MGARCH model.

108.2 DCC-MGARCH Model

The $\{e_t\}$ is a white-noise process with independent identically distributed (iid), which stands for K kind of the rate of return on assets information with mean 0 and covariance matrix $\{H_t\}$, that is, $e_t|\Omega_{t-1} \sim N(0, H_t)$, and $\{\Omega_t\}$ is the information set at t time. The basic structure of the model is defined as:

$$r_t = u_t + e_t$$

$$e_t|\Omega_{t-1} \sim N(0, \mathrm{H}_t)$$

$$\mathrm{H}_t = D_t R_t D_t$$

$$R_t = \left(Q_t^*\right)^{-1} Q_t \left(Q_t^*\right)^{-1}$$

$$Q_t = \left(1 - \sum_{m-1}^{M} \alpha_m - \sum_{n-1}^{N} \beta_n\right)\bar{Q} + \sum_{m-1}^{M} \alpha_m \varepsilon_{t-m} \varepsilon'_{t-m} + \sum_{n-1}^{N} \beta_n Q_{t-n}$$

$$\bar{Q} = T^{-1} \sum_{t=1}^{T} \varepsilon_t \varepsilon'_t$$

$$Q_t^* = diag\left(\sqrt{q_{11,t}}, \sqrt{q_{22,t}}, \ldots \sqrt{q_{kk,t}}\right)$$

Among these formulas, $\{R_t\}$ is dynamic correlation coefficient matrix,

$$D_t = diag\left(\sqrt{h_{it}}\right), h_{it} = \omega_i + \sum_{p=1}^{p_t} \alpha_{ip} e_{it-p}^2 + \sum_{q=1}^{q_t} \beta_{iq} h_{tq}$$

It means every asset return to obey a GARCH process. $\varepsilon_t = D_t^{-1} e_t$ is the standard error term, and $\overline{Q}$ is unconditional variance matrix with standard residual error. The elements in the $\{R_t\}$ are defined as $\rho_{ij,t} = q_{ij,t}/\sqrt{q_{ii,t} q_{jj,t}}$, and Q_t^* is diagonal matrix. In Q_t, the elements contain $q_{ij,t}$, $q_{ii,t}$ and $q_{jj,t}$. Besides, α_m and β_n are known as the coefficients of DCC models (m and n are the lagging numbers), and α_m reflect the impact of the standardization residual product of m lags to dynamic correlation coefficient, and β_n reflect the persistent feature of correlation, where, $\alpha_m \geq 0, \beta_n \geq 0, \sum_{m=1}^{M} \alpha_m + \sum_{n=1}^{N} \beta_n < 1$.

Estimation of DCC-MGARCH models can be divided two steps. First, to estimate the univariate GARCH process of every asset, then we use the conditional variance $\{h_{it}\}$ that has gained to divide residual $\{e_{it}\}$, and get standardized residuals $\{\varepsilon_{it}\}$. Next we will use $\{\varepsilon_{it}\}$ to estimate the parameters of the dynamic related structure by maximum likelihood method. By the way, the DCC estimator has the consistency and asymptotic normality through the two steps approach.

108.3 Descriptive Statistics for Stock Returns

The data used in this paper are the daily closing price of Shanghai A-share index (SHA), Shanghai B-share index (SHB), Shenzhen A-share Index (SZA) and Shenzhen B-share index (SZB). All of the data series were from February 19, 2001

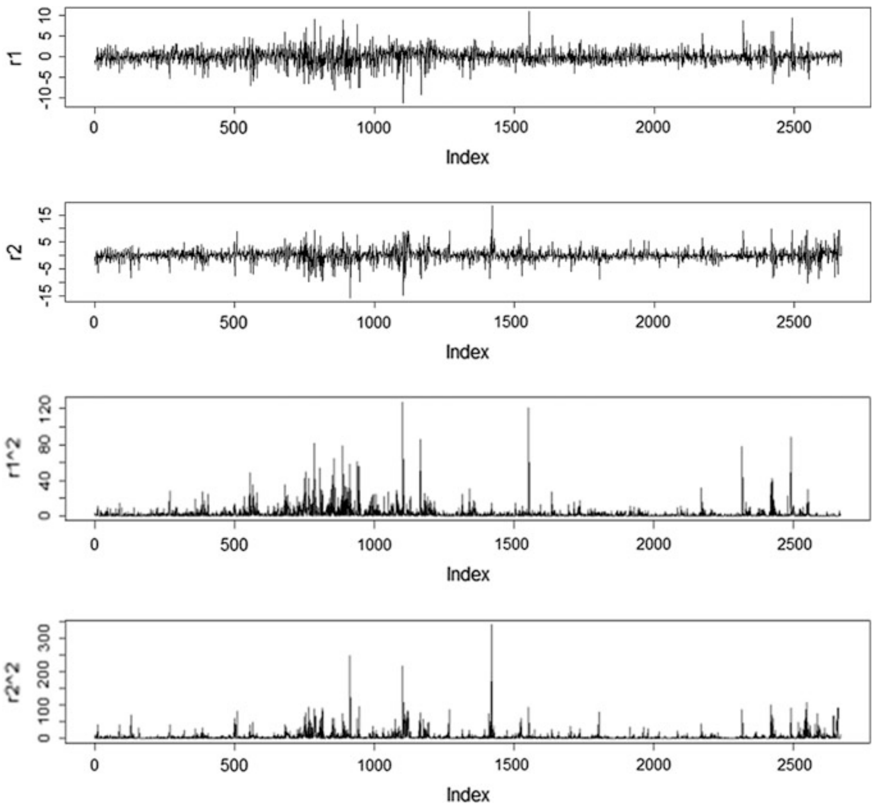

Fig. 108.1 Time plots of Shanghai A and B-share stock index daily return and squared return

to December 15, 2011. There were 2,668 observations for the sample. We will use the following notation in this paper. The daily closing price process is denoted by $\{P_t\}$. Firstly, calculate the corresponding daily logarithmic yield from the raw data.

In order to study the characteristics of the return series and their volatility, we draw the time plots of the daily return and the squared return series of SHA, SHB (Fig. 108.1) and SZA, SZB (Fig. 108.2). In both figures, r1 represents the return series of A-share stock index and r2 represents the return series of B-share stock index. The time plot of return series of Shanghai and Shenzhen A and B stock index shows a number of abnormal peaks, and abnormal volatility appears suddenly and significantly as well as obvious clustering phenomenon. We also found that B-share market's volatility is higher than the A-share market's volatility (pay attention to the different scales of the vertical axis). From the time plots of the squared return series we can see that abnormal volatility's burstiness and volatility clustering phenomenon is more pronounced. Accordingly, we can preliminarily determine that the volatility of the return series is conditional heteroscedasticity.

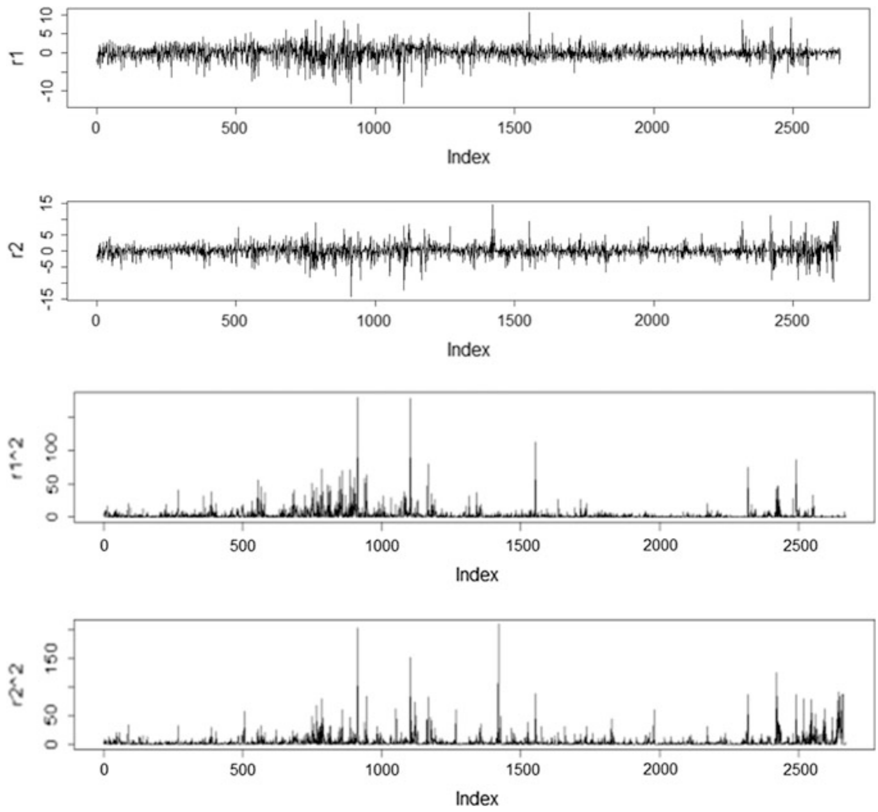

Fig. 108.2 Time plots of Shenzhen A and B-share stock index daily return and squared return

Table 108.1 Descriptive statistics for daily returns of selected stock indexes

	SHA	SHB	SZA	SZB
M	0.0048	0.0365	0.015	0.055
STD	1.7	2.21	1.85	2.08
Skewness	−0.137	−0.037	−0.54	−0.03
Kurtosis	4.74	7.18	4.81	5.67
Q(15)	26.7(0.031)	43.5(00)	30.1(0.01)	68.3(0)
Q^2(15)	350(0)	505(0)	361(0)	617(0)
JB	2,511(0)	5,748(0)	2,710(0)	3,579(0)

Furthermore, Table 108.1 provides some descriptive statistics of daily returns for selected stock indexes. From the table, we make the following observations. (a) Daily returns of selected stock indexes tend to have high excess kurtosis. B-share stock index has higher excess kurtosis than A-share stock index, for both Shanghai Stock Exchange and Shenzhen Stock Exchange. (b) For the entire selected stock index, the skewnesses are less than zero; imply the distribution of the return series is not normal. The JB statistics also shows the normality assumption is rejected at the 1 % significance level. (c) The mean of all daily return series is close to zero, but B-share stock index has higher standard deviations than A-share stock index for both Exchange. (d) The Q(m) statistics of the return series give high Q(15) value with a p value less than 0.05, confirming serial correlations exist in the four stock indexes. (e) The Q(m) statistics of the squared return series indicate an obvious volatility clustering phenomenon, which is consistent with the Intuitive judgment from the time plots.

We need to test the stationary of the return series before molding. In this paper, we choose the ADF method. The outcome shows the ADF test statistics of SHA, SHB, SZA and SZB is −15, −14, −14 and −13, respectively. The corresponding p values are all less than 0.01, confirming the return series don't have unit root. In other words, all the return series are stationary time series. Therefore, we can directly molding.

108.4 Empirical Analysis

108.4.1 Modeling and Estimating of Univariate GARCH Model

Since the return series of SHA, SHB, SZA and SZB have autocorrelation, we use the ARMA model to estimate the conditional mean equations. After several attempts and careful compared by using R software, the fitted models we ultimately choose are

$$
\begin{aligned}
r_{SHA,t} =& 0.0047 + 0.0538 * r_{SHA,t-4} - 0.0391 * r_{SHA,t-6} \\
& + a_{SHA,t} \,(0.14) \quad (2.79) \quad (-2.03) \\
r_{SHB,t} =& 0.0364 + 0.074 * r_{SHB,t-1} + 0.04 * r_{SHB,t-4} + 0.043 * r_{SHB,t-6} \\
& + a_{SHB,t} \,(0.68) \quad (3.81) \quad (2.09) \quad (2.21) \\
r_{SZA,t} =& 0.0153 + 0.0472 * r_{SZA,t-1} + 0.0464 * r_{SZA,t-4} \\
& + a_{SZA,t} \,(0.397) \quad (2.433) \quad (2.392) \\
r_{SZB,t} =& 0.0669 + 0.7631 * r_{SZB,t-3} + a_{SZB,t} \\
& - 0.7187 * a_{SZB,t-3} \,(0.927) \quad (7.112) \quad (-6.498)
\end{aligned}
$$

Where, the value of the corresponding t-statistics for each parameter are shown in parentheses. The Ljung-Box statistics of the residuals of the four conditional mean models give Q(20) equal to 23, 12, 16, 12, with a p value of 0.29, 0.92, 0.73, 0.92, respectively, confirming that the mean equations don't have autocorrelation at the 5 % significance level. Namely the four fitted mean equations are adequate. However, the Ljung-Box statistics for the squared residuals of the four conditional mean models give Q(20) equal to 412, 480, 379, 434, respectively, with a p value less than 2.2E−16, which confirming that the residuals series exist obvious ARCH

Table 108.2 Conditional variance parameter using GARCH(1,1)

	Omega	Alpha1	Beta1
SHA	0.061(4.29***)	0.076(6.25***)	0.904(60.97***)
SHB	0.201(6.46***)	0.204(9.6***)	0.782(43.15***)
SZA	0.063(4.41***)	0.091(6.8***)	0.893(61.68***)
SZB	0.282(6.18***)	0.216(9.2***)	0.742(31.98***)

Note The value of the corresponding *t*-statistics for each parameter are shown in parentheses. "***" denote the parameter is not 0 significantly at the 1 % significance level

effect. We need to establish the corresponding GARCH model for further analysis. For convenience, we use the GARCH (1, 1) model to fit the volatility of the return series, the estimated results are shown in Table 108.2.

From Table 108.2, we can see that all the estimates in the volatility equation are statistically significant at the 1 % significant level, and $\alpha + \beta$ are all less than 1, which satisfy the assumption of the model. Model checking, using the residual, indicates that the fitted volatility model is adequate. Noted that the value of $\alpha + \beta$ is very close to 1, indicating that the volatility of the Shanghai and Shenzhen return series has a significant persistent.

108.4.2 Establishment and Estimation of DCC-MGARCH Model

We firstly get the standardized residuals from the residual (which can gained from the univariate GARCH model) divided by conditional variance, then we use the standardized residuals to estimate the parameters of the dynamic correlation structure by Maximum Likelihood method. The DCC estimators that we obtained in this way are consistent as well as asymptotic normality.

Now we will use the DCC-MGARCH model to analyze the correlation of A and B-share stock returns for both Shanghai and Shenzhen stock market. Setting the GARCH model as GARCH (1, 1) while the degree of the DCC model is also set as 1, using R software to estimate the parameters of the model, the results are shown in Table 108.3.

From Table 108.3, we can know that the parameters of the DCC model are significantly not 0. α is significantly not 0 means that the first-lagged standardization residual product has an impact on the dynamic conditional correlation; β is not only significantly not 0, but also very close to 1, which means the correlation

Table 108.3 The results of parameter estimates for DCC model

	Alpha	Beta
Shanghai(A and B)	0.112(112)	0.817(204)
Shenzhen(A and B)	0.073(73)	0.883(110)

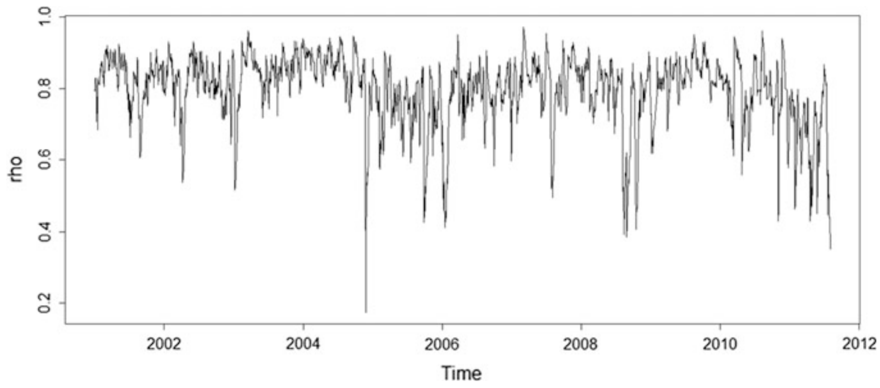

Fig. 108.3 DCC of SH

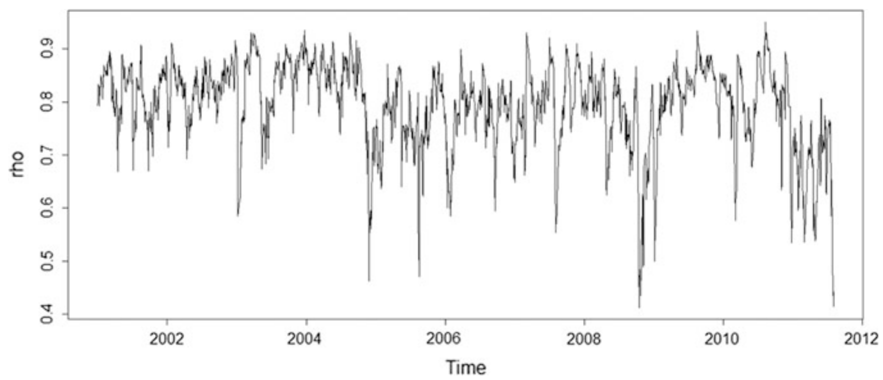

Fig. 108.4 DCC of SZ

of the A and B-share stock returns has strong persistent characteristics for both Shanghai and Shenzhen stock market.

We provide the time plots of the estimation results of the dynamic conditional correlation in Figs. 108.3 and 108.4, so as to facilitate our visual observation of the changes in dynamic conditional correlation between A and B-share stock index for Shanghai and Shenzhen Stock Exchange.

Through the time plots of the dynamic conditional correlation of the yields for both Shanghai and Shenzhen Stock Exchange, we can come to the following conclusions: firstly, during the sample interval (from February 19, 2001 to December 15, 2011), the time-varying characteristics of the dynamic conditional correlation are fairly obvious, which means there is a significant time-varying feature. Secondly, seen from the time change paths, since the B-share market opened to domestic investors on February 19, 2001, the dynamic conditional correlations of A and B-share stock index for both Shanghai and Shenzhen are very similar and appear significant positive related. The two dynamic conditional correlations are both close to even more than 0.9. While in contrast, the volatility of Shanghai Stock Exchange is slightly higher than that of Shenzhen Stock Exchange. Thirdly, the dynamic conditional correlations are significantly low during 2005–2006 and 2008–2009. Particularly, it's even lower than 0.2 for Shanghai Stock Exchange. Fourthly, the dynamic conditional correlations have been in decline and appeared more frequent fluctuations since 2011 for both Shanghai and Shenzhen Stock Exchange.

The dynamic conditional correlation is an important indicator of the degree of movement convergence of financial assets or financial market. The higher the dynamic conditional correlation, the larger degree of convergence of the market share price trend, and the higher degree of market integration. Conversely, the lower the dynamic conditional correlation means the two markets appear lager deviation in price trend, which means obvious market segmentation. Since each market stock price movement contains its own driving factors, we can investigate the dominant factor behind them by analyzing the relationship between A and B-share stock price movements and the reflected dynamic conditional correlation. The dynamic conditional correlations of A and B-share stock index in Shanghai and Shenzhen were always in the high level during 2001–2005, which is closely related with the event that B-share market opened to domestic investors on February 19, 2001, making the investors structure of the B-share market presenting features of convergent to the A-share market. The dynamic conditional correlations are significantly low during 2005–2006 and 2008–2009, which are related to the introduction of share splitting in 2005 and financial crisis in 2008. The strong impact on China's securities market by the two major events exacerbated A and B-share market's volatility and instability. According to the Figs. 108.3 and 108.4, The dynamic conditional correlations of the two stock markets are always in a state of decline with more frequent fluctuations since 2011. Although China's securities market is growing and increasingly mature and the merger of A and B-share market is an irresistible trend, China's securities market is still not mature enough and the segmentation feature of A and B-share market is still relatively obvious, which means it will take a certain time for the two market to embarked on the merger.

108.5 Conclusion

This paper takes daily trading data of A and B-share index in Shanghai and Shenzhen Stock Exchange as sample, dynamically investigate and characterize the correlation between China's Shanghai (and Shenzhen) A and the B-share market through the establishment of the Dynamic Conditional Correlation multivariate GARCH (DCC-MGARCH) model. The results show that: the dynamic conditional correlation between A and B-share market in Shanghai and Shenzhen Stock Exchange is positive in general, whereas appear significant time-varying characteristics in the time path. Phases of view, the dynamic conditional correlation between A and B-share market in Shanghai and Shenzhen Stock Exchange was relatively large and volatility was relatively weak from February 19, 2001 to 2005, suggesting that the stock price in these market showed a certain degree of consistency. However, the correlation showed a significant downward trend after 2005. By contrast with the Shenzhen stock market, the Shanghai stock market's downward trend was more obvious. The correlation got a certain degree of recovery during 2006–2008. By influence of the financial crisis and other factors in 2008, the correlation between A and B-share market fall again and suffered with more frequent fluctuations. In addition, the correlation has been in a state of decline since the second half of 2010.

The dynamic conditional correlation is an important indicator of the degree of movement convergence of financial assets or financial market. The securities industry generally considered that the B-share market merge to the A-share market is the trend. Through the analysis of the dynamic conditional correlation, this paper shows that A and B-share market reflects a certain degree of consistency characteristics since 2001. However, because the China's securities market is not yet mature, the dynamic correlation between A and B-share market is still very large, and the characteristics of segmentation between A and B-share stock index is still very obvious.

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Chapter 109
Empirical Analysis on the Impact Factors of Currency Substitution in China

Ping Yi, Chuang Zhao and Xiao-ling Luo

Abstract Since American financial crisis erupted in 2008, international monetary system is under the pressure of reforming, while the superiority of RMB is recognized increasingly. After exchange rate reformed, RMB circulates in neighboring countries or regions widely. As for the cross-border circulation, the paper attempts to construct an econometric model based on western currency substitution theory, and makes an empirical analysis on the impact factors of currency substitution in China through OLS and principal component method. Results show that interest rate differential is the greatest influencing factor, followed by exchange rate while economic growth rate is indistinctive. Finally, constructive political suggestions are given.

Keywords Currency substitution · OLS · Principal component method · Empirical analysis

109.1 On the Connotations and Measurement Index

As for researches on currency substitution, it was first proposed by the U.S. economist V.K. Chetty in the American Economic Review in 1996. In the past 40 years, the academic of definition of currency substitution was still

P. Yi (✉)
Department of Economics and Management, Tongji University, Shanghai, China
e-mail: Yiping1022@126.com

C. Zhao
Department of Business, Jilin University, Jilin, China

X. Luo
Department of Business, Hunan International Economics University, Hunan, China

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controversial. But in brief, currency substitution means that there are many possibly convertible currencies in circulation in an open economy. When serious inflation or exchange rate expectation happens, it will weaken the residents' confidence of domestic currency. It is also because of the relatively low rate of the local-currency assets return that the residents hold more foreign currency and less local currency, and then instead by capital flight or the circulation of foreign currency in the domestic.

There are absolute index and relative index on currency substitution. Absolute index can be divided into three categories: total amount of foreign currency deposits, foreign currency deposits overseas, foreign currency deposits domestic and overseas added cash of residents in one country. And relative index can be divided into $SR1 = F_d/D$, $SR_2 = F_d/M_2$, $SR_3 = F_f + F_d/M_2$, SR_1, SR_2, SR_3 mean currency substitution rate, F_d is foreign currency deposits in domestic financial system while F_f is that in overseas financial system. M_2 is broad money supply, D is local currency deposit of domestic financial system. As relative index is more accurate than the other and degree of currency substitution is fully reflected by applying of broad concept of money, nearly scholars at home and abroad use SR_2 during study.

109.2 Research Status at Home and Abroad

Western main theories can be attributed to four representative types: the production function theory of monetary service is first proposed by Miles (1978, 1981), followed by the marginal utility theory of monetary demand proposed by Bordo and Choudhri (1982), and the portfolio theory of monetary demand proposed by David T. King (Thomas 1985). Finally, theory proposed by Canada scholar Stephen S. Poloz is the precautionary theory of monetary demand (Poloz 1986). Research of Boyer, R & G. Kingston shows that foreign inflation rate has significant influence on real monetary demand and circulation velocity of local currency in the case of currency substitution (Codington 1983). Bergstrand & Bundt conclude currency substitution is an important impact factor of monetary independence in the United States (Guidotti 1993).

Chinese scholars also analyze currency substitution of RMB on the basis of foreign researches. Li Xin-dan researches RMB substitution by using Ramirez-Rojas model and proposes to form exchange rate zone, strengthen capital control and take interests rate instruments with caution for anti-substitution (Li and Zhong 1998). Yang (2002) holds that the elasticity of substitution between RMB and U.S. dollar is low by using Johansen's co-integration method of Miles model. Yue Yi-ding holds that the main influencing factors on RMB substitution are short-term rate and macroeconomic level by using Ortiz model (Yue and Zhang 2004). Li Fu-guo holds that the nominal rate differential at home and abroad as well as inflation rate is the main influencing factor (Li and Ren 2005). Results got by Bian Zhi-cun, Yu Wan-lin and Li Shi-xin show that actual exchange rate, domestic and foreign rate differentials, exchange rate and CPI are larger factors (Bian 2003; Yu and Zhu 2005; Li and Wang 2010).

It can be seen that development of western currency substitution theory is a process of continuous improvement. But the assumption of these theories is very strict or even idealistic and the variable selection don't accord with Chinese actual situation, which need further modify combining local country's fact to make more valuable. In addition, national scholars mainly study currency substitution by using series analysis. However, which factors is significant in a number of factors? Only rare literature uses principal component analysis, and it provides study space for this paper.

109.3 The Influencing Factor

Aiming at our national condition, the influencing factors on currency substitution can be refined and quantitative as follows:

1. Institutional factor includes the exchange rate regime or monetary convertibility system. China adopts a managed floating exchange rate system and multi-currency holders prefer to choose optimal monetary portfolio to reduce asset loss, which strengthen the precautionary or exchange motives.
2. Scale factor, mainly refers to national income level or the wealth number of residents in one country. The higher the level of national income gets, the greater the demand of foreign currency becomes.
3. Return differential between local and foreign currency. When foreign currency rate of return is higher, the residents will increase holding foreign currency for getting higher interest .While loans rate differentials of local currency increase, currency substitution emerges as cost of local currency increases but return decreases.
4. Political and economic risks. The peaceful political environment and steady economic growth have positive effects on the intrinsic value of domestic currency. Conversely, if the domestic situation fluctuates dramatically, it is likely to lead large-scale currency substitution and capital flight in one country.

109.4 The Empirical Analysis

109.4.1 The Variable Selection and Data Interpretation

According to the theoretical analysis of the impact factors of China's currency substitution, this paper sets $\lg(F_d/M_2)$ as dependent variable Y, independent variable $X_i (i = 1, 2, 3, 4)$ are loan rate differential of RMB and foreign currency i_{fd}, growth rate of GDP Δgdp, inflation rate Π, the official exchange rate e respectively, the dummy variable u equals political and economic risks. In order to improve model's estimation accuracy and convince, this paper sets the annual inflation rate measured by consumer price index as Π, direct price of RMB exchange rate to U.S dollar as e, and Δgdp represents national income level, F_d/M_2 represents degree of currency substitution interest, rate differentials represents premium. Relative index can optimize model and also reduce serial correlation.

Since China reformed the exchange rate in 1994, it opened the market-oriented exchange rate. China has changed from single and managed floating exchange rate system in 1994 to the managed floating exchange rate adjusted on a basket of currencies and market in 2005. Starting from strict examination or approval of exchange rate or compulsory settlement to the gradual relaxation of controls, the formation mechanism becomes more market-oriented. This paper aims at exploring the change of currency substitution in China since the exchange rate reforms by using annual data from 1994 to 2011. Data is from the Word Bank database, the official website of the People's Bank of China and China Statistical Yearbook.

109.4.2 Model Setup and Regression Results

Basic model of China's currency substitution can be:

$$\lg(F_d/M_2) = \alpha_0 + \alpha_1 i_{fd} + \alpha_2 \Delta gd_p + \alpha_3 \Pi + \alpha_4 e + u \qquad (109.1)$$

It can be further simplified as:

$$Y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + u \qquad (109.2)$$

1. By using Eviews 5.0, preliminary regressions results of the model are shown in Table 109.1:

   Expression can be written as follows:

Table 109.1 Preliminary OLS results of China's currency substitution

Variable	Coefficient	t-Statistic	Prob.
C	−5.6584	−4.2337	0.0017
X1	14.3614	15.0448	0.0000
X2	0.1086	1.5330	0.1563
X3	0.0429	0.5139	0.6185
X4	0.0940	2.9061	0.0157
R-squared	0.9891	Adjusted R-squared	0.9848
D-W	1.5716	Prob (F-statistic)	0.0000

$$Y = -5.6584 + 14.3614X_1 + 0.1086X_2 + 0.0429X_3 + 0.0940X_4 \tag{109.3}$$

It is can be known that adjusted R-squared value is 0.9848, indicating that explanatory power is strong. *P* value is 0.0000, which shows equation is significant, that is, all kinds of independent variables together do have an obvious impact on the dependent variable. And D-W value is 1.5716. According to k is 4 and n is 15, d_l can be checked to be 0.71, d_u is 1.61. As 1.5716 is between them, it doesn't fall in the deciding localization of the first-order autocorrelogram so the model's autocorrelation need further verification. Given a significant level 0.05, the corresponding p value of X_2 & X_3 is 0.1563 and 0.6185, which indicate that both are instinctive. In summary, it is likely to have multicollinearity for the second model.

2. Reduce multicollinearity and select the best combinations of independent variables by using principal component analysis.

(a) The adjusted R-squared values are 0.9535, 0.2152, 0.0350, 0.5354 though OLS method for simple linear regression of X_1, X_2, X_3, X_4. So the first step is to retain the best explanatory variable X_1.

(b) The adjusted R-squared values for binary linear regression are 0.9605, 0.9765, 0.9838, and t-values are 0.0944, 0.003, 0.0003 by adding the rest variables X_2, X_3, X_4 for stepwise regression, which can be decisive to retain X_4.

(c) Continue stepwise regression on the basis of the retained variables X1 and X_4. Adding X_2, adjusted R-squared value is 0.9858, more than 0.9838 before. P value of equation is 0.0000 and t values are 0.0000, 0.0006, 0.1268. In addition, all the correlation coefficient has economic significance. However, adding X_3, adjusted R-squared value is 0.9829, less than 0.9838 before and p value is 0.53, much more than 0.05, so X_3 is indistinctive. It is can be seen that X_2 and X_3, that is, economic growth and inflation rate have certain multicollinearity.

3. Final regression results of adjusting model

$$\lg(F_d/M_2) = \alpha_0 + \alpha_1 i_{fd} + \alpha_2 \Delta gd_p + \alpha_4 e + u \tag{109.4}$$

Simplify as
$$Y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_4 x_4 + u \tag{109.5}$$

By using Eviews 5.0, the regressions results are shown in Table 109.2. With the same analysis,

$$Y = -5.0326 + 14.0475X_1 + 0.1124X_2 + 0.1056X_4 \tag{109.6}$$

Adding specific economic explanatory variables, final regression results are as follows:

$$\lg(F_d/M_2) = -5.0326 + 14.0475 i_{fd} + 0.1124 \Delta gd_p + 0.1056e \tag{109.7}$$

Table 109.2 Final OLS results of China's currency substitution

Variable	Coefficient	t-Statistic	Prob.
C	−5.0326	−9.4582	0.0000
X1	14.0475	19.8240	0.0000
X4	0.1056	4.7447	0.0006
X2	0.1124	1.6518	0.1268
R-squared	0.9888	Adjusted R-squared	0.9858
D-W	1.4327	Prob (F-statistic)	0.0000

Comparing sixth and seventh expression, both adjusted R-squared and p value are better than before. Especially, p value of X_4 is decline to 0.0006 from 0.0157, which shows that there is multi-collinearity in the model before. And it is necessary to adjust to make more convincing.

109.4.3 Analysis on Results

By principal component analysis, the economic growth rate and inflation rate have a certain degree of multi-collinearity. In order to make results more accurate, this paper excludes multicollinearity and gets the final regression results. Table 109.2 shows that loan rate differentials between domestic and overseas currency, growth rate of GDP and exchange rate are effective explanatory variables. As to parameters symbols, they are all positive, which in accords with theoretical assumptions. It seems from regression coefficients of explanatory that the greatest impact factor is rate differentials at home and abroad, indicating that rate differentials increases by every one point and currency substitution increases by 14 points, according with residents' sensitivity to interest rate. Similarly, the influencing coefficients of growth rate of GDP and exchange rate are 0.1124 and 0.1056, showing that both are insensitive to currency substitution. But seeing from *t* test, exchange rate passes significant test so it has obviously positive effects, and GDP not. It may result from the high speed of China's economic development since reform and open-up along with strict financial controls, which improve residents' expectation of RMB as well as limit flowing of capital. In summary, loan rate differential is the greatest influencing factor, exchange rate is a weak one, and both have passed significant test. Growth rate of GDP has indirect effect on currency substitution in China.

Why there is so big difference for the results? Combining China's real situation, RMB has become hard currency in Southeast Asia and enjoy title of the second U.S. dollars in recent years. With the establishment of China-ASEAN Free Trade Area, the economic integration degree with Asian countries is higher and higher, and the scope of RMB circulation in neighboring regions or East Asia expands continually. The passive situation of RMB by alternative dollars is changing with China's powerful economic forces. So growth rate of GDP is instinctive to China's currency substitution, even has a passive effect to some extent. Fully market-oriented exchange rate has a certain impact, but it is nearly zero to China. The reason is that the foreign exchange market mechanism is not perfect and capital projects are not fully convertible as well as the financial capital control is strict in China, which prevents the residents' true demand of foreign exchange convertibility. All leads the weak substitution. For rate differential of domestic and overseas currency is a significant factor, the reason is that Chinese often need exchange RMB to U.S. dollars on the purpose of traveling, studying abroad or trading .Chinese are quite sensitive to interest rate. When domestic loan rate gets higher, residents prefer to relatively low-cost foreign currency, so currency substitution comes into being.

In addition, American financial crisis, along with the EURO debt crisis and Japan's strong earthquake, shakes their dominant position and brings opportunities and challenges for China. Currently, China's economic structure is in transition, which will be beneficial to solve the inevitable dilemma during internationalization. The natural geographical advantages and others push RMB to open up all over the world.

109.5 Conclusions and Suggestions

On the basis of theoretical and empirical analysis above, this paper holds that the degree of currency substitution is still low at present and the main influencing factor is loan rate differential of domestic and overseas currency, followed by official exchange rate. GDP growth is indirect impact factor. Taking China's actual situation into account, it needs to pay much more attention to the following aspects.

1. Firstly, to improve the social security system and strengthen the role of domestic demand as well as reduce trade dependence gradually to boost economy. On one hand, it can decrease the upward pressure of currency substitution in the short or long term effectively; On the other hand, it will avoid over-reliance on external economies during domestic economic development, which is key to solve frequent trade friction in China.
2. Secondly, to reduce loan rate of RMB and improve the actual currency revenue, and to establish the wonderful environment of interest rate for attracting foreign investment; To open financial and monetary market gradually and strengthen international investment in the great trend of globalization to improve RMB liquidity and the functions of trading, storage in the international markets.
3. Thirdly, to make exchange rate stable. Our national foreign currency reserves and total assets have shrunk dramatically by the decreasing U.S. dollars, which is not conductive to economy and thus reduce the residents' confidence in investment. The favorable exchange rate environment is strong guarantee to reduce the currency substitution. Only by establishing a good exchange rate formation mechanism can exchange cost be reduced and efficiency be improved.

4. Fourthly, continue to persist in taking economic construction as center and build a harmonious society. Although our country's financial system control is strict and capital project has not yet opened fully. But with the continued growth of economic strength and international status, it is very likely that RMB replace the currencies of other countries until realize regionalization.
5. Finally, to encourage RMB going out, continue enhancing cooperation with ASEN, to start settlement business and expand circulation of RMB in other Asian regions, to speed up constructing offshore financial centers of RMB in China, and based on CEPA and ECFA, to form Greater China Currency areas led by Chinese mainland and cooperating with Honking, Macao and Taiwan for signing Swap Agreements.

By using these approaches and methods, RMB internationalization will speed up. In the upward expectation of RMB appreciation, RMB will be held more by other foreign countries, which will decrease the degree of currency substitution and increase anti-substitution in China. If economy of China continues growing steadily, the speaking right of RMB will enhance and improve in the international monetary systems. This paper firmly holds that RMB can well stand side by side with U.S. dollar and euro to become the world's three major currencies in the near future and toward internationalization ultimately.

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Chapter 110
Research on Effect of Customer Perceived Value on Quality Information Dissemination

Peng Sun, Shu-lin Tang, Qiang Liu and Jing-ting Yuan

Abstract From the angle of customers on quality of product's perceived value, the paper indicates that quality information dissemination is a noisy and stochastic process, which could lead to customer perceived value fluctuation, and usually customer perceived value fluctuation is regarded as the key indicator of product crisis. Take the randomness of quality information appearance into account, the uncertainty of information dissemination and perceived quality fluctuation, the paper describes the changeable disciplines of customer perceived value of different customers at the same time and the same customers of different times by adopting random walk theory in order to recover customers perceived value fluctuation.

Keywords Quality information · Information dissemination · Customer perceived value · Random walk model

110.1 Introduction

With the development of economy and social progress, enterprises must transcend the traditional philosophy of "profit as the only goal", concentrate on customer perceived value. The philosophy indicates that quality information generated during the production process no longer remains within the enterprise, which will deliver to customs, finally achieve purchase behaviors of customers, whose essence is a process that enterprises transmit product quality value to customers in value style.

There are some researches on how to construct the model of disseminating quality information. Previous researches proved that quality information was a

P. Sun · S. Tang (✉) · Q. Liu · J. Yuan
School of Economics and Management, Harbin Engineering University,
Harbin 150001, Peoples Republic of China
e-mail: tangshulin00.student@sina.com

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description of continuous random signal and quality information dissemination is a noisy, non-linear stochastic process from the perspective of information theory (Frick and Hegg 2011). Some researches presented the continuous tracking of information model based on Bayes' theorem which could describe the effect of customer perceived value on quality information dissemination in different areas. These models could help enterprises make the best plan to sale their products (Thomas et al. 2011). Several recent researches had recovered that the dissemination model should contain three roles of information sources, gatekeepers and receivers. However, previous researches argued that there were four roles in quality information dissemination. Recently, some researches indicated that the dissemination model consisted of information source, information dissemination space and perceived space (Yu and Luo 2011). Zhu and You (2010) indicated that negative quality information dissemination could arise from the credit risk and reduce customer perceived value, which was the important factor in quality management. Due to the continuous effect of negative quality information on product utility, customer perceived value showed the nonlinear change (Zhu and You 2010). It suggested that information releasing system, recognition mechanisms of publisher identity and reputation were able to effectively control the situation of expanding production risk caused by quality information dissemination (Narasimhan and Talluri 2009; Wu and Olson 2008).

The paper suggests that quality information dissemination model should be able to describe the features of stochastic process. The random walk theory can meet the requirements and have a visual function.

110.2 Methodology

110.2.1 Problem Description

Quality information dissemination can be expressed as variable multiply forms. Variables include: quality information value V generated by point (x_0, y_0), the probability of customer on (x, y) accepting the quality information $P(V, D(x, y), (x, y))$. The expression is:

$$V(x, y) = V \cdot P(V,\ D(x,\ y),\ (x,\ y)) \tag{110.1}$$

110.2.2 Basic Assumptions

The paper concentrates on the description of determining space discrepancy of information flow value dissemination and dissemination rules, thus the paper has the following assumptions:

Assumption 110.1 Information is disseminated in a specific space and can not disseminate out of the space. Individual information is regarded as a collection of infinite number of discrete mediums, whose total volume is 1. It can be expressed as:

$$P(l,0) = \delta(l) = \begin{cases} \delta(l) = \begin{cases} 0 & l \neq 0 \\ \infty & l = 0 \end{cases} \\ \int_{-\infty}^{+\infty} \delta(l)dl = 1 \end{cases} \tag{110.2}$$

Assumption 110.2 Customer is a strictly rational person. If customer perceived value is higher than product's price, customer will buy it. Otherwise, customer will refuse to buy. If customers have the same perception of quality information, they will adopt the same purchase decision-making behaviors. The more the perception of quality information they have, the greater the probability of decision-making to accept quality information will happen. The functions can be expressed as: $P(D + \Delta D,\ V) \geq P(D,\ V)$.

Assumption 110.3 There are two kinds of rules in quality information dissemination. One is incremental dissemination, the other is attenuation dissemination.

Assumption 110.4 The probability of the source of quality information disseminates itself is 1.

110.2.3 *Random Walk Model of Quality Information Dissemination*

Assume that l is the distance from point (x, y) to the source of quality information's location (x_0, y_0). So the probability of customer on (x, y) accepting the quality information $P(V,\ D(x,\ y),\ (x,\ y))$ can be simplified as random walk process based on a two-dimensional coordinate system $(L,\ D)$ to calculate, which is shown in Fig. 110.1.

In the model, assume that quality information whose value is V existing in the market disseminating to point C is a full probability event. The probabilities are p

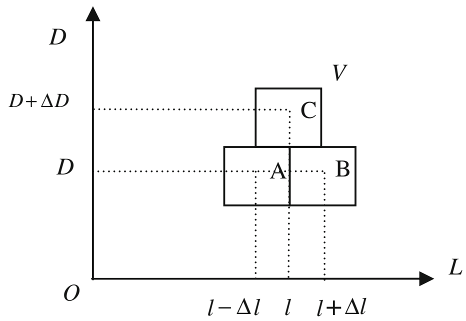


Fig. 110.1 The dissemination model of quality information based on random walk theory

and q respectively $p + q = 1$. The paper adopts the symbol of $P(l, D)$ to represent the probability of the event that quality information disseminates to point (l, D). The relationship function can be expressed as follows:

$$P(l, D + \Delta D) = pP(l - \Delta l, D) + qP(l + \Delta l, D) \tag{110.3}$$

Equation (110.2) was developed by the formula of Tailor. The result is:

$$\Delta D \frac{\partial P(l, D)}{\partial D} = \Delta l(q - p)\frac{\partial P(l, D)}{\partial l} + \frac{(\Delta l)^2}{2}\frac{\partial^2 P(l, D)}{\partial l^2} + \cdots \tag{110.4}$$

Assume that

$$\alpha = \lim_{\substack{\Delta l \to 0 \\ \Delta D \to 0}} a((\Delta l)^2 / 2\Delta D) \quad \beta = \lim_{\substack{\Delta l \to 0 \\ \Delta D \to 0 \\ p \to q}} [\Delta l(p - q)/\Delta D]$$

Because customers in different locations have different perceptions of quality information, so Eq. (110.4) can be expressed as:

$$\frac{\partial P}{\partial V} = \alpha(V)\frac{\partial^2 P}{\partial l^2} - \beta(V)\frac{\partial P}{\partial l} \tag{110.5}$$

$\alpha(V)$, $\beta(V)$ are the reciprocals of customer's perception of quality information in Eq. (110.5). System of differential equations including Eqs. (110.2) and (110.5) are processed by a Fourier transform. The dynamic solutions are:

$$P(V, D, l) = C \cdot \sqrt{\frac{D(x, y)}{4\pi}} \cdot e^{\frac{-l^2 \cdot D}{4}} \tag{110.6}$$

From Assumption 110.4, the boundary conditions is $P(V, D, 0) = 1$, then solve the equation. The answer is

$$C = \sqrt{\frac{4\pi}{D(x_0, y_0)}}$$

Put the answer into Eq. (110.6), the probability of customer on (x, y) accepting the quality information can be represented as:

$$P(V, D, l) = \sqrt{\frac{D(x, y)}{D(x_0, y_0)}} \cdot e^{\frac{-l^2 \cdot D(x, y)}{4}} \tag{110.7}$$

Take the time factor t into account, put Eq. (110.7) into Eq. (110.1), then get the function of quality information dissemination, it can be shown as:

$$V_t(x, y) = V_t \cdot \sqrt{\frac{D_t(x, y)}{D_t(x_0, y_0)}} \cdot e^{\frac{-l^2 \cdot D_t(x, y)}{4}} \tag{110.8}$$

V_t is the value of quality information created at time t and $D_t(x, y)$ is the customer's perception in (x, y) of quality information at time t and $D_t(x_0, y_0)$ is the customer's perception in the source of quality information whose coordinate is the (x_0, y_0) of quality information at time t and l is the distance from point (x, y) to the source of quality information's location (x_0, y_0), it can be shown as:

$$l = \sqrt{(x - x_0)^2 + (y - y_0)^2}.$$

For quality information dissemination in multiple source condition, the influence of a potential customer is equal to the sum effect of each source disseminating its quality information. Because $V(A)$, $V(B)$, $\ldots V(N)$, are regarded as independent events, so the dissemination function of quality information in multiple source condition can be expressed as:

$$V = \sum_{i=A}^{N} V(i) \tag{110.9}$$

110.2.4 Index Settings

In order to achieve the calculation approaches of the above model, the paper constructs the index system which consists of quality information source, quality information dissemination space and customer perception of quality information (Fiore and Kim 2007). The summary of variables in the dissemination model of quality information can be seen in Table 110.1.

110.3 Empirical Analysis

110.3.1 Data Collection

The paper collects the panel date, quality and price data of sea cucumber, related-region statistical yearbook and customer survey from Zhangzidao Fishery Group Co., Ltd after two weeks when oil spill happen and research on the changes in the sales market caused by the oil spill combining with the quality information dissemination model.

(1) Quality information source

In order to avoid the stochastic volatility of stock price, the paper uses the data of 7 days moving average of stock price (MA7) as the indicator to measure quality information value (Raju et al. 1995). V_t is regard as the indicator of quality

Table 110.1 Variables in the dissemination model of quality information

Types of variables	Variable level	Date level
Quality information source	Value	The value of quality information about product creation in the market
	Property	The impact of quality information on products is good or bad?
Quality information dissemination space	Coordinate system	X of dissemination space
		Y of dissemination space
	The source's coordinate	The location where quality information is created
	Sales store's coordinate	The location of sales store
	Customer's coordinate	The location of customer who want to buy the product
Customer perception of quality information	Mass inertia	Certified quality standards
		Sampling percent of pass
		Invest in advertising
	The accuracy of quality information obtained by customer	The times of report about quality information
		The objectivity of report about quality information
	Customer preferences	The ratio of price and industry average price consumption level on (x, y)
		The frequency of consumption behavior on (x, y)
		The ratio of good review and bad review

information value and whose sign represents the impact of quality information on products is good or bad, which can be shown in Table 110.2.

(2) Dissemination space standardization

The range of the dissemination space, the location of quality information source and sales store are given in Fig. 110.2.

(3) Initial value of customer perceived value

Fu and Zheng (1999) thought price was a convex function of quality, defines it as $P = aV^2$.

Table 110.2 The data of quality information source

Date	2011/9/14	2011/9/28
Item		
MA7	27.56	27
V_t	0	−0.56

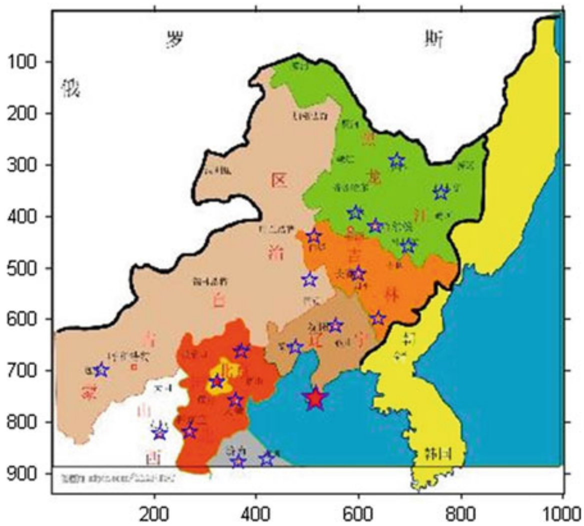


Fig. 110.2 Quality information's diffusion space coordinate system

(4) Customer perception of quality information distribution

After handing out the questionnaire to customers who live in the place as shown in Fig. 110.2, the paper gets customer perception of quality information distribution through the analysis and fitting of the statistic data.

110.3.2 Simulation

Based on the above-mentioned statistics, the paper adopts random walk model to simulate quality information dissemination of products of Zhangzidao Fishery Group Co., Ltd. The simulation results of quality information dissemination are shown in Figs. 110.3, 110.4 and 110.5.

110.4 Discussion

The result shows that quality information dissemination obeys a gaussian distribution, which will generate a black hole of customer perceived value in order to make customers refuse to buy when the quality information is bad enough. The distance from customer to the source of quality information plays a leading role in the effect of the black hole on customer perceived value, followed by customer perception of quality information. In Fig. 110.3, customer perceived value drops quickly and generates a black hole of value in Dalian region. But in the farther region like Beijing-Tianjin region, although customer perception of quality

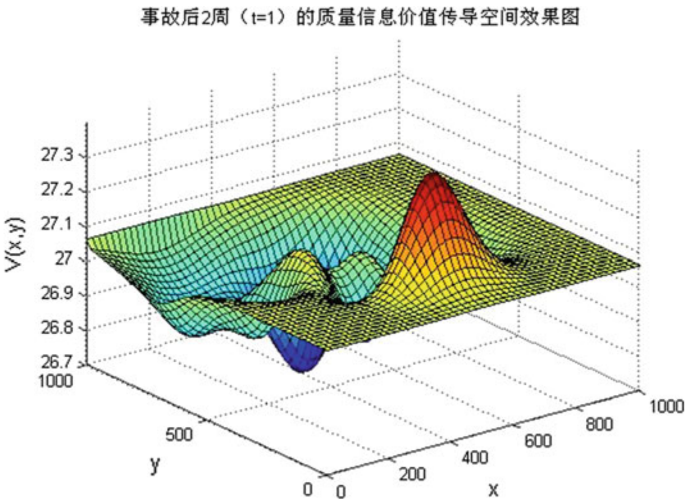
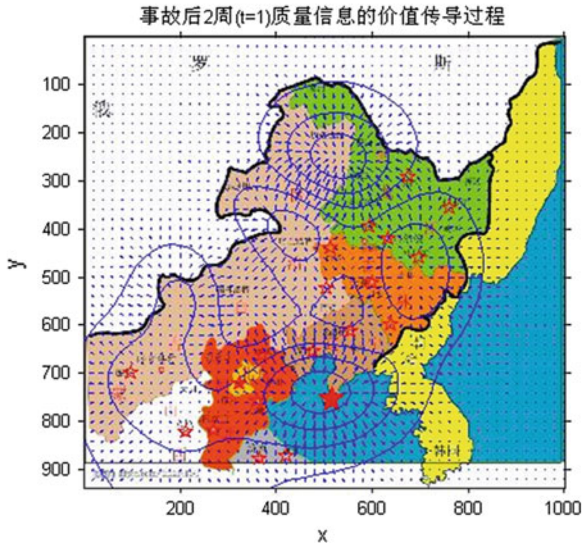


Fig. 110.3 Space distribution of quality information perceived value

Fig. 110.4 Simulation for quality information dissemination



information is higher than that in Dalian region, the maximum of the black hole of value in Beijing-Tianjin region is lower than that in Dalian region along with the increase of the distance.

In the same distance region, customer perception of quality information is the crucial factor in customer perceived value. For example, in Fig. 110.4, the distance from Taiyuan to the source is the same as Harbin to the source and the customer perception in Taiyuan is higher than that in Harbin, but the maximum of the black hole of value and the scope of influence is lager than that in Harbin.

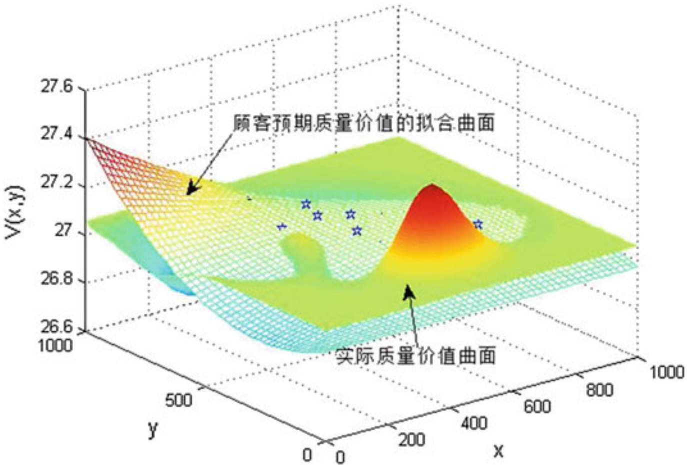


Fig. 110.5 Regional distribution where customers refuse to buy products

Figure 110.5 illustrates customer perceived value drops slowly and customers still have a higher willingness to purchase because of their curiosity, expense inertia and the accuracy of quality information in the region farther from the source or the junction among several sales stores.

110.5 Conclusions

The model can describe customer perceived value in different locations and the results are consistent with real data. It is quite effective in simulating quality information dissemination using random walk model. The model can partly explain the complex fluctuations of the customer perceived value caused by quality information dissemination.

There is a limitation for using the stock price to represent the value of quality information. For example, the irrational high/low price and the tendency variation will happen in stock market, so the stock price does not reflect the value of quality information (Wu et al. 2012).

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Chapter 111
Study on Early-Warning Assessment in Chinese Coal Mine Safety Based on Genetic Neural Networks

Yong-wen Ju, Li-xia Qi and Qian-li Sun

Abstract The early-warning and pre-control process to recognize potential safety hazard of coal mine based on characteristics of production safety is put forwards in the paper. The warning evaluation index system of coal mine safety which influenced by human, machine and equipment, environment, management and information is established. Then it conducted an empirical study by using an evaluation method of neural network based on genetic algorithm. Evidence shows that the method has better adaptability and high accuracy by combining with an example in supporting persistent effect mechanism for the safety production of coal mine.

Keywords Coal mine safety · Genetic algorithm · Neural network · Early-warning assessment

111.1 Introduction

At present, an increase rate in China coal mine demand annually is about 10 %, which promotes the coal industry development and produces kinds of coal accidents at the same time. According to the statistics, China is one of the countries that have the highest frequency of coal mine accidents.

Y. Ju (✉) · L. Qi · Q. Sun
School of Management and Economics, North China University
of Water Resources and Electric Power, Zhengzhou, Peoples Republic of China
e-mail: juyongwen@126.com

L. Qi
e-mail: yx1161@126.com

Q. Sun
e-mail: sunqianli1987@126.com

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The current supervision mechanism of coal mine safety in China is based on the emergency plan management, and the early warning mechanism had not been really set up. It is necessary to build long-term prevention mechanism combined with the theory and evaluation method of coal mine safety and early warning to monitor, diagnose, control and correct production activities of coal mine. It could provide theoretical basis and technical support for preventing and reducing coal mine accidents.

111.2 Literature Review

Domestic and foreign scholars have carried on the active exploration and research in the assessment method of coal mine safety. The main assessment methods include: (1) *Fuzzy comprehensive evaluation*: Ding Xia-jun (2004), Sun Jia (2005), Gao wen-hua et al. (2008), Sun Jian-hua (2009) built the index system and estimate the safety of coal mine by fuzzy comprehensive evaluation, they obtain the conclusion consistent with actual situation by the quantitative evaluation. (2) *Grey relation method*: Xu Yi-Yong 2003), Cao Shu-gang (2007), Yong-shuai (2009) established the evaluation index system based on the reality of coal mine production. Gray correlation analysis is used to evaluate the coal mine safety, and the different levels of security evaluation results are induced accordingly. (3) *Unascertained mathematics evaluation method*: Yan Le-lin (2004) built the index system, confidence identification criteria and rating criteria based on unascertained mathematics theory, the safety indictor of coal mine is analyzed through building the unascertained measure model. (4) *Neural network evaluation method*: Huang Hui-yu (2007), Zhou Zhong-ke (2011), Gao Xiao-xu (2011), Ding Bao-cheng (2011) built the index system and estimate the safety of coal mine by neural network. Then the practicality and effectiveness of the model are verified.

From what we have analyzed above, the assessment methods that are used commonly include the AHP, fuzzy comprehensive evaluation, grey relation method, unascertained mathematics evaluation method and neural network evaluation. However, these methods are short of the ability of self-learning, it is difficult to get rid of the subjective uncertainty and understanding of the ambiguity in the decision-making process. The neural network evaluation could avoid the defect, but there are some inadequacies such as slow convergence velocity and potential trapping into local search. Genetic algorithm can find the global optimum and have a good robustness. Therefore, it has fast convergence velocity and strong self-learning ability through the combination of genetic algorithms and neural networks. In this paper, the coal mine production safety is assessed by using an evaluation method of neural network based on genetic algorithm.

The "human-machine-environment" evaluation index system of coal mine safety is established based on the accident causing theory. Zhang Yu-lin (2008), Xu Yang (2009) consider that the accident was caused due to unsafe state of human, machine and environment. Sun Jian-hua (2009) think that the coal mine safety evaluation index system should include the factors of human, legislation, machine, engineering technology and disaster prevention.

Security information management plays an important role in the process of coal mine production. Coal mine safety is affected because of backward informatization construction in coal mine enterprise. The author thinks that the safety production of coal mine is influenced by the factors of human, machine, environment, management and information. The accident was the interaction of these factors' defects. So, "human-machine-environment-management-information" evaluation index system of coal mine safety is established in this paper.

So, the coal mine safety is assessed by genetic neural network based on the evaluation index system. The genetic neural network has been applied in evaluation of the corporation' core competence and risk project. But there is no related research in the safety assessment of coal mine. The index system and assessment methods built in this paper have great realistic meanings and long-term meanings to enhance early-warning and evaluation theory of coal mine safety.

111.3 Early Warning Assessment Index System of Coal Mine

The index system of "people-machine-environment-management-information" is shown in Table 111.1.

111.4 Empirical Analysis Based On Early Warning Model of Coal Mine

The major part of genetic neural network is to optimize the weights of network. First it finds the optimal solution by genetic algorithm; it can narrow down the searching range. Then it will use the BP neural network to find the optimal solution (Guo-xi and Hui-yu 2005). The specific steps are as follows:

111.4.1 Determine the Network Structure of the Model

The layers of neural network include input, hidden and output layers.

1. *Set the input of the network*: To make the original data more suitable for neural network through pretreating. The quantitative indicators should be normalized, and the qualitative indexes should be quantified. The number of network input nodes are equal to the index number of evaluation index system. Therefore, the input nodes in this paper are 29.

Table 111.1 Early warning assessment index system of coal mine

Rule layer		Index layer
Human factor (X_1)		Violation rate of employees (X_{11})
		Average level of education (X_{12})
		Training time per month(X_{13})
Machine factor (Y_1)		Level of mining mechanization (Y_{11})
		The rate of support equipment at good condition (Y_{12})
		The rate of ventilation equipment at good condition (Y_{13})
		The rate of dust-proof equipment at good condition (Y_{14})
		The rate of fire-fighting equipment at good condition (Y_{15})
		The rate of drainage equipment at good condition (Y_{16})
		The rate of lifting equipment at good condition (Y_{17})
		The rate of mechanical and electrical equipment good condition (Y_{18})
		The rate of transport equipment at good condition (Y_{19})
		The rate of gas drainage equipment at good condition (Y_{110})
Environment factor (Z)	The factors of geological environment(Z_1)	The average fault throw (Z_{11})
		Number of fault bars per unit area (Z_{12})
		Coal thickness coefficient of fault (Z_{13})
		The degree of difficulty of controlling the roof (Z_{14})
	Factors of mine disaster (Z_2)	Spontaneous combustion period (Z_{21})
		Coal dust explosion index (Z_{22})
		Average Gas Emission (Z_{23})
		Mining surface rich water coefficient (Z_{24})
	Factors of work environment (Z_3)	Pass rate of controlling dust pollution (Z_{31})
		Pass rate of controlling sound pollution (Z_{32})
Management factor(U_1)		Degree of perfection on management system (U_{11})
		Capacity of emergency rescue (U_{12})
		Timeliness and effectiveness of management (U_{13})
Information factor (V_1)		Degree of informatization (V_{11})
		Capacity of information recognition(V_{12})
		Capacity of information processing(V_{13})

2. *Determine the output nodes and hidden layer nodes*: The output nodes should be corresponded to the early warning assessment. The output nodes are 5 and the hidden layer nodes are 15 in this paper based on the experience formula. The corresponding output results alert are shown in Table 111.2

Table 111.2 Output result of neural network correspond to the alert

Output result	10000	01000	00100	00010	00001
Safe alert	Highest	Higher	Medium	Lower	Lowest

111.4.2 Optimize Weights of Network by Genetic Algorithm

The steps which optimize weights of network are as follows:

1. *Population initialization*: A combination of the initialization function and the random function is chosen to select the initial population. Cross-scale, crossover probability and mutation probability are included.
2. *Determine encoding mode and evaluation function*: Calculate selection possibility of each individual and select individual which have the biggest sufficiency value for the next-generation (Lin and Lin 2011).
3. *Operate selection, crossover and mutation*: Population is operated by stochastic universal sampling, two-point crossover and uniform mutation.
4. *Output the individual with best fitness degree value*: Select the neural network which has minimum errors and thresholds to train until the error reaches the precision. Set the termination condition and the error is less than 0.0001.

111.4.3 Empirical Analysis of the Model

In order to verify the feasibility and practicality of the model, network training is operated with monitoring data of five selected coal mining enterprises in four quarters in 2011. The error curve of network training is shown in Fig. 111.1. The

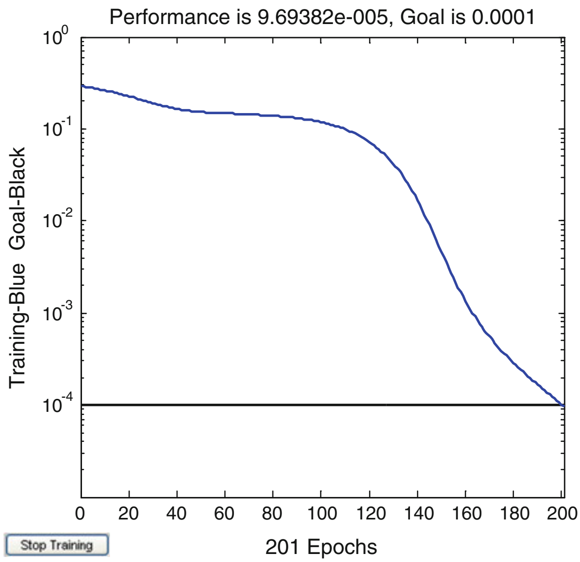

Fig. 111.1 Training curve of BP algorithm

Table 111.3 The test sample of model

X_{11}	X_{12}	X_{13}	Y_{11}	Y_{12}	Y_{13}	Y_{14}	Y_{15}	Y_{16}	Y_{17}	…	V_{11}	V_{12}	V_{13}	T	O
1.00	0.80	0.60	0.40	0.60	1.00	0.80	0.87	0.53	1.00	…	0.67	0.12	0.37	0 0 0 1 0	0 0 0 1 0
1.00	0.75	0.87	0.43	0.80	1.00	0.87	0.33	0.60	0.00	…	0.80	0.75	0.60	0 0 1 0 0	0 0 1 0 0
0.88	0.43	0.27	0.28	0.60	0.60	0.80	0.13	0.13	0.27	…	0.60	0.43	0.13	0 0 0 1 0	0 0 0 1 0
1.00	0.52	0.40	0.51	0.50	0.87	0.87	0.60	0.60	0.60	…	0.50	0.52	0.60	0 0 0 1 0	0 0 0 1 0
0.58	0.25	0.13	0.38	0.77	0.47	0.33	0.07	0.00	0.00	…	0.77	0.25	0.00	0 0 1 0 0	0 0 1 0 0

training result shows that: the network training is completed because the network error is less than 0.0001 after 201 times of training. Select five samples to test the network and it is shown in Table 111.3. The test results are consistent with the practical situation. Therefore, it is proved that the model that build in this paper have right evaluation to the safety situation of coal mine, and it provides a scientific basis for policy-makers to judge the safety conditions and formulate the countermeasures.

111.5 Conclusions

The early-warning assessment system in coal mine safety is a significant process that can prevent and control the accident. This paper analyzes and identifies the potential accidents and risk factors which may affect safety production, and build the genetic neural networks; it is proved that the model built in this paper has right evaluation to the safety situation of coal mine. Therefore, the model can assess the safety production in coal mine, and warn the weak in the production. Coal production could enter the safe orbit through timely adjustment in production by administrator.

Compared with previous studies, the contributions of this paper include: Firstly, the factors contributed coal mine safety production is analyzed comprehensively through the early warning index system including the information factors. Secondly, genetic neural network is able to achieve ideal empirical results when assessing the coal mine safety.

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Chapter 112
Identification of Critical Risk Factors in Software Project Risk Management

Guo-ping Jiang and Ming-chi Lin

Abstract The most important function of software metrics is to support quantitative decision of software project management. In this paper, we focus on identification of the most critical risk factors in software project risk management framework based on metrics and Bayesian network. Sensitivity analysis can be performed to study how sensitive the risk node's probability is according to small changes of probability parameters in the risk BN. For a risk BN of known structure and probability parameters, we first estimate the most probable risk scenario, and then perform sensitivity analysis for the risk node. After we find the critical risk factors, concentrate on these factors in risk monitoring and control process.

Keywords Bayesian network · Critical risk factors · Most probable explanation · Software metrics · Sensitivity analysis

112.1 Introduction

Software project risk management has got a lot of attention in IT industry. Many research institutions made great effort in this domain and harvested the fruits of their labors. Software metrics is another important subject in software project management. Everything that you want to control must be measured first. The most important requirement of software metrics is to support quantitative decision of software project management. For software risk management, software metrics can also work.

It is accepted gradually in software engineering community that software metrics are essential aids to managing software project. Metrics can be used to

G. Jiang (✉) · M. Lin
Department of Economics and Management, Naval University of Engineering, Wuhan 430033 Hubei, China
e-mail: gpjiang1029@163.com

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evaluate development process and the quality of software products. Metrics can also assist in risk management and control by identifying areas of possible risk and then to prioritize and track the risks.

A relative new and hopeful approach of software project risk management utilizing software metrics is Bayesian Network (BN, for short). Risk BN model can handle (Norman 2000):

- Diverse process and product variables;
- Empirical evidence and expert judgment;
- Genuine cause and effect relationships;
- Uncertainty;
- Incomplete information.

The aim of this paper is to discuss how to identify critical risk factors in risk BN model based on software metrics. In Sect. 112.2, we introduce the software project risk management framework and bring forward the problem of critical risk factors identification, and then point out the technical route of solving this problem. In Sect. 112.3, we discuss how to estimate the most probable risk scenario of the risk BN model. Identification method of critical risk factors based on BN sensitivity analysis is put forward in Sect. 112.4. In Sect. 112.5, an illustration example is presented to show how the method can be used. In the last section, we summarize this paper.

112.2 Software Project Risk Management Framework

Bayesian network has got attention in artificial intelligence domain in last 20 years. BN is the product of graph theory and probability theory. It is a complicated weighted causal relationship graph. Nodes in BN denote variables in the problem domain, and arcs represent direct causal relation between variables. The essence of BN is the joint probability distribution of the problem under study.

To model certain risk as a BN in software develop process, the first thing is to analysis causal relationship between risk and risk factors, thus establish model's topology structure; then educe conditional probability table for every node integrating historical data and expertise (Guoping and Yingwu 2004). Characters of risk and risk factors can be depicted by software metrics, so we model the correlative software metrics into the risk BN. In software develop process, manager observe and control these metrics at different stages thus to alleviate risks before their occurrence. Manager can also evaluate risk's effect by observing software metrics' changes.

Every risk BN has a node that denotes the risk under study, in this paper, let X_0 be the risk node, and $(X_0, X_1, X_2, \ldots X_n)$ be the set of nodes; $(X_{m1}, X_{m2}, \ldots, X_{mi}) \subset (X_1, X_2, \ldots X_n)$ be the set of metrics nodes in risk BN (Rosenberg and Hyatt 1996). We suppose that risk node is a leaf node. This is feasible, for we don't model risk's influence into the risk BN at present.

We list risk management functions that can be performed by risk BN as follows (Guoping and Yisngwu 2005):

- Estimate risk probability;
- Estimate the most probable risk scenario;
- Identify critical risk factors;
- Appraise risk control plan, support project risk management decision.

Risk factors are causations that produce the risk, and a risk must have some critical risk factors. Critical Risk factors identification is an important activity in risk management. For a risk BN, how to find out critical risk factors? Performing sensitivity analysis is the general method. For a Bayesian network, performing sensitivity analysis yields insight in the relation between the probability parameters of the network and its posterior marginal. The relationship between post marginal probability of risk node and probability parameters of the BN can be obtained through performing a sensitivity analysis. If we can get the most sensitive probability parameters then these probability parameters are the critical risk factors. To perform sensitivity analysis for a risk BN is to calculate $\Pr(X_0|O)$, where O is the set of observed evidence. We limit evidence to software metrics. The result of $\Pr(X_0|O)$ must be a function of BN's probability parameters. The probability parameters which have bigger coefficients are sensitive parameters. For risk BN, they are critical risk factors.

There are three instances we will confront when identify critical risk factors. First, some evidence O have been observed, $O \neq \phi$, thus we will calculate $\Pr(X_0|O)$; Another instance, $O = \phi$ while BN's probability parameters are not all known, that is to say, we will calculate $\Pr(X_0|\phi)$ with some unknown probability parameters. The third instance, $O = \phi$ and risk BN's probability parameters are all known. For this instance, we can estimate the most probable risk scenario $(X_0 = x_0, X_1 = x_1, \ldots, X_n = x_n)$ for this risk BN, and then take these metric nodes value as evidence, let $O = (X_{m1} = x_{m1}, \ldots, X_{mi} = x_{mi})$. For all of these three instances, calculation of $\Pr(X_0|O)$ is the focus.

112.3 Estimate the Most Probable Risk Scenario

For each value of the risk node x_{0k}, perform probability inference to compute the most probable explanation $x^K(x_{0k}, x_{1k}, \ldots, x_{nk})$ and the corresponding joint probability p_k. Comparing these p_ks, the assignment $x^K(x_{0k}, x_{1k}, \ldots, x_{nk})$ that has the biggest p_k is the most probable risk scenario. So the essential of estimating the Most Probably Risk Scenario (MPRS, for short) for a given risk BN is to calculate the Most Probable Explanation (MPE, for short) of this BN given the evidence $X_0 = x_{0k}$.

Definition 1 Kast and Dechter (1997) (Most Probable Explanation): for a given Bayesian network, the Most Probable Explanation is a complete assignment

$(X_0 = x_0, \ldots, X_n = x_n)$ which is agree with available evidence, and has the highest probability among all such assignments.

Here evidence is $X_0 = x_{0k}$.

There are two solutions for this problem (Dechter and Rish 1997).

Solution 1: **Chain rule**

Obtain the joint probability contribution of risk BN according to the chain rule, and then compare the joint probability of every complete assignment. The assignment $x(x_0, x_1, \ldots, x_n)$ which has the highest joint probability is the most probable risk scenario.

Chain rule: $P_r(x) = \prod_{X_i \in V(G)} p(x_i | pa(X_i))$

For a given BN, this method is simple and clear, but it needs a great deal of computation, especial when BN has many nodes, and every node has several values. So we think of another method, namely Bucket elimination algorithm.

Solution 2: **Bucket Elimination**

Bucket Elimination (BE, for short) is a variable elimination algorithm. BE is one of many algorithms for probability inference in BN. The most outstanding character of BE is simplicity and generality, without introducing new terminology as other algorithms. Figure 112.1 shows the algorithm to compute MPRS based on BE algorithm, where elim-mpe is a BE algorithm introduced in reference (Dechter and Rish 1997).

Generally speaking, nodes elimination order is a NP-hard problem. But for any arbitrary order, BE algorithm can get the MPE result in any case; the only difference is computation time and speed. To our research problem in this paper, we take these steps to obtain nodes elimination order: from risk node backward to root nodes along arcs between nodes, in the trace process, for every node, first left branch then right. The order obtained by this regulation may be not the best one, but it is enough just for this problem.

112.4 Identify Critical Risk Factors

Sensitivity analysis is a general technique for studying the effects of the inaccuracies in the parameters of a mathematical model on this model's output. Sensitivity analysis basically amounts to systematically varying the values of the parameter of the model under study. For BN, sensitivity analysis equals to vary the assessments for conditional probability of the network's nodes (Veerle 2002). Sensitivity analysis provides for studying the effects of the inaccuracy in the specified assessment on a probability of interest. Sensitivity analysis can be performed to study how sensitivity the risk node's probability is according to small changes in the probability parameters in risk BN. Post probability $P_r(X_0|O)$ of the risk node X_0 in a risk BN given evidence O is the occurrence probability of the risk under study. If $P_r(X_0|O)$ is sensitive to a specifically parameter then this

Algorithm 1

Input: A Risk Bayesian network $G(V(G), A(G))$, a target node, namely risk node $X_0 = x_0$ and an evidential set $O = o$ (possibly empty).

Output: a set of most sensitive probability parameters S.

Initialize $S = \phi$;

Calculate probabilities $P_r(x_0 \mid o)$;

- Step 1: Identifies the Set of Relevant Nodes $Sen(X_0, O)$
- Step 2: Identifying the Set of Sufficient Parameters

Rule 1: Eliminate the parameters $\theta_{ij\pi}$ if $x_i \neq j$, for $X_i \in O$.

Where $\theta_{ij\pi} = \Pr(x_i = j \mid pa(x_i) = \pi)$.

Rule 2: Eliminate the parameters if their parents' instantiations are incompatible with the evidence.

- Step 3: Identifying Feasible Monomials

Rule 3: Parameters associated with contradicting conditioning instantiations cannot appear in the same monomial.

- Step 4: Computing the polynomial coefficients

Normalize coefficients of polynomial function of $P_r(x_0 \mid o)$;

Initialization valve r_0;

For each monomial m_i in the polynomial function of $P_r(x_0 \mid o)$ and the coefficient c_i

If $c_i \geq r_0$, then $S \leftarrow m_i$.

Fig. 112. 1 Sensitivity analyses algorithm (Castillo 1997)

parameter's small change will conduce to big change of $P_r(X_0|O)$. That is to say, this parameter is very critical to $P_r(X_0|O)$, and it is critical risk factor of the risk under study.

According to the foregone research work (Castillo 1997); (Guoping and Yisngwu 2005), there is a proposition as follows:

Proposition *Let B be a Bayesian network with digraph $G(V(G), A(G))$ and let P_r be the joint probability distribution defined by B. Let $O \subseteq V(G)$ be the observed nodes in G and let o denote the corresponding observations. Let V_r be the network's node of interest and let $Sen(V_r, O)$ be the sensitivity set for V_r given O. Then for any value v_r of V_r, we have that $P_r(v_r|o) = \frac{a \cdot x + b}{c \cdot x + d}$.*

For every conditional probability $x = P_r(v_s|\pi_s)$ of every node $V_s \in Sen(V_r, O)$, where a, b, c and d are constant that dependent upon the values v_s of V_s and π_s.

In this paper, the node of interest is risk node X_0, observed nodes are metric nodes, $O = (X_{m1}, X_{m2}, \ldots, X_{mi})$.

The problem of risk node's sensitivity to O equals to calculating $P_r(x_0|o)$.

Figure 112.1 show the sensitivity analysis algorithm based on symbolic probabilistic inference (SPI, for short) for computing critical risk factors (Castillo 1997).

Step 1 is identifying the relevant nodes $Sen(X_0, O)$ for not every node in risk BN is relevant to the calculation of $P_r(x_0|o)$. We will not consider the rest nodes further. Add a dummy node for every node in BN, at the same time, add an arc from dummy node point to the previous node, and thus change risk BN to a new DAG G'. All the nodes that are not d-separated by O with X_0 are relevant nodes to calculate $P_r(x_0|o)$, noted as $Sen(X_0, O)$ Guo and Hsu (2002).

112.5 Illustration Example

We use the simplified defects BN introduced in reference (Fenton and Neil 1999) as Fig. 112.2 to show how our method can be used.

We name these eight discrete variables as $X_1, X_2, \ldots, X_8$ respectively, thus change Figs. 112.2 into 112.3. The probability parameters of this BN are known, each variable has binary value 0 or 1. Nodes X_1, X_3, X_4, X_5 and X_7 are metric nodes. Taking nodes elimination order as $\{X_8, X_7, X_6, X_5, X_4, X_2, X_1, X_3\}$, Bucket Elimination algorithm computer the most probable risk scenario of defects BN is

Fig. 112. 2 Defects BN (Fenton and Neil 1999)

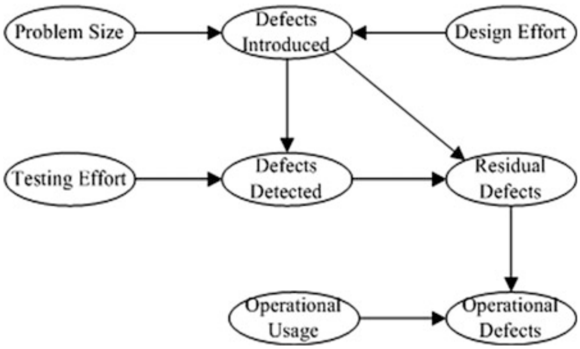

Fig. 112. 3 Defects BN

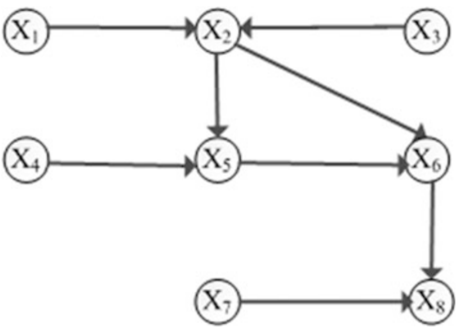

Table 112.1 Feasible monomials

Evidence	Monomials
$X_1 = 0$, $X_3 = 1$, $X_4 = 0$, $X_5 = 1$, $X_7 = 0$	$\{\theta_{2001}\} * \{\theta_{5100}\} * \{\theta_{6010}\} * \{\theta_{8000}, \theta_{8100}\}$
	$\{\theta_{2001}\} * \{\theta_{5100}\} * \{\theta_{6110}\} * \{\theta_{8001}, \theta_{8101}\}$
	$\{\theta_{2101}\} * \{\theta_{5101}\} * \{\theta_{6011}\} * \{\theta_{8000}, \theta_{8100}\}$
	$\{\theta_{2101}\} * \{\theta_{5101}\} * \{\theta_{6111}\} * \{\theta_{8001}, \theta_{8101}\}$

(0,1,1,0,1,1,0,1). Let evidence $O = (X_1, X_3, X_4, X_5, X_7)$ be a set of observed metrics, $o = (0, 1, 0, 1, 0)$. Calculating $\Pr(x_8|o)$ is to find the critical risk factors. The problem's essence is to perform sensitivity analysis of X_8 with the evidence O. Take the algorithm presented in Sect. 112.5, $Sen(X_8, O) = \{X_2, X_5, X_6, X_8\}$. The feasible monomials are listed in Table 112.1.

According to values of X_8, we divide the set of monomials to two subsets $M_0 = \{X_8 = 0\}$ and $M_1 = \{X_8 = 1\}$.

$$\begin{aligned} M_1 = \{&\theta_{2001}\theta_{5100}\theta_{6010}\theta_{8100}, \theta_{2001}\theta_{5100}\theta_{6110}\theta_{8101}, \\ &\theta_{2101}\theta_{5101}\theta_{6011}\theta_{8100}, \theta_{2101}\theta_{5101}\theta_{6111}\theta_{8101}\} \end{aligned}$$

$$\begin{aligned} \Pr(x_8 = 1|o) = &C_1\theta_{2001}\theta_{5100}\theta_{6010}\theta_{8100} \\ &+ C_2\theta_{2001}\theta_{5100}\theta_{6110}\theta_{8101} \\ &+ C_3\theta_{2101}\theta_{5101}\theta_{6011}\theta_{8100} \\ &+ C_4\theta_{2101}\theta_{5101}\theta_{6111}\theta_{8101} \end{aligned}$$

Compute the coefficients of this function, we get final expression:

$$\begin{aligned} \Pr(x_8 =&1|o) \\ &= \theta_{2001}\theta_{5100}\theta_{6010}\theta_{8100} + \theta_{2001}\theta_{5100}\theta_{6110}\theta_{8101} \\ &+ \theta_{2101}\theta_{5101}\theta_{6011}\theta_{8100} + \theta_{2101}\theta_{5101}\theta_{6111}\theta_{8101} \end{aligned}$$

For we regard all the nodes in this risk BN as choice nodes, so every coefficient (Guoping and Yisngwu 2005) equals to 1.

Similarity, we get

$$\begin{aligned} \Pr(x_8 = 0|o) = &\theta_{2001}\theta_{5100}\theta_{6010}\theta_{8000} + \theta_{2001}\theta_{5100}\theta_{6110}\theta_{8001} \\ &+ \theta_{2101}\theta_{5101}\theta_{6011}\theta_{8000} + \theta_{2101}\theta_{5101}\theta_{6111}\theta_{8001} \end{aligned}$$

Normalize above equations, we get:

$$\begin{aligned} \Pr(x_8 = 1|o) = &(\theta_{2001}\theta_{5100}\theta_{6010}\theta_{8100} + \theta_{2001}\theta_{5100}\theta_{6110}\theta_{8101} \\ &+ \theta_{2101}\theta_{5101}\theta_{6011}\theta_{8100} + \theta_{2101}\theta_{5101}\theta_{6111}\theta_{8101}) \\ &/(\theta_{2001}\theta_{5100} + \theta_{2101}\theta_{5101}) \end{aligned}$$

It's not easy to identify which is critical to $\Pr(x_8|o)$ from above results for this special example, we can only conclude that X_2, X_6 are critical to risk's occurrence. So in the software development process, managers should pay more attention to the introduced defects and the residual defects, take corresponding control steps according to the ranges of both.

112.6 Conclusion

In this paper we discuss the method of identifying critical risk factors in software risk management framework based on Bayesian network. In the process of software project development, managers collect correlative metrics, establish BN for the risk being studied integrating historic data and causal relationship between risk factors. They can analyze, appraisal and dynamic control the risk utilizing this risk BN. Identifying critical risk factors is a very important risk management activity. Performing a sensitivity analysis can acquire the relationship between marginal probability of interesting node and other probability parameters in the BN. So we take sensitivity analysis of risk node to investigate risk probability's dependency on the probability parameters in risk BN. According to different application instance, perform sensitivity analysis on risk BN grounded on symbolic probability inference algorithm. For the instance of known probability parameters and no evidence, we first estimate the most probable risk scenario, and then perform sensitivity analysis, obtain the sensitive parameters of risk node. We present the rule of acquire node elimination order and critical risk factors identification method in the paper. We also apply this method to a known defect BN, and result shows that this method is feasible.

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Chapter 113
The Application of Enterprise QHSE Management Performance Evaluation System Based on Maturity Model

Yu Wu and Bao-yin Zhang

Abstract This article analyzes the research of QHSE management performance situation at first. Then a three-dimensional structural model of QHSE Management Performance Maturity Model is established based on Maturity Model. What more, the evaluation index system have been founded which uses Analytical Network Process and Grey Theory to achieve integration measurement and evaluation. Furthermore, above methods are validated into actual cases, in order to make it have good value and reference in practical applications.

Keywords Maturity mode · QHSE · Management performance evaluation · Analytical network process · Grey theory

113.1 Introduction

With the rapid develop of the modern industry, major accidents have been in the news frequently around the world. The event of Gulf of Mexico oil spill in 2010 not only brought the ecological environment deterioration, the economic losses upgrade, the political crisis deepened, but also made the hit-and-run enterprise face with destroyed destiny, Which warns the high risk and high return enterprise once ignore environmental, safety, quality and occupational health management, it is unavoidable to bring unexpected heavy consequences, and will pay a heavy price. In recent years QHSE accident are already common occurrences, QHSE has

Y. Wu (✉)
College of Safety Science & Engineering, Civil Aviation University of China, Tianjin, China
e-mail: y_wu@cauc.edu.cn

B. Zhang
School of Management, Tianjin University, Tianjin, China
e-mail: zhbytju@163.com

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become a very important factor restricting our economic development, the QHSE technology and management method of domestic enterprises need to improve rapidly, and the QHSE management performance evaluation is imminent as well.

Quality, Health, Safety and Environment Management (QHSE), generally refers to a management operation mode which integrates the common element together of ISO9000, OHSAS18000 and ISO14000 standard. The narrow definition of QHSE is to point to the management system of the international oil and gas industry. The broad definition of QHSE refers to quality, health, safety and environment of the integration of management suitable for all types of organization (Han 2008). In general, QHSE is an organic, systemic and structural dynamic management system, which consists of implementing quality health safety and environmental management by organization, duty, practice, process, procedure, resources and so on, through the prevention guiding ideology, using the PDCA operation mode connecting (Zhong 2006; Wang 2005). Therefore, QHSE Management Performance Maturity Model (QHSE-MPMM) has been founded on base of Maturity Model in this paper, which could encourage the enterprises to improve the QHSE management performance, provide the relevant government departments the technical support for supervision.

113.2 The Constuction of QHSE Management Performance Maturity Model

113.2.1 Research of QHSE Management Performance Situation

Nowadays the domestic and overseas research of QHSE management focuses on such two following aspects: one is the research on the feasibility and applicability of integration management, with emphasis on how to integrate quality, environment and occupational health management system; another concentrates on the measure and evaluation of quality, environment and occupational health management respectively (Bernardo et al. 2009). Broadly speaking, the disadvantages of QHSE management research are represented in below aspects:

- The study on the patterns of QHSE management system is not in-depth and unsystematic. There is lack of systemic theory analysis and summary, and lack of a series research of complete theory and practical application, range from applicable field, operation process, and integration mode to comprehensive evaluation.
- The theoretical research on QHSE management is still comparatively superficial, and theoretical framework should be further refined and perfect. It needs to construct and perfect the scientific evaluation index system, considering the

relationship between index and logical levels, research and choose suitable index evaluation method in qualitative and quantitative analysis.

- The QHSE synthetical evaluation method is still at groping stage, lack of actual usable the quantitative evaluation of way and the steps. The evaluation and improving process of the enterprise QHSE management is not short-term conduct, and it is staged for enterprises that use "diagnosis-evaluation-improve diagnosis" evaluation model to improve QHSE management. In addition, the QHSE management evaluation results need to consider benchmarking, to achieve the strategic objective of continuous improvement and promote the enterprise steady progress.

The niche targeting judgments of QHSE management evaluation results are not enough. And the research on key factors which influence the whole enterprise management level should be analyzed and verified necessarily. Only the influence the level of performance management short board is found, the improvement strategies and methods of QHSE management could realize comprehensive benefit ascension.

113.2.2 QHSE Management Performance Maturity Model

(1) *Introduction of the maturity model*

Maturity model is actually a set of standards, to successfully judge the development of the process stages, which is firstly originated from the Capability Maturity Model (CMM) by Carnegie Mellon® Software Engineering Institute (SEI) in 1987 (Zeng et al. 2007).

As the core content of the maturity model, maturity level is consisted of several clear characterizations to indicate the organization from immaturity to maturity process. According to the actual need (such as industry background, basic national conditions, etc.), maturity level can be divided into staged type and successive type factitiously (OGC 2002; Andersen and Jessen 2003)[1].

Internal elements and their mutual relationships in maturity model provide specific steps and practice contents for organizational performance management (Project Management Institute 2003). Because of every maturity level includes different aspect or process area, and every process area includes different element or activity, all above reflect the path to each maturity level. The work what have been achieved in every maturity level means that the organizational performance already reaches those aspects of the performance requirements in that maturity level.

[1] http://baike.baidu.com/view/280963.htm?fr=ala0_1_1,PDCA, 2010

The conception of maturity model not only provides some regulations and targets, but also provides the expected activities and every anticipatory target of the activities, and provides suggestive concrete practices and expectations to realize every target. Thus when the maturity model is used, there would not cause large difference in the practice because of different understanding of different implementer.

At the same time, the maturity model is just a model but not an implementation guide, the specific practice and output content what it provides are suggestive properties, different enterprise should establish more specific working process according to enterprise's own operation condition. That is, the emphases of the maturity model are the analysis of evaluate results and good performance ability improvement. Through evaluation of QHSE management maturity, it is very feasible and widely applicable to improve and promote the management performance.

(2) *QHSE Management Performance Maturity Model*

Based on above study, the QHSE Management Performance Maturity Model (QHSE-MPMM) has been founded in this paper, which defines five maturity levels, that is initial, repeatable, standardized, managed and optimizing, which represents QHSE management performance from the lower level to senior and continuous improvement of process. The three-dimensional structure of QHSE-MPMM is as shown in Fig. 113.1 (Wang and Wang 2009).

There into, each maturity level defines the process of the stage for the organization towards to mature management organization, includes a relatively stable development of the process goals that organization management could achieve, represents a level of organization management, and provides a step for continuous improvement process. The specific meaning of each maturity level is explained in Table 113.1.

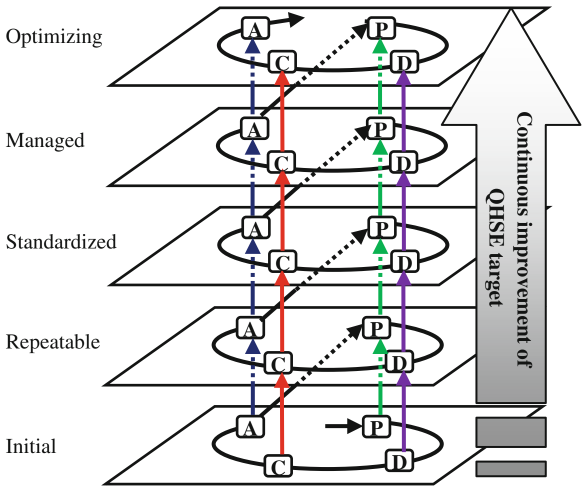

Fig. 113.1 Three-dimensional Structure of QHSE-MPMM

Table 113.1 Five maturity levels of QHSE-MPMM

Name	Definition	Characteristic
Initial	Chaotic management; almost no definition of control process; passive drive management depending largely on individual talents and experience	No QHSE administrative behavior
Repeatable	Organization is established; QHSE management if formulated to track the key process; making the necessary management system, having access to success on former similar experience	Passive QHSE management
Standardized	The management and process are standardization, documentation and standardization; the enterprise employees can complete the requirements of the organization management elements to achieve expected expectations	Conscious QHSE management
Managed	The management and process can be measured, analyzed and controlled.	Initiative QHSE management
Optimizing	The sustainable development of the dynamic management	Dynamic optimized QHSE management

The systemic steps are effective to guarantee of effective evaluation. The evaluation process of QHSE-MPMM includes evaluation firstly, location maturity level secondly, confirmation a new maturity target thirdly, formulating relevant improving measures fourthly, and implementing dynamic evaluation finally.

113.3 The Evaluation Index System of QHSE-MPMM

113.3.1 Establishment Principles of Index System

The evaluation index of QHSE-MPMM should be selected according to the characteristics of the enterprise QHSE management and actual operation situation. There are the following several principles in this paper:

- Objectivity. Each index needs to reflect the overall effect and the inner link of the enterprise QHSE performance management, and more objectivity is needed in judging evaluation, in order to avoid the subjectivity of interference.
- Systematization. The established index system need to simplified and reasonable, index has the ownership of the hierarchy between each other, in order to achieve the whole system function the optimal objective.
- Dynamic. From the view of the development and changes, the index system needs to reflect the dynamic situation changes of QHSE management, and has the function of the development trend to predicting the future.
- Relative independence. Each evaluation index should remain relatively independence to avoid repetition evaluation.

- Comparison and measurement. The index system is to reflect the common attributes evaluation objects, needs to be easy measured and easy vertical and horizontal compared, and the reality of QHSE management situation would be reflected objectively.

113.3.2 Structure of Index System

The level of QHSE management will be influenced by enterprise stakeholders, enterprise inner management level and macro economy and environment, etc. Combined with the typical characteristics of the petroleum enterprise and according to international practice and enterprise practice, 15 key factors of QHSE management have been analyzed at four hierarchies such as plan, do, check and action.

Therefore a three layers of index system is constructed in this paper, which considers the maturity of enterprise QHSE management (called U) as overall evaluation target, four first-class indexes such as plan, do, check and action (called P1, P2, P3 and P4 respectively), 15 s-class indexes that are belongs to appointed first-class indexes, and also there are third-class indexes belong to appointed second-class indexes. There only two layers of evaluation indexes are discussed because of lack of space. Likert Scale method has been used as the evaluation standard of each index, and the specific meaning of each index is listed in Table 113.2.

113.3.3 Measurement of Index System

Firstly, each index value should be standardized because of diffident measure dimension, in order to transform the actual value to a relative value in the interval [0, 1].

Secondly, considering the hierarchy and feedback relations among the index system, Analytical Network Process (ANP) (Wang 2001) is feasible to calculate the index weighting factor (Song and Wang 2010), on account of ANP can reflect effectively the relationship between various factors. Here, U is defined as overall goal of QHSE management maturity grade, $P_s(s = 1, 2, 3, 4)$ are defined as four assessment criteria, such as plan, do, check and action, and $X_{ij}(i = 1, 2, \cdots, m,$ $j = 1, 2, \cdots, n)$ are defined as factors in ANP. And second-class indexes weighting vectors $W = (\omega_1, \omega_2, \cdots, \omega_m)$, first-class indexes weighting vectors $W = (\omega_1, \omega_2, \cdots, \omega_m)$ could be calculated by means of Feedback system super matrix and Limit super matrix.

Under certain conditions, the enterprise QHSE management level is stable during and development period, however, the Influence factors of evaluation QHSE are more complex. Grey Theory is able to consider the influence from each

Table 113.2 Specific meaning and evaluation standard of index system

Assessment target	The first-class index	The second-class index (ANP weighting factor)	Specific meaning of second-class index
U: maturity grade of QHSE management	P_1: plan 0.278	X_{11}: leadership commitment (0.059)	Ensure enterprise expectation and other stakeholder expectations consistently
		X_{12}: guarantee scheme (0.059)	Ensure timely complete business objectives and standardization documents
		X_{13}: risk evaluation (0.084)	Ensure standard identification and evaluation towards occupational health, safety and environmental risk
		X_{14}: Human Resource (0.023)	The effective management ability of Human resources
		X_{15}: regulatory compliance (0.053)	Conformity degree of laws and regulations
	P_2: Do 0.496	X_{21}: project management (0.206)	Ability and effect of Project management
		X_{22}: staff training (0.024)	Ensure necessary ability training of enterprise employees to finish its work effectively
		X_{23}: Communication (0.034)	Establish good communication channels
		X_{24}: risk management (0.133)	Proper level of risk control measures
		X_{25}: assets management (0.034)	Maintain fixed assets to ensure its risks in the acceptable range
		X_{26}: Contractor Performance (0.034)	Ensure the contractor's action or service to meet the quality of enterprise standard
		X_{27}: Emergency Management (0.034)	Safeguarding mechanism of an emergency
	P_3: Check 0.167	X_{31}: Events Management (0.067)	Events learning and continuous improvement
		X_{32}: Risk Monitoring and Control (0.100)	Perfect the risk control and make effective measures for improvement
	P_4: Action 0.059	X_{41}: Performance and examination management (0.059)	Benchmarking management and realize the social responsibility of the enterprise

sample data imposed on the final evaluation results (Liu et al. 2004), and the conclusion would be theoretically accord with the actual object attribute, to obtain the best comprehensive evaluation conclusions (Qin 2009; Jøgensena et al. 2006). The whole calculation steps are shown as following:

Step 1: Five levels of maturity are defined: initial ∈ [0,1], repeatable ∈ (1,2], standardized ∈ (2,3], managed ∈ (3,4] and optimizing ∈ (4,5].

Step 2: Suppose the number of decision makers is p, which effectively filled in the questionnaire. d_{ijk} means the score of second-class index. Therefore Sample matrix D can be obtained:

$$D = \left(d_{ijk}\right)_{(n_1+n_2+\cdots+n_1)\times p} \tag{113.1}$$

$$i = 1,2,\cdots,m,\ k = 1,2,\ldots,p,\ j = 1,2,\cdots,n.$$

Step 3: Threshold value $\lambda_g(g = 1,2,\cdots,5)$ and evaluation gray type $C_e(e = 1,\cdots g)$ are defined, with the purpose of determining the corresponding whitenization weight coefficient $f_e\left(d_{ijk}\right)$, then grey evaluation weight r_{ij} of each second-class index can be calculated as the following:

$$r_{\mathrm{ij}} = \frac{\sum_{k=1}^{p} f_e\left(d_{ijk}\right)}{\sum_{e=1}^{g}\sum_{k=1}^{p} f_e\left(d_{ijk}\right)} \tag{113.2}$$

$$e = 1,\cdots,g;\ k = 1,\ldots,p$$

Then, the grey evaluation weight vector of every second-class index X_{ij} can be obtained: $r_{ij} = \left(r_{ij1}, r_{ij2},\cdots,r_{ijp}\right),\ j = 1,2,\cdots,n;\ i = 1,2,\cdots,m.$

Step 4: the grey evaluation weight matrix of every first-class index X_i can be obtained:

$$R_i = \begin{bmatrix} r_{i1} \\ r_{i2} \\ \vdots \\ r_{i\,n_i} \end{bmatrix} = \begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i1g} \\ r_{i21} & r_{i22} & \cdots & r_{i2g} \\ \cdots & \cdots & \vdots & \cdots \\ r_{i\,n_i1} & r_{i\,n_i1} & \cdots & r_{i\,n_ig} \end{bmatrix} \tag{113.3}$$

$$i = 1,2,\cdots,m$$

With that, the grey overall evaluation weight vector $\mathrm{B_i} = \left(\mathrm{b_{i1}}, \mathrm{b_{i2}},\cdots \mathrm{b_{ig}},\right)$can be obtained:

$$\mathrm{B_i} = \mathrm{W_i}\cdot\mathrm{R_i} = \left(\omega_{\mathrm{ij}}\cdot\omega_{\mathrm{iz}},\cdots,\omega\right) \tag{113.4}$$

Step 5: the grey overall evaluation weight vector B of U can be calculated as the following:

$$B = W \cdot R = \begin{bmatrix} B_1 \\ B_2 \\ \vdots \\ B_m \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & \cdots \\ b_{21} & b_{22} & \cdots \\ \cdots & \cdots & \vdots \\ b_{m1} & b_{m1} & \cdots \end{bmatrix} \tag{113.5}$$

$$U = B \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \vdots \\ \lambda_g \end{bmatrix} = b_1\lambda_1 + b_2\lambda_2 + . \tag{113.6}$$

In the above, the value of U is just a grey number, and it needs to calculate each whitenization weight function $f_g(U)$ of evaluation gray type, and according $max\, f_g(U)$, the maturity grade of U can be estimated finally.

113.4 Ease of Use

The petroleum enterprise (called A for short in the following) was selected as one case to validate the feasibility and validity of above models. The research data were obtained from questionnaire survey and site survey. There are 240 distributing questionnaires, 216 reclaimed questionnaires (recovery rate 90 %), and 200 effective questionnaires (effective rate 90 %). Considering confidential requirement of the project, the original data are not made public. In order to process the data, third-class indexes belong to appointed second-class indexes have been defined the same weighing factor.

According to statistical analysis of questionnaires, the current QHSE management situation of A is shown in Fig. 113.2. But it shows that scores of second-

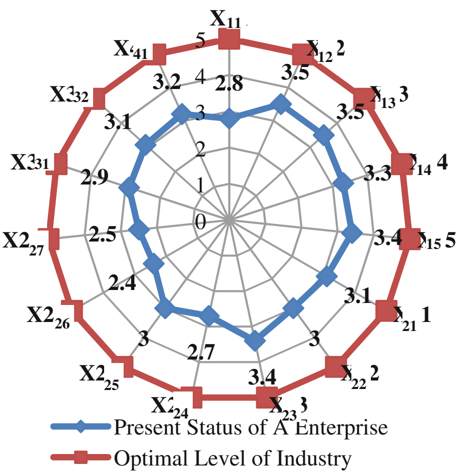

Fig. 113.2 the current QHSE management situation of A

class indexes are concentrated in between 2.4 and 3.5, which reveal that the QHSE management of A are relatively balanced, and there is no significant absence of management and weak links.
Before comprehensive evaluation of A, the weighing factor should be measured by ANP at first (calculation results in Table 133.2). Finally the maturity grade of A was calculated as: $max\,f_g(U) = f_2(U) = 0.8912$. The final evaluation result shows that the maturity level of A belongs to managed scope.

The case shows that the QHSE management of A is in a better level under the background of oil industry, and on the other hand, the evaluation results accords with site survey, which indicates the credibility of evaluation methods.

113.5 Conclusion

QHSE Management Performance Maturity Model has been founded and analyzed, in order to provide a practical research ideas and methods for the enterprise QHSE management performance evaluation, which could provide enterprises with corresponding measure and strategy, especially to the enterprise with high risk coefficient. And the other thing to point out, different industry focuses on the aspects of QHSE performance management are different. Therefore, each evaluation index should be selected and validated carefully, to make research base of QHSE management performance comprehensive evaluation solidly.

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Chapter 114
Study on Application of Internet of Things Technology in the Aviation Equipment Maintenance Safety Management

Da-xin Sun, Xiao-kun Wang, Yong-yu Liu, Cheng-xiang Liu and Guang-sen Zhou

Abstract The article researches and analyses the Internet of Things and aviation equipment maintenance security management, and attempts introduction the Internet of Things technology to aviation equipment maintenance security management to achieve both barrier-free management of maintenance personnel and tracking and positioning management of maintenance tool. This attempt has an important significance upon accelerating up the process of information of aviation equipment maintenance safety management and enhancing the management efficiency of aviation equipment maintenance safety management.

Keywords Internet of Things technology · IT · Aviation equipment · Maintenance safety · Safety management

114.1 Introduction

New information warfare style and substantial increase of the degree of equipment of the information put forward urgent requirements of the aviation equipment maintenance safety management enter a new stage of development—the aviation equipment maintenance safety information management stage (Ji et al. 2004). Internet of Things technology as a combination of sensor technology,

D. Sun (✉) · G. Zhou
Training Department of Air Force, Aviation University, Changchun, China
e-mail: sdx58964@gmail.com

X. Wang · C. Liu
Aeronautical and Mechanical Engineering Department of Air Force, Aviation University, Changchun, China

Y. Liu
Flight Simulation Training Center of Air Force, Aviation University, Changchun, China

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communications technology and computer technology is one of the most important information technology of the 21st century. Internet of Things technology is considered to be the third information technology and information revolution after the computer development and Internet universal application, which has important applications in the military. This paper will be based on Internet of things military applications and attempt introduction of Internet of Things technology into aviation equipment maintenance and support and safety management system, in order to effectively enhance aviation equipment maintenance safety management performance.

114.2 Overview of the Internet of Things Technology and Aviation Equipment Maintenance Safety Management

Concepts and advanced information technology of the Internet of Things, has been quickly used to perception and control a variety of combat supplies in the field of military logistical support in developed countries to meet the requirements of modern warfare on logistical precision protection. Aviation equipment maintenance is an important area of military logistical support, there are many factors affect the safety of aviation equipment maintenance. There are still many weak links in aviation equipment maintenance safety management. However, the information technology wave of the Internet of Things brings opportunity for the aviation equipment maintenance safety management change from the traditional extensive management to intensive and meticulous management.

114.2.1 Internet of Things Technology and Aviation Equipment Maintenance Safety Management

1. *An Internet of Things and its key technologies*: There is no uniform standard definition on the Internet of Things currently. General, the Internet of Things is look like a huge network combining the various information sensing devices and the Internet. Specifically, the Internet of Things is seen as a network, which can intelligent identify, locate, track, monitor and manage any items connected to the Internet, and exchange information and communicate according to the agreed protocol through radio frequency identification (RFID), infrared sensors, global positioning systems, laser scanners, and other information sensing device (Ning 2010).

The Internet of Things has the characteristics of the Internet, but finer, stronger and more comprehensive than the Internet in functionality according to the definition of Internet of Things. Sensor technology, communication technology and computer technology as the three foundation of modern information technology complete the information collection, transmission and processing respectively. The Internet of things combined the three techniques together to achieve real unity of the information collection, transmission and processing. Therefore, the Internet of Things is considered as one of the most important technologies of the 21st century, it would have a profound impact on the future humanity lifestyle.

A lot of technology involved in the Internet of Things, including perception technology, communication technology, network technology, found with search engines technology, data processing technology, network management technology, etc. The RFID technology, communication technology and network convergence technologies, sensor technology and intelligent information processing technology are recognized as the four key technologies of the Internet of Things, in which, the RFID technology is used for object identification, the sensor technology is responsible for perception of the object dynamic information, the communication technology and network convergence technologies is used for information transmission, the intelligent information processing technology is for information processing (Qiu 2011).

2. *Aviation equipment maintenance and Aviation equipment maintenance safety management*: With the rapid development of science and technology and military aircraft widely used in the military area, aviation equipment is increasingly sophisticated and complex, becoming increasingly dependent on maintenance. Aviation equipment maintenance capacity has become an important part of the Air Force combat effectiveness of troops. Aviation equipment maintenance as the primary task of aviation equipment operations and training is to quickly maintain and restore the good and available state of aviation equipment in accordance with the requirements, content and procedures at any time under any circumstances, in order to meet the military operations and training needs.

Aviation equipment maintenance safety management is the management activities conducted by the aviation maintenance system in order to ensure the flight safety and aviation maintenance operations safety. (Deng et al. 2011) Aviation equipment maintenance safety management is one of the main content of the aviation equipment maintenance management, which has great significance in ensuring the combat training tasks carry out smoothly.

From a functional point of view, the main content of the Air Force aviation equipment maintenance safety management includes nine aspects: the planning of safety work, the processing of quality and safety information, safety supervision and inspection, air and ground accidents (incidents) investigation, security situation monitoring, accident prevention macro decision-making, security education and training, safety legislation and safety research (Wang 2008).

3. *Aviation equipment maintenance safety management based on the Internet of Things*: Aviation equipment maintenance safety management based on the Internet of Things is to use the Internet of Things technology for aviation

equipment maintenance safety scientific and informational management integrated a variety of IT will play an important role in the safety management of the maintenance of aviation equipment. The transmission of information between the subject and the subject, the subject and the object, the object and the object through the Internet of Things, which can assist management body in decision-making, planning, organization, coordination and control.

Equipment connected to the Internet of Things has four basic characteristics, which are address identification, perception, communication and controllability. Address identification shows information of equipment name, address identifies location, etc. The perception characteristic is to refer the equipment capacity of perception of environmental. Communication characteristic refers to the equipment capacity of conveying the information accurately. Controllability means that the equipment is under the managers' control. All of these will be beneficial to establish a total system and entire life cycle scientific management of the aviation equipment maintenance. (Li et al. 2011).

114.2.2 The Necessity and Feasibility of the Safety Management of Aviation Equipment Maintenance Based on the Internet of Things Technology

1. *The necessity*: It is necessary to adopt advanced information technology tools, Internet of Things technology in aviation equipment maintenance safety management. The Internet of Things technology will speed up the process of information and optimize the management efficiency of the aviation equipment maintenance safety management.

In the first, identification of aviation equipment maintenance personnel and material, online tracking and visual management can be achieved with the help of advanced Internet of Things technology by means of the non-contact radio frequency identification, wireless data transmission and Internet information sharing. It will be conductive to improve the process of safety management of all aviation maintenance activities of various time, space and aspects, in order to reduce the accidents and incidents endangering the security to a minimum, thereby effectively reduces the aviation equipment failure rate and the rate of accidents.

In the second, with the continuous improvement of the level of aviation equipment information, intelligence and integration the factors that affect the safety of aviation equipment maintenance become more and more and tends to more complicate, and higher requirement to the aviation equipment maintenance safety management is put forward. The integration of human society and the physical system can be achieved by Internet of Things technology to manage the production and living in a more refined and dynamic way. Therefore, leveraging on the Internet of Things technology, aviation equipment maintenance security management procedures can be optimized in order to improve the deployment and use of human, financial, material and information of aviation equipment maintenance security management procedures, and to promote the integration of aviation equipment maintenance, support and combat training operations, so as to enhance the overall efficiency of the safety management of aviation equipment maintenance.

2. *The feasibility*: First, the characteristics of the Internet of Things determine that it can be used to secure the scientific management of the aviation equipment maintenance. Internet of Things is a internet that can not only achieve automatic and intelligent information collection, transmission, processing and connections between objects and objects through a variety of sensing equipment and Internet, but also can implement anytime, anywhere scientific management.

The Internet of Things has the characteristics including networking, joint property, the Internet, automation, sensing, intelligence, etc. Aviation equipment maintenance safety management system based on Internet of Things technology enabling a variety of manpower, resources, funding, information, time and other factors that aviation equipment maintenance required managed independently and rapidly, hence shorten the cycle of perception, positioning, decision and action to meet the coordination, fast and sensitive requirements to aviation equipment support system from modern Air Force combat and training.

Second, the Internet of Things technology is ideally suited for the construction and implementation of safety management of aviation equipment maintenance. There are many uncertain factors affecting the aviation equipment maintenance, such as battlefield environment, equipment condition, maintenance resources, technical level of personnel, etc. These factors are diverse and complex. However, the structure and system based on the Internet of Things has the structured characteristics of network and nonlinear with the capacity of strong anti-jamming and anti-attack. These characteristics ensure the realization of every aspects and each elements of aviation combat equipment and aviation equipment support, throughout the entire life-cycle process from test, production, use, maintenance until to final abandonment that aviation safety-related can be managed and monitored effectively through the Internet of Things, and thus will greatly expand the time, airspace and frequency domain of the safety management, and bring the aviation equipment maintenance safety from in control to under control. (Qi et al. 2009).

114.3 The Application of the Internet of Things Technology in Safety Management of the Aviation Equipment Maintenance

This paper attempts to use Internet of Things technology in the personnel and maintenance tools management of the aviation equipment maintenance safety management.

114.3.1 Barrier-Free Management of the Maintenance Personnel in the Aviation Equipment Maintenance Operation Area

1. *Overview of the Barrier-free personnel management system*: Staff Barrier-free tracking and management system as a personnel management tool developed with the development of the modern radio frequency identification (RFID) technology, which is one of the key technologies of the Internet of Things. The so-called free tracking and management can identify and track a staff or a team entering into the recognition region without any code of conduct and constraints of him or them to achieve the management objective. The tracking and recognition is well-intentioned with the staff or the team knowing the existence of it.
2. *Barrier-free maintenance personnel management in the aviation equipment maintenance operation area*: Aviation equipment maintenance operation areas include not only the maintenance work areas for the maintenance staff carrying out maintenance operations but also the maintenance supplies and reserve areas for storing maintenance spare parts, accessories and maintenance tools.

There are the overlap of the maintenance work area and the complex alternation of the maintenance personnel because some maintenance tasks require different maintenance staff shifts to complete and some maintenance jobs require different maintenance staff alternately to complete, and it makes the aviation maintenance safety management risk factors greatly increase in the spatial domain and time domain. So the personnel barrier-free tracking and management system which is based on Internet of Things automatic identification can be adopted to effectively monitoring maintenance operations and enhance aviation maintenance safety management performance.

3. *The barrier-free management system of the maintenance personnel in the aviation equipment maintenance operation area*: The barrier-free management system of the maintenance personnel in the aviation equipment maintenance operation area is based on the front of the RFID data acquisition system, middleware, data transmission network, computer system, automatic control and display system, image acquisition and processing system, the background software platform and RFID data system. The system architecture is shown as Fig. 114.1.

The center management system includes RFID acquisition system, image acquisition and processing system, display and operating system, document management and accreditation systems, central monitoring system, a central database, communication network system, homework online system, personnel positioning system, staff attendance system, inquiry statistics system. The system block diagram is shown in Fig. 114.2.

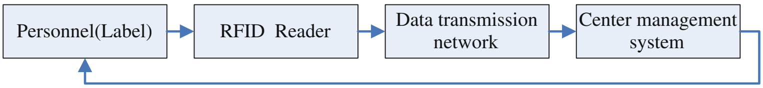

Fig. 114.1 Accessibility management system chart of maintenance staff in the aviation equipment maintenance operation area

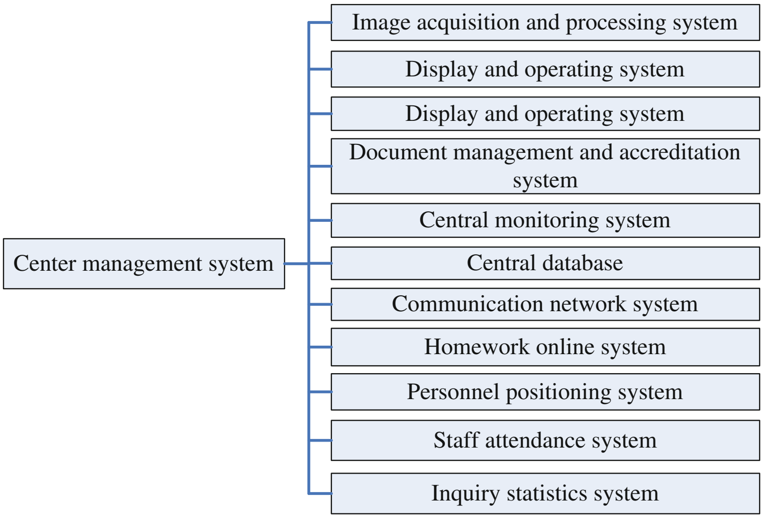

Fig. 114.2 Center management system block diagram of staff accessibility management system

Real-time monitoring and management of the staff in the aviation equipment maintenance area can be achieved through the system. It can dynamically monitor the staff deployment and the progress of the maintenance work, thereby effectively reduces the safety management risk caused by regulatory negligence of personnel and the staff being diverted to the risk area (You et al. 2006).

114.3.2 Tracking and Positioning Management of Aviation Equipment Maintenance Operation Tools

1. *Overview of the tracking and positioning management system*: The tracking and positioning management system is an automatic identification of information system which is a comprehensive application of automatic control technology, radio frequency identification technology, network communications technology, etc. An automated management of the targets can be realized by means of non-contact information acquisition and processing of long-distance moving or stationary targets including people, vehicles and objects.

Fig. 114.3 The aviation equipment maintenance tools tracking and positioning management system block diagram

2. *The tracking and positioning management of aviation equipment maintenance tools*: The custody, using and tracking of the tools and equipment are important local factors to increase or reduce maintenance error probability (Reason et al. 2007). Variety and type of the aviation equipment maintenance tools are numerous. The accidents caused by tools forgotten in the aviation equipment occur frequently, because that the tools hidden in the aircraft skin or cover are difficult to be identified. Therefore, it is essential to adopt tracking and positioning management to the maintenance tools, which is an effectively method to avoid such kind of accidents caused by tools forgotten. The Internet of Things technology can be applied to manage the maintenance tools by tracking and positioning.
3. *The tracking and positioning management system of the aviation equipment maintenance tools*: The passive RFID tags as a unique identification label can be installed in the operating tools. The label information includes names, models, specifications and origin, etc. which can be used as distinction between tools and to develop the management rules of maintenance tools. The tags of the tools carried by the maintenance staff will be read before they enter into the maintenance operation area, then the tracking and positioning management system will records the information of both the tools and the tools carrier. The maintenance staff has to make their tools tags read again after their maintenance operation, and then they can remove their tools from the operation venue. The tracking and positioning management system will compare the current reading records and the former recording information. If there are differences show the tools missing the system will send an alert and promote the maintenance staff to collect the tools carefully until the current record is consistent with the before. The system also has the function of the tools carrier information hinting, which can provides clues for tracking the missing tools. The block diagram of the aviation equipment maintenance tools tracking and positioning management system is shown in Fig. 114.3. In addition, the system can exchange data with the maintenance personnel barrier-free management system, which can help to determine the location of the tools may be left and reduce the investigation time (You et al. 2004).

114.4 Conclusion

The Internet of Things is seen as non-proven reserves of gold by many military experts. In fact, the Internet of Things has so many functions such as intelligent recognition of things function, intelligent monitoring function, location tracking function, etc. that it can be used in the fields of battlefield environment monitoring, target tracking and positioning, weapons and equipment intelligent, personnel and vehicles monitoring and logistical support. It is of great significance in ensuring the maintenance of security, consolidating and upgrading the combat effectiveness of Air Force units and ensuring the Air Force combat training tasks with the in-depth application of the new security management techniques, methods and means.

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Chapter 115
Study on the Causal Relationships Between Context and Human Error in Digital-Based Control System of NPPs

Peng-cheng Li, Li Zhang, Li-cao Dai and Yan-hua Zou

Abstract In order to identify the influencing relationships between performance shaping factors (PSFs) and human error in digital control system of nuclear power plants, firstly, the organization-oriented causation conceptual model of human error is built. It is composed of four modules/levels, namely, levels of the organizational factors, situational factors, error-triggering individual factors and human error, and a model-based human error classification system is developed. Finally, the influencing relationships between contextual factors and human errors are identified based on incident reports, expert opinions and literatures. The results show that the impacts of contextual factors on human errors are very complex, and different contextual factors may produce different types of influencing on the same human error, the same contextual factors may produce different types of influencing on different human error etc.

Keywords Nuclear power plant · Digital control system · Human errors · Performance shaping factors · Causation model of human error

115.1 Introduction

With the rapid development of computer, control, and information technology, the instrumentation and control (I&C) system of nuclear power plants (NPPs) is transformed from traditional analog-based control to digital-based control, the man–machine interface (MMI) in control room is transformed from the traditional

P. Li (✉) · L. Zhang · L. Dai
Human Factor Institute, University of South China, Hengyang 421001, China
e-mail: lipengcheng0615@163.com

L. Zhang · Y. Zou
Hunan Institute of Technology, Hengyang 421001, China

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hard-wired board to the computer-based workstation, so that the operating environment in an advanced main control room (MCR) is very different from the that in a traditional control room, which makes the performance shaping factors (PSFs) impacting human reliability change, such as technology system, human-system interface (HIS), procedure system, alarm system, analysis and decision support system, size, structure, and communication paths of team (Committee on Application of Digital Instrumentation and Control Systems to Nuclear Power Plant Operations and Safety, National Research Council 1997; O'Hara et al. 2002). Operators' cognitive and action modes also changed, then new human error mechanism emerges including some new human error modes, PSFs, and their influencing relationships etc. Therefore, it is necessary to develop a new causation model of human error which describes human error mechanism and identify the influencing relationships between context (or PSFs) and human error in order to provide guidance for human error identification.

115.2 The Organization-Oriented Causation Model of Human Error

Some well-known catastrophic accidents, such as Three Mile Island, Chernobyl, Piper Alpha, Zeebrugge, and Challenger in high-hazard industries have shown that organizational factors are one of the main causes contributing to human errors. The classical probabilistic risk analysis (PRA) technique focuses on the technical system and human reliability, and considers the effects of organizational factors on human errors, but the dependencies between technical systems and organizational factors and the relationships between situational factors and human errors are not clearly stated. Mosleh et al. (1997) thought that an appropriate model for assessment of the influence of organization on its product (or metrics of its performance) should consider both the structural aspects and the behavioral aspects. The interaction of organization and systems or components is carried out by the "front-line" staff (such as operators, maintainers) activities. They lie in a particular contextual environment. Their behaviors and states are influenced by a variety of organizational and situational factors. Each organization is made up of different sub-organizations (or departments), teams, units, and personnel including decision-makers, managers, safety officials, work planners, staff etc., and they have their own structure and function. Their activities are implemented to provide the work conditions and manage activities for "front-line" operators by means of motivating, designing human–computer interface, educating, guiding, managing and constraining their behavior, so as to increase the safety of their performance (Rasmussen 1997). Therefore, the organization-oriented "structure-behavior" model has been developed as a guiding framework for incorporating organizational factors into human reliability analysis (HRA) based on field research and system theory (Li et al. 2012). It is simplified to the form as shown in Fig. 115.1 in

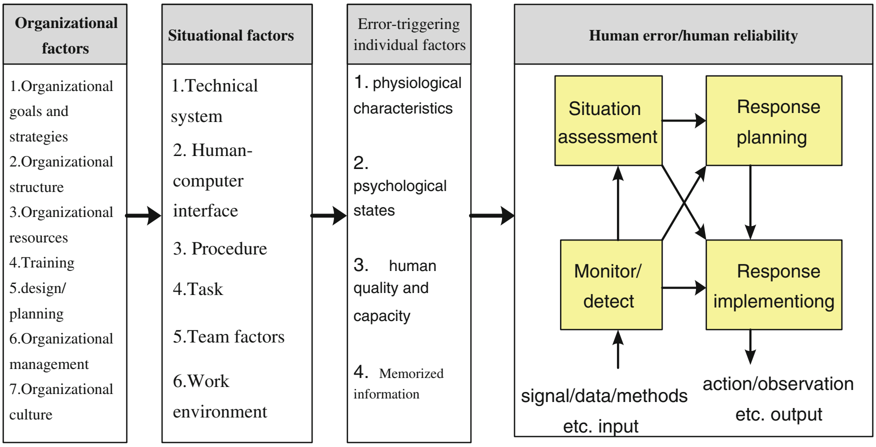

Fig. 115.1 The conceptual causal model of human error

this paper, namely a conceptual casual model of human error in order to facilitate human error and human reliability analysis. The conceptual casual model is similar to Reason's "Swiss cheese" model (Reason 1990). It is composed of four modules/levels, namely, levels of the organizational factors, situational factors, error-triggering individual factors and human errors.

115.3 The Model-Based Human Error Classification System

115.3.1 Human Error Classification

With the improvement of automation level, the role of operator has been transformed from the operator to monitor, decision-maker and manager in complicated socio-technology systems such as NPPs. The MCR operations may be regarded as being performed based on the four primary cognitive activities for NPP operations (Thompson et al. 1997; Lee et al. 2008), namely: (1) monitoring/detection, (2) situation assessment, (3) response planning, and (4) response implementation.

Monitoring and detection refer to the activities involved in extracting information from the complex dynamic work environment (Lee et al. 2008). In general, in the stage of monitoring and detection, the operator's task is mainly to gather information, including single piece of information and more information. The operator's cognitive activities are monitoring/detection, recognition and verify for individual information, and their activities are information filtering, screening, etc. For multi pieces of information, which is combined into a cognitive activity, that is multiple information gathering. When operators detect abnormal events in a plant, they would identify and assess the situation to form a reasonable logic explanation on the plant condition. This process is referred to the situation assessment. The operator's activities mainly include comparison, explanation, projection and cause identification (Kontogiannis 1997; Endsley 1995; Chang and Mosleh 2007). Response planning refers to deciding upon a course of action to address an event, given a particular situation assessment. In general, response planning involves identifying goals, generating one or more alternative response plans, evaluating the response plans, and selecting the response plan that best meets the goals identified (Vicente et al. 2004). Response implementation refers to taking specific control actions required to perform a task. The five operation teams composed of twenty people are interviewed and investigated (semi-structured questionnaire in terms of activity process) to identify the specific classification of human errors as shown in Table 115.1.

115.3.2 The Classification of PSFs or Context

According to Fig. 115.1, human reliability is influenced not only by situational factors, but also by other factors, such as individual and organizational factors. The organizational factors fall into 7 categories: goals and strategies, structure, resources, training, planning/design, organization management and organization culture. Situational factors include the man–machine interface, work environment, task and technology system factors. Error-triggering individual factors are composed of four groups of individual factors in the paper, which are physiological characteristics, psychological states, memorized information and human quality and capacity factors, respectively. It is subject to be further divided into particular sub-categories. The detailed classifications of PSFs are shown in reference (Li et al. 2011).

115.4 The Influencing Relationships Between Context and Human Error

In HRA methods, there are some methods that study the influencing relationships between the contextual factors such as CREAM (Hollnagel 1998) and SPAR-H (Gertman et al. 2005). However, there are little literatures that describe the causal relationships between contextual factors and human error/human reliability, only (Chang and Mosleh 2007) assess the effects of the performance influencing factors (PIFs) impacting the operators' problem-solving responses. The types of effects of PIF on a given operator are classified into three types: (1) individually dominant, (2) collectively dominant, and (3) adjusting. Individually dominant (denoted as "I"), is that of a single PIF having a pronounced effect on a specific behavior. For

Table 115.1 The classification of human error

Cognitive processes	Cognitive activities	Human error modes	Specific errors (relevant keywords)
Monitoring/detection	C1: monitoring/detection	E1: monitoring/detection error	-None, late, wrong, loss
	C2: recognition	E2: recognition error	-None, late, wrong
	C3: verifying	E3: verifying error	-None, late, wrong
	C4: multiple information collection	E4: multiple information collection error	-Omission, irrelevant, insufficient, redundant
Situation assessment	C5: comparison	E5: comparison error	-None, late, wrong
	C6: diagnosis/explanation	E6: explanation error	-None, late, wrong, loss
		E7: projection error	-None, wrong
	C7: projection	E8: cause identification error	-None, late, wrong
	C8: cause identification		
Response planning	C9: goals identification	E9: goals identification error	-None, late, wrong
	C10: construct	E10: plan construct error	-None, late, wrong
	C11: evaluation	E11: plan evaluation error	-None, late, wrong
	C12: selection	E12: plan selection error	-None, late, wrong
	C13: following	E13: plan following error	-None, late, wrong
Response implementation	C14: timing	E14: operation omission	-Omission
	C15: positioning(space)	E15: not timely operation (time)	-Too late, too early
	C16: selection	E16: operating object error(space)	-Right operation on wrong object, wrong operation on wrong object
	C17: implement	E17: inadequate operation	-Too long/short, too much/little, incomplete, regular speed too fast/slow.
	C18: communication	E18: wrong operation	-Wrong operation on right object, operation in wrong direction, wrong sequence, wrong input, wrong record
		E19: information communication error	-None, unclear, incorrect

Table 115.2 The influencing relationships between individual factors and human errors

Human errors			Monitoring/ detection				Situation assessment				Response planning					Response implement					
Individual factors			DE	RE	VE	CO	CE	EX	PR	CA	GO	CT	EV	SE	FO	OM	NO	OB	IN	WR	CN
Mental state	Stress	Time stress	–	–	A	C	A	C	C	C	–	C	A	A	–	C	C	C	C	C	C
		Task load stress	–	–	A	A	A	C	C	–	–	C	–	–	–	C	C	C	C	C	C
		Information load stress	–	A	A	A	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	Emotion	Frustration	–	–	–	A	–	C	C	–	A	C	–	–	–	C	C	C	C	C	C
		Conflict	–	–	I	A	–	A	A	–	A	C	–	–	–	C	C	C	C	C	C
		Pressure	–	–	–	A	–	A	A	C	A	C	–	–	–	C	C	C	C	C	C
		Uncertainty	–	–	I	A	–	A	A	–	A	C	–	–	–	C	C	C	C	C	C
	Cognitive mode	Alertness	–	–	A	I	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Attention	A	A	A	I	–	–	–	–	–	–	–	–	–	A	A	A	A	A	A
		Bias	–	–	I	I	I	I	I	I	I	I	I	I	I	–	–	–	–	–	–
	Intrinsic characteristics	Attitude	–	–	I	–	–	–	–	A	–	–	–	–	–	A	A	A	A	A	A
		Self-confidence	–	–	–	–	A	A	A	A	–	A	–	A	–	–	–	–	–	–	–
		Problem solving style	–	–	–	–	A	A	A	–	–	A	–	A	A	–	–	–	–	–	–
		Motivation	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	–
		Morale	–	–	–	–	–	–	–	–	–	–	–	–	–	A	A	A	A	A	–
Physiological state	Fatigue		–	–	–	–	–	–	–	–	–	–	–	–	–	I	I	I	I	I	–
	Physical limitations		–	–	–	–	–	–	–	–	–	–	–	–	–	I	I	I	I	I	–

(continued)

Table 115.2 (continued)

Human errors		Monitoring/ detection				Situation assessment				Response planning					Response implement					
Individual factors		DE	RE	VE	CO	CE	EX	PR	CA	GO	CT	EV	SE	FO	OM	NO	OB	IN	WR	CN
Memorized information	Recall perceptual information	–	–	–	C	C	C	C	A	A	C	A	A	–	–	–	–	–	–	C
	Previous actions	–	–	–	–	–	–	–	–	–	–	–	–	–	A	–	–	–	–	–
	Current action	–	–	–	–	–	–	–	–	–	–	–	–	–	C	C	C	C	C	–
	Prospective memory	–	–	–	–	–	–	A	–	–	–	–	–	–	A	A	A	A	A	–
	Stored information	–	–	–	A	A	C	C	A	A	C	–	A	–	–	–	–	–	–	–
Qualities and abilities	Knowledge and experience	A	A	A	A	A	C	C	I	I	C	I	A	–	I	I	I	I	I	I
	Skill	–	–	–	–	–	–	–	–	–	–	–	–	–	I	I	I	I	I	C
	Moral level	–	–	–	–	–	–	–	A	A	–	–	–	I	I	I	I	I	I	I

Note: *DE* = Detection, RE Recognition, *VE* = Verify, *CO* = Collection; *CE* = Compare, *EX* = Explain, *PR* = Project, *CA* = Cause identification, *GO* = Goals identification, *CT* = Construct, *EV* = Evaluation, *SE* = Select, *FO* = Follow, *OM* = Omission, *NO* = Not timely, *OB* = Object error, *IN* = Inadequate operation, *WR* = Wrong operation, *CR* = Communication error

Table 115.3 The influences of contextual factors on individual factors

Individual factors			Mental state				Physiological state		Memory	Qualities and abilities		
Contextual factors			ST	EM	CO	IN	FA	PH	ME	KN	SK	MO
Situational factors	Task	Task novelty	C	A	–	A	–	–	A	–	–	–
		Task complexity/load	C	A	–	A	C	A	A	–	–	–
		Task importance	A	–	–	A	–	–	A	–	–	–
		The number of simultaneous tasks (dynamic)	I	A	–	A	C	A	A	–	–	–
	Human–computer interface	Information display characteristics	C	C	C	–	I	C	C	C	C	–
		Soft control characteristics	C	C	C	–	A	C	–	C	C	–
		Alarm system features	C	C	C	–	A	C	A	C	C	–
		Human–computer interaction characteristics (interface management)	C	C	C	–	A	C	A	C	C	–
		Dynamic state of the plant, such as the rate of change of the current value	A	–	–	–	A	–	C	–	–	–
	Technology system	Available time	I	–	–	A	–	A	–	–	–	–
		Reliability	–	–	–	–	–	A	A	–	–	–
		The level of automation	–	–	I	–	A	–	A	I	I	–
		Complexity	C	C	C	–	A	–	A	C	C	–
		System response speed/delay	–	A	A	–	–	–	–	–	–	–
		The compatibility of hardware and software	–	–	–	–	–	A	A	–	–	–
	Work environment	The dangers of the work environment	A	A	I	–	–	I	-	–	–	–
		The comfort of work environment	–	–	A	–	I	I	-	–	–	–
	Procedure	Procedures	C	–	–	–	–	–	A	–	–	–
	Team factors	Communication	A	–	–	–	–	–	A	–	–	–
		Cooperation and coordination of work	A	C	A	A	–	–	–	–	–	–

(continued)

Table 115.3 (continued)

Individual factors			Mental state				Physiological state		Memory	Qualities and abilities		
Contextual factors			ST	EM	CO	IN	FA	PH	ME	KN	SK	MO
Organizational factors	Organizational strategy	Organizational goals	–	–	–	–	–	–	–	–	–	–
		Policy/system	–	–	–	–	–	–	–	–	–	–
		The formulation of long-term plan	–	–	–	–	–	–	–	–	–	–
		Allocation of resources	–	–	–	–	–	–	–	–	–	–
		The primary and secondary of management	–	–	–	–	–	–	–	–	–	–
		Strategic approach and measures	–	–	–	–	–	–	–	–	–	–
		Centralization of organizational decision-making	–	–	–	–	–	–	–	–	–	–
		The determination of organizational structure	–	–	–	–	–	–	–	–	–	–
	Organizational structure	The level of organizational structure	–	–	–	A	–	–	–	–	–	–
		Roles and responsibilities	A	–	A	A	–	–	–	A	A	A
		The paths of communication	A	–	–	–	–	–	–	–	–	–
		Authorization	–	–	–	A	–	–	–	–	–	–
	Organizational management	Human resource management	–	A	A	A	–	A	–	A	–	A
		Supervision and control	–	A	–	A	–	–	–	–	–	–
		System/interface design	–	–	–	–	A	A	–	–	–	–
		Education and training	–	–	–	–	–	–	–	I	I	I
		Work design/organize/arrangement	C	C	–	–	A	–	–	–	–	–
		Quality audit/assurance	–	–	–	–	–	–	–	–	–	–
	Organizational culture	Organizational learning	–	–	C	A	–	–	–	A	A	A
		Safety standards and norms	–	–	A	A	–	–	–	–	–	–
		Safety awareness/attitude	–	–	C	A	–	–	–	–	–	A
		Security practice and measures	A	–	–	A	–	–	–	A	A	–

Note *ST* = Stress, *EM* = Emotion, *CO* = Cognitive mode, *IN* = Intrinsic characteristics, *FA* = Fatigue, *PH* = Physical characteristics, *ME* = Memorized information, *KN* = Knowledge experience, *SK* = Skill, *MO* = Moral example, as shown in Table 115.2, *bias* could have a direct and determining influence on information collection. A biased mind could reject certain types of incoming information thus the useful information is ignored. Collectively dominant (denoted as "C"), is the case where a group of PIFs acting together have the same kind of influence as the "I". For example, as shown in Table 115.2, time-stress and recall-perceptual-information together represent the handling a certain chunk of information. As a result, these two PIFs together have a coordinative influence on information collection. Adjustment influence (denoted as "A") is that of some PIFs having a certain influence on behavior which is not, however, as significant as in types "I" or "C". For example, as shown in Table 115.2, time stress could affect the function of "verity" activity to a certain degree but not completely disable it. In this paper, the three types of influencing relationships described above as well as no effect (denoted as "N" or "-") are adopted to analyze the influencing relationships between contextual factors and human errors. The influencing relationships between individual factors and human errors (see Table 115.2), and organizational, situational factors and individual factors (see Table 115.3) are identified on the basis of the literatures, the analysis of incident reports and experts' judgment.

115.5 Conclusions

The development of technology makes the contextual environment change which brings about new human error modes, the distribution of human errors, and new influencing relationships between PSFs and human error. Therefore, it provides new demands for the prevention of human error and HRA. The conceptual causal model of human error is built and the classification of human errors and PSFs are constructed. And the influencing relationships between PSFs and human errors are identified to construct the corresponding influencing maps in order to provide guidance for human error identification. However, the "robustness" and "reliability" of influencing relationships should further improved base on a lot of data from event reports of digital NPPs and statistical method such as correlation analysis etc. This needs further future work.

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Chapter 116
Research on Implementation Model of Enterprises Risk Management

Yan-fang Gao and Yuan-yuan Chen

Abstract Risks bring about opportunities as well as challenges to the enterprises. If corporations expect to achieve the fixed goal,they have to maximize the effectiveness of assets, and minimize risks at the same time. That's why companies must identify and assess all the significant risks, take response measures and ensure sustainable development by building an increasingly sophisticated risk management system.

Keywords Risk management · Implementation · Assessment · Response

Since the serious financial scandal of Barings Bank, Enron, WorldCom and others had been exposed one after another, modern enterprise risk management has become a focus of the international concern. In October 2004, COSO, which was formed in 1985 to sponsor the National Commission on Fraudulent Financial Reporting, namely the famous Treadway Commission, introduced a new report, "enterprise risk management :integrated framework". In this framework, a more comprehensive concept that is risk management appeared to instead of risk assessment which existed as a factor in the former COSO report. Besides that, the board and the management administration are required to pay their attention on major risks areas. As one of main tasks of the management, risk management should ensure that there is a good and effective risk management process in the organization.

Y. Gao (✉)
School of Economics, Wuhan University of Technology, Wuhan, China
e-mail: nmgyf512@yahoo.com.cn

Y. Chen
School of Postgraduate in Inner Mongolia University of Finance and Economics, Hohhot, China

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116.1 The Significance of Implement of Risk Management in Companies

Enterprises are symbiotic with risks. In recent decades, similarly tragic stories staged in commercial arena: a company with amazing profits which once listed in the world's top 500 enterprises has been given instantaneous heavy blow and even went bankruptcy; the blue chips in the stock market might become a junk stock one day. Because of a variety of uncertainties and the increasing of risks the enterprises face, a sound risk management has increasingly become an essential element for a modern company to survive.

No business exists without risks, which means risks also can offer opportunities to enterprises, so a corporation has to deal with various difficulties and face with a variety of risks. The company will not be profitable if risks don't exist. Obviously, from the point of view of enterprise's profitability, a company's strategy should bear more risks. In addition, risks cause challenges because they may endanger the company's survival directly. If the corporations expect to achieve the stated objectives, get the maximum return of shareholders' interests, and maximize the efficiency of assets with minimizing risks at the same time, companies must identify and assess all the significant risks, take response measures and ensure sustainable development by building an increasingly sophisticated risk management system. Risk management refers to a process of identifying and assessing the uncertainty that obstruct the company's goal, and taking response measures to control those uncertainties in an acceptable range.

The environments where the trend and indication of economic development are unpredictable are changing, and so are the customer preferences and demands, so it is essential for companies to foresee the risks arise from those changes. For those unforeseen emergencies, the management should make the risk management plan with a positive attitude. The idea of risk management is to analyze all the risks existing both in and out of the company, and then deal with those through formulating the management strategies, so as to increase the profitability. The complete and effective risk management system and procedure contribute to the management to deal with the various risks calmly and to the company survive and develop.

116.2 The Implementation Procedure of Risk Management

116.2.1 Analyzing the risk environment

The internal and external risk environment factors may have bad influence on a company to achieve its goals. The external risk environment factors are including state law, regulation, policy and economic environment changes, the development of science and technology, industry competition, market changes, natural disasters and so on. The internal factors contain the defects of governance mechanisms, the characteristics of business activities, the nature and management of assets, the failure or the interruption of information system, and the fact that staff's qualities and skills cannot meet the requirement, etc. The management authorities must focus on the changes in factors about risk environment so that they can give further consideration to whether the changes and controls of organizational structure are in line with the situation.

116.2.2 Identifying risks sufficiently

The task of risks identification is to identify where the risks are and what cause them, and to make qualitative estimates of the consequences. Risk identification needs to answer the following questions: What are the potential risk factors in the business? What kinds of risks these risk factors can cause? How severe the consequences of these risks?

1. Risk factors and risk categories

(1) The factors of Risk

Risk factors are the potential causes and conditions of risk accidents.

To a company, there are a lot of factors that can affect the risks, furthermore, the degrees of influence from the same factor are different dramatically in different types of enterprises, so the enterprises should identify the risk factors according to the importance of matters, which may affect enterprises adversely, shown as following:

(a) Integrity and capability of the management
(b) The impact of staff changes and abnormal pressures the company suffered
(c) The extent of government regulation and the limits of national policies and regulation
(d) Firm size and the assets' liquidity
(e) Market competition
(f) Financial environment and microeconomic situation
(g) The risks of financing and investing
(h) Tax risks
(i) The degree of information system's computerization
(j) The scientific and technological progress, and social and cultural changes
(h) The natural environment of operating areas and the extent of decentralizing
(l) Adequacy of the systems and procedures
(m) Audit interval and results
(n) The agreement of audit found and the measures that were taken based on its findings
(o) The transparency to the public

(2) Risk types

Overall, enterprise risks can be classified in different ways. In accordance with business types, the risks can be divided into following four categories:

(a) Strategic risks

Strategic risks are those factors that affect the whole development direction of the company, corporate culture, information, survival ability and corporate performance. They contain domestic and international macroeconomic policies, economic conditions, industry status, national industrial policies, the strategy and planning of a firm, and corporate strategic partner, etc.

(b) Operational risks

Operational risks are those risks which can lead to direct or indirect loss to a company due to the lacks or errors in operation procedures, staffs and systems, or even the external events. They are including the performance and management status of the company; the knowledge structure and professional experiences of the middle and senior management; the management of quality, safety, environmental protection, and information safety; natural disasters and other pure risks; the effect caused by the uncertainty of future market prices such as interest rates, exchanges rates, stock prices and commodity prices on a company to achieve its stated objectives; the capabilities of a company supervising, evaluating and improving its current business operation, etc.

(c) Financial risks

Financial risks refer to those financial uncertainties derived from the unpredicted and beyond controlled factors in financial activities, which may cause financial losses. They include corporate liabilities, contingent liabilities, the debt ratio, solvency; cash flow, accounts receivable and its proportion of total sales revenue, cash flow rate; product inventory, the proportion it accounts for the cost of sales, accounts payable and the proportion it accounts for the purchases and corporate profitability.

(d) Legal risks

Legal risks refer to the negative or unpredicted losses that caused by a company when it enjoys rights and fulfills the obligation improperly in its process of establishment and operation. They include business-related political and legal environment at home and abroad, major agreements and trade contracts signed by the company, the occurrence of major legal disputes; the intellectual property of an enterprise and its competitors.

2. The methods of identifying risk factors and various risks

In practice, there are lots of methods used to identify risks, such as Brainstorming, Delphi Method, Scenarios Analysis and SWOT analysis method.

(1) Brainstorming

Brainstorming, which is known as collective thinking, is an intuitional prediction and identification method that can help to collect future information by creative thinking of experts. In brainstorming, multi-disciplinary experts might be invited to be participated. Under the guidance of a facilitator, the participants express their own views on risks about a particular area. When using this method to study risks issues, the facilitator is required to stimulate the experts' inspiration in the speech at the beginning of meeting, so as to prompt experts to answer the questions quickly. Through the exchange of information and mutual inspiration, experts will be induced to generate the phenomenon called "Thinking resonance", which means the ideas can be complementary and have the "portfolio effect". Therefore, more future information will be discovered and the results of prediction and identification will be more accurate.

(2) The Delphi method

The Delphi method, also called the expert survey, is a risk method where the experts identify risks based on their intuitive ability and come to an agreement on a particular issue. The process to identify risks with Delphi method is as following, firstly, selecting the areas and experts relevant to the topic by the risk team; secondly, establishing a direct inquiry of contact with those experts and gathering their opinions by the letter of inquiry; thirdly, inducing these ideas and feedback to the experts in an anonymous way to consult them again. After several rounds of inquiry, and consulting, inducting and modifying the results repeatedly, the basically same view can be agreed by the experts.

(3) Scenarios Analysis

Scenarios Analysis is a systematic technology that applies to predicting and identifying the risks of a project with more variables. It assumes that all the key factors may occur, so various Scenarios are imagined; and then different results are put forward in order to take the appropriate measures of response in the future. Its basic principle is to design variable future prospects after the analysis of related issues within and outside the system according to the diversity of development trends, and to make description of the system development trends situation and pictures in a way which is similar to writing a screenplay. Scenario analysis can be particularly useful for the following: to alert policy makers to focus on risks or consequences that may aroused by certain measures or policies; to clarify the scope of risks need to be monitored; to study the effects key factors have on the future process; to draw attention to what kinds of risks the technology development will give rise to, etc.

(4) SWOT analysis

SWOT analysis is the analysis of advantages, disadvantages, opportunities and threats, it can ensure to review the project from each angle of the trend analysis so as to expand the breadth of risk concerned.

S Strength, namely the strengths of (advantages to) enterprises themselves, such as sufficient cash, the improvement of market share, skilled workers, strong capabilities of product development.

W Weakness is the enterprise's own weaknesses (disadvantages), such as the shortage of funds, the decline in market share, the situation business equipment or skilled workers cannot suited to new technologies or new materials, poor ability to develop new product.

O Opportunities, the opportunities are offered by external markets, such as good market prospects, the financial crisis of competitors, the increasingly rich of raw materials' supply, the appearance of new materials or new technology.

T Threat, is the threat of external markets, such as that the market outlook is not optimistic, that competitors adopt new technologies or new materials early, that materials supply has become tighter, that material prices are increasing, and that consumers' quality requirements are higher.

The Weakness and Threat above are where the risks faced by business come from.

116.2.3 Assessing risks appropriately

There are lots of risks can be defined according to the risk assessment procedures. And the management and controlling of risks are based on the resources consumption, so in order to ensure resources to play an ideal role, the company needs to assess the risks which have identified to determine the order of the controlled risks.

Besides that, the risk assessment results have an impact on the efficiency and effectiveness of the resources use by affecting its tactics directly. Typically, based on the consideration of cost-effective, the company will take different measures towards different risks. To decide what kinds of countermeasures should be taken is depended on the analysis on the possibilities and anticipated results of identified risks.

Quantitative analysis and qualitative analysis can be used to assess risks. In quantitative analysis, the risk was assessed from two perspectives generally: risk probability and risk impact. The risk probability is the likelihood of risk, which relies on someone's subjective experience. Risk impact, also known as risk seriousness, refers to the degree of impact risks may have on the enterprise, namely its losses. After clarifying the risk probability and risk impact, the Value at Risk can be estimated according to the following formula:

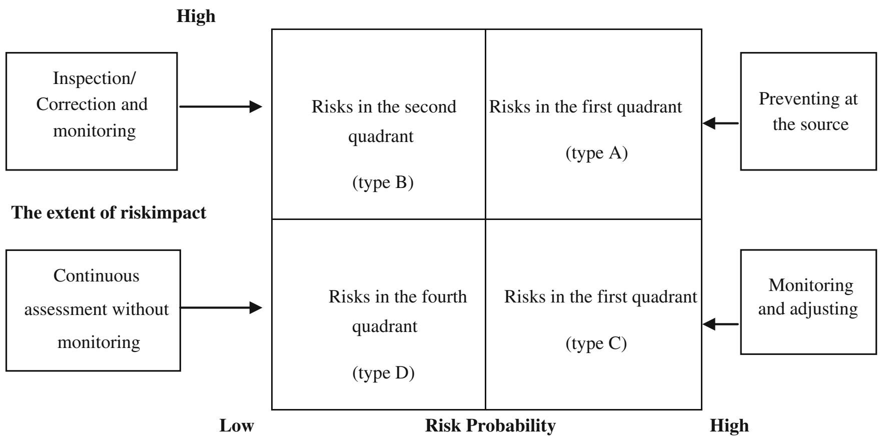

Fig. 116.1 The risk assessment process in Quantitative analysis

$$\text{RiskValue} = \text{Risk Probability} \times \text{RiskImpact}$$

It is clear that the size of Risk Value depends on Risk Probability and Risk Impact from the above formula. If risk probability is zero, risk values are zero no matter how much the degree of risk impact is; if risk probability is high while risk impact is zero, then the risk value is also zero; if both the risk probability and risk impact are high, the risk value is necessarily high, to which the risk management should be given high attention. The risk assessment process in Quantitative analysis is shown below Fig. 116.1:

The risks in the first quadrant should be paid more attention to by the management because risk probability and impact are both higher; generally, since the risks in the second and third quadrant either have much influence on the firm or have higher possibility to occur, the management needs to take ex post risk management measures such as examination and correction, that is not as good as the preventive measures in effect and prone to bring residual risks, which are risks that cannot be eliminated after taking countermeasures, that's why the risks in these two quadrant require focus. Due to the unimportance and small likelihood, the risks in the fourth quadrant may be disregarded.

Table 116.1 Schematic diagram of risk analysis matrix

Possibility	Degree of influence				
	Very small	Small	General	Serious	Very serious
Almost certainly	Serious risk	Serious risk	High risk	High risk	High risk
likely	Moderate risk	Serious risk	Serious risk	High risk	High risk
may	Low risk	Moderate risk	Serious risk	High risk	High risk
unlikely	Low risk	Low risk	Moderate risk	Serious risk	High risk
Highly unlikely	Low risk	Low risk	Moderate risk	Serious risk	Serious risk

The risk assessment results can also be reflected qualitatively by risk analysis matrix, as shown in Table 116.1:

When a company is facing high risks, immediate actions should be taken in response and the board of directors, the management, and the related agencies should be involved; If it is facing serious risks, the management and related departments need to pay close attention to the occurrence of such risks; If it is facing moderate risks, the risks should be managed by specific monitoring program; And if it is faced with low risk, they should be managed through routine procedures, and may not require specific use of resources.

116.2.4 Choosing countermeasures to risks correctly

The company needs to determine to take what kinds of countermeasures according to different risks: avoiding the risks? Accepting the risks? Reducing the risks? Transferring the risks? That depends on the nature of risks and risk assessment results. For example, the organization can accept the risks that have returned; meanwhile, the organization should take some control measures to reduce the risks to an acceptable level and achieve the desired return. In this process, the risk management's main work is to analyze and evaluate whether the risk return is reasonable and the risks countermeasures are effective. The risk countermeasure is ineffective if the company cannot afford the risks.

Risk countermeasures are including risk avoidance, risk retention, risk transfer, risk reduction and the use of risk.

1. Risk avoidance

Risk avoidance is not to take positive measures to deal with the risks, namely choosing the methods like giving up, stopping or to rejecting to avoid the losses.

2. Risk retention

Risk retention, as known as risk acceptance, means to keep the risks when they are inevitable or can bring good returns.

3. Risk transfer

Risk transfer, which is called risk-sharing, means to transfer financial losses and legal responsibility to others by contracts, economic and financial instruments and others, so that to reduce the frequency of risk occurrence and the losses.

4. Risk reduction

Risk reduction refers to the system control measures and methods which are used to achieve the target of risk control by finding the sources of risk accident that make losses, reducing the likelihood and frequency of losses to occur and the extent of losses when a company is facing the risks and determining neither to giving up nor to transferring them

In control activities, the company limits and reduces the risk by designing business control procedures, many of the internal control procedures are designed for this purpose.

5. Use of risk

Use of risk means that a company regards risks as an opportunity and takes advantage of difficulties in operation to develop new market so as to achieve higher strategic targets.

When choosing risk countermeasures, companies should also consider the cost-benefit relationship, and then choose the appropriate risk response measures to control risk according to corporate risk tolerance.

116.2.5 Monitoring the information communication system of risks

Whether the risk management is successful or not is decided by the communication of risk information. Risks information communication requires that the information can be passed to the related internal staffs timely and effectively so that measures can be taken quickly. Take the Microsoft as an example: it transmits risk information to employee's desktop directly by Corporate Intranet, and offers the definition of each risk, its positive and negative consequences, the place where the staffs can get the help about risk management and other risk management methods online. In addition, some of risk management information is also passed to other interested parties, such as the supervisors, board and audit committee who need to understand the risk management and others like suppliers, debtors who want to know about risk management of enterprises.

116.3 Problems should be Paid Attention to in Risk Management

116.3.1 Building the risk management system suitable for enterprise features

In order to implement risk management effectively, the spirit of risk management should be deeply rooted in corporate culture and staffs' hearts and risk management should be integrated into the routine operation by a perfect risk management system. The core of risk management is to make the management understand what kinds of risks the enterprise is facing, how these risks change with a changing business environment, what level of risks the enterprise should afford, and how to manage these risks.

The level of enterprise's capabilities to manage risk, as well as the strength of the risk management needs, usually have a great difference because of the different industry, size, corporate culture and management philosophy. What determines that enterprise risk management activities, such as tools, techniques, the role of enterprise risk management, and distribution of responsibilities, is different with another enterprises', even though every entity need its compositions to maintain the control to their activities. A complete and effective risk management system should be able to achieve the following objectives:

1. Make sure that the corporate risk management strategy is consistent with business development strategy;
2. Clarify risk management responsibilities in different levels and ensure the implementation of the risk management system;
3. Build the collection, analysis and reporting system of risk information, provide the basis for the risk of real-time monitoring and response;
4. Prevent or mitigate the risks that may cause significant losses to the enterprise effectively, and guarantee the achievement of corporate strategic objectives;
5. Integrate risk management and business activities, and avoid additional costs.

116.3.2 Key elements to implement risk management

The signs of effective implementation of risk management are that the information for risk management was possessed, common terminology and standards are existed, risk management and the process of corporate strategic planning were integrated, risk management data has been quantified as much as possible, risk management has been integrated into every department and business unit, every employee knows clearly about their responsibility in risk management, a company can track and comply with the activity's costs, the complied doings help to reduce the risk of non-compliance, etc.

Therefore, key factors in the successful implementation of risk management include: (1) Supports from senior managers; (2) The recognition of risk management on the implementation within various functional departments and staff; (3) risk management and corporate strategy have been integrated, and the risk appetite and the countermeasures are set and adjusted from the dynamic and the long-term perspective; (4) To enhance the validity so that to make the implementation of risk management informed by stakeholders in a timely manner, that means the management should transform information from various sources into the information which can be prone to action by refining, processing and other methods, and exchange information with the related users fully.

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Chapter 117
Reconsideration on the Design of Warnings with Neuro-IE: From the View of Risk Perception and Decision Making

Qing-guo Ma, Wen-jing Ji, Wei-peng Lai, Ya-wen Yu, Fu-yuan Xu and Jun Bian

Abstract As more and more industrial accidents happened in our country over the years, safety in production has become a key issue which influences our social stability and development. Warnings, as a significant means for safety management, have plays an important role in industrial production and behavior operation. This article analyses the design of safety signs from the view of risk perception and decision making, finding that affect is very important in the relationship between the elements of safety signs and audiences' risk perception, a conclusion that could be helpful to the design of safety signs.

Keywords Warnings • Risk perception • Affect heuristic • Neuro-IE • Neuro-Design

Q. Ma · W. Ji · J. Bian (✉)
School of Management, Zhejiang University, Hangzhou, China
e-mail: bjbianjun@gmail.com

Q. Ma · W. Ji · W. Lai · Y. Yu · J. Bian
Neuromanagement Lab, Zhejiang University, Hangzhou, China

W. Lai
Department of Psychology and Behavioral Sciences,
Zhejiang University, Hangzhou, China

F. Xu
Business School, University of Shanghai for Science
and Technology (USST), Shanghai, China

Y. Yu
School of Economics and Business, Xinjiang
Agricultural University, Xinjiang, China

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117.1 Introduction

Nowadays in china, workplace injuries occurred frequently. Heavy casualties, property damage, loss of productivity, worker's compensation and litigation… a series of disquieting troubles would arise after each accident, which really influences the life of not only employees but also the employers. In that case, it becomes more and more necessary and important to identify the hazards associated with the equipment and the environment so as to prevent some accidents.

Neuro-Industrial Engineering (Neuro-IE) is firstly put forward by (Ma and Wang 2006), which tries to use advanced neuroscience ways and biofeedback technology to measure the indexes of human brain and physical condition in order to attain the more objective and authentic data to analyze, and then applies these physiological and psychological information into the production management as new factors, so as to make the working plans meet the real working condition and satisfy the workers' needs. Safety Production is a key component of Neuro-IE, which accentuates the real-time monitoring and warnings of workers' misses and errors during the operation from the brain level as well as workers' experiences.

When hazards presented in the workplace, effectual steps should be taken to change the work environment to avoid or minimize the hazards. Firstly, attempts should be made to clear the hazard out of the jobs, equipment, tools and environment. Unfortunately, it may not be available or practical to remove all hazards. So the second method of reducing hazards is to use guards that prevent people from coming into contact with the hazard. That is to say, hazards should be guarded against physically or procedurally. When a hazard cannot be adequately guarded against, then, as a third method, people should be warned about the hazard. Managers should take steps to ascertain that Warnings (safety signs) are designed to maximize the likelihood that audiences will notice, understand, and comply with them.

Warnings are important parts of safety management—they are intended to identify and warn against specific hazards. They also describe safety precautions, advise evasive actions and provide other directions to reduce hazards.

Overall, most discussions of Warnings emphasize that how they could serve to alert, inform, or remind audiences of potential risk and consequences (Hellier et al. 2000; Wogalter et al. 1992; Rogers et al. 2000), but few studies discuss the hidden mechanism behind the relationship between the design of safety signs and people's perception of risk. This article will provide insight into this topic with new thought of Neuro-IE (or Neuro-Design).

117.2 Perception of Risk

Rogers et al. once reviewed four components of the warning process (Rogers et al. 2000), which are (a) noticing the warnings—attention is directed to the warning; (b) encoding the warnings—external information is translated into some inner representation through reading words, processing symbols and so on; (c) comprehending the warnings–the meaning of the safety signs is understood; and (d) complying with the warnings—behavior or operation is performed according with warnings.

Risk perception, which is associated with individual's evaluation of the probability and the severity of negative consequence, is a key stage for warnings understanding. Previous researchers have discussed the relationship between various elements of the warning (e.g. signal word, color, and shape) and their influence on the perception of risk (Edworthy and Adams 1996; Wogalter and Silver 1990; Leonard 1999; Yu et al. 2004).

Just taking signal word and color for example. Research have indicated that the presence of signal word increases the warnings effectiveness (Young et al. 1995; Ma et al. 2010), and also have revealed a strong and reliable relationship between the different kinds of signal words and the different levels of perceived hazard (Hellier et al. 2000; Wogalter et al. 1992). When it comes to the color of warnings, Edworthy and Adams have showed that various colors are associated with different levels of risk (Edworthy and Adams 1996). Indeed, color-coding systems have consistently associated colors with particular levels of hazard (see ANSI Z535.4 1998). For example, red is used to imply the highest level of risk, orange to identify a hazard, and yellow to signify caution (Lehto 1992).

These studies suggest that changes in the elements of warnings influence the perceived level of risk, but why there is such an influence is rarely discussed. The following part of this article tries to provide an insight into this question We would see that affective processes are certain to play a role in determining the strength and direction of such influence.

117.3 Affect Heuristic

For many years, people were portrayed as "economists", rationally weighing the risks informed from Warnings against the benefits when deciding whether to act in a safe manner.

Current theories on dual processes of cognition provide us a different perspective. These theories suggest that judgments could reflect two systems of thought (Chaiken and Trope 1999; Kahneman and Frederick 2002) referred to as experiential and analytic (Epstein 1994). The major distinction between the systems is that the analytic system requires conscious effort and works in an explicit step-by-step manner, whereas the experiential system is covert and relies on rapidly processed feelings or emotions that a person may not be able to specify. In simple terms, the analytic system involves reasoning while the experiential depends largely on intuition.

Similarly, Slovic et al. (2004) suggested that risk was perceived and responded to by two fundamental ways: firstly, by feelings, which generate instinctive and intuitive reactions to danger; second, by analysis, which requires logic, reasoning, and scientific deliberation.

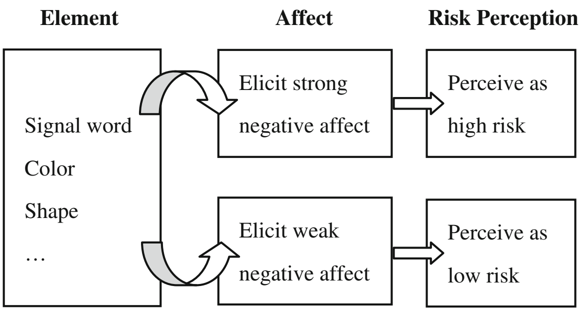

Fig. 117.1 The relationship of elements of safety signs, affect and risk perception

Affect often serves as a cue for important judgments. It's easier and more efficient to retreat relevant examples from memory by an overall, readily available affective impression than weighing the pros and cons deliberately, especially when the required judgment or decision is complex and mental resources are limited. Slovic used the term "affect heuristic" to signify this characterization of a mental shortcut (Slovic et al. 2005).

To date lots of empirical researches support affect heuristic. For example, Alhakami and Slovic found that the inverse relationship between perceived risk and perceived benefit of an activity (e.g., using pesticides) was linked to the strength of positive or negative affect associated with that activity as measured by rating the activity on bipolar scales such as good/bad, nice/awful, and so forth (Alhakami and Slovic 1994). This finding implies that people judge a risk not only by what they think about it but also by how they feel about it. If their feel pleased toward an activity, they tend to judge the risks as low and the benefits as high, and vice versa (Finucane et al. 2000).

Drawn from the review, the affect elicited by safety signs might influence the perception of risk. Combining the conclusion that exogenous elements of warnings such as signal word and color influence the individual's perception of risk, we suppose chances are that some elements of warnings per se don't influence the individual's perception of risk directly, but they elicit different strength of affect firstly, which in turn influence the individual's perception of risk. That is to say, different designs of signal word or color may elicit different strength of affect, which further have different degrees of influence on the individual's perception of risk. The stronger affect warnings elicit, the higher hazard level people will perceive, and the more probability people will respond in accordance to safety signs. To test this hypothesis, further studies are needed to gain empirical evidence (Fig. 117.1).

117.4 On the Design of Warnings

Now that we understand the complex relationship between the variations in the way of warning design, i.e. the affect elicited by safety signs and the risk perception which has the potential to shape future behavior, the challenge for us is to think creatively about what this point can inform the design and relative protective behavior.

Noyes et al. noted that the information safety signs provided was very limited and might not be sufficient for people to take risk into account and make rational decision (Noyes 2001). Papastavrou and Lehto claimed that one consequence was that false alarms may occur, which could result in a warning being ignored and render it ineffective. Warnings could be made more effective if they are designed to convey more information, in particular, the likelihood of occurrence (Papastavrou and Lehto 1995). In this situation, risk analysis may not function well, so we should take advantage of affect heuristic into the Warning designs. From this perspective, safety signs should be designed affectively salient to elicit strong emotion.

As outlined above, different signal words and colors may elicit different level of strength of affects (though empirical research are desperately needed), and in turn influence people's perception of risk that potentially shapes behavior. Thus we have to stress affective attributes (like signal words, shapes and colors) to ensure the individual's compliance with the safety signs. Yet, we have to bear in mind that strong affect elicited may lead to counterproductive behavior. The question arises as what degree of affect elicited by safety signs is appropriate for the individual to comply, which is an issue meriting further research.

Designing affectively salient safety signs may conflict with the ideas (Hellier et al. 2000; Edworthy and Adams 1996; Wogalter and Silver 1990) that the hazard level communicated by safety signs have to match the hazard level associated with the referent, since the accurately hazard-communicating design may not be an affectively salient design. It's noteworthy that the purpose of warning design is not only to inform individuals about the potential hazard, but to persuade them into actions to avoid risk.

117.5 Conclusion

This article advances that affect plays a key role in the relationship between the elements of Warnings and people's perception of risk. Precisely speaking, some elements of Warnings per se don't directly influence the audiences' perception of risk. They elicit different strength of affect first, which then influences the individual's perception of risk. This new perspective on Warnings with new thought of Neuro-IE could assist managers to design appropriate safety signs for safety management.

However, in order to validate the conclusion above, a more in-depth investigation into the affect elicited by safety signs, and its contribution to people's perception of risk is needed. Neuroscience is believed to be a promising way to investigate this question, especially Neuro-VA (Neuro-Value Analysis), which could let the brain and body tell us their secrets. It would really be an exciting try in Warning Design.

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Chapter 118
Research on Countermeasures and Suggestions of Financial Risk Management in Construction Enterprise

Lu Zhang

Abstract Under the condition of market economy, the competition have become increasingly fierce between the numerous enterprises. The construction enterprises' level of financial risk management not only relate to the existence of own, but also have the important influence about the enterprises' healthy, stability and sustainable development. According to the characteristics of the financial risk management in construction enterprise, the article analyzes how to set up the prevention methods and points out the main contents on the financial risk management and it puts forward some measures and suggestions for the reference.

Keywords Construction enterprise · Financial risk management · Measure · Suggestion

118.1 Preface

In recent years, with the rapid development of the economy and the continuous growth of domestic investment in infrastructure, construction enterprises in China are facing good opportunities for development and have obtained the considerable development.

Since 2010, the construction enterprises face with the great difficulties because of the macroscopic constrictive policy and the changes of market environment. The gradual deterioration of the foreign economic situation and the high CPI high has lead to the domestic economic growth continued to slow down. Meanwhile, the uncertain of the construction enterprises' living environment are causing the serious and intense market competition between the construction enterprises. The new changes of the situation make the construction company facing various

L. Zhang (✉)
Business School, Jianghan University, Wuhan, China
e-mail: zlmeiyu521@yahoo.com.cn

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kinds of risks, especially the financial risks in the whole process of the capital movement in the enterprise. Because of a variety of objective existence of uncertain factors in the financial activities, the construction enterprises occur gradually deviation with actual financial earnings and expected returns, and result in a loss of opportunity or possibility.

The current construction market competition is becoming increasingly fierce, and the economic environment of the construction enterprise is complex and changeful. All kinds of uncertain factors in the operating process increase the financial risk of the construction enterprise. As an important part of enterprise management, the financial risk management is directly related to the financial situation, the profit level and the level of financial management. Meanwhile, it associates directly with the survival and development of enterprises. In fact, the timely and perfect the enterprise mechanism of financial risk management is a very important significance and far-reaching influence for avoiding financial risks and improving the competitive ability and the ability of the sustainable development in the construction enterprises.

118.2 The Concept and Characteristics of Financial Risk in Construction Enterprise

In a broad sense, the means of the financial risk in construction enterprise includes of some risks in financial activities, such as the risk of financing, investment risk, capital recovery risk and the risk of distributing income. In a narrow sense, it refers to the risk of the debt financing, therefore is called the financing risk, and it is the crisis of bankruptcy and insolvency because of debt management and due to the repayment of principal and interest on the financial crisis (Zhang 2011).

Financial risk is the inevitable problem when the construction enterprises are facing the fierce market competition and establishing the process of modern enterprise system. And the financial risk also reflects the present management situation of the building enterprise, has the following characteristics:

The first, financial risk connects the whole management process in the building project, from initial project planning project and investment benefit analysis to construction implementation and delivery. The whole process involves the safe and reasonable use of capital, it ensures maximum economic benefits. Therefore, the financial risk has the comprehensive characteristics (Peng 2011).

The Second, the financial risk produces because of the competition environment under the market economy, especially in our country, the relevant economic system has not yet been fully healthy situation. So the financial risk of the construction enterprise is objective existence and transferred by the individual and the subjective volition. The performance of the financial risk in the financial activities is the deviation between the actual results and financial target.

The third, the risk itself refers to the possibility of potential loss due to the uncertainty of enterprise. The performance of the financial risk includes in two aspects: on the one hand, the possibility of the loss; on the other hand, the financial loss amount when the loss occurs.

118.3 The Main Financial Risk in the Construction Enterprise

As the peculiar characteristics of the flowing production and long cycle, there are many differences to the general enterprises with raising funds, product pricing, project price settlement, budget and assessment of the cost. These conditions make the financial risk to be more complicated.

118.3.1 Project Bidding Risk

The risk includes bidding risk and contract risk. Some construction enterprises take the meager profit or cost price, even lower than the cost of engineering bid, in order to win the bid. At the same time, more individual owners put forward some harsh conditions in the progress of the project bidding which these construction enterprises cannot get safeguard with profit, and these bring a lot of difficulties for the production of the enterprise management. The uncertainty of the bidding cost and profit spatial leads to facing a loss of financial risk for the construction enterprises.

118.3.2 Capital Risk

Architectural engineering requires a large amount of money. If the capital is in short supply, it may influence material procurement and could not pay the wages of the workers, and it thus directly affects the construction progress. If the serious case, it may cause the inability to fulfill the contract and bring inestimable loss for construction enterprises.

Construction enterprises get financing mainly by the bank credit channels. In order to ensure the normal operation of enterprises and capital requirements, most construction enterprises use the estate, land and other real estate for a considerable amount of bank mortgage (Jiang 2011).

When the project profit rate is less than the loan interest rate of the bank, the financial risks of the enterprise will suddenly increase. If the owners deliberately do not fulfill the contract, default on their projects, these will have greatly increased the possibility of loss of bad debts for the construction enterprises.

The owners will pass on the invest cost and investment risk to the construction enterprises which makes the most of construction enterprises bear the great financial risk. If the Long-term accounts receivable cannot be realized, it seriously affect not only the enterprise capital turnover for the operating difficulties of the production, but also the real results of the operation if it does not clean up because increasing constantly the risk of bad debts may form a loss and reduce the possessors rights and interests for the construction enterprises (Yu and Dai 2008).

118.3.3 Contract Risk

The contract is the source of the financial risk in construction enterprise, and if the contract is unreasonable, it is bound to cause the passive situation in the project implementation. Many homeowners use the urgent psychology to try to project for construction enterprises and increase some additional unequal terms when they contract, and this makes the construction enterprises be in very adverse position in the early of the engineering project. Some owners will transfer the price fluctuation risk to the contractor. Sometimes, these units request the contractors to sign the fixed price contract or pay the bid bond in advance (Chen 2011).

118.3.4 Margin Risk

At present, many construction enterprises need pay the margin before the contract is signed in the construction market and generally less than 10 % of the contract price. The margin has many names, a portion of the margin are named the quality guarantee for a project 5 %, and the other part are indicated the margin of 5 %, and it seems to have become the reasonable regulations. In fact, the main source of the financing and payment about margin is the circulating fund of the enterprise, and some of the funds loan from the bank. The profit margin of the construction enterprises is very low. The average profit rate of a lot of construction enterprise is less than 2 %. Paying all kinds of margin almost exhausts all the circulating fund of enterprise. In order to get engineering project, take business and enable enterprises to survive, this kind of behavior by bank lending is tantamount to quench a thirst with poison. All various types of the margin lets the enterprise cannot bear heavy burden, further reducing the profits level of the enterprise, and hinders the development of the enterprise.

118.3.5 The Risk of with Funds

In current period, because of the numerous of the construction projects at each district, the investment amount of the construction rises sharply, and the financing platform of many owners is restricted with the fund predicament. So, a lot of places require the construction units themselves to construct with funds in the early of the project. In this case, many construction units may have its own funds of contracting with fund in order to get project. And more serious situation is that if the contraction company has its own funds become one of the important conditions for the successful bid. In addition, some owners do not pay the project funds after signing the engineering contract, and some sign the agreement to pay progress payment when the engineering project contracts a certain proportion. Some of the owners pay the funds when the main structure of project has completed, this makes construction enterprises pad more huge amount of funds and increases the burden for the enterprises. Meanwhile, it may affect the project progress and quality because of defaulting the project money, and seriously restrict own development of the construction enterprise (Ruiqian 2006).

118.3.6 Cost Risk

The project cost is a comprehensive index. It is simply divided into several contents: such as artificial cost, mechanical cost, material cost and management cost. The project cost is decided by project tender offer. It increases the construction cost and formats the risk of overrunning cost with rising factor market prices in the construction process of the labour, materials and equipment market.

118.4 The Main Countermeasures and Suggestions

The serious financial risk which the construction enterprises are facing need analyze the causes of risk in detail. According to the actual situations of the enterprise, it should propose the special construction suggestions to cope and prevent.

118.4.1 Strengthening the Restraint of the System

The construction enterprise as a main body in the market economy, its levels of the financial risk is affected by the market risk. To create a stable market environment is very important for the stable financial operations and reducing financial risk in the construction enterprise. From this point of view, the enterprises should strengthen to build and perfect the financial system, and they regularly carry out to clean up and revise. Meanwhile, these companies should strengthen the execution in the implementation process.

118.4.2 Increasing Auditing Supervision

In particular, the company must strengthen the audit supervision. The external audit supervision of the construction enterprises can reduce the accounting error and cheating behaviors which generally occurs in the internal construction enterprise, so that the accounting information more accurately reflect the actual financial situation in construction enterprises, and it will reduce the financial risk of the building enterprises. The internal audit is the control once again for the accounting control in construction enterprise. This audit urges the accounting department to the accounting control of the continuous improvement and perfection through the evaluation of accounting supervising, and strives to decrease the accounting errors to a minimum for the financial situation of the construction enterprises.

118.4.3 Strengthening Project Bidding Supervision

A lot of construction enterprises are lack of knowledge and blind investment for investment risk when they decide to invest some projects, especially undertaking business in the external engineer projects. So, it may lead to the huge losses and financial risk continuously. Therefore, the first is to set up the evaluation mechanism of the bidding risk and the companies should undertake the reasonable engineering tasks. After the enterprises obtain the tender documents, they must carry on the thorough research and analyze the bidding documents and comprehensively consider the risk cost. At the same time, they should understand correctly the bidding documents, hold the intent and requirements of the owners, research carefully the instructions of the bidders, examining the detailed review of the drawings, reviewing the project quantity. The contractors also truly analyze the text of the contract, and identify the risk tolerance of the enterprise with the enterprise's own quota from its own strength and investment profit and loss prediction in project. Though weighing the costs and benefits, the companies finally decide whether to bid and the bidding price. The second is to take measures to avoid the prone risk. The construction companies use the negotiation right and the review right and the approval right with building contract when they sign the construction contract. These independent and mutual restriction method can reduce the contract loopholes. The contract should be considered strictly, these enterprises do not blindly accept the exemption of the clause the owners and should clear the settlement terms of the disbursing project funds. Meanwhile, the companies also ask the project terms to be notarized request, and it create the favorable conditions for resolving the possible economic disputes in the future.

118.4.4 Actively Promoting the Comprehensive Budget Management

From the organization system, the enterprises need establish the efficient coordination organization system with the business process and the functions of various departments cooperate with each other. This system has a clear division of labor and clear responsibility, at the same time, it create a good working environment for the comprehensive budget management. From the working key, the companies should perfect a sound overall budget management system, and strengthen business budget management especially the project budget management for building the real basis of the budget management. They also strengthen cash flow budget management, accelerate the capital turnover, enhance cash guarantee ability, strengthen debt management, deepen the budget management concept of the assets balance and effectively prevent the debt risk. From the core link, these units request to strengthen the execution control and analysis of the budget, especially for the important matters of the budget execution monitoring. At the same time, the companies should decompose horizontally the object of the budget analysis to the various business processes and deepen to the budget responsibility center (Dong 2011).

118.4.5 Guarding Against Financial Risks

According to the financial structure of the existing building enterprise, many enterprises have the serious phenomenon which its ratio of liabilities to assets is higher and the bank loans are too much. The unreasonable capital structure will make the financial burden of the enterprises too heavy and cause the seriously insufficient solvency, and this can result in a shortage of funds risks. For this, the first is to deepen the centralized management of the fund. To execute the centralized management standards of the fund and overcome the difficulty of capital accumulation is the focus, and the companies need further enhance the awareness of the importance on the funds centralized management, and take measures to improve the unit's capital accumulation degree. The second is to establish the scheduling system of the fund management and improve capital operation efficiency. The enterprises should build the internal capital settlement center to change the situation of the capital settlement and payment of dispersed phase. Though the scale operation and strengthening the capital operation, it can reduce the overall cost of capital. The third is to use well the inventory of existing assets. Because of a large number of the extrusion and precipitation of the capital, the enterprises require to clean the periodic and massive inventory work, and find out the real situation of existing assets. They conduct the construction equipment of the enterprise for cleaning, waste, disposal of the unused value and repair, and will concentrate the capital into the most urgent engineering project. The fourth is to strengthen the management of the account receivable. The enterprises need formulate the strategy of gathering capital to ensure claims recovery. The financial department should analyze regularly the receivable years of accounts, clear accounts and arrange the accounts receivable. The engineering economics department should strengthen the degree of the project management. At the same time, they also establish the reasonable mechanisms of the incentive and restraint, mobilize the enthusiasm of personnel to speed up the efficiency of the debt recovery (Jia 2011).

118.4.6 Perfect Cost Management System

The construction enterprises should establish the internal cost control management system, make the scientific the index of the target profit management, and implement strict cost accounting and control system in the production process. On the one hand, construction enterprises need build the effective system of the cost management in the construction process and implement the strict cost accounting and monitoring system. According to the design drawings and technical information, they consider completely the limit of project contract and the condition of the construction site and the target liability cost and other factors. Though formulating the practical engineering construction scheme to reach the purpose of reducing the cost. At the same time, many companies also make the scientific plan for technical and organizational measures to include in the construction projects. On the other hand, the enterprises carry out the management of the responsibility cost. To strengthen the monitoring of material cost, labor cost, mechanical cost and other key point for the construction project cost, some companies wish to control the cost in the reasonable responsible cost range. And the third is to do a good job in economic activities analysis. The financial analysis is the important content of enterprise financial management, and financial work is the important embodiment of value. The financial department should fully develop the data advantage of the professional expertise and information integrating, and comprehensively use all various of the methods to develop deeply the financial analysis. It should look substantially from the data and timely reveal the potential risk of the enterprise and the short board of management, and improve the timeliness and accuracy of the analysis (Wu 2010).

118.4.7 To Further Strengthen the Accounting Management

The enterprises should adapt to the need of the construction market, timely formulate the related accounting rules to properly handle the financial problems. The fundamental starting point is to meet management needs, and the companies card the systematic management reports. Meanwhile, they also integrate the monthly, quarterly and the report system of the project management reports, reduce the duplication of the reporting, and realize information sharing. These companies request to strengthen the record management in advance major and the execution supervision in the middle for the financial matters. At the same time, they implement the annual final accounts system for each units. In addition, the enterprises also should follow up the official reply and urge the relevant units timely to correct.

118.4.8 Promoting the Standardization and Fining for the T Project Financial Management

The related management regulation about the financial management of the enterprise project should comprehensively study, cleanup and perfect. On the one hand, the enterprises need establish the financial supervision system, including the early financial disclosure, interim financial check and afterwards summing up the project, and strengthen the finance direct guidance and service for the project. Meanwhile, they should timely solve the project financial problems to ensure the implementation of the financial management requirements in enterprises. On the other hand, these companies further clarify the management responsibilities of the project fund, straighten out the allocation relationship among the project funds, and ensure the orderly operation of the capital. At the same time, they should restrict the disciplines of the project funds payment to strengthen the cash expenditure management. From contract source and settlement links, the construct companies promote the project cost control by controlling funds.

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Chapter 119
Research on Key Technology of Wireless Multimedia Communication for Mine Rescue

Xue-zhao Zheng, Jun Deng and Yong-fei Jin

Abstract The risk and complexity of the conditions and environment in underground disaster area, restricted the use and development of the mine rescue wireless multimedia communications, and affected the rescue command and decision to a certain extent. According to the needs of the site this article discussed from the attenuation law of wireless MESH networking signal in mine rescue process, the synchronous acquisition and transmission technology of multimedia information, the development technology of intrinsically safe power supply and the reliability design of the system devices, then inspected the actual effect of the system devices through applications on site, and provided reliable on-site information for experts and rescue command staffs.

Keywords Margins mine rescue · Signal attenuation · Intrinsically safe power supply · Synchronous acquisition

119.1 Introduction

The environment and condition of coal-mining work is usually complex and volatile in the places where the extraordinarily serious disaster accident occurs suddenly, especially in the process of dealing with the regional calamity, thus the task of emergency rescue in mine is relatively arduous, it is inevitable to overcome a series of difficulties, including high temperature, dense smoke, gas and excessive CO, insufficient light in coal mine, narrow tunnel, unfavorable ventilation, etc. However, due to the constraints of coal mine space as well as environment condition, and meanwhile dragoman need to carry a large number of first-aid and life saving equipments when they go to the disaster area for emergency rescue in coal

X. Zheng (✉) · J. Deng · Y. Jin
School of Energy Engineering, XI'an University of Scinence
and Techmology, XI'an, China
e-mail: zhengxuezhao@yahoo.com.cn

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mine, which will greatly consume the physical strength of dragoman and affect the efficiency of rescue operation, therefore it is extremely important to minimize the load that dragoman has to carry and prepare the reliable and communication apparatus with the greatest amount of information Rolader et al. (2004). With the help of wireless communication method, it is possible for dragoman to engage in the rescue operation directly, thus the rescue procedures can be simplified and the response speed of rescue can be improved, dragoman can report the situation of disaster area to underground rescue base and emergency rescue command centers at different levels on the ground exactly and effectively in real time, thus it can provide the information in a more real-time and reliable manner for command and decision-making in the process of rescue and relief work to some extent. Therefore, it is necessary to carry out the research on the characteristics, mechanism of wireless multimedia communication data transmission as well as the intrinsic safety and miniaturization of equipments, and it is also urgent to develop the wireless multimedia communication system which is appropriate for the emergency rescue work in coal mine based on the investigated theory, so as to transfer the information during and after the process of rescue and relief work in disaster area to underground rescue base and relief headquarters on the ground as well as emergency rescue command centers at different levels, it is of great significance to enhance the ability of coal mine emergency rescue and improve the national technology level of rescue and relief work for mine accidents Pan et al. (2005).

119.2 System Technical Proposal

It is a wireless multimedia communication system for mine rescue which is convenient to carry when dragoman provides disaster relief; this system adopts the transmission plan of wireless MESH (mesh network) networking; the equipment carried by dragoman in the process of disaster relief is of compact size with reliable performance, and it creates a system of its own with various information, to support the real time transmission of audio, video and environmental parameter data, and in addition of that, it also has sufficient and reliable bandwidth; it can be used to synchronously monitor a variety of environmental parameters including CH_4 (inflammable gas), O_2 (life support gas), CO and T (temperature) for data acquisition, transmission and storage; this system is equipped with a dynamic topological structure, it is possible to acquire the gas component in more than four directions by each node, all nodes can work independently and they can be changed or added whenever necessary, it is possible to increase the number of acquisition points without restrictions by adding more nodes; it has favorable transmission performance and high quality of anti-interference; this system has multiple methods for acquired data presentation, which can be displayed on the ground and underground synchronously, and moreover, it can provide the interface for data output; it is equipped with the function of alerting for rescue environment in case of any abnormal environmental parameter Jiang et al. (2005).

119.3 Main Technical Parameters

1. The transmission range of wireless function from mine rescue base to disaster area $\geq$1,000 m, accomplish the MESH networking more than 10 hops.
2. Real time transmission of video, audio information and environmental parameter;
3. Base equipment and front-end equipment can work independently as a separate system;
4. Record the video and audio data information at the site of accident in a real-time manner;
5. Monitoring the images at the site of accident by multiple points. 2 image presentation in the base, and 3 image presentation on the ground, talkback speech sounds;
6. The weight of video and audio acquisition equipment carried by draegerman $\leq$2 k.
7. The wireless intrinsically safe type computer has the function of commanding independently;
8. Working time of system $\geq$6 h.

119.4 Key Technology

119.4.1 Study on Signal Attenuation Law of Wireless MESH Networking in the Process of Mine Rescue

Because the environment is complex and volatile in mines, the space of tunnel is relatively narrow, there can be coal and rock stratum all around in the tunnel, hackly and irregular, there are also some supporting structures for coal mining, electromechanical equipments as well as steel rails and so on, thus it is a complex and non-free space under the extremely special environment for transmission, which can exert a significant influence on the transmission characteristics of electromagnetic wave. Especially in the mine hit by an adversity, its condition is worse with complex landform, there will be turning corners, branches and explosive gas within the tunnel, at the meanwhile there is a large number of electromagnetic interference in it, thus the communication environment is extremely terrible. To solve these problems, this paper carries out the research on the impact of various conditions such as the section, gradient and roughness of different tunnels on the transmission characteristics of electromagnetic wave in wireless MESH networking based on the previous studies. Moreover, a lot of experiments have been conducted by utilizing the simulated tunnel for mine safety production experiment in Xian University of Science and Technology, and the transmission characteristics of electromagnetic wave within the waveguide have been taken as a reference in the process of experiment research, Maxwell's equations is used to work out the calculation results of wave mode equation, to testify that the traditional research method of metal waveguide theory can be applied in the research on the transmission characteristics of electromagnetic wave in tunnel in the process of wireless MSEH networking, which can lay the foundation for studying about the transmission characteristics in tunnels with specific sections. Heavy graded tunnel with multiple turning arched section and rectangular section is the basis for actual research on tunnel. In the meantime, the wireless radiofrequency is adjusted to test and verify that when the operating frequency is in the high-frequency range, its communication is table with strong flexibility, high signal to noise ratio, high channel capacity, high speed of information transmission, thus it is suitable for broadband multimedia communication and convenient for networking, the antenna and equipment for high frequency is relatively small; in addition of this, the electromagnetic interference for high frequency is less, with wider transmission range and longer communication span, which is exactly in favor of wireless multimedia communication. However, the diffraction ability of electromagnetic wave in the high-frequency range is weak, and there are more demanding requirements for the performance of receiving machine, and meanwhile, the energy of electromagnetic wave is relatively stronger, which conflicts with intrinsic safety, thus it needs to be achieved by circuit control.

1. After testing, the law curve between frequency and horizontal polarization (aEh) as well as vertical polarization (aEv) electromagnetic wave transmission attenuation in the arched tunnel is shown in Fig. 119.1.
2. Impact of mine turning corners and branches on wireless signal transmission

Due to the requirements of mining and ventilation, the tunnels in mine are not straight, with turning corners and branches. When the transmission frequency of electromagnetic wave is constant, if the tunnel is more winding, the transmission attenuation will be greater; at the same turning, if the transmission frequency of electromagnetic wave is higher, its attenuation will be greater. At the same time, the branches in the tunnel will intensify the transmission attenuation of

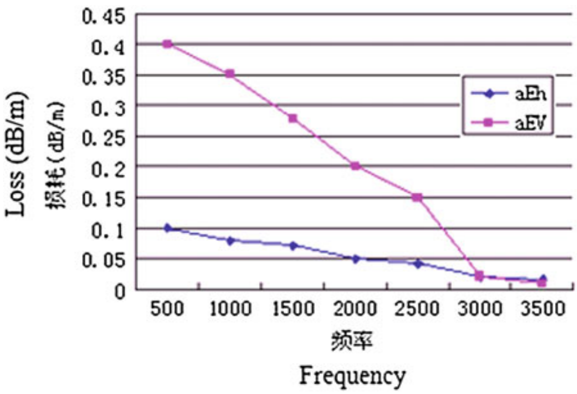


Fig. 119.1 Attenuation law of electromagnetic wave in UHF frequency range in the arched tunnel

electromagnetic wave, the higher the transmission frequency of electromagnetic wave is, and the greater the transmission attenuation caused by branches will be.

Experimental data collected in the tunnels of Badin Colliery mine of Shandong Yankuang Group is shown in Fig. 119.2. (From the experiment, it can be seen that in the straight tunnel, the higher the frequency is, the smaller the attenuation ratio will be, while in the winding tunnel, the higher the frequency is, the greater the ratio of attenuation will be, thus the trends of theoretical analysis and test result are consistent.)

3. Application of MIMO-OFDM technology to solve the interference and significant attenuation problem of wireless communication signal in the process of mine rescue.

The resource of frequency spectrum is woefully inadequate, which has become a bottleneck keeping down the wireless multimedia communication and transmission in mines with each passing day. Therefore, how to fully develop and make use of the limited frequency spectrum resource and improve the utilization rate of frequency spectrum so as to minimize the information interruption troubles caused by signal attenuation in the process of mine rescue is one of the main research topics in this paper. In this paper, it is designed that Multiple-Input Multiple-Output (MIMO) technology and Orthogonal Frequency Division Multiplexing (OFDM) technology are used to realize the data transmission at a high speed in MESH networking and improve the quality of transmission.

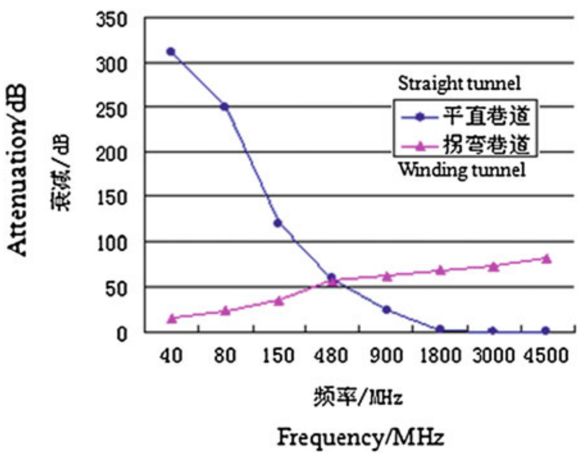


Fig. 119.2 Attenuation law of wireless signal in straight tunnel and blinding tunnel

119.4.2 Study on Synchronous Acquisition and Transmission of Multimedia Data in the Process of Mine Rescue

1. Synchronous acquisition program with hardware

Hi3512 chip by HISILCON Company is selected as the main hardware for synchronous acquisition of multimedia data in mines, and it can achieve a series of functions, including system control, H.264 video compression and coding, audio signal processing, signal transformation of environmental parameter, network transmission, etc. The corresponding communication interface of Hi3512 can be used to accomplish the initial configuration work for video acquisition chip, audio acquisition chip, data conversion chip, video coding and compression chip. This chip adopts ARM926EJ—S and DSP dual processor core as well as the so framework with multiple cores and high integration density of hardware acceleration engine, thus it has a strong ability of video processing. In addition of that, it also has independent 16 KB instruction Cache and 16 KB data Cache, embedded 16 KB instruction tightly coupled memorizer and 8 KB data tightly coupled memorizer, with DSP enhancement structure, embedded 32 × 16MAC and Java hardware accelerator, MMU is internally installed, thus it can support various open operating system, with a maximum GHz of 240MIPS (Ikrath and Schneider 1968). In the meanwhile, its embedded DSP core has three ALUs with eight levels pipeline design, which can support a variety of protocols, such as MPEG-4, H.264/AVC, thus it can meet the demands of real time system performance. The functional block diagram of Hi3512 chip is shown in Fig. 119.3.

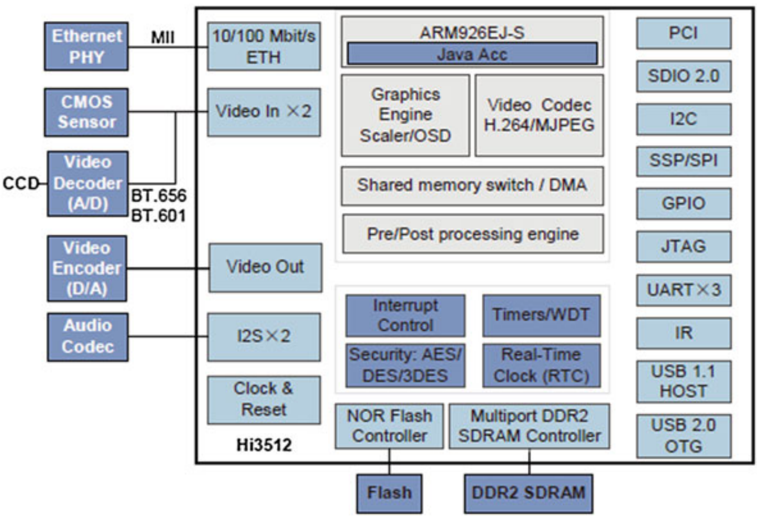


Fig. 119.3 Functional block diagram of Hi3512 chip

2. Program with software

This software is a kind of dialog box structure software, which is programmed by means of VC++ language under the integrated environment of Microsoft Visual C++ 6.0 with the help of MFC and class library in SDK provided by dual stream video server manufacturer, and it run on the operating system platforms of Microsoft such as Windows XP and Windows 7. The main techniques in use contain graphical interface programming technique, Socket network programming technique, dynamic link technique, file operation technique, custom message routing technique Akkaya and Younis (2005), etc. The categories of dell Dynamic Link Library mainly include network operation, audio and video coding-decoding category, document literacy, synchronization and mutual exclusion of critical resource. The specific function and structure chart is shown in Fig. 119.4.

① Software boot-up

Initialize the object which needs to be initialized in OnInitDialog () function of main dialog box, mainly including the appearance of software interface, setting for some default initial values, as well as the software version, etc.

② Network detection

Complete the initialization of Winsock by means of WSAStartup (), that is the first step for Socket network programming, so as to whether or not receive the windows socket as well as the error number.

③ Equipment initialization and equipment detection

It is possible to acquire the network information of network card for this computer by means of gethostbyname (), so as to estimate whether this computer and video server are within the same network or not, and which network card to choose for communication. And then, library function in SDK can be used to detect and initialize the video server. HHNET_Startup () is used for network service of function boot-up, HHNET_SearchAllServer () function is applied to search the digital video service equipment (DVS) in network, HHNET_MessageCallback () sets the

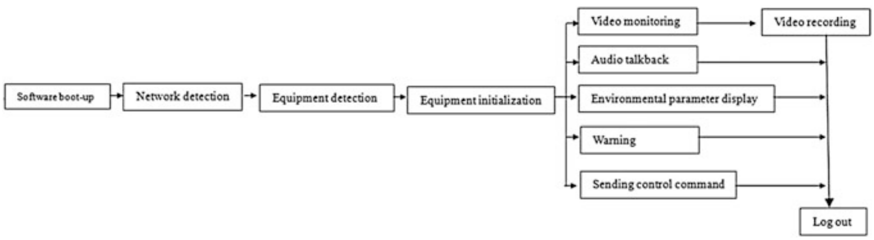


Fig. 119.4 Structure chart of software for synchronous transmission of audio–video and environmental parameter

mechanism of callback function for message handling, HH5PLAYER_InitSDK () function initializes the parameters of video player, HH5PLAYER_SetDecoderQulity () sets the quality of video output, HH5PLAYER_InitPlayer2 () can set the video player window, HH5PLAYER_OpenStream () can be used to start up the player to prepare for receiving the video data which is sent back by video server and display it by playing after decoding.

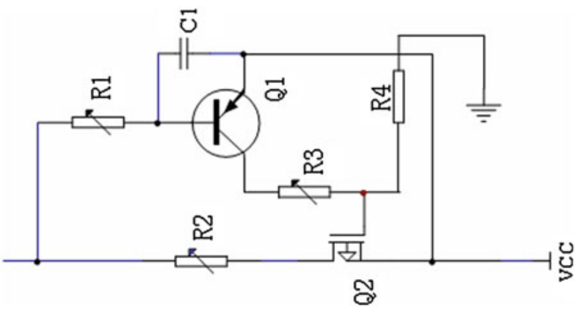
119.4.3 Development Technology for Intrinsically Safe Power Source

Voltage output is 12 and 5 V, and the capacity is 10 and 16 Ah. There are no functions such as voltage stabilization, over-current protection, over-voltage protection, short circuit protection and the like in the circuit, all the procedures of protection function are doubly designed, so as to meet the demands of intrinsic safety.

The key technology for intrinsically safe circuit lies in cutting off quickly to protect the circuit. This over-current protection circuit by cutting off quickly consists of opened nanosecond triode and closed nanosecond field-effect tube, and the base of opened nanosecond triode is connected with the drain of closed nanosecond field-effect tube by electric resistance, the emitter of opened nanosecond triode is connected with the source electrode of closed nanosecond field-effect tube, the grid electrode of closed nanosecond field-effect tube is connected with the divider resistance of collector circuit of opened nanosecond triode. The above-mentioned triode plays a role of monitoring the discharge current of power source, if the voltage drop of this current on the triode and electric resistance which is connected with the triode exceeds the gate threshold voltage of this triode, this triode will be opened within the time of nanosecond, the potential of collector will become higher, which enable the field-effect tube is closed within the time of nanosecond, thus the ignition energy of short circuit will be reduced in the twinkling of an eye, to realize the purpose of eliminating the hidden danger of explosion and protecting the load.

There is the circuit principle of an actual example of new type over current protection circuit in Fig. 119.5. This protection circuit constitutes of opened nanosecond triode Q1 and field-effect tube Q2, the model number of triode Q1 is 3906, while the model number of field-effect tube Q2 is SI4435. The base of triode Q1 and the drain of field-effect tube Q2 are connected with the output end of protection circuit respectively by electric resistance R3 and R4, the emitter of triode Q1 is connected with the source of field-effect tube Q2; the collector of triode Q1 is grounded by electric resistance R3 and R4, the grid electrode of field-effect tube Q2 is connected between electric resistance R3 and R4; capacitance C1 is in parallel connection between the base and emitter of triode Q1 for interference elimination. When the load works normally, triode Q1 is in the status

Fig. 119.5 Circuit principle diagram of intrinsically safe circuit



of cut-off, the field-effect tube Q2 is in the status of break-over, thus the camera is in normal operation; once the camera breaks down or any short circuit leads to the over current, the potential of triode Q1 base is less than that of collector, thus the triode Q1 will be in the status of break-over, the voltage of field-effect tube Q2 is in the high level due to the voltage division by electric resistance R4, the field-effect tube Q2 will be cut off within the time of nanosecond, therefore the load can be protected effectively.

119.4.4 Design for System Equipment Reliability

Because the work environment and condition in coal mine is complex and volatile, especially after the accidental disaster happens, its environment will become worse, thus the task of mine rescue is extremely arduous, because it is necessary to overcome a series of difficulties such as high temperature, dense smoke, gas and excessive CO, insufficient light in coal mine, narrow tunnel, unfavorable ventilation, etc. Therefore, it is required that the equipment must be safe and reliable, to minimize the rate of misoperation and improve the efficiency and safety of rescue work. For this reason, it is necessary carry out the redundancy design for equipment and make up parallel system, so as to improve the reliability of equipment. The reliability of equipment can be worked out by means of formula (119.1).

$$R_{Hn} = \sum_{i=0}^{r-1} C_n^i (1-R)^i R^{(n-i)} \tag{119.1}$$

Where R_{Hn}—Reliability of equipment in normal operation;

C_n^i—The number of events when i designs are in normal operation among n safety designs;

R—Reliability of each safety design (it is supposed that the reliability of each safety design will be the same).

For example, there are triple protections in the process of designing the protection circuit, and the specific parameters are as follows:

Over discharge cut-off delay: $\leq$0.10 s
The first stage over current cut-off current: <2.60 A
The second stage over current cut-off current: <1.30 A
Over current cut-off delay: $\leq$105 ns
Sort-circuit current: <15 ma
Short circuit cut-off delay: $\leq$125 ns.

119.5 Application of System Equipment

There is an event of gas explosion in a certain mine in March of 2009, there is no casualty because the rescue work is organized well, but the vertical drill holes 1# and 3# for gas drainage under suction are damaged, it is unable to estimate the position of vertical drill hole damage exactly no matter on the ground or in the mine, which has brought much inconvenience for production recovery in the mine, after the discussion made by the expert group of accident investigation, the system equipment is adopted to carry out the vertical drill hole reconnaissance. Field force truss up the equipment with mining intrinsically safe infrared video camera and miner light, and they are put into the vertical drill holes 1# and 3# for gas drainage under suction by steel wire rope at a low speed, respectively, the equipment records the situation of vertical drill holes investigation in a ream time manner when it is put down, and choke points are detected at the 1#352 m point and 3#353 m point, which provides the praiseworthy first hand information for formulating the effective plan to repair the vertical drill holes for gas drainage under suction; and the infrared video camera also records the whole process of detection instantaneously.

119.6 Conclusion

This paper expounds and proves the existing characteristics of various wireless communication systems in mines based on the analysis on the environmental features of coal mine after disaster, and it also puts forward the technical data of wireless multimedia communication for mine rescue, and in the meanwhile, the following research on the key technology of system equipment has been done.

1. It studies the transmission characteristics of RF electromagnetic wave in mines and makes the analysis on the impact of environmental factors such as the sectional area of tunnel, shape of section, turning corner, gradient, support, branches and so on in the process of electromagnetic wave transmission in the limited space, and it is proposed in this paper that the design method of MIMO-OFDM technique and MIMO technique can be used to realize the high speed data transmission of MESH networking and improve the quality of transmission.

2. Based on the characteristics of mine emergency rescue, it analyzes the synchronous acquisition method for multimedia video-audio and environmental parameters in the process of rescue work, Hi3512 chip is used for the synchronous acquisition and encoding of video, audio and environmental parameters. With the help of software development tools such as Microsoft Visual C++ 6.0, assorted SDK for dual stream network video server, Microsoft Foundation Classes (MFC) and so on, it develops the software system which has the functions of searching and discovering the device address of server, video monitoring by infrared video camera, video recording, audio talkback transmission, sending control signal, data acquisition and presentation by sensor, warning as well as the synchronous acquisition of video-audio and environmental parameters.
3. It also carries out the design for intrinsically safe portable power supply, and GB3836.4-2010 is taken as the primary basis, to adopt IC main control chip for battery protection, and based on the principle of minimum ignition energy, the method for over current control and short circuit cut-off time to control the spark ignition energy, so as to meet the requirements of intrinsic safety.
4. By means of field application, this paper also makes efforts to test and verify that "wireless multimedia communication system for mine rescue" can factually describe the situation of field detection.

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Chapter 120
Digital Human Modeling for Musculoskeletal Disorder Ergonomics Researches in Healthcare

Le Zhang, Jian-wei Niu, Xiao-lin Feng, Si-yang Xu, Xin Li and Si-si Guo

Abstract Musculoskeletal Disorder (MSD) is always considered as one of the most significant occupational injury in industry. In recent times, more and more people analyze MSD in healthcare. Meanwhile, Digital Human Modeling (DHM) can analyze human factors in Virtual Environment (VE) by simulating industrial tasks. However, few people involve DHM in healthcare MSD researches. This paper presented an approach of applying DHM ergonomics analysis in nursing investigation. The fundamentals of Nursing Tasks (FNT) were simulated in Siemens Classic Jack (Jack) with biomechanical DHM. Jack Tasks Analysis Toolkits (TATs) were adopted to evaluate human factors in MSD analysis. The TAT results and traditional questionnaire investigation showed similar MSD regions. It indicates that DHM has potentials to offer a visual analysis and enhance approach for simulation of dynamic system in healthcare MSD analysis to reduce the incidence of MSD in nursing.

Keywords Digital human modeling simulation · Healthcare · Jack · Musculoskeletal disorder · Nursing

120.1 Introduction

Musculoskeletal Disorder (MSD) represents one of the leading causes of occupational injury and disability in industrial applications. For example, MSD researches have been successfully launched in automobile assembly plant (Fredriksson et al. 2001). Meanwhile ergonomists start turning to conduct MSD researches in healthcare. MSD researches about nursing healthcare tasks have been developed in

L. Zhang (✉) · J. Niu · X. Feng · S. Xu · X. Li · S. Guo
School of Mechanical Engineering, University of Science and Technology Beijing, Beijing, China
e-mail: hunterctzl@gmail.com

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the United States, Europe, Japan and China (Menzel et al. 2004; Simon et al. 2008; Smith et al. 2006; Yeung et al. 2005). Over the past 40 years, nursing has been steadily increasing the publication output in MSD and in the last 10 years there has been a substantial increase in all publications (Hale and Hill 2006).

Most nursing MSD researches were based on questionnaire investigation. The success of Nurse Early Exit Study, Copenhagen Psychosocial Questionnaire and Nordic Musculoskeletal Questionnaire proved the validity that the adapted questionnaire had an acceptable structure and provided reliable information from the nursing profession in physical and psychosocial (Arsalani et al. 2011). Self-report survey for musculoskeletal symptoms, Psychometric Evaluation Questionnaire and Job Description Questionnaire were used to identify the MSD among perioperative nurses and technicians and demonstrated a high prevalence of work-related MSD among nurses, with 84 % pain complaint on lower back pain, 74 % on ankle and 74 % on shoulder, and found 31 % lower back pain, followed by 24 % ankle/knee pain to be the main causes of absenteeism from work (Sheikhzadeh et al. 2009).

Digital Human Modeling (DHM) had been widely used in New Product Launches (Demirel and Duffy 2007), Product Lifecycle Management (Demirel and Duffy 2007) and Manufacturing Process (Santos et al. 2007). DHM tools have potentials to improve the product development challenges and provide control of the entire process of product design. Using DHM to create dynamic simulation of healthcare work is an innovation in MSD researches and fills the blank of biomechanical analysis in traditional approaches. Motion structure representation algorithm in DHM identifies the basic spatial–temporal structure of human motion, and it can be generalized to produce an infinite number of similar motion variants and create basic motion simulation models (Park et al. 2005). Various nationality, gender, accommodation percentage and size DHMs can be generated in virtual environment (VE) to properly accommodate the ergonomics designated and evaluation of products and workplaces of the target population (Jung et al. 2009). Application of DHM in healthcare MSD research can provide visual result and improve the environment design of healthcare.

This study proposed a nursing MSD research in Chinese hospital. Siemens Classic Jack 7.1 (Siemens PLM Software Inc and Simens Classic Jack 2012) (Jack) was used as the DHM software to simulate nurses' healthcare work in VE. Jack has biomechanical DHM to simulate dynamics works and Task Analysis Toolkits (TATs) to investigate ergonomics in diverse environments. Totally 189 questionnaires were filled by nurses in a Chinese hospital and 30 anthropometry statistics was collected to create specific Chinese nurse DHM. Static simulation and dynamic simulation were both analyzed by TATs and the result was compared with the questionnaire investigation.

The organization of this paper is as follows. Section 120.2 introduces the processes of the research. Section 120.3 reports the result of the analysis. Discussions are given in Sect. 120.4. Finally, Sect. 120.5 summarizes this study.

120.2 Method

Firstly, questionnaires were used for traditional MSD investigation. Five body MSD regions of Nordic Standard Questionnaire were settled in the questionnaires. Then DHM was used to simulate the nursing tasks. A VE of Chinese hospital ward was built in Jack. To utilize Jack for visual ergonomics analysis, static and dynamic simulations of healthcare work were created and two TATs were manipulated for investigation. The methodology of healthcare MSD analysis was explained in details. Comparison between the two approaches, namely questionnaire investigation and DHM, was addressed.

120.2.1 Traditional MSD Questionnaire Investigation

One hundred and eighty-nine registered Chinese female nurses from intensive care units, emergency room, operation room etc. were asked to fill in anonymous questionnaires. The questionnaire included three sections. The first section collected anthropology information like age, status, and weight. The next section included questions for risk factor such as task type, task repetitive times, and career duration. The last section provided MSD symptoms of Nordic Standard Questionnaire.

Valid statistics was tested in SPSS 16.0 (IBM 2012) by Chi square. The subjects were divided into two groups, manipulating tasks less than 10 times a day and more than 10 times a day. The initial assumption was no difference between each group. With 95 % Confidence Interval, we refused the initial assumption when the P value is smaller than 0.05 and considered there is significant difference between each group. Odd Ratio proved the risk factors of each region.

120.2.2 Creation of Virtual Environment and DHM

The head nurses in each ward indicated that the most common task of nursing was Fundamental of Nursing Task (FNT). Thus, the simulation task was arranged as turning patient's body on bed, a FNT. Three experienced nurses performed the entire process of turning a patient in bed. Details of the task were recorded by video.

Before manipulating DHM to simulate FNT, a hospital ward and Chinese nurse feature DHM must be created in VE. Jack provides a function to input CAD formats model in VE. A valid hospital bed CAD model was created in Pro-E software and then input into Jack as a figure. Based on the Chinese national anthropometric standard (GB 10,000–88, 1989), an anthropometric database representing Chinese female adults aged 18–55 was created in Jack. The basic nurse

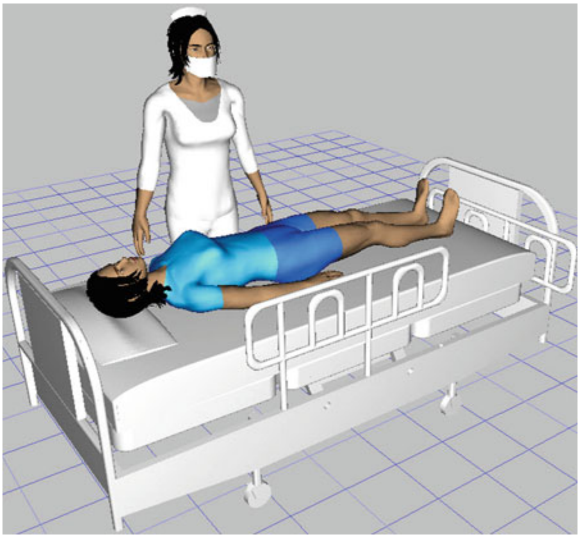

Fig. 120.1 Virtual environment of hospital bed and nurse in jack

figure was a 50th percentile default Chinese female. To refine the figure, we measured 10 major anthropometric measurements of 30 Chinese nurses and took the average to scale figure by Advance Scaling function. The color of figure's clothing, shoes and hair were simulated according to the real subjects.

The hospital bed, nurse and patient in VE, as Fig. 120.1 shows, simulated the nursing healthcare circumstance in Jack.

120.2.3 DHM Simulation and Ergonomics Analysis

In Jack, the FNT process was divided into 8 postures and 7 movements. The postures included start pose, grasping distant arm, moving distant arm to the chest, grasping legs, moving legs, grasping close arm, moving close arm to the chest, and turning body. Those movements were created by Animation Tool to present the animation between two postures and combined together as a fluent movie. Figure 120.2 shows each motion.

Lower Back Analysis Tool (LBAT) and Static Strength Prediction (SSP) provided dynamic and static analysis in Jack. LBAT evaluated the spinal forces acting on virtual nurse's lower back under every motion and loading condition, flagged the exact moments when the compression forces exceed NIOSH limits. SSP calculated the percentage of a working population that has the strength to perform the task based on posture, exertion requirements and anthropometry. The results were presented by body regions. The region is considered dangerous when the percentile is lower than 75 %.

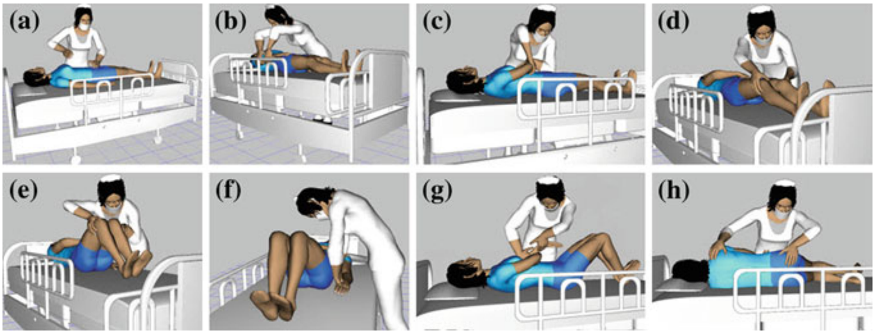

Fig. 120.2 **a** Eight postures represent motions in dynamic nursing healthcare simulation a: start pose; **b** grasping distant arm; **c** moving distant arm to the chest; **d** grasping legs; **e** moving legs; **f** grasping close arm; **g** moving close arm to the chest; **h** and turning body

Table 120.1 Chi square test result of fundamental of nursing task

Body region	Odd ratio	P value	CI(95 %)
Shoulder	2.062	0.056	0.943–4.508
Elbow	1.686	0.113	0.801–3.549
Torso	2.543	0.015	1.187–4.451
Knee	3.151	0.001	1.55–6.405
Ankle	1.701	0.091	0.848–3.415

Reference group does FNT less than 10 times a day, while test group does more than 10 times a day

120.3 Results

Chi square analysis was presented in Table 120.1. When doing FNT more than 10 times a day, shoulder ($P = 0.056$, $OR = 2.062$), torso ($P = 0.015$, $OR = 2.543$) and knee ($P = 0.001$, $OR = 3.151$) faced significant risk to have MSD symptoms. In contrast, elbow and ankle suffered less MSD in FNT.

LBAT indicated that the load of lower back was over the NOISH recommendation when DHM bended torso to lift patient's body. Figure 120.3 shows the largest force on back when nurse turning patient's body. Table 120.2 lists the results of SSP. Shoulder, torso and knee were less than 75 % in most lifts. Ankle was between 75 and 90 % in some lifts while elbow was higher than 90 %.

120.4 Discussion

In this study, questionnaire investigation and DHM simulation were operated to present risk factors in nursing MSD analysis. The questionnaires showed which region had significant relation to risk factors. In Jack, TATs gave force on lower

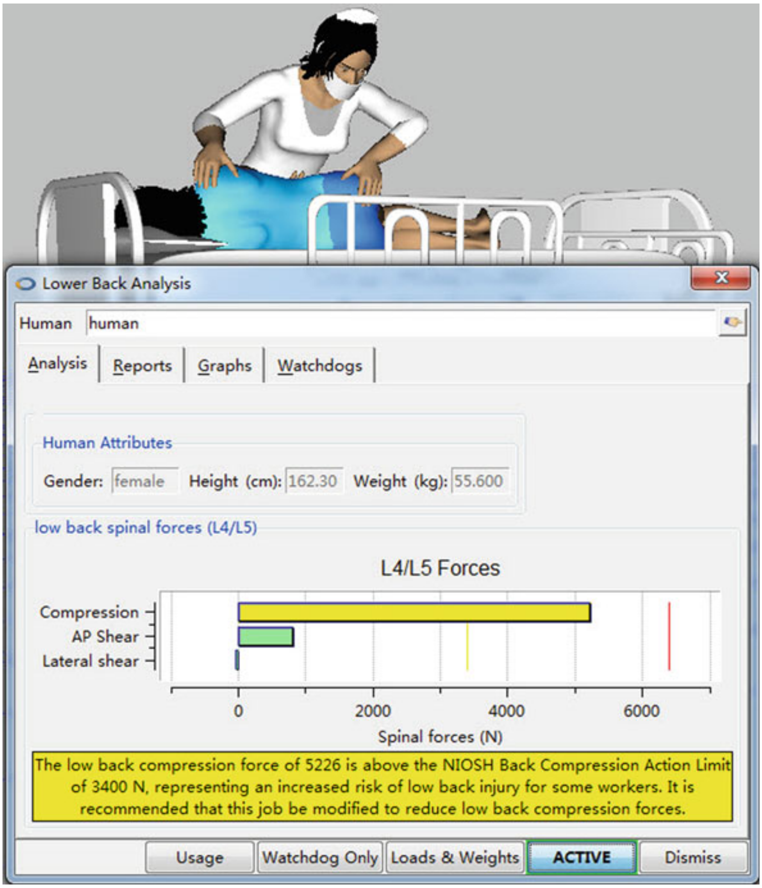

Fig. 120.3 Result of lower back analysis

Table 120.2 Risk percentile of each body region in 4 motions

Risk percentile	Moving distant hand	Moving legs	Moving close hand	Turning body
Less than 75	Knee, Shoulder, Torso	Shoulder, Torso	Knee, Shoulder	Knee, Shoulder, Torso
75–90	Elbow	Ankle, Knee	Ankle, Torso	Ankle, Elbow
90–100	Ankle	Elbow	Elbow	

Smaller risk percentile means the body region is easier to get musculoskeletal disorder

back and MSD risks of each region. In addition, SSP and questionnaire investigation had a similar result indicating that shoulder and torso suffer the most significant MSD in FNT, elbow and ankle don't have significant risk in FNT.

In future work, more studies should be provided to prove the validity of statistics analysis utility in DHM ergonomics research. Questionnaire investigation should be used to collect nurses' anthropometry and psychological information and improve the reliability of DHM. With the improvement of DHM, virtual reality can be added in nursing training. Nurse with digital devices can perform healthcare work in VE and represented by DHM. Thus, MSD can be improved by virtual interactive design of nursing processes (Tian and Duffy 2011).

120.5 Conclusion

Considering MSD causes numerous occupational injuries in healthcare, people should pay more attention on nursing MSD investigation. This study investigated the Chinese nurses' MSD by questionnaires and DHM. The result indicated that traditional questionnaire investigation and DHM analysis in healthcare MSD research matched well. In detail, two approaches both pointed out that shoulder and torso had significant MSD in PNT. Questionnaires provided the important information to DHM and statistics analysis. DHM showed visual result by dynamic simulation of FNT in the VE. With DHM simulation, Jack analyzed MSD by TATs and showed force and risk percentile to indicate risk factors. More DHM simulation and ergonomics analysis should be applied in the future and DHM simulation should be used to train nursing work in virtual reality to prevent the MSD and improve nursing process.

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Chapter 121
Insurance Funds Investment Strategy and Risk Management Structure

Xiang Guo and Wen Wang

Abstract Three aspects—insurance companies' own risk management capabilities, regulatory policy and market constraints from the insured impacted the use of funds in insurance companies. The three parts interact, and ultimately determine the optimal investment strategy. This paper takes insurance companies, government regulation and market discipline as research objects, to create a model which contains elements of risk management. It also analyzes the influence of risk management costs and the overall level of risk management in insurance companies' investment and information disclosure.

Keywords Investment strategy · Risk management structure · Liability reserve disclosure

121.1 Introduction

As Chinese insurance industry develops, issues on insurance funds risk management have become research hotspot in recent years. Risk management study on insurance funds focuses on investment entities, organizational structure, legal risk, early-warning systems and protection mechanisms, etc. Analysis based on ERM is a weak area. Even the practical risk management analysis is concerned about areas such as the risk management process and measures, no attention to the company's overall risk management structure and external regulation. Insurance regulation is

X. Guo (✉) · W. Wang
School of Insurance and Economics, University of International Business and Economics, Beijing, China
e-mail: gxinnofund@163.com

W. Wang
e-mail: wangw6966@vip.sina.com

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an insurance company's background environment, and regulatory policies changes will have a direct impact on the insurance company. As special financial institutions, insurance institutions with a lower risk management level have a motive for higher risk investment with less cost. Due to the incomplete information and moral hazard, regulatory agencies and the insured are difficult to draw intuitive judgments for an insurance company's' risk management capability. So little it is known about the use of insurance funds, lack of the overall control mechanism.

In the context of regulatory policy, we have adopted a comprehensive analysis framework applying the investment strategy based on the insurance company's risk management structure variables. It combines the insured's expense requirements and market constraints of insurance companies, hoping to build a theoretical model containing the above three. The paper is structured as follows: the first part is a brief analysis of the existing problems in the field. The second part introduces the literature on this research. Third part is theoretical analysis in order to discuss the internal logic based on risk management perspective. The fourth section expanses theoretical analysis, contributing to understand the information transmission from the point of reserve extraction and information disclosure. The last part is the conclusion of the full paper.

121.2 Literature

Cramer (1930) conducted the first study of risk in insurance investment noticing that insurance companies need to focus on investment risk. Subsequently, investment risk quantitative research on the insurance company gradually started, and later formed random distributions or complex process models describing the probability of loss and loss function (Kahn 1964). Most Scholars have focused their attention on portfolio theory (Markowitz 1952) and finance theory (Sharpe 1963; Lintner 1965; Mossin 1966). From perspective of the relationship between insurance companies' capital structure and investment risk, Michaelsen and Goshay (1976), Harrington and Nelson (1986) quantitative analyzed the relevance between capital structure and investment risk. When insurance companies invest the greater proportion of debt funds, the investment risk accordingly became smaller, so capital structure is an important factor impact on investment risk.

Hofflander (1966), Kahane (1975) studied investment model on the assumption of the insurers' expected quadratic utility function. Frost (1983) analyzed whether modern portfolio investment model was feasible based on the insurance fund structure. Moridaira (1992) added the portfolio insurance to the CAPM model. Based on differences between assets and liabilities income, Babbel and Hogan (1992) made models for shareholder and policyholders value maximization. Leibowitz et al. (1992) realized the maximize effect of capital gains, which eventually determined the added value in asset management process. In optimal portfolio of Markowitz model, financial debt leverage has a greater impact on the asset investors' allocation. Empirical results confirmed that shareholder decision will significantly affect financial leverage, while surplus income method can internalize this effect (Sharpe and Tint 1990; Leibowitz et al. 1996). How insurance companies choose to invest in the capital market to minimize the probability of bankruptcy has become scholars' study issue, such as the Black–Scholes risk-based capital model, or Brown motion with drift process (Browne 1995).

Domestic investment in research unfolded as follows: the insurance investment channels, investment regulations (Li 2000). Lee et al. (2003) described risk process with compound Poisson process, following Hipp (2000). Insurance company achieved optimal investment through minimizing the probability of bankruptcy. Principal-agent problem may exist in liabilities and earnings perspective. Reasonable and effective risk investment model must be constrained by risk and asset specificity (Qin et al. 2003).

As can be seen from the above literature review, the domestic studies most unfolded in a practical point, lack of theoretical research. Also these papers are only extensions in empirical research methods, and less concerned about risk management and disclosure in the whole process. The impact of enterprise risk management in control measures and information disclosure is not yet clear, which becomes this papers' research direction.

121.3 Theoretical Analysis Based on the Perspective of Investment Strategy and Risk Management Structure

Risk management structure is a concept based on risk management process costs and compensation incurred. Different studies selected different indicators to measure them. This paper divided it into two parts: the fixed cost and variable cost. There exists the following condition: less risk management costs may not stand for good risk management conditions, so overall risk management level variable is added for a specific risk management cost structure. This risk management structure feasible set in this paper contains three parts: the fixed cost, variable cost and risk management level. Then the reserve is introduced into the model as an agent variable for insurance regulatory policy. For a certain insurance reserve extraction ratio and optimal risk management structure, how is the relation between investment strategy and external regulatory?

(A) Model Hypothesis

(a) Insurance business is divided into three phases. First they absorb the premium and to accrue liability reserve. The second stage is to use insurance funds in accordance with specific investment strategy. The third stage is to make payments and to obtain the amount of upfront investment income.

(b) As reflected in this model, the insurance regulatory bodies publish how the reserve is extracted. Insurance companies determine their risk management structures. Insurance companies have to pay the amount of F payments in the end as external market constraint.

(c) Each insurance company faces two types of investment opportunities: risk-free investment and venture investment. Risk-free investment opportunity exists with profit I in the period end, while venture investment includes speculative options. Due to the existence of non-systematic risk, high-risk venture capital projects are also possibly to obtain higher returns. Suppose the probability of high returns is q with return H, the probability of low returns is $(1-q)$ with return $L, q \sim U(0,1)$. Insurance companies or asset management companies will examine risk profiles of investment projects in detail, but regulators and policyholders are difficult to obtain this information. In the third stage, the final investment cash flow value T depends on the insurance companies' investment strategy in the former phase: if it invests risk-freely, then $T = I$; otherwise $T = H$ or $T = L$.

The elements set of risk management structure include three factors: insurance companies' fixed cost s, variable cost $\boldsymbol{\lambda}$ and overall risk management level $\boldsymbol{\alpha}$. So risk management structure is expressed as $\{s, \lambda, \alpha\}$. Because of small changes of fixed cost in risk management, we do not include that value in the cash flow, which means the numbers in the $T = \{H, I, L\}$ have subtracted S. In a given level of risk management, insurance companies will choose investment strategy for their own benefits, which are influenced by the risk management structure variables λ, α and pay expenses F.

(B) Optimal Investment Strategy

In connection with the model, we define the optimal investment strategy of the insurance company. Under conditions without considering the amount of expense, if there exists q^e and $0 \le q^e \le 1$, insurance companies choose venture investment when $q \ge q^e$. Otherwise they choose risk-free investment when $q \le q^e$. Then this strategy is expressed as $[q^e]$. Due to $q \sim U(0,1)$, insurance company's final cash flows probability distribution based on investment strategy $[q^e]$ are calculated as follows:

$$p = \begin{cases} \frac{1}{2}(1-q^{e2}) & T = H \\ q^e & T = I \\ \frac{1}{2}(1-q^e)^2 & T = L \end{cases}$$

Expected value of cash flows under strategy $[q^e]$ is expressed as $\mathrm{E}[q^e]$

$$E[q^e] = \frac{1}{2}(1-q^{e2})H + q^e I + \frac{1}{2}(1-q^e)^2 L \tag{121.1}$$

As $E[q^e]$ changes, the standard deviation $\sigma(q^e)$ is a decreasing function. When q changes from 1 to 0, $\sigma(q^e)$ increases from 0 to $(\frac{H-L}{2})^2$. First-order optimal condition is

$$\hat{q} = \frac{I - L}{H - L} \tag{121.2}$$

$$E[\hat{q}] = \frac{1}{2}(1 - \hat{q}^2)H + \hat{q}I + \frac{1}{2}(1 - \hat{q})^2 L \tag{121.3}$$

when q^e decreases gradually and $\sigma(q^e)$ increases adversely, strategy moves towards risk-based investment. $E[q^e]$ first increases to maximum $E[\hat{q}]$, then gradually reduced to $\frac{H+L}{2}$.

Formula (121.3) shows that only in strategy $[\hat{q}]$ can insurance companies achieve maximum return on investment. Insurance companies should strive to maintain the investment strategy $[\hat{q}]$ in order to maximize the expected cash flow and this investment strategy is called optimal investment strategy.

(C) Conclusions and Instructions Related to the Model

(a) Risk management structure variables' investment incentive function

$$q_m = \frac{(1 - \alpha)\lambda + \alpha(I - F)}{(1 - \alpha)\lambda + \alpha(H - F)} \tag{121.4}$$

In this conclusion, for a certain risk management structure $\{s, \lambda, \alpha\}$, this paper studies the impact of risk management on investment options. Investment strategy can be seen as the function $q_m(\lambda, \alpha)$. We can see that $q_m(\lambda, \alpha)$ is an increasing function of λ from $\frac{\partial q_m(\lambda,\alpha)}{\partial \lambda} > 0$, which means the higher variable cost of risk management, the more conservative investment strategy insurance companies would take. We can also find that $q_m(\lambda, \alpha)$ is a decreasing function of α from $\frac{\partial q_m(\lambda,\alpha)}{\partial \alpha} < 0$ which means insurance companies incline to take risker investments under higher level of risk management. The significance of these findings is clear: in a given λ, the insurance company will gradually shift to venture capital as α increases. In a given α, risk management costs will be a financial burden on insurance companies as λ increases, and insurance companies will choose conservative investment strategy. Therefore λ and α have an opposite effect in investment strategy choice.

For the expense $F(I > F > L)$ and risk management structure $\{s, \lambda, \alpha\}$ the inference are as follows: (121.1) When $\lambda = 0, \alpha \neq 0$, risk management process has no influence on insurance funds and insurance risk management structure model degrades to the basic model (121.2). When $I - F > \lambda > 0, \alpha = 0$ the risk management level equals zero. That is to say, put into much risk management resources but do not receive corresponding effect. The strategy $[q_m]$ equals [1], insurance companies will take risk-free investment. (121.3) $\lambda = 0, \alpha > 0$ is the optimal structure for companies. In this circumstance, insurance companies can not only get the benefits of risk management but also minimize the overall cost. But the economic environment fluctuations actually make it difficult to achieve this optimal state. The initial cost in implementation of risk management will be larger and decreases with in-depth risk management application in all aspects of insurance sectors.

(b) Risk management Structure and Reserve

Insurance reserve π and claims paid F are interrelated. If the reserves are independent of the insurance company's risk management structure, insurance company will choose risk management structure for their own investment operations. But in fact, regulatory authorities reserve policy needs to be more risk-prevention, so in this paper we set the reserve accrual method related to investment strategies. Given a payment level F ($F < H$) and a risk management structure $\{s, \lambda, \alpha\}$, a reasonable reserves the extraction amount expresses as follows:

$$\pi_m = \theta\left\{q_m(F - I) + \frac{1}{2}(1 - q_m)^2(F - L)\right\} \tag{121.5}$$

q_m is determined by Eq. (121.4),π_m is determined by F,λ,α and income set $\{H, I, L\}$, θ as the scale factor. Keep F and α constant, the insurance company managers will seek to maximize their own interests. Equation (121.5) reveals intrinsic relationship between reserves and the above variables. The reserve reflected the investment strategy and risk management structure which is the basis for information disclosure. If reserves are formulated for the optimal investment strategy, it can redress insurance companies' own strategy and risk management level: if q_m equals $\hat{q}$ and companies don't choose the appropriate risk adjusted investment management structure for their own business, the loss is $T(\hat{q}) - T(q_m)$. Given F, Insurance companies selected the corresponding risk management structure for the investment, and also match the liability reserves.

Risk Management Optimization. In Eq. (121.5) under the reserve extraction method established, insurance companies will choose the risk management structure to make the investment strategy $\hat{q}$. If the risk management structure variables meet the following condition $\hat{\lambda} = \frac{\hat{\alpha}}{(1-\hat{\alpha})}(F - L)$, risk management structure will motivate companies to choose investment strategies $\hat{q}$. The conclusion confirms that a risk-based management structure will guide insurance managers choose optimal investment strategy. Management variables are not unique. And $\frac{d\hat{\lambda}}{d\hat{\alpha}} = \frac{F-L}{(1-\alpha)^2} > 0$ represents $\hat{\lambda}$ and $\hat{\alpha}$ have the same variation. This is the same as the previous conclusion: When λ is big and α is small, $q_m > \hat{q}$ and more conservative management is caused. When λ is small and $\hat{\alpha}$ is large, $q_m < \hat{q}$ and the opposite effect promotes the insurance fund managers to obtain better possible investment strategies.

Analyze the above findings Together. From Eq. (121.4), a group of risk management structural parameters determines a unique investment strategy q_m. Considering the risk management structural parameters in responsibility reserve equals to determining the specific investment decisions. On this basis, the insurance managers give priority to the optimal risk management structure $\{s, \hat{\lambda}, \hat{\alpha}\}$ with pre-determined commitment to maximize the value of the investment. On the other hand, from Eq. (121.5), if the reserve extraction has nothing to do with the risk management structure $\{s, \hat{\lambda}, \hat{\alpha}\}$, indicating q_m is not fully internalized. Moreover it is clear that risk management structure is determined by company's maximize-value behavior choice. And even we can predict the final investment strategy, risk-transfer mechanism still exists, and $q(F) < \hat{q}$.

The role of risk management in insurance companies' asset investment risk control has attracted a lot of scholars to attention. Regulators could determine insurance company's risk management structure with reserve program. As conclusion above indicated, whether the insurance company managers will choose an optimal risk management structure depends on the specific programs for the reserve. The theoretical model inherent structure shows reserve fund withdrawal plan based on risk management is the key to motivate managers to choose the best insurance company's risk management structure, while risk management structure will enable managers to select an optimal investment strategy.

121.4 Information Disclosure and Reserve the Extraction Design in Insurance Companies

Information and communication is an important element in COSO-ERM analysis framework. Traditionally, regulators and the stakeholders of insurance company mainly access information through financial statements. In the presence of financial fraud and number whitewash conditions, it is difficult to obtain true risk information. Even if the information is real stated, they can only passive accept information, lack of means to exert reasonable influence. The above analysis shows the existence of a mechanism designed to encourage insurance companies to select appropriate risk management structure. This is the mechanism designed to extract the reserve. Therefore, there is internal mechanism for regulatory agencies to affect insurance sectors' risk management through design of regulatory measures. Of course the mechanism is not only displayed as reserve extraction in this paper. Far discussed in this section, when risk management structure is incorporated into the reserve extraction design, issues should be considered as follows: after liability reserve has developed based on the current situation, what would occur when the insurance companies change their risk management structure? There exist two different solutions: firstly, regulatory agencies corresponding changes reserve extraction to adapt it. This idea is actually unfeasible and the reason is that the risk management level reduction may be a company's single act, but the extraction policy is the policy of the industry, so adjust cost is large. Secondly, the final evaluation and penalty methods can be used. With those who reduce risk management level in each financial year, insurance companies should be subject to additional regulatory penalties. Regulators send control signals to the insurance company by means of punishment.

The financial data of insurance funds do not directly reflect their risk management, and risk management related data refinement can be used as risk management measure. Explore to establish the appropriate financial and non-financial indicators effectively to represent the insurance company's risk management capabilities. Insurance companies can pre-select an optimal risk management structure to show regulators and policyholders their investment approach and the intent to protect the interests of policyholders. Consider the transparency of regulation in insurance companies. Owing to the cost of information disclosure which is less than the cost of regulatory supervision of both the insured and regulation agency, public investment information disclosure has a strong practical value.

In one sense, the responsibility reserve extraction is equality to information disclosure. As long as the insurance company's risk can be measured, information disclosure will lead to more transparent investment strategy. And that will encourage regulators to take more effective control measures. High level of information disclosure corresponds to a high level of supervision.

121.5 Conclusion

Combined with the insurance regulation, insurance companies and market constraints in this paper, a theoretical model is proposed for considering risk management effect in insurance company investment. The model results are discussed in the equilibrium when level of risk and risk management can be measured. In reality, due to the information collection and processing costs, there is a big difficulty to measure accuracy of risk and risk management level. Currently, papers widespread use variance as an approximation of risk measure, and the measures of risk management level can be considered by using the possible loss ratio as an approximation (loss amount prevented by risk management to the total loss amount). However, these approximations still remain in the initial stages of data use. How to effectively achieve the quantification and measurement of these indicators is the focus of follow-up study.

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Chapter 122
Study on Evaluation of Safety and Quality in Military Aircraft Maintenance

Ji Ding, Qiong-jian Fan, De-xiang Sun, Ji-jun Zhang and Bo Ren

Abstract Evaluating safety and quality in military aircraft maintenance is one of the most important aspects in ensuring flight safety. Constructing index system of maintenance safety and quality of grass-root level, using the method of set pair analysis (SPA) to evaluate maintenance levels of several aeronautical maintenance army and proving accuracy of the model compared with TOPSIS and gray correlation analysis. Based on component and network technologies, the assessment system is set up. Provide basis for controlling maintenance safety and quality and ensure aircraft support under the condition of informatization.

Keywords Military aircraft maintenance · Safety · Quality · Comprehensive evaluation

122.1 Introduction

When referring civilian or military aviation, safety is always the eternal theme. At present, foreign countries have formed a variety of aviation safety evaluation systems which is more mature, such as the International Operational Safety Audit (IOSA) [1] in

[1] IATA.IOSA Standards Manual [EB/OL]. http://www.iata.org/NR/rdonlyres/E3C8A673-8C50-4C32-899B-3EE54BFC4568/0/ISM_2nd_Edition.zip

J. Ding · D. Sun (✉) · J. Zhang
Training Department of Air Force Aviation University,
Changchun, China
e-mail: sdx58964@gmail.com; iott1230@163.com

Q. Fan
Aeronautical Control Engineering Department of Air Force
Aviation University, Changchun, China

B. Ren
Aeronautical and Mechanical Engineering Department of Air Force
Aviation University, Changchun, China

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International Air Transport Association (IATA), Air Transport Monitoring System (the ATOS) (Chen 2008) in the U.S. Federal Aviation Administration (FAA); As to domestic aviation safety evaluation, the use of fuzzy comprehensive evaluation method (Zhang and Wang 2006), multi-attribute decision making method (Li et al. 2007), bayesian network evaluation method (Ding and Yi 2009) have been widely used. Although aviation safety assessment has made a lot of results, but it can be seen from the type of the results, the decrease of risk caused by military aircraft maintenance activities is not given enough attention as the reduce of risk posed by the flight operations. At the same time, the research has not formed as a unified safety and quality comprehensive evaluation system on the safety and quality of grassroots-oriented military aircraft maintenance, the achievement is limited and the related safety and quality indicators remains mostly in isolated and gap analysis. Therefore, it is necessary to establish a quantified grassroots-oriented military aircraft maintenance safety and quality evaluation system. Drawing on the useful experience of the foreign military, using the Set Pair Analysis methods (SPA), this paper aim to establishing and improving the maintenance of safety and quality evaluation system, the significance to improve the level of maintenance management and combat effectiveness is obvious.

122.2 The Basic Concept of Set Pair Analysis

Set pair analysis (Zhao 2000) (SPA) is a system analysis method which is proposed by Keqing ZHAO, Chinese famous scholar. SPA believe that uncertainly is the essential nature of things, the certainly and uncertainly as a comprehensive inspection system, the system of certain is divided into the "same" and "opposition", the uncertain is defined as "different". The "three" are interrelated constraints, and under certain condition into each other. The core concept of Set pair analysis is contract degree. Set pair is associated with a certain set consisting of two pairs, connection degree is a characteristic set of links in the quantitative characterization, the expression is $\mu = a + bi + cj$. Where i is the different coefficient value in the range of $[-1, 1]$; j denotes the opposing coefficient who's value is set as -1; a, b and c denote the same degree, different degree and opposing degree respectively. A and c is certain relatively while b is not. We can know from the definition that $a + b + c = 1$.

122.3 The Multiple Index Evaluate Model

122.3.1 Establish the Evaluation Index System and Index Calculation Criteria

Aircraft Maintenance Management of the U.S. air force ordinance define eight index to judge the quality of maintenance work, they are major failure rate of the aircraft equipment, ground accident rate, the rate of qualified personnel, aircraft status report accuracy, plan efficiency, flight emergency rate, aircraft mission support rate, staff compliance rate. Aeronautical Engineering Protection Ordinance proposed by the Russian air force in 1991, provides a unified index system for the assessment of aviation equipment and maintenance of equipment status and technical quality, contains 279 indicators totally (Zhang et al. 2006). At present, the air corps quality control room uses ten tips of index to make judgment of the quality and safety of the aircraft maintenance work. In order to meet the needs of aviation equipment informatization development and reform of the aviation maintenance, on the basis of foreign military useful experience, we can consider the use of maintenance safety index (SI) and service quality index (QI). The gass-roots military aircraft maintenance safety quality evaluation index architecture is shown in Table 122.1. The index calculation type can be divided into three categories. The index of I can be calculated by the data of the statistics from the quality control room of air force units. The intact rate of aircraft, success rate of the support task and the time of direct maintenance belong to this class. What should be noted is that all of the index quantity value needed to be divided by the designed value or the mean of same type of aircraft. The index of II is the data that our quality control system doesn't record, and we should use special method to collect the information. III index is a quality assessment score index, such as the personnel pass rate. The value of the index is the test result, and quality evaluation is a combination of theory written and practical test.

122.3.2 Determine the Links Between the Comparison Space and Index (Chen et al. 2009a, b; Cao et al. 2008)

Now the military aircraft maintenance safety and quality assessment is denoted by G = (S, E, W, X), S = {s1, s2, …, sm} denotes a set of the maintenance forces to be assessed, Sr denotes the rth maintenance force; and E = {e1, e2, …, en} denotes the evaluation index set, er is the rth index.

$W = \{w_1, w_2, \ldots, w_n\}$ means the index weight set, w_r is the weight of index r, while $\sum_{i}^{n} w_r = 1, w_r > 0$; $x = (x_{kr})_{m \times n}$ indicates the decision matrix, x_{kr} shows the await maintenance troop s_k's quantification value about the index e_r. The maintenance security quality optimal evaluation set $U = \{u_1, u_2, \ldots, u_n\}$ and the worst evaluation set $V = \{v_1, v_2, \ldots, v_n\}$ are determined by each index weight value, among them, u_r, v_r mean the maximum and minimum value separately. The comparison space [V, U] consists of the optimal and worst evaluation set.

While the benefit index such as the aircraft complete rate meets $\frac{x_{kr}}{u_r+v_r}, \frac{x_{kr}^{-1}}{u_r^{-1}+v_r^{-1}} \in [0,1]$, they shows the approach degree of data x_{kr} and u_r, x_{kr} and v_r. The data larger, the approach degree bigger, therefore the similarity level, contrary level and the difference level are defined as following:

Table 122.1 Index weight and value

Index of the maintenance quality evaluation	Type of Index	Index weights	Maintenance force A	Maintenance force B	Maintenance force C	Maintenance force D
Aircraft in good order	☐	0.025	0.90	0.75	0.80	0.85
Success rate of the support task	☐	0.022	0.94	1.15	1.20	0.90
Hourly direct maintenance time	☐	0.014	0.85	1.05	1.10	0.92
Mean time to repair	☐	0.013	1.16	0.87	0.94	1.00
Mean preventive maintenance time	☐	0.010	0.86	1.04	1.06	0.96
Frequency of replace engine	☐	0.021	7	7	8	9
Check time of per-machine	☐	0.020	15	16	17	18
Re-dispatch time of 4 aircrafts in the same condition	☐	0.008	28	28	29	27
Maintenance flight rest rate	☐	0.005	0.60	0.45	0.55	0.56
Maintenance error per-thousand rate	☐	0.015	0.70	0.68	0.65	0.55
Flight error per-thousand rate	☐	0.120	0.65	0.65	0.55	0.50
Flight accident portent per-ten thousand rate	☐	0.130	0.35	0.30	0.20	0.10
Serious flight accident per-ten thousand rate	☐	0.150	0	0	0	0
Three-grade accident per-ten thousand rate	☐	0.140	0	0	0	0
Serious ground accident per-ten thousand rate	☐	0.160	0	0	0	0
Common ground accident per-ten thousand rate	☐	0.110	0.25	0.23	0.22	0.20
Mean flight time between accident	☐	0.002	0.72	0.65	0.63	0.63
Flight frequency to maintenance day rate	☐	0.012	1.40	1.45	1.50	1.50
Personnel pass rate	☐	0.008	95	95	96	98
Maintenance plan efficiency rate	☐	0.004	40	42	45	44
Accident spare exchange rate	☐	0.011	0.90	0.70	0.60	0.80

$$a_{kr} = \frac{x_{kr}}{u_r + v_r} \tag{122.1}$$

$$c_{kr} = \frac{x_{kr}^{-1}}{u_r^{-1} + v_r^{-1}} \tag{122.2}$$

$$b_{kr} = 1 - a_{kr} - c_{kr} = \frac{(u_r - x_{kr})(x_{kr} - v_r)}{(u_r + v_r)x_{kr}} \tag{122.3}$$

So, to the benefit index, set pair connection level is:

$$\mu\{x_{kr}, u_r\} = \frac{x_{kr}}{u_r + v_r} + \frac{(u_r - x_{kr})(x_{kr} - v_r)}{(u_r + v_r)x_{kr}} i + \frac{x_{kr}^{-1}}{u_r^{-1} + v_r^{-1}} j \tag{122.4}$$

Note: Index weight is calculated via AHP and expert survey.

As the same reason, to the cost index such as maintenance responsibility aircraft error thousand rate, set pair connection level is:

$$\mu\{x_{kr}, u_r\} = \frac{x_{kr}^{-1}}{u_r^{-1} + v_r^{-1}} + \frac{(u_r - x_{kr})(x_{kr} - v_r)}{(u_r + v_r)x_{kr}} i + \frac{x_{kr}}{u_r + v_r} j \tag{122.5}$$

The similarity and contrary rate of Eqs. (122.4) and (122.5) show the await troop's evaluation index tendency of good or bad. Also, the similarity and contrary rate of two equations are symmetrical with the same difference level. In conclusion, the equation is integrated as:

$$\mu\{s_k, u\} = a_k + b_k i + c_k j \tag{122.6}$$

where $a_k = \sum_{r=1}^{n} w_r a_{kr}, b_k = \sum_{r=1}^{n} w_r b_{kr}, c_k = \sum_{r=1}^{n} w_r c_{kr}$.

Since $a_{k,}$ c_k are confirmed relatively, they indicate the await maintenance troop s_k's optimal and worst level approaching to maintenance security. Under relative certain conditions, the relative approach level of await maintenance troop s_k ($k = 1, 2, \ldots, m$) and optimal evaluation set U is defined as:

$$r_k = \frac{c_k}{a_k + c_k} \tag{122.7}$$

When the approach level c_k is bigger, the await troop s_k get closer to the optimal evaluation set U, so according to $r_{k,}$ await troop aircraft maintenance security quality can be evaluated.

122.3.3 Example Analysis

Using above evaluation method, the paper evaluate four await troops. Each evaluation index value is showed in Table 122.1. The weights are confirmed in Table 122.1, and the integrated connection level and relative approach level are calculated via Eqs. (122.4)–(122.7), shown in Table 122.2. Meanwhile, in order to improve the reliability and veracity of proposed method, gray relation evaluation method and the TOPSIS evaluation method are used to examine the results, shown in Table 122.3. From Table 122.2 and 122.3, it is known that the results three methods are no difference, they are: C > B > A > D. In summary, the set pair analysis method's application to aircraft maintenance security quality evaluation is feasible and accurate.

122.4 Achievment of Dynamic Distributed Application System

Given that the aircrafts of different troops are located in diverse areas, when the military plane maintenance security evaluation system is exploited, integrated, layered and distributed system is required to ensure that the system is compact and the components could be transplanted, extended and operated. Exploited method based on components makes it possible. CSCW (Computer Support Cooperation Workgroup) is a set of software based on distributed computer system, its goal is to design application system supporting all kinds of synergy works, and improve people's ability of solving problems. Under B/S framework, client screen is realized via WWW browser, the proposed browser—Web server—data base server framework is shown as Fig. 122.1. IE browser is installed by clients; and Microsoft IIS is installed by Web browser, the ASP is used as the browser script language, the interactive marking component and ActiveX control component are installed to provided download; Windows NT is installed in evaluation server, the COM components are deployed and managed by NT's MTS; the system data base and maintenance module procedure are installed in data base.

Table 122.2 The spa evaluation results of await troops

Parameters	Await maintenance troops			
	A	B	C	D
Integration level a_k	0.227	0.244	0.273	0.216
Diversity b_k	0.445	0.408	0.467	0.456
Contradiction level c_k	0.328	0.348	0.260	0.328
Relative close level r_k	0.409	0.412	0.512	0.397
Rank	3	2	1	4

Table 122.3 The gray relation and TOPSIS evaluation results of await reoops

Await troops	Gray relation	Rank	TOPSIS	Rank
A	0.864	3	0.941	3
B	0.906	2	0.947	2
C	0.942	1	0.958	1
D	0.746	4	0.932	4

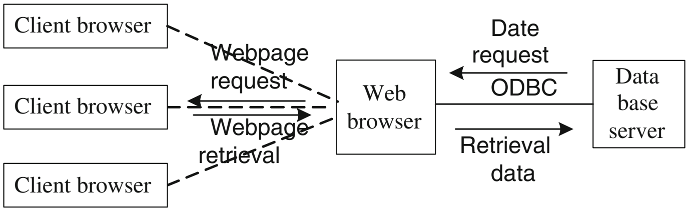

Fig. 122.1 Browser-web server-data base server three-layer framework

In the evaluation process, the interactive of the personnel and process are achieved by ASP dynamic webpage and ActiveX control component. When other systems are integrated, they send requests to the evaluation server, and invoke the ports of server evaluation components to put the evaluation into effect.

122.5 Conclusion

The paper begins with military aircraft maintenance security evaluation index system, the set pair analysis method is used, based on original data connection level, the troop maintenance security quality is evaluated, and the maintenance security quality evaluation system based on component and network technology is discussed, it is beneficial for the equipment department to master the maintenance quality condition, and provide support for information-based air battle.

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Chapter 123
The Application of Fuzzy Comprehensive Evaluation on Special Equipment Risk Assessment

Yuan-rong Zhang, Jian Zhang, Yu-dong Li and Chao Ji

Abstract This paper uses fuzzy comprehensive evaluation method to assess the safety level of special equipments. An assessment model that examines quantity and quality factors was presented. The proposed model has two dimensions, the possibility and severity of accidents. The possibility of accidents was evaluated by dimensions of people, equipment, management and environment. Emergency response was concerned in judging the severity of accidents. Indicators of the assessment model were established based on expert opinions collected via questionnaires. Analytic Hierarchy Process was utilized to calculate the weights of indicators in each layer to construct the assessment model. Finally, the fuzzy comprehensive evaluation method was used to assess the safety level of a portal crane in the case company.

Keywords Risk assessment · Special equipment · Fuzzy comprehensive evaluation

Y. Zhang (✉) · J. Zhang
Fujian Special Equipment Inspection and Research Institute,
Fuzhou 350008, China
e-mail: 1253511623@qq.com

J. Zhang
e-mail: 32141081@qq.com

Y. Li · C. Ji
Business School, Sichuan University, Chengdu 610065, China
e-mail: 635308167@qq.com

C. Ji
e-mail: 815481560@qq.com

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123.1 Introduction

China has categorized boiler, pressure vessels (including cylinders), pressure pipelines, elevators, chain blocks, motor vehicles in plant, passenger transport telphers and large amusement facilities as special equipments (Rongji 2003). Special equipments were widely used in various areas of national economy and people's daily life. Once accident occurred with special equipments, significant loss and serious adverse social impact will happen (Zhifeng and Yanchao 2006). Take the year of 2011 for sample, according to the statistics, there are 296 cases of accidents related to special equipments occurred in China. These accidents caused direct losses of 66.81 million Yuan, with 310 people killed and 247 people injured.

Safety assessment can get comprehensive information referring to safety statue and risk level of special equipments in service. It is useful both for enterprises' risk management improvements and safety supervision institutions' risk control (Zhenlin and Jinlan 2008). In the recent 10 years, risk based inspection (RBI) has been widely used overseas to assess the risk of pressure vessels (Dong 2010). RBI is a method for using risk as a basis to prioritize and manage the efforts of an inspection program (Patel 2005). But the bases for safety management on special equipments in China are still experiences and laws (Ziqiu and Men 2006).

123.2 Construction of Special Equipment Risk Assessment Model

123.2.1 Constructing the Index System

According to the characteristics of risk and examining domestic and international literature, this study uses the two dimensions, the possibility and severity of accidents, to classify the risk level.

The present safety management of special equipments are mainly depended on the inspection to equipments. Factors of people, management and environment are usually not concerned. Statics shows that most accidents are related to people directly or indirectly (Han 2008). This study developed a systematic hierarchy index system by examining domestic and international literature (Yang 2008, 2006; Wu 2007) and conducting a questionnaire study. The index system was shown in Fig. 123.1.

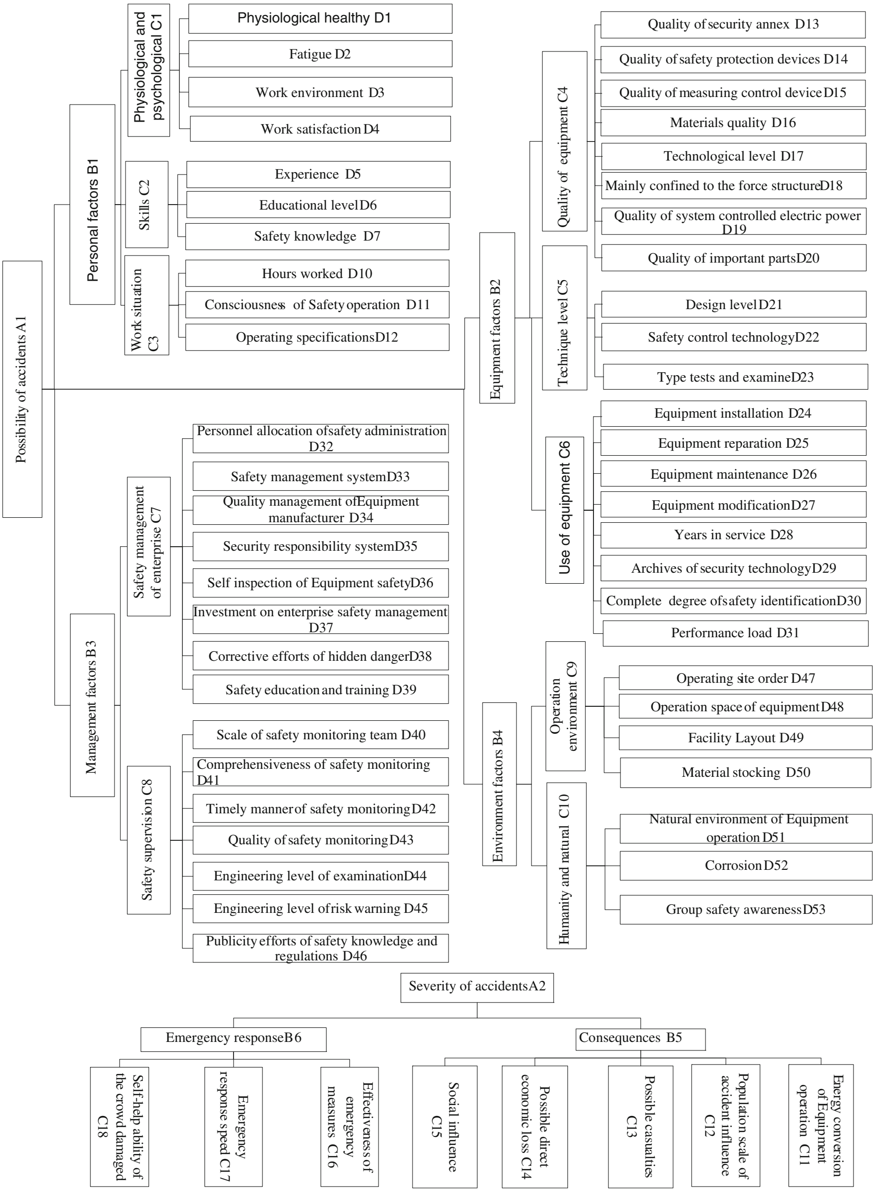

Fig. 123.1 Index system for special equipment

123.2.2 Establishment of Assessment Model

Regarding the established index system, the weights of each layer should be calculated for a complete equipment risk assessment model. Analytic Hierarchy Process is a simple, flexible and practical multi-criteria decision making method presented by professor Saaty in the early 1970s (Satty 2004).

The basic steps of AHP in this study are as follow:

Step. 1: Define the problem and create hierarchical structure for every relevant factor by experts.
Step. 2: Design AHP questionnaires and distribute to respondents. Transform geometric means of questionnaires into the pairwise comparison matrix.
Step. 3: Calculate the weights of each layer and the consistency ratio (CR).

The calculation results of each layer are shown as vectors, all the CR was less than 0.1.

(a) *Weights of the accident possibility indicators*

$A_1 = (0.4668, 0.2776, 0.1603, 0.0953)$
$B_1 = (0.0836, 0.4443, 0.4721)$
$C_1 = (0.3705, 0.3448, 0.1852, 0.0995)$
$C_2 = (0.3720, 0.2017, 0.2454, 0.1019)$
$C_3 = (0.5396, 0.1634, 0.2970)$
$B_2 = (0.5396, 0.1634, 0.2970)$
$C_4 = (0.050, 0.039, 0.071, 0.077, 0.027, 0.027, 0.172, 0.337)$
$C_5 = (0.5584, 0.3196, 0.1220)$
$C_6 = (0.2598, 0.1602, 0.2153, 0.0818, 0.0825, 0.0508, 0.0252, 0.1245)$
$B_3 = (0.6667, 0.3333)$
$C_7 = (0.2022, 0.2370, 0.1763, 0.1168, 0.0627, 0.0856, 0.0422, 0.0773)$
$C_8 = (0.0504, 0.2049, 0.1751, 0.1640, 0.2437, 0.0826, 0.0793)$
$B_4 = (0.7500, 0.2500)$
$C_9 = (0.1512, 0.4098, 0.3207, 0.1183)$
$C_{10} = (0.1059, 0.5816, 0.3090)$
$C_{11} = (0.7500, 0.2500)$

(b) *Weights of the accident severity indicators*

$A_2 = (0.7500, 0.2500)$
$B_5 = (0.0445, 0.2483, 0.4903, 0.0966, 0.1203)$
$B_6 = (0.2970, 0.5396, 0.1634)$

123.3 Applying of the Model

123.3.1 Introduce of the Fuzzy Comprehensive Evaluation Method

An actual decision making question is often influenced by many attributes or factors, people need to make a comprehensive evaluation by these attributes or factors. In most cases, these attributes or factors are fuzzy, to make comprehensive evaluation of these fuzzy factors is called fuzzy comprehensive evaluation (Guangfu et al. 2010; Huang et al. 2010).

The basic procedures of multi-level fuzzy evaluation are as follows (Zhou et al. 2011):

1. Partition factor set of evaluation into several subsets according to certain criteria:

$$U = \bigcup_{i=1}^{s} u_i$$

2. Utilize single level fuzzy comprehensive evaluation for every u_i

Determine level set: $\mathrm{V} = \{v_1, v_2, \ldots, v_n\}$, n represents the grade number of evaluation.

Establish evaluation matrix

$$\mathrm{R} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

Data r_{ij} denotes the degree that factor i belongs to level j in the evaluation. It is usually calculated from the scoring of factors by a function.

Weight vectors $A_i = \{a_{i1}, a_{i2}, \ldots, a_{ip_i}\}$, $\sum_{r=1}^{r=p_i} a_{ir} = 1$ should be determined before the evaluation. The single level evaluation result of u_i is:

$$P_{ui} = A \circ R = (b_1, b_2, \ldots, b_n)$$

3. Utilize single level fuzzy comprehensive evaluation for subsets

Regard ui as a comprehensive factor, and use P_{ui} to construct the evaluation matrix to calculate the final result.

If the division in the first step u_i(i = 1, 2, …, s)is still too much, it can be divided into 3 or more levels.

123.3.2 Backgrounds of Case Portal Crane

The M10–30 type portal crane was made in May 1989 and was installed in 1990 in Quanzhou harbor. The original design for the biggest elevating capacity is 10 tons, and the hoisting extent maximum 30 m, minimum 8.5 m. At the beginning of putting into use in 1990, as port workload is not heavy, equipment utilization was not high; the load of door crane is small, and crane safe technology to little effect on performance.

Since 1999, due to the rapid economy development in Quanzhou, equipment load and utilization has increased significantly. To meet the increasing production capacity requirements, the company entrusted Shanghai Donggang Machinery Corporation to modify the hoist boom in November 2001. Rated lifting weight was increased to 16 tons after the modification.

After putting into use for 22 years, fatigue crack of metal structure and aging electrical system would probably be the hidden risk of accidents.

123.3.3 Determination of Membership Functions

As the index system includes both qualitative and quantitative indicators, the judgments were made by scoring the indicators from 1 to 100.

In this study, the risk range was divided into five levels, which was shown in Table 123.1. The original data was collected by questionnaires and geometric means of scores was calculated.

According to the evaluation level given in Table 123.1 and experts' opinions, the formulas of membership functions were presented below:

Good:

$$u(x) = \begin{cases} 0 & 0 \le x < 80 \\ (x-80)/10 & 80 \le x < 90 \\ 1 & 90 \le x \le 100 \end{cases}$$

Preferably:

$$u(x) = \begin{cases} 0 & 0 \le x < 70 \\ (x-70)/10 & 70 \le x < 80 \\ 1 & x = 80 \\ (90-x)/10 & 80 < x \le 90 \\ 0 & 90 < x \le 100 \end{cases}$$

Table 123.1 Risk range and set

Evaluation set V	Good (level 1)	Preferably (level 2)	General (level 3)	Poorer (level 4)	Extremely poor (level 5)
Scores	≥90	80	70	60	≤50

General:

$$u(x)=\begin{cases}0 & 0\leq x<60\\ (x-60)/10 & 60\leq x<70\\ 1 & x=70\\ (80-x)/10 & 70<x\leq 80\\ 0 & 80<x\leq 100\end{cases}$$

Poorer:

$$u(x)=\begin{cases}0 & 0\leq x<50\\ (x-50)/10 & 50\leq x<60\\ 1 & x=60\\ (70-x)/10 & 60<x\leq 70\\ 0 & 70<x\leq 100\end{cases}$$

Extremely poor:

$$u(x)=\begin{cases}1 & 0\leq x<50\\ (60-x)/10 & 50\leq x<60\\ 0 & 60\leq x\leq 100\end{cases}$$

123.3.4 Calculation of Fuzzy Evaluation

Take layer C1, the physiological and psychological factor for example, the fuzzy comprehensive evaluation matrix R1 was calculated by substitute into the membership functions:

$$\mathrm{R1}=\begin{pmatrix}1 & 0 & 0 & 0 & 0\\ 0 & 0 & 1 & 0 & 0\\ 1 & 0 & 0 & 0 & 0\\ 0 & 0 & 1 & 0 & 0\end{pmatrix}$$

And, $\mathrm{W_{C1}}=(0.3705, 0.3448, 0.1852, 0.0995)$

We can get fuzzy judging analysis sets according to the formula $P_{ui}=A\circ R$:

$$\mathrm{P_{C1}}=(0.5626, 0.4374, 0, 0, 0)$$

Other fuzzy judgment analysis sets was calculated as same. Regard $\mathrm{B_i}$ as a comprehensive factor,and use $P_{Bi}, i=1, 2, 3, 4$ to construct the evaluation matrix of possibility of accidents $\mathrm{R_{Ai}}$:

$$R_{A1} = \begin{pmatrix} P_{B1} \\ P_{B2} \\ P_{B3} \\ P_{B4} \end{pmatrix} = \begin{pmatrix} 0.12 & 0.47 & 0.29 & 0.13 & 0.00 \\ 0.10 & 0.10 & 0.22 & 0.10 & 0.48 \\ 0.28 & 0.25 & 0.30 & 0.09 & 0.08 \\ 0.12 & 0.00 & 0.66 & 0.08 & 0.15 \end{pmatrix}$$

and, $W_{A1} = (0.4668, 0.2776, 0.1603, 0.0953)$

We can get fuzzy judging analysis sets according to the formula $P_{ui} = A \circ R$:

$$P_{A1} = (0.14\ 0.28\ 0.31\ 0.11\ 0.16)$$

Taking the same procedure, the result of severity of accidents can be calculated:

$$P_{A2} = (0.14\ 0.18\ 0.37\ 0.31\ 0.00)$$

123.3.5 Analysis Results and Recommendations

In this study, risk matrix (Zhang and DeJun 2010) was used for measuring overall risk level of special equipment. Hidden risks are divided into five levels, shown in Table 123.2. Each level represents a corresponding implication, shown in Table 123.3.

According to the evaluation results, levels of two dimensions were determined by maximum membership degree principle:

1. $P_{A1} = (0.14\ 0.28\ 0.31\ 0.11\ 0.16)$, accident probability belongs to level 3.
2. $P_{A2} = (0.14\ 0.18\ 0.37\ 0.31\ 0.00)$, severity of accidents belongs to level 3.

According to Table 123.2, the potential accident level of case portal crane is General hidden danger. As R_{A1} demonstrates, $P_{B2} = (0.10\ 0.10\ 0.22\ 0.10\ 0.48)$, which means that equipment factors have a rather poor performance. Accidents are likely to occur due to equipment failure. The case crane requires improvement and continual attention to avoid further degeneration.

Table 123.2 Safety level of special equipment

Accident Possibility	Severity of accident				
	Level 1	Level 2	Level 3	Level 4	Level 5
Level 1	Safety	Slight	Slight	General	General
Level 2	Slight	Slight	Slight	General	Serious
Level 3	Slight	Slight	General	General	Serious
Level 4	General	General	General	Serious	Super-serious
Level 5	General	Serious	Serious	Super-serious	Super-serious

Table 123.3 Evaluation risk levels and corresponding implications

Risk levels	Execution outcomes and implications
Safety	Excellent performance for equipment safety
Slight	Failure may occur, requiring continual attention
General	Accidents are likely to occur, requiring improvement and continual attention to avoid further degeneration
Serious	Safety statue of equipment is poor and accidents are very likely to occur, requiring immediate rectification and improvement with execution feedback
Super-serious	Serious accident will occur if emergency measures not be implemented immediately, and equipment should not put into use until hidden risk has been eliminated.

123.4 Discussion

Although the fuzzy evaluation scores was given by relevant experts in this study, the subjectivity of people is still a remarkable question. More objective risk assessment results should be obtained by the analysis of statistical data base. A further research on scoring mechanism should be implemented.

What's more, it is impractical to assure all the evaluators have a good knowledge of math. Thus, professional software should be developed to promote the use of the proposed evaluation method in this study.

123.5 Conclusion

This paper used the fuzzy comprehensive evaluation method to assess the risk level of special equipments. A systematic index system was developed based on literature and experts' knowledge. Risk level was determined based on risk matrix and opinions from experts in relevant fields. A case evaluation was conducted and evaluation results indicate that the case portal crane has a risk level of General hidden danger B and should be rectified before turn in service.

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Chapter 124
Aviation Equipment Maintenance Safety Management Based on the Technology of IOT

Xiao-kun Wang, Yong-yu Liu, Zhe-yu Li, Ming-feng Li and Shu-li Zhang

Abstract The paper researches and analyses the Internet of Things and aviation equipment maintenance security management. It provides specific measures for aviation equipment maintenance security management on application of the Internet of Things technology. This paper has an important significance upon accelerating up the process of information of the aviation equipment maintenance safety management and enhancing the management efficiency of it.

Keywords Internet of things technology · IT · Aviation equipment · Maintenance safety · Safety management

124.1 Introduction

New information warfare style and substantial increase of the degree of equipment of the information put forward urgent requirements of the aviation equipment maintenance safety management enter a new stage of development—the aviation equipment maintenance safety information management stage (Ji et al. 2004). Internet of Things technology as a combination of sensor technology, communications technology and computer technology is one of the most important information technology of the 21st century. Internet of Things technology is considered to be the

X. Wang (✉)
School of Optical and Electronic Engineering, Changchun University of Science and Technology, Changchun, People's Republic of China
e-mail: Wangxiaokun_yanyan@163.com

X. Wang · Y. Liu · Z. Li · M. Li
Aviation University of Air Force, Changchun, People's Republic of China

S. Zhang
Redstone Forestry Branch of Jilin Forest Industry Co., Ltd., Jilin, People's Republic of China

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third information technology and information revolution after the computer development and Internet universal application, which has important applications in the military. This paper will be based on Internet of things military applications and attempt introduction of Internet of Things technology into aviation equipment maintenance and support and safety management system, in order to effectively enhance aviation equipment maintenance safety management performance.

124.2 Overview of the Internet of Things Technology and Aviation Equipment Maintenance Safety Management

Concepts and advanced information technology of the Internet of Things, has been quickly used to perception and control a variety of combat supplies in the field of military logistical support in developed countries to meet the requirements of modern warfare on logistical precision protection.

124.2.1 An Internet of Things and its Key Technologies

There is no uniform standard definition on the Internet of Things currently. General, the Internet of Things is look like a huge network combining the various information sensing devices and the Internet. Specifically, the Internet of Things is seen as a network, which can intelligent identify, locate, track, monitor and manage any items connected to the Internet, and exchange information and communicate according to the agreed protocol through radio frequency identification (RFID), infrared sensors, global positioning systems, laser scanners, and other information sensing device. The Internet of Things has the characteristics of the Internet, but more finer, stronger and more comprehensive than the Internet in functionality according to the definition of Internet of Things. Sensor technology, communication technology and computer technology as the three foundation of modern information technology complete the information collection, transmission and processing respectively. The Internet of things combined the three techniques together to achieve real unity of the information collection, transmission and processing. Therefore, the Internet of Things is considered one of the most important technology of the 21st century, it would have a profound impact on the future humanity lifestyle.

A lot of technology involved in the Internet of Things, including perception technology, communication technology, network technology, found with search engines technology, data processing technology, network management technology, etc. The RFID technology, communication technology and network convergence technologies, sensor technology and intelligent information processing technology are recognized as the four key technologies of the Internet of Things, in which, the RFID technology is used for object identification, the sensor technology is responsible for perception of the object dynamic information, the communication technology and network convergence technologies is used for information transmission, the intelligent information processing technology is for information processing (Qiu 2011).

124.2.2 *Aviation Equipment Maintenance Safety Management*

With the rapid development of science and technology and military aircraft widely used in the military area, aviation equipment is increasingly sophisticated and complex, becoming increasingly dependent on maintenance. Aviation equipment maintenance capacity has become an important part of the Air Force combat effectiveness of troops. Aviation equipment maintenance as the primary task of aviation equipment operations and training is to quickly maintain and restore the good and available state of aviation equipment in accordance with the requirements, content and procedures at any time under any circumstances, in order to meet the military operations and training needs.

Aviation equipment maintenance safety management is the management activities conducted by the aviation maintenance system in order to ensure the flight safety and aviation maintenance operations safety (Deng et al. 2011). Aviation equipment maintenance safety management is one of the main content of the aviation equipment maintenance management, which has great significance in ensuring the combat training tasks carry out smoothly. From a functional point of view, the main content of the Air Force aviation equipment maintenance safety management includes nine aspects such as the planning of safety work, the processing of quality and safety information, safety supervision and inspection, air and ground accidents (incidents) investigation, security situation monitoring, accident prevention macro decision-making, security education and training, safety legislation and safety research (Wang 2008).

124.3 The Needs Analysis of Using Internet of Things Technology for Aviation Equipment Maintenance Safety Management

At present, our military aviation maintenance safety management plays an active role in improving the level of aviation maintenance management and preventing accidents and incidents due to poor management. However, with a large number of new aviation equipment put into use, the existing maintenance system, maintenance programs and support methods need to be optimized continuously by using scientific methods and means. The level of maintenance and management information also needs to be greatly improved (Zheng 2006). Therefore, it is of great significance to use advanced Internet of Things technology for aviation equipment maintenance safety management, hence to speed up the information process of aviation equipment maintenance safety management and to optimize aviation equipment maintenance safety management comprehensive benefits.

124.3.1 The Visualization Needs of the Aviation Equipment Maintenance Safety Management

There are many uncertain factors affecting the aviation equipment maintenance, such as battlefield environment, equipment condition, maintenance resources, technical level of personnel, etc. and these factors are diverse and complex. The aviation equipment maintenance safety management needs to effectively manage and monitor every aspects and each elements of aviation combat equipment and aviation equipment support throughout the entire life-cycle process from test, production, use, maintenance until to final abandonment that aviation safety-related, thus to arrange maintenance equipment and personnel timely and reasonable according to maintenance processes and maintenance tasks and to promote capability to dealing with emergencies. Leaders and function departments at all levels also need to grasp and understand all kinds of information of maintenance safety management timely and make a whole process control of the maintenance safety management work processes and the quality of work.

Visualized monitoring and supervision of aviation equipment maintenance personnel and material in important links, nodes and parts of maintenance process can be implemented by using Internet of Things visualization techniques and automatic identification technology with a combination of computer platforms, databases, etc. This advanced visualized dynamic management model based on the Internet of Things technology will greatly change the backward state of the traditional aviation maintenance safety management supervision, decision-making and disposal to maintenance process. It will be conductive to improve the process of safety management of all aviation maintenance activities of various time, space and aspects, in order to reduce the accidents and incidents endangering the security to a minimum.

124.3.2 The Information Needs of the Aviation Equipment Maintenance Safety Management

The wide range of applications of IT-oriented high-tech in the field of aviation equipment maintenance directly promotes the information process of aviation equipment maintenance safety management. Increasingly, the aviation equipment maintenance safety management depends on information in the information age.

The information technology has become a key to improve aviation equipment maintenance security management capabilities and to implement aviation equipment maintenance safety management reform under the under the conditions of information warfare. It can achieve a high degree of sharing and comprehensive utilization of the limited technical resources, material resources and battlefield information resources, promote the modernization and fine development of the aviation equipment maintenance safety management and improve the comprehensive benefits of the aviation equipment maintenance safety management by means of collection, transmission, processing and use of the aviation equipment maintenance information related to safety and risk control.

The Internet of Things has the characteristics of the network, and joint property, the Internet, automated, perception, intelligence. The information maintenance safety management system with the functions of intelligent decision-making, automatic monitoring, total factor management based on the advanced Internet of Things IT can not only provides protection of the rapid information flow interaction for security monitoring, but also can comprehensively reflect the matches and combination degree of the factors such as manpower, material, financial resources, information, technology, management level and aviation equipment maintenance objects. The information of the aviation equipment maintenance safety management will well meet the high security requirements of the aviation information equipment.

124.3.3 The Needs of Technology-Based of the Aviation Equipment Maintenance Safety Management

The modern aviation equipment as a high technology integration requires high maintenance technology and the maintenance safety management of which is difficult. To manage and monitor every aspects, each elements of aviation combat equipment and aviation equipment support throughout the entire life-cycle process from test, production, use, maintenance until to final abandonment that aviation safety-related effectively are bound to establish aviation equipment maintenance safety management system which is characterized by advanced functions, fast and efficient, scientific management, excellent performance, stable operation and is compatible with the safety requirements of aviation equipment maintenance. For this reason, it is necessary to adopt a large number of high-tech to effectively ensure the efficient operation of the safety management systems in aviation equipment maintenance.

Internet of Things is a internet that can not only achieve automatic and intelligent information collection, transmission, processing and connections between objects and objects through a variety of sensing equipment and Internet, but also can implement anytime, anywhere scientific management. The characteristics of the Internet of Things determine that it can be used to secure the scientific management of the aviation equipment maintenance. The information and integrated logistics management system and process monitoring system based on the Internet of Things technology can effectively improve the management efficiency of the aviation equipment maintenance materials and spare parts storage areas and greatly reduce the security risks caused by inadequate reserves and varieties confusion of raw materials and parts. The information aviation equipment maintenance safety management system based on RFID technology combined with Open GL and many other technologies can achieve a variety of functions such as storage of raw materials and spare parts, raw materials and parts from top to bottom shelf, real-time stocktaking by using both the label to record the library, raw materials and parts information and the fixed, mobile and handheld readers to capture and instant delivery the information anywhere and anytime. The traceability of management behavior and raw materials and parts information can be achieved by means of convenient, fast and accurate acquisition of the raw materials and parts data, which can provide accurate dynamic information for raw materials and spare parts management.

Internet of Things technology can be used for overall process tracking of the aircraft throughout the life cycle, monitoring the critical systems of aircraft, especially for monitoring aircraft flight status, equipment working status, aircraft parts performance. And it will be conducive to obtain and analyze the data in the work of the equipment, apparatus, parts and components of the aircraft during flight, and scientifically determine the aircraft maintenance interval. For example, the information of basic run situation of the aircraft engine, oil performance indicators, etc. can be obtained by using the Internet of Things technology, then a more comprehensive condition monitoring and fault diagnosis on the operational status of aircraft engines can be implemented, and hence to effectively protect the safety of the flight (Ning 2010).

124.4 The Specific Measures for Aviation Equipment Maintenance Safety Management Using the Internet of Things Technology

Aviation equipment maintenance safety management based on the Internet of Things is to use the Internet of Things technology for aviation equipment maintenance safety scientific and informational management. It should under the guidance of the concept of innovation, continue to introduce and promote the application of advanced technology, and take the development of the maintenance of safety management personnel with information literacy as the fundamental to achieve the scientific and information aviation equipment maintenance safety management.

124.4.1 The Implementation of the Aviation Equipment Maintenance Safety Management Based on the Internet of Things Technology Should Under the Guidance of the Science Maintenance Concept

The concept is ideas and value judgments that one held. Every aspect of the aviation equipment maintenance safety management are inseparable from the decision-making and judgment. The construction of aviation equipment maintenance and safety management system based on the Internet of Things technology itself is a innovation of the safety management concept. The Internet of Things technology will greatly expand the time, airspace and frequency domain of the safety management, and makes the battlefield awareness more accurate, the weapons and equipment more intelligent, the logistical support more sensitive. The Internet of Things will trigger a restart of revolution in military affairs and significant changes in army building and combat (Zhang 2010). It will also trigger the new changes of the aviation equipment maintenance safety management.

The new concepts as a strong impetus to the development of aviation equipment maintenance such as speed management, total productive maintenance, integration of continuous maintenance, total quality maintenance and green maintenance, etc. are constantly emerging, which provide a theoretical draw for the establishment of aviation equipment maintenance safety management system based on Internet of Things technology (Zhang et al. 2007). The implementation of the aviation equipment maintenance safety management based on the Internet of Things technology should from the actual needs of the aviation equipment maintenance safety management, based on the advanced IT and innovative management ideas, and to continuously guide scientific development of the aviation equipment maintenance safety management.

124.4.2 The Implementation of the Aviation Equipment Maintenance Safety Management Based on the Internet of Things Technology Should Take the Advanced Technologies as the Support

The information aviation equipment needs information management. The rapid development and wide application of the high-tech clusters with the Internet of Things technology as the core in the military field provides possibility and environmental conditions for the aviation equipment maintenance safety management to develop and innovate. In addition to the constant inheritance and innovation to the existing experience, methods and means, the aviation equipment maintenance safety management should not only widely learn, research and take the foreign military advanced management methods as reference, but also continue to introduce and promote the use of the advanced technology to adapt to the requirements of modern information equipment maintenance safety management.

The key technologies such as automatic identification technology including the technology of optical memory cards, radio frequency identification technology, smart cards, bar codes, etc. can be used to automatically obtain the maintenance resource data by means of identifying, tracking and recording the data of the maintenance spare parts and equipment, controlling the transfer of maintenance equipment and monitoring the repair process, equipment and personnel. The automatic identification technology used in the field of the aviation equipment maintenance has many advantages such as improving the fault diagnosis, reliability and fault trend analysis, shortening the time of recording accurate and comprehensive maintenance data, obtaining technology information, searching for repetitive failures and ordering maintenance required spare parts, etc. to improve the efficiency of maintenance work and to promote the integration of the aviation maintenance management and other functional management areas.

In addition, the remote maintenance security monitoring and the remote maintenance personnel and material support can be achieved by means of the Internet of Things technology. The maintenance and support in front and the rear command and control can be linked by the way of Internet of Things technology, which will break the traditional maintenance time and space, compress the weapons and equipment maintenance and support space, speed up the flow of weaponry and equipment maintenance and support information, greatly improve the aviation equipment maintenance efficiency, effectively guarantee the safety of aviation equipment maintenance.

124.4.3 The Implementation of the Aviation Equipment Maintenance Safety Management Based on the Internet of Things Technology Should Pay Close Attention to the Maintenance Security Management Personnel Development

The modern aviation equipment are certain high-tech weaponry with the characteristics of high integration degree, multi-performance parameters for measuring and strict control of the use and consumption (Tao 2009). With the Air Force being equipped with modern new aviation equipment the aviation equipment maintenance quality and safety management will confront with more pressure and challenges. With the enormous pressure and challenge, the aviation equipment maintenance safety management must have a highly qualified personnel who are skilled and have a fine style of work to research innovation management methods and tools.

The aviation equipment maintenance safety management based on Internet of Things technology will meet the trends and requirements and strives to make the transition from a conventional experience-based maintenance to a scientific technology-based maintenance, the maintenance organizations form a troops intensive type to a knowledge and technology-intensive type, the maintenance key points form hardware-based to hardware and software combined, the maintenance performance from single support mode to a combination of command, control and technology mode, the maintenance personnel from a skills-based type to a intelligent-based type. The talent is the fundamental of the safety management, and the personnel development is the most urgent, important and critical step of the aviation equipment maintenance safety management. A group of talents are needed to implement the aviation equipment maintenance safety management based on the Internet of Things technology, who grasp of advanced information technology and management knowledge, being able to take advanced scientific means to increase the technology content of the maintenance security management and implement fully the aviation equipment maintenance safety management.

124.5 Conclusion

The Internet of Things is seen as a non-proven reserves of gold by many military experts. In fact, the Internet of Things has so many functions such as intelligent recognition of things function, intelligent monitoring function, location tracking function, etc. that it can be used in the fields of battlefield environment monitoring, target tracking and positioning, weapons and equipment intelligent, personnel and vehicles monitoring and logistical support. The more advanced aviation equipment, the higher the degree of dependence on technology and its operational effectiveness of the play even more depending on the effectiveness of the maintenance and support work, the role of equipment maintenance to protect the safety of the more significant (Wang 2009). Therefore, we must attach importance to the maintenance of aviation equipment repair security system security management issues. With the support and attention of the national strategy for the Internet of Things Internet of Things in China system will be established step by step and improve the Internet of Things will be more and better applications in every aspect of aviation equipment maintenance safety management and each of these elements, in order to ensure the maintenance of security, consolidate and upgrade the combat effectiveness of Air Force units, to ensure that the carry out of the Air Force combat training tasks play an important role.

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Chapter 125
Empirical Test of Asymmetric Wealth Effect of China Stock Market

De-cai Zhou, Hai-dong Xie and Zheng-feng Du

Abstract Basing on monthly data from January 2003 to December 2011, Use Multivariate dynamic Markov regime switching model to build the China stock market business cycle index, then use cointegration and error correction model to test its consumptions wealth effect. The test results show that China's stock market not only has a significant short-term wealth effects, but also has significant long-term wealth effect. However, the coefficient is negative, which is actually a crowding out effect. Using of the autoregressive dynamic distributed lag model, do further empirical analysis and find the asymmetric characteristics of stock market wealth effect in China. The main reason is maybe the substitution effect of investment to consumption larger than those of income effect in China, which may be related to the immature China stock market, investors and instable revenue expectation.

Keywords China stock mark · Asymmetric wealth effect · Business cycle index · Empirical test

125.1 Literature Review

Ando and Modigliani (1963) have first proved that stock market has significant wealth effect in the analytical framework of permanent income hypothesis and life-cycle approach. Since then, the overseas and domestic research on stock market wealth effect has focused on using different models and data to test empirically the size of wealth effect.

The foreign research of stock market wealth effect can be roughly divided into two overlapping stages: The first stage is testing empirically wealth effect of house

D. Zhou (✉) · H. Xie · Z. Du
School of Economics & Management, Nanchang University, Nanchang, People's Republic of China
e-mail: decaizhou@163.com

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-hold' assets, such as stocks, bonds and real estate, such as Hall (1978), Campbell (2000), Parker (1999), Boone et al. (2001). The second stage is empirically analyzing the asymmetry of the household' assets wealth effect, which has sprung up in recent years. Patterson (1993) and Shea (Shea 1995) discussed the asymmetrical influence of wealth shock on consumption. Kuo and Chung (2002) connected the asymmetric sensitivity of consumption with economic cycle. Cook (2007) and Stevans (2004) do empirical analysis to verify the asymmetric effects on consumption. Poterba (2000) thought that the stock market wealth effect is potentially asymmetrical. Zndi (1999) tested and found that the stock market wealth increasing by $1 may make consumption increase by about 4 cents, but $1 shrink may lead to a consumption reduction of 7 cents. However, Nicholas and Stephen' conclusion is completely opposite to Zndi's (1999) (Apergis and Miller 2005).

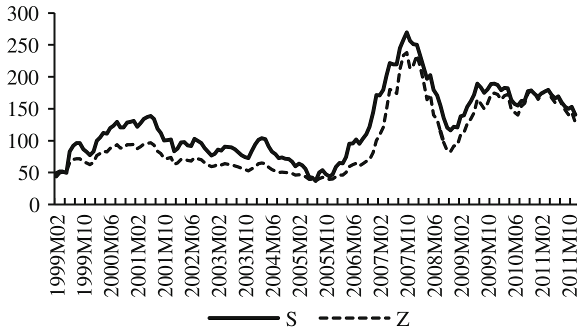
Empirical test of conclusions on the China stock market wealth effect can be mainly divided into two categories: The first is that the China stock market wealth effect does not exist in the consumption sense, such as Xia et al. (2003), Tang et al. (2008), Liu et al. (2008). The second is that China stock market wealth effect is existence, though less obvious, and relatively weak, such as Li (2001), Gao and Fan (2001), Li and Xu (2003), Luo (2004), Hong and Tian (2007), Luo and Liu (2008).

The researches results above are the basis for our paper. However, the study of the China stock market wealth effect is only concerned about the existence or the size of the wealth effect, ignoring the inherent characteristics of the wealth effect, such as asymmetry.

125.2 The Wealth Effect of Stock Market on Household Consumption: Empirical Test Based on Cointegration and Error Correction Model

We study the wealth effect of stock market on household consumption mainly using the variables of the stock market index, household income and consumption. The stock index is expressed by building the business cycle index of China stock market. Different from Standard practice that select only a single Shanghai Stock Exchange Composite Index (SHSECI), we have chosen three stock indexes: the SHSECI, Shenzhen Stock Exchange Composite Index (SZSECI) and Hong Kong's Hang Seng China Enterprises Index (HKCEI) as the observed variables to build a business cycle index of China stock market. We have introduced SZSECI in order to contain the impact of the growing SME board of China in recent years on the consumption; taking into the low degree of internationalization and marketization of China stock market, we have also put in HKCEI in order to conclude the impact of international stock markets on China's consumption. We select monthly urban household per capita disposable income and consumption on behalf of household income and consumption. There is because urban household are the main investors of China stock market, and rural household are less involved in it.

Fig. 125.1 Business cycle index (S) and the reference (Z)



125.2.1 Construct Business Cycle Index of China Stock Market Based on the Multivariate Dynamic Markov Regime Switching Model

Due to limited space, we don't describe the Multivariate dynamic Markov regime switching model and the scholars who are interested in it can read related works of Kim and Nelson (1998). Select monthly arithmetic average of the daily closing price of three stock indexes which are SHSECI, SZSECI and HKCEI from January 1999 to December 2011 as the observed variables to build Business cycle index of China stock market(S). The reference index is CITIC A shares Composite Stock Index (Z) which is transformed into the index which the mean is 100. The results show in Fig. 125.1, data from the SINA net and CITIC index net. It can be seen from Fig. 125.1 that the business cycle index of China stock market is consistent with the reference index CITIC Composite A Shares Stock Index.

125.2.2 Empirical Test to Wealth Effects of China Stock Market on Consumption Based on Cointegration and Error Correction Model

1. *The data's selection and disposal.* We selected urban per capita consumption as dependent variable and business cycle index of China stock market and urban per capita disposable income as independent variables. They are all monthly data, which originate from CEInet and range from January 2003 to December 2011. Amongst, the data of the consumptions and the income after 2007 are calculated from the Quarterly data with per capita social retail goods as weights. In order to eliminate the effect of inflation, all data are adjusted to the actual value by setting CPI's base period at January 2003. Considering household consumption and their disposable income turn out significant seasonal properties, we adjusted them by the method of X12.

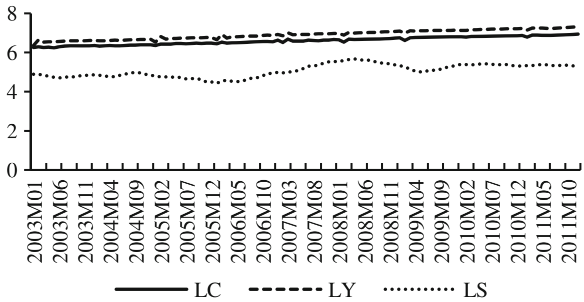


Fig. 125.2 Times series of LC, LY, and LS

transforming data into logarithm form does not change the original cointegration relationships and the linearize the trend, eliminate heteroscedasticity among time series, we take natural logarithm to them, marking household consumption, disposable income and stock market business cycle index as LC, LY and LS. The final outcome of the disposal is displayed in Fig. 125.2, which indicates that the lag 4–8 of business cycle index of China stock market take effects on household consumption and the effects are asymmetrical. Therefore, we make LS lagged for 6 orders.

2. *Tests on data's stability.* Use unit root test to examine the stabilities of the series. Reach the outcome at the Table 125.1. The Table 125.1 shows that three variables LC, LY and LS have unit roots under ADF test and PP test and they are unstable time series. However, their first difference of DLC, DLY and DLS all reject the null hypothesis on the 1 % significance level, namely, they are stable time series.
3. *Cointegration test.* The variable unit root test results show that the LC, LY and LS are all one order integrations. In order to avoid spurious regression, we examine whether there are cointegration relationships among three variables. The results of Johansen cointegration relationship test based on multiple VAR model are shown in Table 125.2. Trace test results show that, on the 5 % significance level, we reject the hypothesis that there is no cointegration equation and accept the assumption that there exists 1 cointegration equation. This indicates that there is one cointegration relationship among the three variables. The result of Max-eigenvalue test also shows that, on the 5 % level, we reject the assumption that there exists no cointegration equation, the three variables have 1 cointegration equation. It can be seen that this two kinds of test results show that LC, LY, LS exist cointegration relations, namely that three there is a long-term equilibrium relationship between them.
4. *Granger causality test.* Cointegration test results show that there is a long-term stable equilibrium relationship among LC, LY and LS ranging from January 2003 to December 2011. The following granger causality tests further prove their short-term relationships; the details are shown in Table 125.3. The Table 125.3 shows the stock business cycle index is the granger reason of

Table 125.1 Unit root test

Variables	ADF test			PP test		
	T-statistics	Prob	Stability	T-statistics	Prob	Stability
LC	−0.8184	0.8094	Stable	−0.6897	0.8440	Unstable
DLC	−9.4011	0.0000	Stable	−123.7329	0.0001	Stable
LY	−0.1603	0.9388	Unstable	−1.6781	0.4394	Unstable
DLY	−9.6525	0.0000	Stable	−125.8168	0.0001	Stable
LS	−1.3695	0.5946	Unstable	−1.3103	0.6228	Unstable
DLS	−5.8209	0.0000	Stable	−5.8402	0.0000	Stable

Table 125.2 Johansen cointegration test

Null hypothesis	Eigenvalue	Trace test		Max-eigenvalue test	
		Statistics	Prob	Statistic	Prob
None*	0.664045	121.9182	0	112.3502	0
At least 1	0.065637	9.567978	0.6821	6.992752	0.6704
At least 2	0.024692	2.575226	0.6626	2.575226	0.6626

Table 125.3 Granger causality Tests

Null hypothesis	Optimal lag	F-stat	P value
DLY doesn't granger cause DLC	3	0.52529	0.6659
DLC doesn't granger cause DLY	3	0.70339	0.5523
DLS doesn't granger cause DLC	3	3.72185	0.014
DLC doesn't granger cause DLS	3	0.37106	0.7741
DLS doesn't granger cause DLY	3	4.15309	0.0082
DLY doesn't granger cause DLS	3	0.47803	0.6983

household consumption and disposable income, and there are no granger causalities between household consumption and disposable income.

5. *Estimation of cointegration and error correction equations.* Cointegration test and granger causality test results show that there are equilibrium relationships among LC, LY and LS both in the short-term and in the long-term; therefore, we use cointegration and error correction model to study the stock market's wealth effect to the household consumption. According to lag order tests, coefficients that lag 1 order are basically not significant. This paper choose lags order 2 $\sim$ 4 in error correction model, and then use Eviews 7.0 to estimate the relationship among LC, LY LS, the results are as follows:

Cointegration equation:

$$\begin{gathered} LC_t = 0.6979 + 0.8656LY_t - 0.0165LS_t + ECM_t \\ (14.2944^*)\ (85.5859^*)\ (-2.3638^*) \end{gathered} \tag{125.1}$$

Error correction equation:

$$
\begin{gathered}
DLC_t = \underset{(-2.5399^{*})}{-0.5009ECM_{t-1}} \underset{(-0.0056)}{-0.0106DLC_{t-2}} \underset{(-0.9692)}{-0.2165DLC_{t-3}} \\
\underset{-0.1348DLC_{t-4}}{-0.1348DLC_{t-4}} \underset{(1.2464)}{+0.2018DLY_{t-2}} \underset{(1.8976^{**})}{+0.3792DLY_{t-3}} \underset{(1.9296^{**})}{+0.2463DLY_{t-4}} \\
\underset{(2.3784^{*})}{+0.2206DLS_{t-2}} \underset{(-3.5757^{*})}{-0.3631DLS_{t-3}} \underset{(1.7071^{**})}{+0.1579DLS_{t-4}}
\end{gathered}
\tag{125.2}
$$

Amongst the numbers in brackets are t-statistics, those with * and ** represent significant on 5 and 10 % levels respectively.

The results indicate that: (1) as it is shown in Eq. (125.1), household consumption (LC) and disposable income (LY), stock market index (LS) have a long-term equilibrium relationship. The marginal propensity of consume (MPC) of current period disposable income (LY) is 0.8656, the marginal propensity of consume (MPC) of stock index (LS) is −0.0165, and t-statistics are significant, indicating that the stock market have dramatic long-term negative wealth effect to household consumption, namely the crowding out effect, which is opposite to developed countries' basically positive wealth effect. In the long run, stock market's excessive boom may take up great deals of consumption funds, posing a crowding out effect on consumption. This may be due to the fact that only about 20 years have passed since the establishment of China stock market. So the market is not mature, has too much speculation and volatility, it is hard for consumption to form stable long-term earnings expectation.

(2) It can be seen from the error correction Eq. (125.2) that there exist short-term dynamic relations among changes in household consumption (DLC) and in household disposable income (DLY), in the stock market (DLS). First of all, the coefficients of 3 $\sim$ 4 order lagged disposable income are significant at 7 % level, indicating that China household consumes according to permanent income; Second, all the coefficients of changes in stock market index (DLS) are significant at 5 and 10 % levels respectively, indicating that the stock market has significant short-term wealth effect to household consumption, but the effect is not stable. This may have something to do with the China stock market's drastic volatility and fluctuation.

6. *Analysis of generalized impulse response function*. Generalized impulse response function is used to measure the effect of random perturbation terms from a standard deviation shocks on endogenous variable's current and future values. From the Fig. 125.3, it is known that the household consumption has a strong positive reaction to one of its own standard deviation in period 1, about 0.0395, then it increase gradually, and stabilize at about 0.10 after the period 23; it has a strong positive reaction to one of household disposable income standard deviation in period 1, about 0.0351, then it increase gradually, and stabilize at 0.098 after the period 23; it also has a strong positive reaction to one of household disposable income standard deviation in period 1, about 0.0015, then it f fluctuate gradually, and stabilize at 0.008 after the period 12. This shows that there have short and long terms wealth effects of stock index.

125.3 Asymmetrical Wealth Effects of Stock Market: Based on Autoregressive Distributed Lag Model

In order to study stock market's asymmetrical wealth effect on household consumption, referring to Nicholas Apergis and Stephen M. Miller (2004), this paper adopt the error correction model as follows (Apergis and Miller 2005):

$$DLC_t = ECM_{t-1} + \sum\nolimits_{i=1}^{I} \alpha_{1i} * DLC_{t-i} + \sum\nolimits_{j=0}^{J} \alpha_{2j} * DLY_{t-j} + \sum\nolimits_{k=0}^{K} (\alpha_{3k} * DLS^{+}_{t-k} + \alpha_{4k} * DLS^{-}_{t-k}) + \sum\nolimits_{m=0}^{M} \theta_m \mu_{t-m} \tag{125.3}$$

Amongst DLS^{+} and DLS^{-} represent positive impact and negative impact of changes in stock market respectively. In order to eliminate multi col-linearity and self-correlation caused by multi-orders lags, this paper estimate the above model by using auto regression dynamic distribution model. Amongst error correction term is the one estimated from cointegration lag 0-2.

$$\begin{aligned} DLC_t = {} & \underset{(-7.500^{*})}{-0.6901ECM_{t-1}} \; \underset{(-5.6788^{*})}{-0.5068DLC_{t-1}} \; \underset{(-1.2512)}{-0.1056DLC_{t-2}} \\ & \underset{(13.5913^{*})}{+0.6561DLY_t} \; \underset{(4.4966^{*})}{+0.3001DLY_{t-1}} \; \underset{(1.3329)}{+0.0823DLY_{t-2}} \\ & \underset{(-2.3400)}{-0.1318DLS^{+}_t} \; \underset{(0.8036)}{+0.0136DLS^{+}_{t-1}} \; \underset{(2.7276^{*})}{+0.1523DLS^{+}_{t-2}} \\ & \underset{(2.1228^{*})}{+0.1448DLS^{-}_t} \; \underset{(-1.2035)}{-0.00269DLS^{-}_{t-1}} \; \underset{(-2.6051^{*})}{-0.1852DLS^{-}_{t-2}} \\ & +\mu_t \underset{(-2.9991^{*})}{- 0.3450\mu_{t-2}} \end{aligned} \tag{125.4}$$

Where the bracketed figures are t-statistics, those with * represent significant at 5 % significance level.

The results of model indicate that: (1) the development of stock market has both positive and negative wealth effect on household consumption in short-term, but negative in long-term. It is asymmetrical. In the short-term, stock market's positive

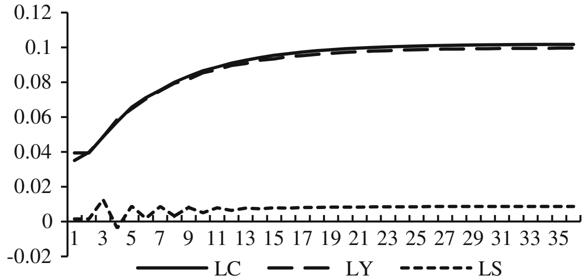


Fig. 125.3 Response of LC to genalized one S.D innovations

impact on household consumption is negative and significant at the 5 % level, The effects of the positive impact of the stock market index of the lag 1 and 2 on household consumption is positive. But only the coefficient of lag 2 is significant at the 5 % level. All positive effects are 0.0341. Spot stock market index's negative impact on household consumption is positive and significant at the 5 % level. The effects of the negative impact of the lag 1 and 2's stock market index on household consumption is negative. But only the coefficient of lag 2 is significant at the 5 % level. All negative effects are −0.0673. The negative effects are 0.9719 times higher than the positive effects. These figures illustrate that the household consumption is more sensitive about the stock market's bad news than good news. It is obviously asymmetrical. All the positive and negative effects are -0.0332. It turns out that in the long run wealth effect of stock market on household consumption is negative which actually a kind of crowding out effect. In other words, as the stock market develop, the household do not use stock returns to consume, but to increase investment in the stock market. It is incompatible with the situation that the wealth effects of stock markets are mostly positive in developed countries. This may be due to several reasons: Firstly, the development level of China's stock market is relatively low. The stock market is easy to soaring prices, then result that the stock market investment become high-risk ones and its income is uncertain and cannot form a stable income expectations. Secondly, it is poor maturity of the China stock investors, who are chasing shadie seriously. It makes the investment substitution effect is greater than the income effect. Thirdly, China's stock market environment is not ideal and it has the phenomenon of the short bull market and long bear market. The bull markets is generally one year and bear market for 3–5 years, and it also appeared the famous 28 phenomenon, that is, 20 % of investors make money, 80 % of investors lose money. So it naturally cannot be better to boost the consumption.

(2) The coefficient of the error correction term is −0.6901 and significant in the 5 % level, indicating that short—term has a large reverse correction to long-term.

(3) Whether spot or lag 1 and 2, household disposable income impact on household consumption is positive and significant at the 5 % level, but the extent of this impact is gradually decreasing, indicating that the household is based on permanent income consumption.

125.4 Conclusion

Based on the latest monthly time series data, we used the cointegration and error correction model and dynamic distributed lag model to study China stock market's wealth effect. The cointegration and error correction model indicate that the wealth effect on household consumption is significant both on short-term and long-term, but the value is mostly negative which is incommensurate that the wealth effect is mostly positive in developed countries. Further, taking advantage of the studies using the dynamic distributed lag model, China stock market shows both short-term and long-term wealth effect on household consumption, and the overall effect is negative. That confirms the conclusion of our cointegration and error correction model once again. We also find that the wealth effect of China stock market has an asymmetric characteristic. The main conclusions are as follows:

1. *The conclusions of cointegration and error correction model.* The cointegration equation shows that the stock market index (LS) has negative impact on household consumption (LC) in the long term, and the coefficients are significant at the 5 % level. Reasons that make the investments in China's equity market unable to play a role of blood transfusion to household consumption, and impede the transition from China stock market to consumptions are the companies in it abusing the power of financing, as well as the market environment of bull short and bear long and 28 phenomenon. Disposable income (LY) for long-term impact on household consumption (LC) is positive and is significant at the 5 % level, indicating that in the long term, China household pay with permanent income in consumption.

From the error correction model, the changes of stock market index (DLS) and disposable income (DLY) have a significant effect on one of household Consumption (DLC). But the impacts are both positive and negative. Combined with the analysis equation decomposition and impulse response, we find that the impact of changes of stock market index (DLS) and household' disposable income (DLY) to one of household consumption (DLC) is increasing at the beginning and then tend to stability gradually in the short term (about 1–2 year). Those mean that the wealth effect of stock index (LS) and disposable income (LY) to household consumption exists and keeps forever.

2. *The conclusions of dynamic distributed lag model.* Firstly, we have confirmed two conclusions of cointegration and error correction model: one is that the change of China stock market index (DLS) has a significant wealth effect on one of household consumption (DLC), and the effect are both positive and negative, but is negative in general, that is -0.0176; the other is that the changes of household disposable income (DLY) has a significant effect on one of household consumption (DLC) and is gradually decreased with increasing order lag, which shows that China household pay with permanent income in consumption. Secondly, the change of China stock market index (DLS) has significant and asymmetric wealth effect on the changes household consumption (DLC). The negative impact of the change of stock market index (DLS) is 1.9720 times of the positive one. So the difference is very large.

China stock market wealth effect is mainly manifested as crowding out effect, which does harm to the long-term development of China stock market. Therefore, we need to improve the system of stock market, especially making the flow from investment to consumption channels smoothly, say, the establishment of bonus system.

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Chapter 126
Research on Risk Prevention and Control Model Facing Industry Technology Alliance's Lifecycle

Bin Dai

Abstract This paper presents a thorough analysis on the lifecycle and risk inducements of Industry Technology Alliance by using relative theories, and on basis of the analysis, to construct a risk prevention and control model facing the whole lifecycle of Industry Technology Alliance. The model integrates those elements related to risk prevention and control of Industry Technology Alliance, such as organization, environment, objective, tool, measure and so on, thus it can provide comprehensive and systematic theoretical support for the practices of risk prevention and control of Industry Technology Alliance.

Keywords Industry technology alliance · Lifecycle · Risk inducement · Risk prevention and control model

126.1 Introduction

In December of 2008, Ministry of Science and Technology and other five ministries of the PRC together issued Guiding Significance on the Construction of Strategical Alliance for Promoting Industry Technology Innovation. The guiding significance specifically presented the definition of Strategical Alliance of Industry Technology Innovation (in this paper, it is called Industry Technology Alliance for short). According to the definition, it is not difficult to conclude that Industry Technology Alliance is essentially a kind of strategic alliance for R&D in the contractual type. Due to the existence of organization and culture diversity, members' opportunist acts, uncertainties of operating environment and so on, Industry Technology Alliance is facing great risk. American McKensey's survey

B. Dai (✉)
Business School of China West Normal University,
Nanchong, China
e-mail: Daibin_2001@163.com

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data prove the ubiquity of alliance risk (Chen 2000). Against this background, the risk management of Industry Technology Alliance, especially the risk prevention and control, should be paid due attention to.

With the investigation of documents, it is easy to find that many foreign and domestic scholars have deeply researched the prevention and control issues about different kinds of risk; for instance, moral risk, trust risk, and intellectual property risk, and they have achieved a lot (Das and Teng 1998; Gomes-Casseres 1987; Inkpen and Beamish 1997; Hennart et al. 1999). However, the above-mentioned research achievements are scattered, lacking systematical consideration over Industry Technology Alliance's lifecycle. Thus, this paper firstly analyzes the whole operating process of Industrial Technological Alliance by using lifecycle theory, and on the basis of which, it tries to construct a risk prevention model of Industry Technology Alliance, so as to provide comprehensive and systematic theoretical support for risk prevention practices of Industry Technology Alliance.

126.2 Bases of Constructing Risk Prevention Model

126.2.1 An Analysis of Industry Technology Alliance's Lifecycle

In 1972, Greiner indicated that any organization has its lifecycle in his book which named The Evaluation and Change of Organization (Greiner 1997). As a specific organization form of cooperation and innovation of technology, Industry Technology Alliance has its internal evolution process, and this process is called Industry Technology Alliance's lifecycle. Industry Technology Alliance's lifecycle studied in this paper refers in particular to alliance organization's periodical and regular evolution process from Industry Technology Alliance's birth to death, and prosperity to decline.

In recent years, many scholars are continuously perfecting enterprise lifecycle theory, and at the same time, they also apply this theory into the researches of other organizations sharing the some similarities with enterprise, such as, Knowledge Chain, Industry-University-Research Alliance, Strategy Alliance and so on. Those researches have gained a series of results, which pave a road of references for the analysis of Industry Technology Alliance's lifecycle in this paper. Gu et al. (2007), gives an explanation of knowledge chain and its lifecycle, and divides the lifecycle of knowledge chain into four stages, namely, gestation stage, organizing stage, operating stage and disintegration stage; analyzes the flow path and content of knowledge chain management of every stage in lifecycle, thus constructing a framework model of knowledge chain management on the basis of lifecycle (Gu et al. 2007). Wu et al. (2010), points out that industry-university-research alliance's lifecycle includes gestation stage, organizing stage, operating stage and termination stage, and that conflicts between organizations have different representations in every stage, so dynamic managements should be adopted into the conflict management of industry-university-research alliance, in other words, different strategies would be employed in different life stages (Wu et al. 2010). Zhou Ming, as well as other scholars, according to the characteristics of logistics strategy alliance, analyzes the sticky situations in the implementation process, and constructs the whole lifecycle model of logistics strategy by combining whole lifecycle theory (Zhou and Tang 2007). Ren and Xu (2010) adopt enterprise's cooperative and innovative acts in strategy alliance as research objective, and study the focal points of enterprise's cooperative and innovative management in different alliance stages, by the means of constructing management model of cooperative and innovative key elements, with alliance's lifecycle stages as the fine sorted variables (Ren and Xu 2010). Employing the research results above as reference, this paper divides Industry Technology Alliance's lifecycle into four stages: gestation stage, organizing stage, operating stage and disintegration stage. Industry Technology Alliance takes the technological innovation requests of the industry in which it is as driving motion. When some key enterprises in the very industry call for technological innovation and expect to be satisfied through the approach of cooperating and innovating, those enterprises will act as the sponsor units of Industry Technology Alliance to gestate and organize the alliance, once the construction is finished smoothly, there will come the operating stage of the alliance; after a period of alliance's operation, alliance would come to meet two possibilities: one is that expectant objective is achieved, and the other is that a nasty conflict shows up. No matter which possibility arises, the alliance will enter into the disintegration stage.

According to above analysis of Industry Technology Alliance's lifecycle, we have constructed A Lifecycle Model of Industry Technology Alliance, as shown in Fig. 126.1.

126.2.2 An Analysis of the Inducements of Industry Technology Alliance's Risk

Industry Technology Alliance's risk mainly comes from the uncertainties of its ambient environment, deficiency of alliance subjects' ability and disharmony among alliance members (Harrigan 1986), however, there hide deep-seated risk inducements behind the above-mentioned risk sources. Through researches, we have found risk inducements of Industry Technology Alliance as follows: (1) The Uncertainties of Industry Technology Alliance's Ambient Environment; (2) Lapse of Alliance Chance Recognition; (3) Inappropriate Selection of Alliance Members; (4) Lapse of Trust among Members; (5) Lack of Effective Communication among Members.

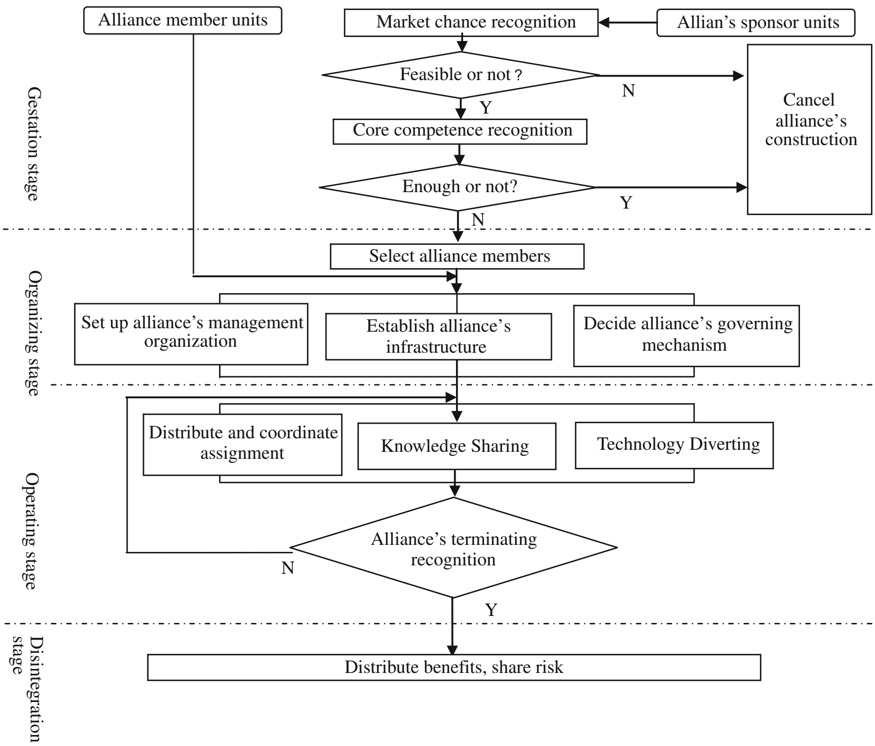

Fig. 126.1 Lifecycle model of industry technology alliance

126.3 An Analysis of the Construction and Constituents of Risk Prevention and Control Model

Basing on the above analysis of Industry Technology Alliance's lifecycle and risk inducements, this paper tries to construct A Risk Prevention and Control Model for Industry Technology Alliance's Lifecycle, as shown in Fig. 126.2.

Just as shown in Fig. 126.2, A Risk Prevention and Control Model for Industry Technology Alliance's Lifecycle is composed of six parts, namely, organization of alliance's risk management, ambient environment of alliance's risk prevention and control, general strategies for alliance's risk prevention and control, internal measures of alliance's risk prevention and control, as well as basic methods and tools of alliance's risk prevention and control.

Organization of alliance's risk management refers to the specialized organization built within Industry Technology Alliance to deal with the risk management. Ambient environment of alliance's risk prevention and control is the sum of all elements that are seated out of alliance, not controlled by it, with two parts made up of: legal framework and social system. While the legal framework can prevent and control some risk existing within alliance by the force of obligatory

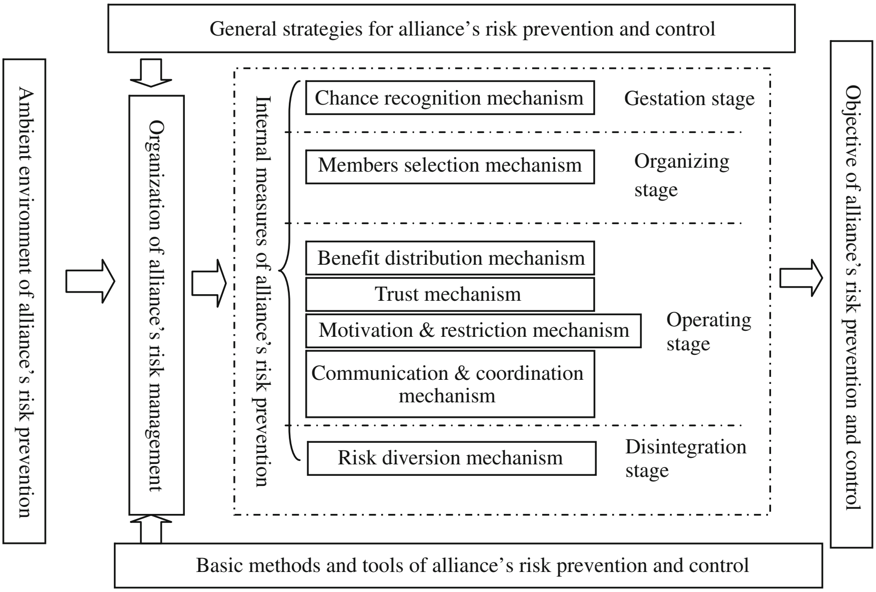

Fig. 126.2 Risk prevention and control model facing industry technology alliance's theory

and legible contracts; the social system takes honesty moral as basis, with optional and vague agreement as methods, to prevent and control some risk existing within alliance. As the legal framework and social system have their respective starting points, so the two systems have different scopes of application and objects. General strategies for alliance's risk prevention and control can be defined like this: the general idea of the organization of risk prevention and control management for choosing some concrete prevention and control strategies from a broader range of risk prevention and control strategies, such as risk evasion, risk control and risk retention, with the objective of alliance's risk prevention and control as center, and with alliance's own background and ambient environment as basis. Internal measures of alliance's risk prevention and control refers to various kinds of risk prevention and control mechanisms adopted by subjects of alliance's risk management, being directed against different alliance's risk inducements, and they adopt various mechanisms of risk prevention and control by taking focal points of risk management in the different stages of alliance's whole lifecycle into consideration, and there are nine mechanisms, including member selection mechanism, alliance's benefit distribution mechanism, alliance's risk shift mechanism and so on. Objective of alliance's risk prevention and control is the final effect to be reached by alliance's risk prevention and control, and it serves as a guide for the alliance's prevention and control activities; it has two concrete forms: pre-loss objective and post-loss objective.

The above-mentioned six components constitute an integrated alliance's risk prevention and control system, and none is indispensable. Their logic relations can be concluded like this: in the guidance of general strategies for alliance's risk prevention and control, organization of alliance's risk management effectively prevents and controls the risk, which probably would appear during the alliance's whole lifecycle, by comprehensive application of various basic methods and tools of alliance's risk prevention and control, with the aid of all the internal measures and the active effects of ambient environment of alliance's risk prevention and control, and finally objective of alliance's risk prevention and control is achieved.

126.4 Conclusion

With the investigation of documents, we found that the researches about Industry Technology Alliance's risk prevention and control are relatively scattered, lacking systematical consideration over Industry Technology Alliance's lifecycle. Considering the flaw, in this paper, we firstly have analyzed the lifecycle of Industry Technology Alliance with some related theories, and divides the lifecycle into gestation stage, organizing stage, operating stage and disintegration stage; secondly, we have analyzed the possible risk inducements which would appear during the alliance's lifecycle, and concluded those risk inducements mainly include: "the uncertainties of Industry Technology Alliance's ambient environment", "inappropriate selection of alliance members" and "lapse of trust among members" so on; Finally, on the basis of analysis of the lifecycle and risk inducements, we have constructed A Risk Prevention and Control Model for Industry Technology Alliance's Lifecycle. The model effectively integrates related elements, such as organization, environment, objective, tool, measure and so on, thus it can provide comprehensive and systematic theoretical support for the practices of risk prevention and control of Industry Technology Alliance.

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Chapter 127
Governance of Bid-Rigging in the Bidding

Dong-sheng Ni and Xiao-wei Guan

Abstract This paper builds the motivation—behavioral model of bid-rigging to explore the reasons of bid-rigging. There are mainly four factors—there venues, costs, psychodynamic and opportunity of bid-rigging effecting the motivation which lead to the action. This paper analyzes the four factors and gives the corresponding countermeasures.

Keywords Bid-rigging · Costs · Motivation · Opportunity · Psychodynamic · Revenues

127.1 The Concept of Bid-Rigging

In order to be the successful bidder, Bidders either collude with each other, damaging the interests of project owners, or Bidders collude with tenders, agency or evaluation experts, damaging the interests of other bidders or the project owners (in essence, national interests). It is a common illegally means and behaviors to attempt to be the successful bidder in the field of bidding (Zhang 2010).

127.2 The Reasons of Bid-Rigging

The reasons of bid-rigging are multiple and complex. In this paper, because analysis of bid-rigging can be traced back to the bid-rigging behavior motivation which are internal incentives of the behavior (Kong 2009). This paper not only

D. Ni (✉)
School of Business, Beijing Wuzi University, Beijing, China
e-mail: nds.88@163.com

X. Guan
Business Management, Beijing Wuzi University, Beijing, China

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considers the intrinsic psychological factors, but also considers the impact of external factors on the motivation of bid-rigging.

127.2.1 The Motivation of the Bid-Rigging

So-called "motivation" is to promote the individual engaging in certain activities, to make the activities toward the target directions and the cause of action to achieve a certain purpose. The motivation is the individual's internal psychological processes; the behavior is the outward manifestation of the inner psychological processes, so the motivation is the direct reason of the behavior.

Needs are the internal condition and incentives are the external cause in stimulating motivation.

Needs are the unbalanced state of the organic body. They result in the performance of organisms on the internal and external environment of stability requirements and become the sources of the organism activities. Needs generate an internal driving force and are kinds of internal stimuli. Incentives are the external factor of driving the organism to produce certain behaviors.

The motivation has three functions as follows: Firstly, the activation function; it can stimulate the organism to carry out an activity; the organism with some motivation is very sensitive to certain stimuli, especially for those closely related to the stimulus and motivation. Thereby it stimulates the organism to produce a reaction or an activity. Secondly, guide function; it is guided by certain goals, so the behavior of the organism will point to its target in the role of motivation. Thirdly, enhancements, after the organism carry out an activity, it can maintain and adjust the intensity and duration of activities. When the activities point to the target, the motivation of the organism to be strengthened, and thus the organism will continue to the activities; On the contrary, when the activities deviate from the target, the motivation of the organism is not strengthened, and the positivity of the individual to continue its activities would be reduced, or even lead to complete cease of activities (Fig. 127.1).

The motivation of bid-rigging is there as on of bid-rigging and promotes bidders to implement the behavior. Needs of certain inner causes and external incentives are important driving forces of bid-rigging.

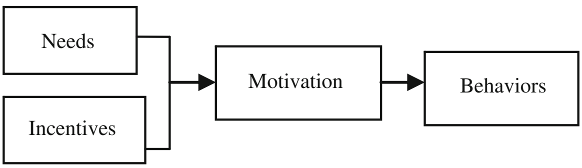

Fig. 127.1 The relationship between motivation and behaviors

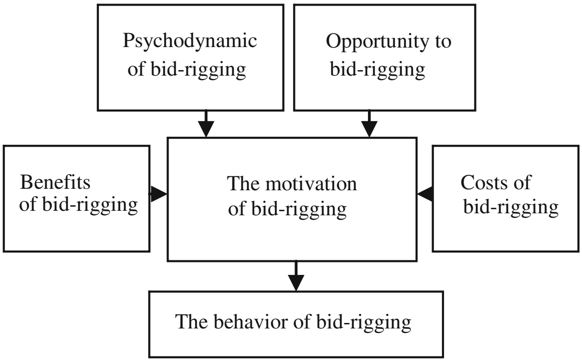

Fig. 127.2 Bid-rigging motivation—behavioral model

On the basis of previous research, this paper builds bid-rigging motivation—behavioral model (Qing 2010) to analyze the factors affecting bidders' motivation. There are mainly four factors as shown in Fig. 127.2.

127.2.2 Bid-Rigging Motivation—Behavioral Model

When bidders decide to select the normal bidding or bid-rigging, they will consider and contrast the costs and benefits, and then make the appropriate selection. Specific as shown in Fig 127.3 (Shao 2009): The bidders' decisions diagram.

T	The revenues of being the successful bidder
C	The preparation costs of normal bidding
△C	The implementation costs of bid-rigging
C1	The loss of the punishment being investigated in the failure of bid-rigging
△C1	The loss of the punishment being investigated in the successful of bid-rigging—C1
W1	The probability of winning in normal bidding
W2	The probability of winning in bid-rigging
P	The probability of being investigated after the successful of the bid-rigging
P1	The probability of being investigated after the failure of bid-rigging
R1	The revenues of normal bidding
R2	The revenues of bid-rigging

1. The revenues of bid-rigging.

Bidders win the bid and gain the corresponding benefits by certain means, expressed as T in Fig. 127.3. The bidders carry out the bid-rigging in order to increase the probability of being the successful bidder so that they can raise their benefits, but they must pay the additional cost. The revenues of bid-rigging are difference between the revenues of being the successful bidder and the related costs to rig-bidding.

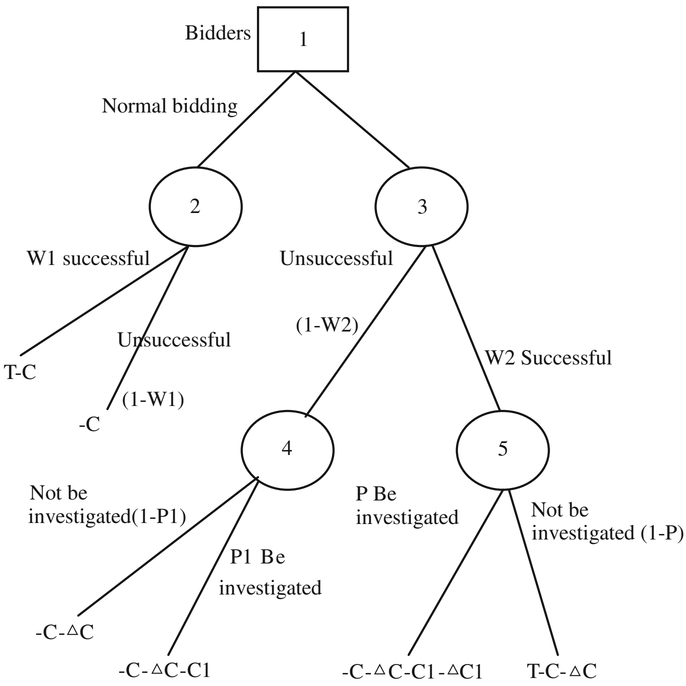

Fig. 127.3 The bidder's decision diagram

2. The costs of bid-rigging.

There are three kinds of costs in Fig. 127.3; C is the prepared costs of normal bidding, as long as bidders take part in the bidding, this part of the costs will occur. In order to ensure the smooth progress of bid-rigging, bidders need to pay additional costs △ C, that is the implementation costs of bid-rigging. In general, △ C is much higher than C. Implementing bid-rigging may be investigated, if a bidder won the bid and were being investigated, he would suffer to punishment loss composed of two parts (C1 + △ C1); if the bidder did not win the bid, the punishment loss is smaller, containing only C1. Hence (C1 + △ C1) is the risk costs of bidders bearing the mental stress and material losses after they carrying out bid-rigging. All in all, the costs of bid-rigging is both the implementation costs and the risk costs of bid-rigging (Fan and Li 2011). When the costs of bid-rigging increase, the benefits relatively reduce.

When bidders decide to select the normal bidding or bid-rigging, they will consider the costs and benefits, specific as follows. By the bidder decision diagram shows:

$$\begin{aligned}
R1 &= W1 * (T - C) + (1 - W1) * (-C) \\
&= W1 * T - C \\
R2 &= (1 - W2) * [P1 * (-C - \triangle C - C1) + (1 - P1) * (-C - \triangle C)] \\
&\quad + W2 * [P * (-C - \triangle C - C1 - \triangle C1) + (1 - P) * (T - C - \triangle C)] \\
&= W2 * (T - PT - PC1 - P\triangle C1) - P1 * (1 + C1) - (C + \triangle C) \\
\Delta R &= R1 - R2 \\
&= W1 * T - C - [W2 * (T - PT - PC1 - P\triangle C1) - P1 * (1 + C1) - (C + \triangle C)] \\
&= (W1 - W2) * T + W2(PT + PC1 + P\triangle C1) + P1 * (1 + C1) + \triangle C
\end{aligned}$$

When R1 $<$ 0 and R2 $<$ 0, the bidders' benefits are less than zero. That means bidders no matter what choice facing with a loss, so bidders do not join in the bidding.

When R1 $<$ 0 and R2 $>$ 0, the bidder to select the normal bidding, their income is less than zero, and to choose bid-rigging can get positive income, then he may choose bid-rigging.

When R1 $>$ 0 and R2 $<$ 0, the bidder choosing normal bidding will gain income, and selecting bid-rigging will gain loss, so he will choose normal bidding.

From R1 = W1 * TC, we can see, when W1 $<$ C/T, the bidders do not choose to participate in normal bidding. In practice, the successful bidder gains T is much larger, while the preparation costs of the normal bidding is relatively smaller, so when they think the slim hope of the successful to normal bidding, they will not take part in bidding or select bid-rigging.

When R1 $>$ 0 and R2 $>$ 0, a bidder choosing to normal bidding or bid-rigging will receive revenues. Due to the "economic man" assumption of rationality, bidders will choose the larger income items. If △ R $<$ 0, the bidders will choose bid-rigging; if △ R $>$ 0, they will choose normal bidding.

However, in reality the bidders' rationality is limited, and people in determining the income are tend to avoid risk and in determining the loss is inclined to risk. When R1 $>$ 0, this can be regarded as that bid revenues are determined and the risks of bid-rigging are larger. At this point, the bidder chooses to avoid risk. If the difference between R1 and R2 is not large, and △ R $<$ 0, the bidders will still choose normal bidding.

In order to make bidders greater possibility to choose normal bidding, it needs try to make △ R $>$ 0 or close to 0.

$$\triangle R = (W1 - W2) * T + W2 * (PT + PC1 + P\triangle C1) + P1 * (1 + C1) + \triangle C \tag{127.1}$$

Drawn on W1 partial derivatives: $\frac{a\Delta R}{aW1} = T > 0$.

Showing that, increasing the probability of being the successful bidder to normal bidding will help to curb bid-rigging.

Drawn on W2 partial derivatives:

$$\frac{\mathrm{a}\varDelta \mathrm{R}}{\mathrm{aW2}} = \mathrm{PT} + \mathrm{PC1} + \mathrm{P}\,\Delta\,\mathrm{C1} - \mathrm{T}$$

Showing that, the results cannot be judged for positive or negative, there being many factors impacting on bid-rigging. In order to curb bid-rigging, it is useful to minimize the probability of the successful bid-rigging. This means increasing the probability of being investigated after the successful of bid-rigging and the loss of the punishment being investigated in the successful of bid-rigging.

Drawn on P partial derivatives:

$$\frac{\mathrm{a}\varDelta \mathrm{R}}{a\mathrm{P}} = W2 * T + W2 * \Delta\mathrm{C1} \ > 0.$$

We can see, the greater probably bidders are investigated after the success of bid-rigging, the smaller possibly they choose bid-rigging.

Drawn on P1 partial derivatives:

$$\frac{\mathrm{a}\Delta\mathrm{R}}{\mathrm{aP1}} = 1 + \mathrm{C1} > 0.$$

We can see, the greater probably bidders are investigated after the failure of bid-rigging, the smaller possibly they choose bid-rigging. Therefore, in practice, once the traces of the implementation of bid-rigging are found, it should conduct further investigations.

Drawn on C1 and $\triangle$C1 partial derivatives:

$$\frac{\mathrm{a}\Delta\mathrm{R}}{\mathrm{aC1}} = W2P + P1 \ > 0; \frac{\mathrm{a}\Delta\mathrm{R}}{\mathrm{a}\Delta C1} = W2P \ > \ 0.$$

We can see, the greater loss of the punishment bidders are investigated in bid-rigging, the smaller possibly they choose bid-rigging. Therefore, bidders found bid-rigging should be severely punished.

Drawn on $\triangle$C partial derivatives:

$$\frac{\mathrm{a}\Delta R}{\mathrm{a}\Delta C} = 1 > 0.$$

We can see, the greater implementation costs of bid-rigging, the smaller possibly they choose bid-rigging. Therefore, increasing the implementation costs of bid-rigging is help for decreasing bid-rigging (Xiao 2007).

3. Psychodynamic of bid-rigging.

Bid-rigging is a kind of groups' behavior. So-called "groups" are the crowds of some common activities which is two or more persons to achieve common goals in a certain way. From the definition of bid-rigging, it is easy to see the bid-rigging crowds in line with the concept of groups, and thus the bid-rigging groups with the general criminal groups have common psychological characteristics, as follows:

(a) Herd behaviors under groups' awareness and pressure.

Once the bid-rigging groups are formed, the members of the groups will produce psychological awareness of group and voluntary action in accordance with the will of the groups. The awareness, on one hand, enable the individual to reduce the loss of their analytical skills and understanding; on the other hand, it greatly enhances the cohesion of the groups, so that groups' members in a fun, understanding, values and behaviors produce more and more unified thinking. Invisible psychological pressure to the members of the groups, it may impel them abandoning their original understanding and obeying the groups' behaviors.

(b) Sympathetic effects of emotional.

Sympathetic effect of groups' emotions is the transfer of emotions, cross contamination and mutual influence change the nature of the acts. If bid-rigging groups are together, a bidder proposed the idea of bid-rigging, it stirs up the impulse of another, and this impulse will stimulate the desire of the third result in further promoting bid-rigging.

(c) Guilt proliferation flu.

Guilt proliferation flu is a kind of psychological feeling brought by many people in bid-rigging groups sharing the common consequences so that unnecessary to assume full responsibility. Psychology tends to make the collusive tendering process. The individual does not bear a deep sense of guilt, and relieve their inner self-blame. That means reduce the cost of spirit.

(d) The regression of self-consciousness.

Most people in groups often lose self-consciousness. It is different between in groups and alone in a person's behavior. Commonly, the greater probably the members of group slack self-consciousness, the more possibly they lack sense of responsibility and have greater destructive (Song 2005).

4. The opportunity to bid-rigging

The external incentive of bid-rigging motivation is the conditions in enticing bidders not being found to complete bid-rigging.

(a) Bidding Law legal system is not perfect

At present, related to the relevant provisions of the bidding include the "Tendering" "Government Procurement Law", "Construction Law", the "auction", "Contract Law", "not anti-competition law" and many other National bidding and local normative documents (Liu and Zhu 2011). But due to the different introduction's time and background of relevant legal and regulatory documents, the relevant provisions are different and even conflicting. The provisions of the bid-rigging tend to principles in the relevant laws and regulations and some concepts are vague, that means produce loopholes in operation and provide a platform for some lawbreakers (Wang and Weng 2009).

(b) Supervision system is not perfect.

The responsibility of investigating and dealing with bid-rigging is related to the various departments including the Business Sector, the Judiciary and Administrative Departments of various industries, which make their management practices to different policies. The difference of relevant provisions, law enforcement scale and intensity in different department makes the system of supervision disharmony. What's more, means of market surveillance is relatively backward. Although around have built bidding trading centers or trading center of public resources and some major projects are also included in the unified trading in the market, oversight means remains to be further improved (Fu 2011; Zhang and Liu 2010).

(c) Market credit system is not perfect.

Credit is the cornerstone of the market economy. On one hand, China is in the initial stage of the socialist market economy. People in their daily lives succumb easily to "power" and "relationship"; On the other hand, China has not established a unified information platform and query system of bidding, so that some speculators in a place illegal conversion positions again illegal, and not easy to find. Thus, it is difficult to form a situation of "one illegal, nationwide (all province) limited". This means the probability of being successful bidder to normal bidding is small, but the risk of bid-rigging is small (Zhang and Liu 2010).

127.3 Governance of Bid-Rigging

From the above all, we learn that the benefits, costs, psychodynamic of bid-rigging and the opportunity to bid-rigging four aspects together effecting the motivation of bid-rigging, which eventually lead to bid-rigging acts. For effective management bid-rigging, we can consider how to reduce the impetus for the motivation of bid-rigging from the four aspects to reduce bid-rigging.

127.3.1 Balance the Benefits and Costs of Bidders

From the above benefits and costs analysis of bid-rigging we learn that when bidders believe normal bidding can get income, they would consider select normal bidding, but it largely depends on the probability of winning in normal bidding. Bidders selecting normal bidding can gain income, only when bid-rigging income is much larger than former, they will choose it. Therefore, it is wise to reduce the income of bid-rigging and increase the costs of bid-rigging by reducing the probability of successful bid-rigging, increasing the costs of bid-rigging, raising the probability of being investigated after bid-rigging and rising up the loss of punishment being investigated after bid-rigging.

127.3.2 Reduce Psychological Dynamics

The behavior of bid-rigging is a king of groups' behavior being promoted by the psychological dynamics of their groups. It is useful to reduce the power of groups' psychology role for cutting back the probability of bid-rigging by reducing the bid-rigging groups' opportunities to contact, shaping just social cultures and increasing the number of the bidders.

127.3.3 Reduce Opportunities

It is important to decrease the opportunity to bid-rigging for cutting back the probability of bid-rigging by improving the legal system, Supervision system and Market credit system.

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Chapter 128
Study on Harmonious Labor-Capital Relationship in China's Private Enterprises

Si-ping Peng and Yi-yang Lu

Abstract This paper theoretically discourse on the historical evolution and theoretical development of the labor-capital relationship worldwide. Moreover, based on deep surveys and studies conducted in several private enterprises in Foshan, Guangdong province, this paper explore the present situation of the labor-capital relation in China. Eventually, several guiding ideology and practical measures helping to construct harmonious labor-capital relationship in China's private enterprises will be presented: Building Independent and Powerful Labor Union, Improving the Labor Legal System, Implementing Effective Labor Arbitration Mechanism, and Adopting Fair Interest Distribution Mechanism.

Keywords Labor-capital relationship · Private enterprise · Coordination mechanism

128.1 Introduction

Along with the china's rapid transition toward industrialization, marketization and modernization, the environment for labor-capital relationship has shifted from planned economy to market economy. The new type of relation has become the foundation for economic relations and social relations in modern China. Accordingly, the labor-capital contradiction came on stage and became intensified. Some unexpected labor emergency incidents cause insidious threats to China's social stability and economic development. How to properly manage and construct a harmonious labor-capital relationship has become an unavoidable social reality in present-day China.

S. Peng (✉) · Y. Lu
Department of Technology and Information,
Nanhai Neusoft Institute of Information, Foshan, China
e-mail: pengsp@neusoft.com

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128.2 Literature Review

128.2.1 The Historical Evolution of Labor-Capital Relationship of Western Developed Countries

The labor-capital contradiction has been going on since the capitalist system was found. Conflicts representing different economic interests reveal different characters of the labor-capital relation throughout the development history of western market economy.

1. The labor-capital relationship in the period of free-market capitalism.

From the industrial revolution to the late nineteenth century, called the period of free-market capitalism, class conflict was the characteristic manifestation of the labor-capital contradiction. In some business sections, worker organizations began to emerge, known as the labor union. These immature unions were severe suppressed through force and legal actions by employers who represent the interest of the capitalist class. In that period, rights of association, strike and demonstration were strictly prohibited. Therefore, the employer side dominated the labor-capital relation.

2. The labor-capital relationship in the period of monopolistic competition capitalism.

From the late nineteenth century to early twentieth century, western economies were under a transition from free competition to monopoly. During that period, the labor unions had obtained unprecedented development. The force balance of labor-capital relation was changed by workers' continuous movements. Negotiation between employee and employer became a new way to solve their differences rather than using strike and suppression. Europe and North America' governments had gradually changed their policies that previously indulged the employer side, and then adopted more constructive intervention policy to solve the labor-capital contradiction. A series of laws, like the Factories Act, Labor Protection Act, Labor Insurance Act, Labor Union Act, Mediation and Arbitration of Labor Disputes, came on stage in succession. Moreover, governmental labor administrations were beginning to appear.

3. The labor-capital relationship after World War II.

After the Second World War, the labor-capital relation underwent a significant change. With the development of state capitalism, governments strengthen the comprehensive supervision and intervention on labor relation and labor reproduction. In addition, a set of standardized legal system, institutionalized legal system and adjustment mechanism were found. Generally speaking, the tension of the labor-capital relations had eased up in that period and moved toward cooperation. The manner to solve labor-capital contradiction became of depending on law and regulations.

128.2.2 Researches on Labor-Capital Relation Theory in Western Countries

At the beginning of industrialization, labor theories include Classical Economics, the theory of Surplus Value, the theory of Class Struggle, the theory of Industrial Democracy, the theory of scientific management, the theory of Rational Bureaucracy, and the theory of Industrialism, etc. These theories can be grouped into two categories: Labor-Capital Cooperation theory and Labor-Capital Conflict theory.

The Labor-Capital Cooperation theory is based on Classical Economics. In Classical Economics, Adam Smith and David Ricardo are the earliest to theoretically analyze the labor issue. They thought that the whole social economic should be consistent with the laws of nature, and people could freely use their own labor and money in pursuit of their own interests.

However, John Mill was not satisfied with the opinion about Laws of Nature in a market economy. He tried to reconcile the interests of employees and employers by launching the workers association under the principle of equality. John Mill thought these could help to build a win–win relationship between employees and employers rather than putting them into conflicting positions.

Different from the above opinions, Karl Marx stressed that the essence of the labor-capital relation is a class struggle by illustrating how the labor is commercialized, how the surplus value is made, and how the capital is accumulated. He pointed out that the ultimate way to solve the labor-capital conflict is to eliminate the system of Wage Labor through the class struggle and violent revolution to achieve labor independence (Marx and Engels 1964).

128.2.3 Researches on Labor-Capital Relation Theory in China

Based on Karl Marx's theory, Mao Zedong, the leader of the Chinese Revolution, put forward a principle of Be Favorable to both Labor and Capital, because Mao realized that the low productivity is a social reality during the initial stage of new China. The theory of Be Favorable to both Labor and Capital can be seen as a treatment for labor-capital relations. Not only to maintain the employee' rights but also admit the legitimacy of obtaining surplus value by the employer (Zhang 2007).

However, in the academic field, the concept of labor-capital relations is only defined within the scope of private enterprises (Chang 2004). After implementing socialist market economy, Chinese academia believed a significant change in labor-capital relations was that this relation has gotten off the character of class struggle. At this stage, the labor-capital conflicts mainly stems from the interest differentiation in social transition process (Chen and Zhang 2010). An important finding is that these two sides are nonantagonistic and coordinated. Hence, this provides a possibility of cooperation between labor side and capital side.

Since the 1990s, more and more researches on labor-capital relations were conducted and turn out diverse perspectives. Compared with the previous Labor-Capital Conflict theory or Labor-Capital Consistency theory, the Labor-Capital Cooperation theory became more popular in Chinese academic circles.

128.3 Findings in Private Enterprises of Foshan City

Private enterprises in Foshan Guangdong could be considered typical examples of the Chinese private economy, so the paper uses employees from Foshan's private enterprises as the study targets. The research team of this paper randomly distributed 500 questionnaires from August 2011 to September 2011, and then collected a total of 368 valid questionnaires from employees at all levels including management, technical staff and frontline staff.

Within these 368 valid questionnaires, male employees accounted for 60.63 % and the rest for women. Most of them are low-educated. 36.49 % has senior middle school education while 42.44 % has high school education. According to the Human Capital Theory, people's education level and their personal qualities are significant positive correlated. Therefore, employees' education level has a significant impact on labor-capital relations.

128.3.1 Employees' Income Situation

Generally speaking, employees' income level is relatively low and hard to meet employees' expectation. Monthly income is categorized into 4 levels, those below 1,500 Yuan are 52.72 %, those within 1,500–2,499 accounted for 30.72 %, those within 2,500–3,499 accounted for 10.84 %, and the rest above 3,500 only take 5.72 %. This survey shows that although the absolute income has substantial improved in recent years, the relative income still is low comparing to the Consumer Price Index, CPI. One thing has to be stressed that the income increase is mainly through work overtime, and unreasonable delaying wages and wage deductions is very common. Therefore, we could say at present, the income situation in Chinese private enterprises is not satisfactory and need a further reasonable improvement. Wu Jinglian, a famous Chinese economist, pointed out that from the experience around the world, the various social conflicts are mainly originated from the increasing income gap during the social transition process from traditional society to modern society. This paper accepts Wu's opinion that the problem of income gap should be given seriously attention.

128.3.2 Employees' Social Security Situation

Frankly speaking, the labor contracts in Chinese private enterprises started from scratch and grew gradually, but it still falls behind the social expectation.

Firstly, only 64.72 % employees have labor contracts while the rest 35.28 % hasn't. Labor contract defines the rights and obligations for both sides. More importantly, labor contract is to protect employees' lawful right when industrial accidents occur. As a result, the unsatisfied labor contracts situation could be a huge potential social problem.

Secondly, in terms of social security, few employees in private enterprise have this protection. In this survey, five basic insurances was listed in the questionnaire including endowment insurance, unemployment insurance, medical insurance, industrial injury insurance and maternity insurance. Employees who have all five insurances only account for 13 %. 65 % has part of five and 22 % has nothing. Such situation is not optimistic because a sound social security system is a prerequisite for a harmonious labor-capital relation and for a stable society.

Thirdly, let's look into the labor union. This survey shows that only 41.28 % employees joined the labor union because they thought the union can't play its function which is to protect the employees' right. Further finding in the questionnaire shows that only 7.78 % thought the union is fully functional. 43.94 % thought it can play some sort of function while 48.28 % believed it is useless. Hence, the labor unions in private enterprises can't play a proper role to maintain employees' right resulting in that employees are unwilling to get help from the unions when their legitimate rights and interests have been infringed.

128.3.3 Staff Training

Staff Training is not popular adopted in private enterprises. This survey shows that only 59.46 % ever received career training. A general situation is that inadequate resource was put in staff training in Chinese private enterprises. Lack of training isn't helpful especially for those young people who eager to improve themselves when they come to industrial cities. In the long-term, low investment in staff training could an obstacle to employees' personal development. Consequentially, such vicious circle could be harmful to enterprise development and social harmony.

128.3.4 Manners for Employees to Deal with Labor-Capital Conflict

This survey shows that the economic reason is the trigger for labor-capital conflicts. Although employees eagerly want a wages raise and living conditions improvement, they prefer to take rational action when problems happen. 20.68 % believe a direct talk with employers should be helpful, while 8.28 % want to get help from the labor unions or the labor arbitration committee. A depressed finding is that 48.02 % choose to keep silence and 19.2 % choose to resign. These figures illustrate that at present, individual action is the main manner for employees to deal with labor-capital conflict, thus putting employees into a vulnerable situation. Such situation is far from perfect and there is a long way to achieve Collective Bargaining, an ideal way for employees to conquer the labor-capital conflict.

128.3.5 Employees' Satisfaction at Employers

At the end, this survey shows how the employees think of their employers. 3.34 % mark Excellent, 10.88 % mark Good, 33.82 % mark Fair, 39.72 % mark Poor, and 11.24 % mark Very Poor. In conclusion, the current labor-capital relation in China's private enterprises is not optimistic.

128.4 Analysis on Current Labor-Capital Relations

At present, although the political environment and the social interest structure become suitable for labor-capital cooperation, the real situation is not optimistic due to various factors summarized as follows:

128.4.1 Huge Strength Disparity Between the Labor and the Capital

Huge strength disparity couldn't lead to cooperation between labor and capital. In other word, the strength of them determines their relation (Cheng 2004). Therefore, the precondition of cooperation between labor and capital is that none of them have dominating strength. If we look back into the historical evolution of the labor-capital relations in western countries, we can find out that the wider of strength disparity, the more intense of labor-capital conflict.

Under the marketization, the interest is independent and definite for either side of the labor or the capital. Therefore, conflicts between them are unavoidable when they pursue their own interest. A distinguishing feature of labor-capital conflicts in China is that the capital side is powerful while the labor side is weak and scattered. Consequently, the capital side usually ignores or even damages the legitimate rights and interests of the labors. In other word, the labor side cannot effectively manage to contend with the capital side in order to safeguard their legitimate rights and interests. Furthermore, the worse case is the labor unions cannot effectively represent the interests of its members.

128.4.2 Imbalance of Economic Interest Distribution

The principals of interest distribution in Chinese market economy are according to workload or according to production factor. Due to the contribution from production factor is difficult to measure and following the principle of profit maximization, the capital side normally use the income distribution rights to expand their profit. The profit increase on capital side will certainly lead to the wage reduction on labor side. Foreseeable, the conflict between them is inevitable. The imbalance of economic interest distribution is the most direct and important source of their conflicts.

The current situation is that the capital side utmost brings down the wage growth and delays paying wage. Frequent conflicts hereby happen because this distribution manner has exceeded the limit of the labor. The common way for labors to respond the unreasonable wages is resignation, leading to a Chinese social phenomenon of 'labor shortage'. Another way for labor to respond the arrears of wages is more noticeable, violent conflicts.

Above analysis shows that the principal of equitable distribution is grossly trampled by the capital side, indicating that the Chinese labor-capital relationship is still at an early stage of development.

128.4.3 Immatureness of the Labor-Capital Coordination Mechanism

Although China has 30 years experience of socialist market economy, the labor-capital coordination mechanism is still immature. In 1994, the Labor Law has set principle and norm for Collective Negotiation and Collective Contract Provisions. In 2001, the Tripartite Consultation System for labor-capital coordination was formally established. Ironically, these coordination mechanisms only are words on paper so far rather than practical effectiveness.

At present, the contradiction caused by unregulated distribution manner and the labor disputes are becoming increasingly prominent putting lots of pressure on the labor-capital coordination mechanism. This phenomenon shows the absence of public governance, equitable distribution and self adjustment in Chinese civil society (Yang 2010).

128.5 Solutions for Constructing Harmonious Labor-Capital Relationship

128.5.1 Strengthening the Role of Labor Union

Independent and powerful labor unions are requisite for coordinating the labor-capital relation (Yang 2011). The unions must represent workers' interests instead of listening to any other organization or institution (Ren 2011). It is an organization of workers that have banded together to achieve common goals such as better working conditions. It bargains with the employers on behalf of union members and negotiates labour contracts with employers. The most common, but by no means only, purpose of these organizations is maintaining or improving the conditions of their employment. This may include the negotiation of wages, work rules, complaint procedures, rules governing hiring, firing and promotion of workers, benefits, workplace safety and policies (Deng 2011). It also places an important role in social and political affairs putting pressure on governments to promulgate laws and regulations to protect workers' interests.

128.5.2 Improving the Labor Legal System

The labor and the capital are two opposing interest groups. When their demands diverge from each other, the labor laws always are the most powerful and effective factor to help. The labor laws are the result of historical evolution of labor-capital relations and also are the internal cause for some appearance of labor-capital relations (Li and Tang 2011). Although after years of development, China's labor legislation still lags far behind the reality needs. There has been nearly 30 years since the China's Labor Law was published in 1994. Frankly speaking, this law has played a very important role for protecting the legitimate rights and interests of workers.

However, because of the incomplete labor laws system, the incomprehensive law content and the diverse execution system in different provinces, the efficiency of China's labor laws is weak and feeble. A promising sign is that on January 2008, the implementation of the Labor Contract Law gives workers a little hope for a future better protection. In addition, a serious problem is that in the execution process, some law enforcement agencies don't act according to labor laws even they know some enterprises have violated the workers' interests.

Therefore, we not only need to improve the labor legal system, also need to push the labor law enforcement.

128.5.3 Adopting Fair Interest Distribution Mechanism

In the present stage, unfair interest distribution in private enterprises has caused severe labor-capital conflicts, so we should emphasize that a fair interest distribution mechanism is the foundation for constructing harmonious labor-capital relations. Employees' enthusiasm for work is mainly depends on whether their interests are well protected (Han and Sun 2008). Employees' discontent caused by unfair interest distribution could led to low-productivity and further resignation, or even violent revenge on other parties resulting into social instability.

If the employers could ensure the rights and interests of workers, such as ensuring proper respect, providing good working conditions and social security, providing reasonable wages and so on, can greatly arouse the enthusiasm of employees. Thereby, the production efficiency could be improved. That's a beneficial economic cycle for both the labor and the capital.

128.5.4 Implementing Effective Labor Arbitration Mechanism

The tripartite consultation system, consisted of labor administrative department, labor union and employers' organization, is the basic pattern and main operating mechanism for labor arbitration (Lu and Fan 2010). Moreover, the collective negotiation and collective contract system should be regarded as the main approaches for labor arbitration instead of the direct intervention by the labor administrative department. Thus, the role of labor administrative department is to create harmonious external employment environment (Ge 2006), to define the legalistic rights for both sides of labor and capital, to regularize their behavior toward interest disputes, and to balance their strength in labor-capital negotiations.

However, although negotiation is practical, this paper believes that in order to better protect the employees' interests, the legal procedures and the government direct intervention are necessary when the negotiations between them is failed.

128.6 Conclusion

Labor and Capital are two most important production elements and behavioral agents in a modern market economy (Lin 2007). Hence, the labor-capital relation is the most influencing and core relation in a market society. A harmonious relation could lead to social stability and high economic growth, vice versa. In Chinese southeast coastal areas, the private enterprises intensive areas, the labor-capital conflicts take place more frequent than before, and the situation become worse and worse. Some extreme behaviors, like the strike and revenge on society, took place from time to time causing mass fear (Wen 2010). Such disturbing labor-capital relation severely hinders the construction of the socialistic harmonious society. This paper concludes that we should actively reflect on the root behind these social phenomena, and then establish theoretical basis for constructing a harmonious labor-capital relationship.

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Chapter 129
Study on Risk Aversion of Integrating Entrepreneurship Education into College Professional Curriculum

Wen-juan Chen and Guan-xin Yao

Abstract It has been a common view that the necessity of Integrating Entrepreneurship Education into College Professional Curriculum, but its promotion process will have tremendous impact on the current personnel training model and classroom teaching system in our common universities, with kinds of risks, such as integration failure or promotion inability. Firstly, this study analyzes the doubt of Integrating Entrepreneurship Education into College Professional Curriculum, it mainly represent at Teaching System, Teaching Link, Teacher Resources etc. Then the risk and cause of Integrating Entrepreneurship Education into College Professional Curriculum is pointed out, such as the difficulty of integration process, the imbalance of education resources, low employment under the new training system etc. At last, four ways of risk aversion of Integrating Entrepreneurship Education into college professional curriculum, it mainly consist of to enhance the construction of the training system of the employment core competitiveness in the top level design, reforming model of the innovation and entrepreneur oriented education with emphasis on the integrated design, establishing the work flow of "proposal-experiment-modification-generalization" and constructing a resources security system based on "comprehensive sharing platform".

Keywords Entrepreneurship education · Professional curriculum · Risk aversion

129.1 Introduction

It is necessary to develop the college entrepreneurship education, for it can build an innovative country with great human resources power, raise the overall quality

W. Chen (✉) · G. Yao
School of Management, Jiangsu University, Zhenjiang,
People's Republic of China
e-mail: ybf@ujs.edu.cn

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of university personnel training, and also strengthen the core competitiveness of graduate employment. Besides, it is a trend and a top design to integrate the entrepreneurship education into College Professional Curriculum, for it can help to construct high-quality colleges and cultivate high-quality human resources (Zhao 2009).

The study of Entrepreneurship Education into professional curriculum is increasing, the typical studies as: Yi (2010), who thinks that Entrepreneurship Education into professional curriculum is necessary, and it should change Employment education into Entrepreneurship Education as early as possible. Wang et al. (2011) proposes local university as example, putting forward the Entrepreneurship Education personnel training model of “Multi participation, Gradient advanced type”. Mao (2010) takes opinion of that it should integrate of those ways organically, including education concept strengthening, course structure integration, teaching content fusion, teachers’ team training, entrepreneurship training and professional practice mutual promotion etc. Wang (2011) raises the “professional” implementation strategies of Entrepreneurship Education, constructing the college students’ innovative business education system, promoting college students’ innovation system of incentive innovation, optimization university student’s pioneering work ability training environment. Li (2009) raises the concept of that Entrepreneurship Education and professional education between the fusion of two, Mainly through the ways as classroom penetration, optimize the talent training scheme, strengthen the base construction, the integrated enterprise etc. Li and Sun (2011) thinks it should promote the fusion of university management majors and pioneering education experiment course, through standard Entrepreneurship Education evaluation principles. Huang (2009) around the core ideas of entrepreneurship education of university logistics management, putting forward counter measures of entrepreneurship training courses typically, Shao and Si (2011) combines the results of college students’ practice innovation training project researching, putting forward measures to solve the problem exiting in the current Entrepreneurship Education teaching system. Cao (2010) studies the entrepreneurship training mode of university management specialty pharmaceutical economic. He (2011) explores Entrepreneurship Education of Information and computing, put forward curriculum teaching with strong mathematical basis and new technology, short term project design and larger project design course, combining the entrepreneurial training and outside school training.

After all, the current research status can be roughly divided into two categories, one is the countermeasures study of entrepreneurship education and professional education fusion under common sense, the other one is entrepreneurship education mix with a professional education teaching. However there are no studies of risk aversion, this study analysis the realistic confusion, risks and risk attribution of Entrepreneurship Education into college professional curriculum, and raises the way of risk aversion.

129.2 Risks and Risk Attribution of Integrating Entrepreneurship into College Professional Curriculum

In view of deficiency in natural disposition motivation of most students, the low of advocating entrepreneurship, the limited resource, Entrepreneurship Education into college professional curriculum still exist many operational risks.

129.2.1 There are Some Risks in the Integration Process

In this process, it may be difficult to successfully establish the lasting effect mechanism, which is corresponded to the situation of the school. The reasons are as follows: firstly, reform itself has the risk of failure. As a public welfare institution, vast majority of faculty are lacking the passion of innovation; secondly, teaching reform is a project combination of top level design and the overall design. If it can not receive enough attention from the college leaders and relevant departments, the new mechanism will not be so prosperous; lastly, entrepreneurship in China is just beginning, and its system is still not perfect. As a new educational concept and mode, there is a risk of less benefit for it to penetrate the university curriculum comprehensively.

129.2.2 The Education Reform will Lead to the Imbalance of Education Resources

With entrepreneurship as an important element integrating into college professional curriculum, the structure of teaching resources, practice base and other resources cannot match it. The main reasons may be as following: firstly, the combination between professional and entrepreneurship should be found, and the construction of college teaching team should be improved, otherwise it will be difficult to ensure the effective operation of the training system after the integration. Secondly, the time-distribution system of professional courses will be certainly influenced by this integration. Thirdly, after students' entrepreneurship awareness and ability, it will be more challenging for the practice bases and business incubator bases in colleges (Yan and Zhao 2011).

129.2.3 Risks of Low Employment Under the New Training System

With the deep development of education, the students' innovation and entrepreneurship are increasing improved, but the ultimate employment multiplier effect is very limited, and even brings the risks of low employment. The reasons are as follows: first, more and more students may devote to the innovation activities, but the business success rate of undergraduates and fresh graduates is usually low, it will reduce the quality of first employ; second, after the integration, some academic research oriented students may ignore their academic and professional skills.

129.3 Risk Aversion of Integrating Entreneurship Education into College Professional Curriculum

1. The prominent pushing hand of risk aversion is to enhance the construction of the training system of the employment core competitiveness in the top level design is. First of all, the leadership system should be straightened out, a sound coordination mechanism should be set up in terms of teaching, employment, scientific research and student work departments, and the priority of the training system of the core employment competitiveness should be strengthened. Secondly, the training scheme should be constantly perfected "the three organic unification", namely, should be put into practice, the organic unification of the vitality of entrepreneurship education and the rigor of specialized education, the idea of entrepreneurship education and the goal of specialized education, and the directions of entrepreneurship, major and employment. In this way, the successful construction of the training system of the core employment competitiveness will be promoted. Thirdly, schools should enhance the propaganda and guidance of employment and entrepreneurship education. What should be emphasized is to sow a seed of innovation and entrepreneurship into students' mind as part of the core employment competitiveness to lead them to start their own business when there is a chance in the process of employment. Proper guidance and support to a small portion of students who run startups directly should be given. Entrepreneur team who enter the campus entrepreneurial base should comply with the principle of "entrance entail mature" to fully ensure the success rate of the factual running stage and to strive the multiplication efforts of employment and entrepreneurship among the students.
2. A reform model of the innovation and entrepreneur oriented education with emphasis on the integrated design is the basic means of risk aversion. Integrating specialized education does not mean building every thing from the ground up but rather scientifically grasp the internal relation between entrepreneurship, specialized and organization education and consider the entrepreneurship education

as a new educational idea and model through the whole process of specialized education (Lin 2009). We should develop a curriculum system oriented to innovation and entrepreneurship, strive to collaborate with entrepreneurs of profound professional background and entrepreneur experience in developing the curriculum in order to realize the integration of the content; realize the internationalization of the curriculum development from the vantage point of construction of innovative nation and the prospect of internationalization of higher education institute management; facilitate integration of the specialized curriculum education, practice session and the theory, practice, training and incubation of entrepreneurship education to realize the practice of the carrier of the course; respond to the call of the equality-oriented education to enrich the fist and second classroom as well as exploring the third one in order to realize the diversification of the curriculum offered.

3. Establishing the work flow of "proposal-experiment-modification-generalization" is the major method of risk aversion. Although the education officials can pay much attention to and have an integrated layout, the integration cannot be completed in a day and inability to adjust to the diverse and changeable specific circumstances is still possible. Colleges can propose and modify on the one hand while propagating and spreading on the other hand in the process of progradation. After the demonstration of the educational reform and training system, such work method of high danger measurability and process controllability can be generally spread through all colleges. While, those reform measures which are greatly resisted and of high risk rate can be experimented in a selection of few colleges. At the same time, the similarities and differences of the research process and results should be found out, the sequential work with focuses should be promoted, and proper revision and adjustment should be taken if there is a need.
4. Constructing a resources security system based on "comprehensive sharing platform" is an important handle of risk aversion. The first is the cooperation platform of school and industry. Colleges can make use of the university and school level organizations as the entrepreneur education guiding committee, entrepreneur education research centre and entrepreneur incubation base. From these, they can select a faculty with teaching skills on entrepreneurship education to enhance internal training and improve the teaching level. And they can also mobilize forces outside campus to build resources security through such ways as external entrepreneurs' and celebrities' speeches and cooperation of running the school. The second is cross-school cooperation platform. Those newly constructed university towns in cities should be wisely used to try to integrate the "entrepreneurship education" among colleges and construct cross-school education network and comprehensive resources sharing entrepreneurship platform. The third is school-government cooperation platform. School must get government's support to build university students' entrepreneurial park and other forms of incubation centre outside campus; they must also get preferential policy to facilitate the registration, petty loan and tax cuts of startups.

129.4 Conclusion

This study analyzes the current research status of entrepreneurship education into the current specialized curriculum teaching. The realistic confusion of entrepreneurship education into College Professional Curriculum at Teaching System, Teaching Link and Teacher Resources etc. is pointed out, the risks and risk attribution of integrating entrepreneurship into college professional curriculum is studied which include risks in the integration process, the risk of education reform leading to the imbalance of education resources and risks of low employment under the new training system. At last, four ways of risk aversion of integrating entrepreneurship education into college professional curriculum are proposed, such as enhance the construction of the training system of the employment core competitiveness in the top level design is, a reform model of the innovation and entrepreneur oriented education with emphasis on the integrated design, establishing the work flow of "proposal-experiment-modification-generalization" and Constructing a resources security system based on "comprehensive sharing platform".

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Chapter 130
The Role Analysis for the Shareholding Structure to Risk Control in Public–Private Partnerships

Xing Bi and Jing-xing Chang

Abstract The PPP (Public–Private Partnership) model has become increasingly important as a means of financing the construction of infrastructure, but it has many special characteristics, such as a large investment, long construction period, involving many partners, and the complex contract structure relatively. This makes the project risk control extremely important, which also is the key to success. Through a detailed literature analysis, first of all, the paper points out the main points of risk control with two-dimensional analysis of the risk, and determined both public and private risk allocation coefficient according to the equity structure, and then the control was given the most advantageous risk control side according to the shareholding structure adjusted, in order to achieve the new ideas for the purposes of risk control.

Keywords PPP · Risk control · Ownership structure

130.1 Introduction

PPP (Public–Private Partnership) is a way of supplying Public products, which between outsourcing and privatization and combines both those characteristics, which makes full use of private resources for the design, construction, investment, operation and maintenance of public infrastructure, and provides related services to meet public demand (The National Council for PPP, USA 2002).

PPP Project financing allows private capital to become more involved in the project. Considered the government's public sector and private sector concession agreement as the basis for the full cooperation, both sides are responsible for the

X. Bi (✉) · J. Chang
College of Management and Economics, Tianjin University,
Tianjin, China
e-mail: bistar@126.com

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entire cycle of operation of the project to improve efficiency and reduce risk. But generally the PPP project requires a large investment and long time, faced with high-risk. The contract structure is relatively complex and the project negotiation process is often protracted (Grant 1996). There is often a controversy, as a result of being unable to deliver on promises in the implementation process or some other reason, so that only a small number of PPP projects can operate normally in practice among them. The main reason is the lack of fair and reasonable risk-sharing between public and private sector standards and it is difficult to drive both sides industriously to control risk allocated (Victorian Department of Treasury and Finance, Australia 2001). Consensuses on the principle of risk allocation have been reached (Li et al. 2005), but the concrete implementation of the risk incentives and risk-control is still an urgent problem in the PPP project.

130.2 Methodology

130.2.1 Two-Dimensional Analysis for Risk

Relative to the general project, the PPP project with long construction period, involving the public sector, private sector, the project company, bank financial institutions, insurance companies, engineering construction, contractors, engineering consulting companies, suppliers of equipment and materials, the project products (services) buyers and many other parties, and the contractual relationship between the parties is more complicated (Ng and Loosemore 2007).

This will undoubtedly increase the risk of the project, which has brought many challenges to the smooth implementation of the project. Project risk control has become a bottleneck in the development of the PPP mode. Good risk control stems from a clear understanding of risk (United Nations Institute for Raining and Research 2000). For risk control study, the paper analyses the project risk from the two dimensions including the project stage and the type in-depth to lay the foundation.

From the view of project process, the risk exists in the whole process and stages of the project. General project is divided into seven stages: feasibility study stage, bidding stage, the organizational phase of the contract, financing stage, the project construction phase, the project operation phase and the project transition phase. In this paper, the first three stages are collectively referred to the project early stage. The different stages have different risk characteristics and risk control points (Jiang 2008).

According to risk types, the risk also is divided into political risk, construction risk, operational risk, market risk, legal risk and financial risk (Finnerty 1996).

Two points method are not independent each other with a different classified way of the same risk (see Fig. 130.1). Each risk does not just exist at a certain stage; every stage does not just have a type of risk. Such as: the rising risk of market risk in the cost of materials present in the construction phase, but the

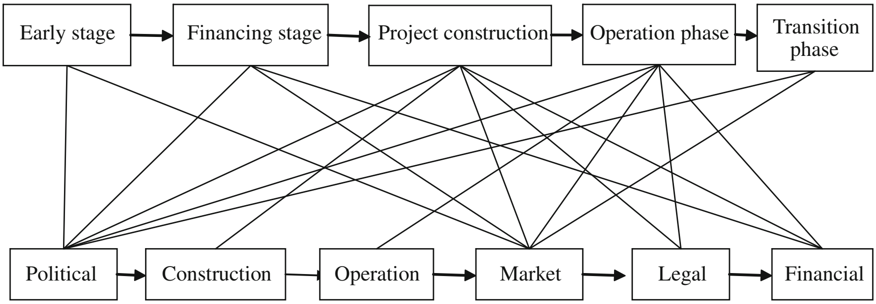

Fig. 130.1 Two-dimensional analysis for risk

market demand, the only competition in the market risk does exist in the phase of the operation. Meanwhile, the same stage of construction is not only market risk, but political, financial and other risks. These two division methods benefit from the perspective of two-dimensional understanding of risk, which can identify the main risks of the various stages and the generic of risk at this stage. Thereby increasing the sense of three-dimensional understanding of the risks, which contribute to more clearly identify who have more advantages to control risk in order to better allocate and control risk (Hall et al. 2003).

The complexity of the risk we can not only singly control a certain stage, but also do with the type of risk, analysis of both the sources of risk, and thus determine the risk control methods. How to achieve effective control is the focus of this study.

130.2.2 Risk Allocation Principles

For the principle of risk allocation of the project academia has reached a consensus (Zhang 2005): who have the best power to the risk to bear the corresponding risk. Thus, when the risk occurs, we first determine the stage of the risk and generic the risk of, determine who control this risk, which means who in the best position will reduce the probability of the occurrence of the risk and the losses caused. Meanwhile, who have the power to control risk would be derived him to manage the risk industriously. In accordance with the principles on the allocation of these risks, construction risks should be allocated to the private sector because the private sector in the best position to control the construction process of the project; some risks, such as political risk, the risk of legal changes and nationalization risk, should to be beard by the public sector with more control. Because the public sector, as a government or government representatives, has the ability to influence the rules and regulations, policies, laws and other regulations. Therefore, it is in a more favorable position than the private sector to identify, evaluate and control these risks.

130.3 Discussion

130.3.1 The Impact of Ownership Structure on Risk Allocation

Reasonable risk allocation principles, the most favorable control side of the risk needs control power that matches the risk and the proceeds corresponds to risk to excited its risk control initiatively. Control and equity are inseparable. The project company's ownership structure or investment structure reflects the shareholder's legal rights to interests of the project assets and legal contractual relationship between the shareholders each other. Under the constraints of the project site laws and regulations, accounting and tax and other objective factors, it is one of ownership structure of assets of projects to achieve the shareholder's investment objectives (Lyandres and Zhdanov 2006). How much equity represents how much control, and it also represents a party to the risk control ability.

This paper tries to discuss the risk control from the ownership structure perspective. First before the start of project, both public and private determine their own risk allocation through particular negotiations. Generally, the risk which is able to identify which side is more advantage to control is borne by the appropriate parties, the one, which is difficult to identify which side is more advantages to control or both sides do not have the advantage of risk control, should be allocated in accordance with the accounting for interests in shares by the two sides. Then the risks borne by the private party can be divided, and generally private parties are composed by the Joint Venture, each participating enterprise have professional advantage at one stage. Giving it control power by reasonable adjustments of the ownership structure in the course of the project, so as to achieve the incentive to fully play their own advantages to control the risk (see Fig. 130.2).

Under the guidance of the principle of risk allocation, the problem of the risk allocation becomes to distinguish who have more control power to risk. Found by comparison: (1) the private party shall bear the risk of project financing, construction, procurement, operation and maintenance; (2) The Government should

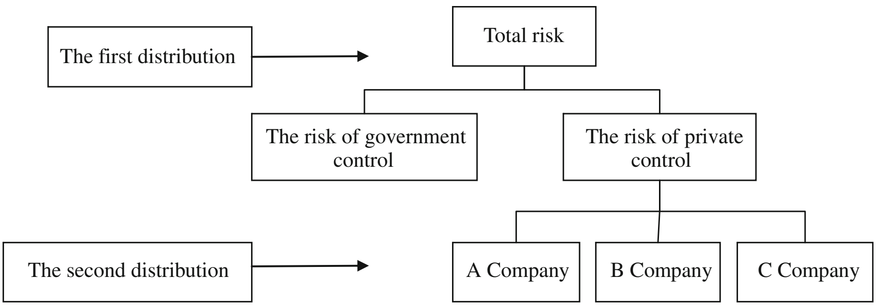

Fig. 130.2 Risk allocation flow

undertake public policy, law changes and other risks; (3) force majeure risk which is not good to determine which side to take the risk, should be a mutual undertaking. We set the risk distribution coefficients A, B, C, and $A + B + C = 1$. A represents the risk distribution coefficient of the Government, B represents the risk distribution coefficient of the Government, C represents the risk of both the government and the private side shared. C sector would redistribute according to the ownership structure of the entire project. If private parties invested in M, and government-funded N, the private party equity accounted for $K = M/(N + M)$, then $1-K$ for the government. The ultimate risk of the partition coefficient of the private side is $X_1 = A + K * C$, for government departments, the allocation of risk factor is $X_2 = B + (1-k) * C$. Then the allocation coefficient of risk are linked to final income with the project, the more coefficient and more higher income distribution in order to achieve the purpose of incentives to control risk.

130.3.2 Private Party Risk Redistribution

Through the allocation of these risks, the private parties determine the risk of their own to bear. The private party is a coalition of several enterprises generally in the PPP project, each one has its own expertise areas, and general project has Stage characteristic of financing, construction and operational phases. The implementation of project will benefit from professional advantage.

Faruqi and Smith (1997) think that sharing the PPP project company with contractors and equipment suppliers and other professional firms will benefit the project on schedule, completion of standard quality to achieve business, give full play to the already existing experience in the actual operation and improve operational efficiency. Zhang (2005) points out that the construction and finance are two risk types of PPP projects, the government and the creditors are very concerned about the project shareholder structure, and that the shareholders who tend to achieve profit-sharing of project is to be more conducive to the implementation of the project. Yescombe (2010) think that it will effectively reduce the financing costs, improve financing efficiency that the cooperation between the dual identity of investors for short-term interest, such as the construction contractors, equipment suppliers, and those pure investor who are interesting in long-term benefits of the project. Xu Xiaodong and the Chen Xiaoyue points out that the changes in the company's largest shareholder is in order to obtain the benefits of control.

It is conducive to the improvement of the effectiveness of corporate governance, enlarged scale and more specialized management (Xu and Chen 2003).

Combining of existing research results, the advantages of company shares will play their strengths to control projects risk in the stage of financing, construction and operation, reduce risk probability and ensure the successful implementation of the project. To this end, it is a good way that can be taken to encourage private consortium enterprises by restructuring equity structure according to the process of the project.

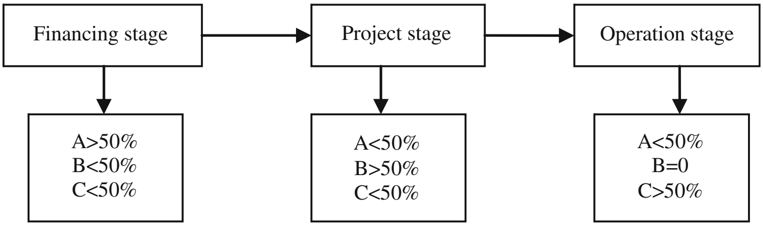

Fig. 130.3 Make the ownership structure adjustment according to the stage of project

Assuming that the private joint venture contains investment management company (A), Construction Company (B) and operating companies (C), every company has the different proportion of equity in different stages of the project. Company keeps the absolute ownership (shareholding > 50 %) in its best control stage, meanwhile, and the distribution of income is directly related to the equity proportion in order to motivate the purpose of risk control. Specific actions: firstly, A keeps the concentrated ownership in the financing stages in order to reduce higher financing costs risks. For the construction phase, the ownership is concentrated hold by the Company B, using its own experience and technological advantages to control construction costs, completion date, quality of the project and other risks in the field of construction. Finally to the operational phase, the ownership is concentrated hold by the Company C which has the most advantage to control risk at this stage. The entire equity interest in the conversion process could be the associates within the body of equity transfer agreement (see Fig. 130.3).

130.4 Conclusion

PPP project model can effectively reduce the burden on public finances to optimize the fiscal expenditure configuration, the introduction of advanced technology and management experience, and improve efficiency. There is a wide range of applications, covering the field of transportation, power plants, water supply, sewage/waste disposal, medical, national defense, prisons and police. However, its risk control issues become more prominent than the average one, which has become the bottleneck in the development of PPP projects. Starting from the two-dimensional analysis of risk, the paper raises both public and private to accept risk which mainly be allocated in accordance with the division of the types of risks, every company of the private parties bear the risk of secondary distribution which is to be allocated in accordance with the project process. Combining equity restructuring and risk allocation, there is to incentives and give the most advantage risk controlling party absolute control power in order to achieve the best risk control purposes.

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Chapter 131
Hedging Based Price Decline Risk Management of Refined Oil Inventory

Xing Bi, Yao-long Zhang and Yan-wei Liu

Abstract Nowadays oil has become an important energy source with both political and economic attributes. Frequent fluctuation of oil demand and price in the international market confronts enterprises with many uncertainties in refined oil inventory management. In order to prevent the risk of oil price decline brought up by those uncertainties, this article analyzed the inventory methods of different refined oil, chose hedging as the method to manage price decline risks of oil inventory, compared the different optimal hedge ratio models, and made empirical analysis to gasoline hedging.

Keywords Hedging · Risk management · OLS

131.1 Introduction

Uncertainty of demand or price usually causes risk in inventory management to enterprises. Inventory management, especially inventory price management of refined oil, is of great influence on enterprise operations. Although the rise of inventory value in price-increasing period can absolutely create extra profit for the enterprises, the decline of inventory value will bring huge losses when the oil price goes down if the enterprises cannot reasonably avoid the risks. Therefore, price decline risk is an important inventory risk that enterprises are faced with. In the future, the government is likely to further adjust the pricing mechanism of refined

X. Bi (✉) · Y. Zhang
College of Management and Economics, University of Tianjin,
Tianjin, China
e-mail: bistar@126.com

Y. Liu
Office of International Cooperation, Peking University Health
Science Center, Beijing, China

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oil. Therefore, the oil price may be more frequently regulated, the correlation between oil prices domestic and abroad strengthened, the price of refined oil further marketed, and the risk of inventory price fluctuation increased. For this reason, study on price decline risk management of refined oil inventory is of great significance to enhance enterprise operation efficiency, avoid financial risks, and ensure the smooth running of daily sales.

131.2 Methodology

131.2.1 Methods of Refined Oil Inventory Management

There are already some advanced management ideas and management tools on an international level about inventory management and effective inventory risk control, such as insurance stock quota, lead-time, Activity Based Classification, VMI (vendor-managed inventory) theory, JIT (just-in-time) purchasing system, hedging, and etc.

Insurance stock quota is a quantity criterion of the necessary material reserve for regular production when the supplier delays the supply for enterprises or when some other accidents occur (Yan and Hong 2005). Usually these inventories will not be used unless the stocks are overused or the supplies are delayed. For some enterprises, their products have seasonality or the transportation of their products is affected by seasons, so seasonal stocks are needed.

Lead-time is the period from the start of ordering to receiving order quantity (Minggui 2005). Strictly speaking, lead-time is random and indeterminate. But it is often regarded as a determined constant in application. Sometimes enterprises need to order products to replenish stocks. With the delivery of cargo from storage, the inventory level will gradually decrease to a point, and then replenishment is required, or stockout appears, thus seriously affecting the regular enterprise operations. This point is called “order point”. When the inventory level reaches the “order point”, ordering will start.

Activity Based Classification is a key control method, which classifies the analyzing objects into three different categories (A, B, and C) according to their main technology economic characteristics, in order to distinguish between important objects and general ones and to focus on the management of decisive A-category objects (Xili 2009). ABC classification management of inventory is to classify the inventories of enterprises into A, B, and C categories in accordance with certain criteria. The most important inventories belong to A category, general inventories B category, and the unimportant ones C category. Commonly, there are two classification criteria: amount standard and standard number of varieties, among which amount standard is the most fundamental criterion, while the other one is only a reference.

VMI means that the upstream enterprises, such as the suppliers, manage and regulate the inventories of downstream customers on the basis of the production, operation and inventory information of their downstream customers (Junxu 2008). It is an inventory operation mode in the supply chain environment. In essence, it is a method that turns the problem of multi-stage supply chain into that of single-stage inventory management, compared with the traditional method of replenishing products according to the ordering of traditional costumers. VMI is a solution that utilizes the actual or predicted consumption demand and inventory as market demand forecast and inventory replenishment, which means the suppliers can get the information for consumption demand through sales data, and more effectively plan and more quickly respond to market change and consumption demand.

JIT purchase, also called Just In Time purchase, is evolved from the idea of Just In Time production management (Fuquan and Wenli 2005). Its fundamental idea is to provide appropriate products with appropriate quantity and quality at the appropriate place and time. JIT purchase includes the support and collaboration of suppliers, the process of producing, freight transportation systems, and etc., which can not only draw down inventories, but also speed up inventory turnover, shorten lead time, improve shopping quality, and achieve results of satisfactory delivery.

The above theoretical methods all reduce enterprise inventories, speed up inventory turnover and reach the goal of inventory risk control from the perspective of minimizing inventory cost and maximizing service standard. However, the common practice for many large multinational petroleum companies is to hedge against oil futures, which can help lock the cost and prevent drastic fluctuation of profit due to the fluctuation of market prices, thus guaranteeing the smooth operation of enterprises.

Hedging is a trading that insures the price of goods that is needed to buy in the future or is bought to sell in the future, making use of futures contract as the temporary substituent of goods that will be traded in spot market of the future. In normal market conditions, the trends of spot market and futures market are similar. Since the two markets are affected by the identical supply and demand relation, the prices of the two markets rise together and fall together; however, the operations of the two markets are the opposite, so one gains profit when the other gets a loss, meaning that profit in futures market can cover the loss in spot market or the otherwise.

131.2.2 Optimal Hedging Ratio Model Comparison

Modern hedging theory includes three topics: the scale of hedging, the effectiveness of hedging and the cost of hedging. The scale of hedging is described by the hedging ratio; the effectiveness of hedging is measured by the degree that hedging helps reduce the price risk the hedgers are faced with; the cost of hedging means the degree that hedging reduces the expected profit of hedgers. The effectiveness of hedging and the cost of hedging combined together decide the efficiency of hedging. Effective hedging can reduce the maximum amount of risks relative to each unit cost. The so-called optimal hedging method is to choose a method from a series of available efficient hedging methods to reach the maximum utility. At present, there are mainly two kinds of hedging ratio calculation methods in domestic and international literatures: risk minimization based and revenue maximization based.

1. *Optimal hedging ratio model based on risk minimization*: Keynes (1930) indicated that with the futures price and spot price completely correlated, in order to get the best hedging effect, the optimal hedging ratio should be 1, and it is recommended to buy futures contract in futures market with the equal number and opposite direction of goods in spot market futures contract. But the assumption does not coincide with the actual situation, because the futures price and spot price interact with each other, but are not completely correlated. Now scholars focus on risk minimization and regard it as the optimization objective. Ederington (1979) measured risks with hedging intraclass variance, and got the optimal hedging ratio by using the least squares method with risk minimization as the optimization objective. Lien and Luo (1993), Viswanath (1993), Ghosh (1993), Holmes (1996), Sim and Zurbruegg (2001) all found that there exists cointegration relationship between the futures price sequence and spot price sequence. In view of the above, Ghosh put forward the VAR model (Vector Autoregression Model) and the ECM model (Error Correction Model) to calculate optimal hedging ratio. The characteristic of risk minimization based static optimal hedging ratio models is that they truly reflect the hedgers' desire of avoiding risk in the futures market while the disadvantages are: ignorance of hedging profit issue; no consideration for the influence of dynamic change factors in futures trading on hedging effect.
2. *Optimal hedging ratio model based on revenue maximization*: Optimal hedging ratio decision models based on revenue maximization are rare, mainly because the primary function of futures market is to avoid price risk instead of purely pursuing best interests. Cecchetti et al. (1998) calculated the optimal hedging ratio from data with the hedging portfolio wealth maximization as the objective function. Huang (2004) got the optimal hedging ratio through setting up a hedging model with the optimization objective of maximizing profit. Chen and Hsu (2008) determined the optimal hedging ratio with the optimization goal of expected revenue on condition that negative yields would be normally distributed. The characteristic of revenue maximization based static optimal hedging ratio models is that they reflect the hedgers' desire of pursing maximum benefit in futures trading. But their biggest drawback is to ignore that there also exists great risks in futures trading. Besides, those models lack consideration for the dynamic changes of the risk factors.

131.3 Results and Discussion

When people hedge against futures market, the main problem is to choose a hedging ratio, that is to say the ratio of futures trading volume to spot transactions. At present, there are mainly two kinds of hedging ratio calculation methods in literatures at home and abroad: risk minimization based and revenue maximization based. Since the main concern of futures market is avoiding price risks, which can be completely fulfilled in practical application by risk-minimization-based ordinary least squares (OLS), the OLS model is chosen to determine the optimal hedging ratio in gasoline hedging empirical analysis.

The chosen hedging objects are Shanghai fuel oil futures, WTI futures of NYMEX and Brent futures of ICE; selected data sample interval is between January 2nd, 2009 and June 1st, 2011; data sources are gasoline factory price of National Development and Reform Committee, fuel oil futures price of Shanghai Futures Exchange, WTI futures price of NYMEX Futures Exchange, and Brent futures price of ICE Futures Exchange. Since the unit of the first two prices is Yuan a ton, while the unit of the latter two is dollar a barrel, dollar a barrel is chosen as the price unit in empirical analysis, conversion between RMB and US dollars being done with current exchange rate, 1 ton gasoline equaling to 8.51 barrel gasoline and 1 ton fuel oil equaling to 7.25 barrel fuel oil.

Correlation analysis and cointegration test to spot price and futures price with the introduction of correlation coefficient index and the use of Eviews software indicates that gasoline market is highly correlated with Shanghai fuel oil futures market, WTI futures market and Brent futures market. Therefore we can hedge against gasoline with these futures markets.

The essential issue of hedging against gasoline spot with futures is to establish the optimal hedging ratio. In order to reduce the inventory risks of refined oil and minimize the income risk, the risk minimization hedging model is chosen.

131.3.1 Model Specification

R refers to the change of hedging value; $h(t)$ refers to the hedging ratio; S_1 *and* S_2 respectively refer to spot prices at time t_1 *and* t_2; F_1 *and* F_2 respectively refer to futures prices at time t_1 *and* t_2; $\Delta S - h(t)\Delta F$ stands for the eventually change of short hedging, and $h(t)\Delta F - \Delta S$ stands for the eventually change of long hedging. Then:

$$VAR(R) = VAR(\Delta S - h(t)\Delta F) = \sigma_s^2 + h(t)\sigma_f^2 - 2h(t)\rho\sigma_s\sigma_f \tag{131.1}$$

And $\sigma_s^2 = VAR(\Delta S), \sigma_f^2 = VAR(\Delta F), \rho = COV(\Delta S, \Delta F)/\sigma_s\sigma_f$, to get the optimal hedging ratio which equals to minimizing the variance of $R(VAR(R))$, furthermore:

$$\begin{aligned} \frac{dV}{dh(t)} &= 2h(t)\sigma_f^2 - 2\rho\sigma_s\sigma_f = 0 \\ \frac{dV^2}{dh(t)^2} &= 2\sigma_f^2 > 0 \end{aligned} \tag{131.2}$$

$$h(t)^* = \rho\frac{\sigma_s}{\sigma_f} = \frac{COV(\Delta S, \Delta F)}{\sigma_f^2} \tag{131.3}$$

Formula (131.3) gets the optimal hedging ratio.

Build regression equation according to minimum risk based hedging ratio as follows:

$$\Delta \ln\ S_t = \alpha + \beta\Delta \ln\ F_t + \varepsilon_t \tag{131.4}$$

And α is the intercept of regression equation; ε_t is random error; slope coefficient β is estimated for the value of the hedging ratio:

$$\beta = COV(\Delta \ln\ S_t, \Delta \ln\ F_t)/VAR(\Delta \ln\ F_t) = h \tag{131.5}$$

131.3.2 Empirical Analysis on Optimal Hedging Ratio

For hedging strategies, we respectively construct the price change sequences for time interval of 30, 60 and 90 days according to spot price and the corresponding futures closing price during a certain period, to estimate the optimal hedging ratio under different hedging deadlines. Taking the 30-day interval as an example, its statistical characteristics of trend can be described in Table 131.1

Table 131.1 demonstrates that the average rate of spot price and futures price changes are all positive, which means both the spot and futures price have a rising overall trend. In a point view of price volatility, the prices of WTI futures and Brent futures have showed stronger volatility than the spot price of gasoline, and the price of Shanghai fuel oil futures.

With regard to the price sequences of different time period, we can get regression results as follows according to the regression equation formula (131.4): (see Table 131.2).

Table 131.1 Price change sequence characteristics description of 30-day interval

30 days	$\Delta \ln$ *GAS*	$\Delta \ln$ *SHFUEL*	$\Delta \ln$ *WTI*	$\Delta \ln$ *BRENT*
Mean value	0.016654	0.022735	0.026623	0.030780
Standard deviation	0.031930	0.037248	0.091746	0.087323
Kurtosis	2.709309	4.268926	3.523253	3.969592
Skewness	0.694197	0.716683	0.063010	−0.226190
Observations	29	29	29	29

Table 131.2 The regression results

Durations	Hedging subject	β	T	p	R^2	F
30 days	$\Delta \ln$ *SHFUEL*	0.2715	1.7350	0.0941	0.1003	3.0103
	$\Delta \ln$ *WTI*	0.1615	2.7213	0.0112	0.2152	7.4055
	$\Delta \ln$ *BRENT*	0.1737	2.8044	0.0092	0.2256	7.8650
60 days	$\Delta \ln$ *SHFUEL*	0.2549	2.1753	0.0389	0.1540	4.7320
	$\Delta \ln$ *WTI*	0.2116	4.2141	0.0003	0.4058	17.7583
	$\Delta \ln$ *BRENT*	0.2115	4.2967	0.0002	0.4152	18.4618
90 days	$\Delta \ln$ *SHFUEL*	0.3386	3.3422	0.0026	0.3088	11.1700
	$\Delta \ln$ *WTI*	0.2623	5.5693	0.0000	0.5638	31.0171
	$\Delta \ln$ *BRENT*	0.2566	5.8219	0.0000	0.5855	33.8942

Table 131.2 shows that different hedging subjects with the identical hedging time limit would have different optimal hedging ratios. Taking the 30-day interval as an example, the hedging ratio is 0.2715 when hedging against fuel oil futures, while the hedging ratio is just 0.1615 and 0.1737 against the WTI and Brent. Identical hedging subjects with different hedging time limit would also have different optimal hedging ratios. Taking the WTI futures as an example, the hedging ratio of 30-day futures is 0.1615, 0.2116 for 60-day and 0.2623 for 90-day.

131.3.3 Hedging Efficiency Comparison and Analysis

The calculation of hedging ratio is conducted in risk minimization principle, and the hedging efficiency is measured by the decline degree of risk.

According to Johnson (1960) who defined the hedging performance as the decline degree of variance after hedging, income variance of hedging and no-hedging can be described as:

$$VAR(U_t) = VAR(\Delta \ln \ S_t) \tag{131.6}$$

$$VAR(H_t) = VAR(\Delta \ln \ S_t - \beta \Delta \ln \ F_t) \tag{131.7}$$

Then hedging efficiency index can be calculated:

$$H_e = [VAR(U_t) - VAR(H_t)]/VAR(U_t) \tag{131.8}$$

H_e index reflects the decline degree of risk of hedging to no-hedging, that is to say the effectiveness of hedging. After hedging with some contracts, the degree of risk for spot price change could be reduced; the more the risk reduction is, the stronger the effectiveness of futures contract is. Comparing different futures hedging efficiency through formula (131.8), we get the results shown in Table 131.3.

Table 131.3 Hedging efficiency comparison

Durations	Hedging subject matter	H_e
30 days	$\Delta \ln$ *SHFUEL*	0.1003
	$\Delta \ln$ *WTI*	0.2152
	$\Delta \ln$ *BRENT*	0.2256
60 days	$\Delta \ln$ *SHFUEL*	0.1540
	$\Delta \ln$ *WTI*	0.4058
	$\Delta \ln$ *BRENT*	0.4152
90 days	$\Delta \ln$ *SHFUEL*	0.3088
	$\Delta \ln$ *WTI*	0.5638
	$\Delta \ln$ *BRENT*	0.5855

131.4 Conclusion

Hedging efficiency comparison in Table 131.3 shows that under the measure of risk minimization index and with the same futures contract time limit, the hedging effect of Brent futures is the best, WTI futures taking the second place, and Shanghai fuel oil futures is the least efficient in hedging. Taking Brent futures as an example, 30-day futures contract will reduce 22.56 % of risk, 60-day contract reducing 41.52 % and 90-day contract reducing 58.55 %. By this token, Brent futures with 90-day contract work better than the other Brent futures. Consequently, it is recommended to buy 90-day Brent futures contract in futures market in refined oil inventory risk management, in order to avoid price decline risk in gasoline spot market.

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Chapter 132
BP Neural Network-Based Commercial Loan Risk Early Warning Research

H. Zhou

Abstract To establish a scientific and effective commercial loan risk early-warning model is an important measure to effectively prevent, defuse the risk of commercial banks. This paper analyzes the main factors on commercial loans risk and establishes early warning indicator system, also uses BP neural network to build a bank commercial loan risk early-warning model. The empirical results show that: the neural network model can achieve higher accuracy.

Keywords Risk warning model · Commercial loans · BP neural network

132.1 Introduction

Building a scientific and effective risk early warning system for commercial loans, has important practical significance to identify the risk of loans from commercial banks and to take timely measures to prevent spreading of the risk. Traditional risk early warning system mainly predicts through statistical techniques such as multivariate statistical analysis, and logistic regression, which has significant limitations to solve the increasingly complex problem due to constraints of dealing with highly nonlinear data, over-reliance on historical data, and not having the dynamic early warning capacity. With the development of artificial intelligence, the BP neural network is introduced into the economic forecasting and early warning, which provides a new research idea for the areas of research.

Tam and Kiang (1992) use the BP neural network to train the network, provide a set of weights according to some samples of the input to the network, and after training, the company of any new input can be divided into bankruptcy and

H. Zhou (✉)
College of Management and Economics, Tianjin University,
Tianjin, China
e-mail: zh5553158@163.com

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non-bankruptcy. According to the prediction accuracy, adaptability and robustness, the empirical results show that the neural network is a better assessment of the bank's risk profile.

Ozkan-Gunay and Ozkan (2007) use Turkey's failed bank sample to predict the risk of using artificial neural networks. The empirical results show that: artificial neural networks can classify the patterns of financial data usefully. Use this classification, most of the banking crisis can be predicted in advance, and more importantly, it is also able to detect potential crisis signals.

To sum up, BP neural network has three significant advantages of dealing economic data: First, the neural network has advanced paralleled processing system as well as high speed self-learning and self-adapting abilities, with a lot of adjustable arguments which enhance the flexibility of the system. Second, BP neural network can process any kind of data. By learning continuously, the network can figure out the regular pattern from numerous complicated data of unknown patterns. The neural network overcomes the complexity of traditional processing and difficulties of choosing proper model functions. In other words, it is a natural process of no linear modeling which does not have to distinguish which kind of linear relation exists, thus brings great convenience to modeling and analyzing (Davis and Karim 2008; Ozkan-Gunay and Ozkam 2007; Hwang 2002).

132.2 Risk Early Warning System

132.2.1 Principles of Index Design (Lin 2002; Chen et al. 2002; Altman 1968; McCulloch and Pitts 1943)

First, principle of comprehensiveness. Risks of loans involve various factors and sources, therefore comprehensive estimate should be considered from diverse aspects.

Second, principle of science. Science and fairness are the principles of all systems of index. Choosing index, determining weights of index, selecting data, calculating and combining should be based on well-accepted scientific theories (statistical theory, management and decision-making theory etc.).

Third, principle of independence. Representative index are better to be chosen when setting up indexes since they may overlap with each other, thus indexes of relative independence should be chosen.

Fourth, principle of measurableness. All the contents within the index system should be measured directly according to measuring standards and definite results can be achieved.

Fifth, principle of operability. In terms of index selecting and estimate, the evaluate outcome should be comprehensive and processing procedure should be operable.

Table 132.1 Selection of financial indicators based on the performance results

Profitability	Sales profit margin, operating margin, pre-tax profit margin, net margin, return on assets
Operational capacity	Total asset turnover, fixed asset turnover, receivables turnover, inventory turnover
Solvency	Asset-liability ratio, current ratio, quick ratio, interest coverage ratio
Development capacity	Sales growth, profit growth rate of main business, capital gains rate
Cash flow	Cash maturity debt ratio, inflow and outflow of cash ratio
Commercial reputation	Loans due for settlement rate, accounts payable due for settlement rates, inventory loan ratio

132.2.2 Setting of Risk Recognizing Index System

(a) Financial Risks

Corporate financial risk is a microeconomic risk, which is the possibility of the actual future results of corporate financial activities deviating from the expected results. How the performance of the organization and management of the corporate financial activities will be inevitably reflected in the business capital of movement on the status and results of the performance of the financial status and outcome. The selected financial indicators are shown as Table 132.1.

(b) Non-financial risk

Non-financial factors relative to financial factors, refer to the sum of risks which have great impact on bank credit risk and cannot be reflected on the financial statement analysis. They are mainly reflected in the following areas: industry risk, business risk, management risk and moral hazard. This paper choose the following indicators to measure non-financial risk and these indicator are showed in Table 132.2.

132.3 Establishing of the Risk Early Warning System for Commercial Banks

The feed forward Three-Layer BP (Back Propagation) neural network is considered as the most suitable method for simulating the approximate relationship about

Table 132.2 Indicators to measure non-financial risk

Industry risk	Cost structure, industry maturity, industry subject to periodic impact, legal and policy environment
Operational risk	Firm size, product diversity, development stage
Management risk	Experience and quality of management layer, management stability and financial management capacity

the input and output. It has a wide range of applications in the economic field and has achieved good results, such as stock price forecasting, middle and long term forecasting of exchange rate and so on. It is the most mature and widely used one in the ANN, however, the research in the early warning area, especially the risk early warning system for commercial bank loans, is still not much. Therefore, putting ANN into this area is a very meaningful exploration and trial.

132.3.1 The Three-Layer Three-Node Neural Network Structure

In the above system, we define the early warning as the following three types: corresponding to normal, attention and warning respectively. Therefore, the output model of the network should be as follows: (1,0,0),(0,1,0),(0,0,1). According to the experiences, the hidden nodes should meet $2^n > m$ generally, where n is the number of the hidden nodes.

The three-layer three-node output neural network structure is shown as follows:

1. In the Fig. 132.1, $\hat{x}_{p1}^{(1)} \ldots\ldots \hat{x}_{ph}^{(1)}, \hat{x}_{p1}^{(2)} \ldots\ldots \hat{x}_{ph}^{(2)}$ are the evaluation index attribute values of the p-th sample mode of the domain $U = \{u_1, u_2, \cdots u_n\}$, denoted as: $\hat{X}_p = \left\{\hat{x}_{p1}^{(1)} \cdots\cdots \hat{x}_{ph}^{(1)}, \hat{x}_{ph}^{(2)} \cdots\cdots \hat{x}_{pk}^{(2)}\right\}$.

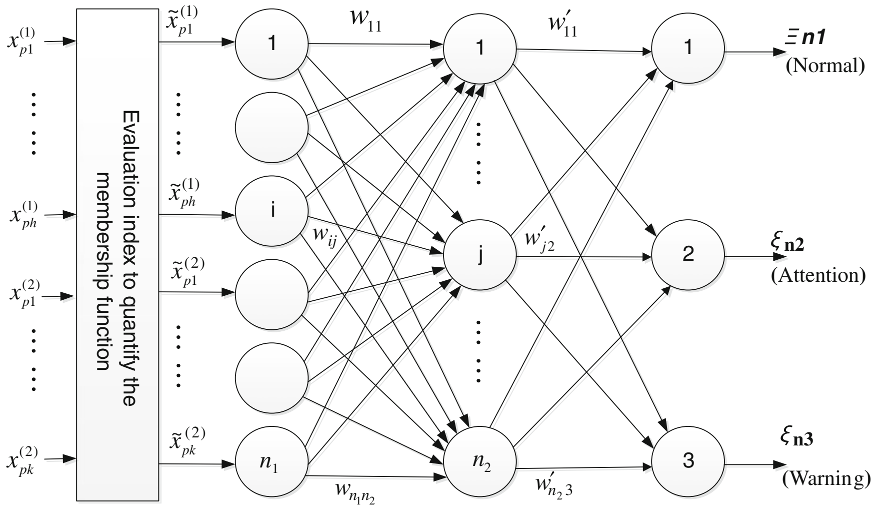

Fig. 132.1 The three-layer three-node output neural network structure

2. $\tilde{x}_{p1}^{(1)} \ldots\ldots \tilde{x}_{ph}^{(1)}, \tilde{x}_{p1}^{(2)} \ldots\ldots \tilde{x}_{ph}^{(2)}$ are the evaluation vectors(the membership vectors) after normalizing by the corresponding membership function, denoted as:

$$\tilde{X}_p = \left(\tilde{x}_{p1}^{(1)} \cdots\cdots \tilde{x}_{ph}^{(1)}, \tilde{x}_{ph}^{(2)} \cdots\cdots \tilde{x}_{pk}^{(2)}\right).$$

3. $W_{ij}(i = 1, 2, \cdots, m; j = 1, 2, \cdots, n)$ is the connection weight coefficient from the i-th unit of the input layer to the j-th unit of the hidden unit layer; $W_j(j = 1, 2, \cdots, n)$ is the connection weight coefficient from the j-th unit of the hidden unit layer to the output layer; Y_p is the output of the p-th sample pattern.

4. Considering the general situation, we assume that the number of the sample mode is s, and then the evaluation index attribute values matrix and the expected output matrix can be respectively denoted as:

$$\hat{X} = [\hat{X}_1, \hat{X}_2, \cdots, \hat{X}_s]^T = [\hat{x}_{pi}]_{sxnl},$$

$$B = [b_1, b_2, \cdots, b_s]^T = [b_p]_{sxl}.$$

132.3.2 The Algorithm Flow

With regard to the three-layer three-node output BP neural network structure, Mehmet and Mclean proposed the General Delta Rule, namely the Back Propagation (BP) Algorithm, which is the most effective and practical method. Its algorithm flow as shown in the Fig. 132.2.

Here we still use the general delta rule, which adopts the Sigmoid Function as the excitation function, i.e.

$$f(Net_{pi}) = 1/\left(1 + \exp(-Net_{pi})\right) \tag{132.1}$$

$$Net_{pi} = \sum_j W_{ji} o_{pi} + \theta_j, \tag{132.2}$$

where $i = 1, 2, \cdots, n_1; j = 1, 2, \cdots n_2$,

$$o_{pi} = {}^{1}\!/_{1} + \exp\left\{-\sum_j W_{ji} o_{pi} - \theta_j\right\} = {}^{1}\!/_{1} + e^{-Net_{pi}}, \tag{132.3}$$

where θ_j is the threshold of the unit U_j.

For this kind of excitation function

$$\partial o_{pj} / \partial Net_{pj} = o_{pj}\left(1 - o_{pj}\right) \tag{132.4}$$

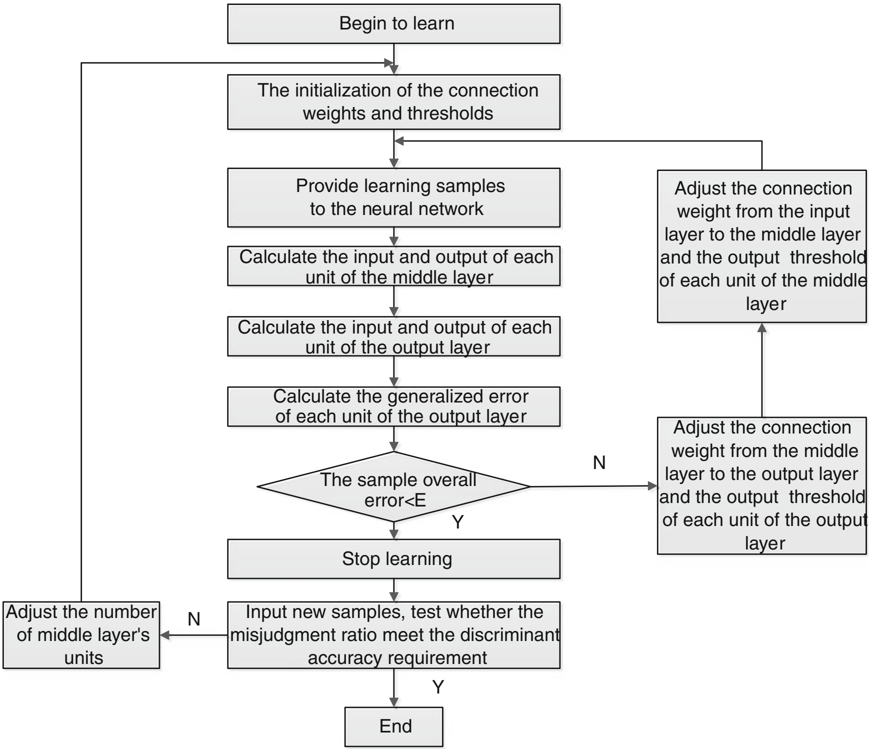

Fig. 132.2 Algorithm of back propagation

with regard to the output layer unit,

$$\partial o_{pj}/\partial Net_{pj} = o_{pj}(1 - o_{pj}), \tag{132.5}$$

with regard to the hidden layer unit,

$$\delta_{pj} = (\xi_{jp} - o_{pj})o_{pj}(1 - o_{pj}) \quad (j = 1, 2, 3). \tag{132.6}$$

In order to make the learning rate large enough and difficult to produce concussion, it is still necessary to add "trend items" to the Delta Rule, namely

$$\Delta W_{ji}(t + 1) = \eta\delta_{pj}o_{pi} + \alpha W_{ji}(t) \tag{132.7}$$

where α is a constant, which determines the influence degree of the past weight changes on the current weight changes.

The following algorithm assumes that the network is the Forward Multi-layer Network, the Excitation Function adopts the Sigmoid Function and threshold makes the same training.

132.4 Empirical Test of Risk Early Warning Model for Commercial Banks

As a test, this paper selects 15 of the financial risk early warning indicators to establish the BP network. 15 financial indicators means that there are 15 input nodes in the BP network and each input nodes corresponds to a financial indicators. The System's input has defined 3 nodes: (1,0,0), (0,1,0), (0,0,1) corresponds to normal, attention and warning, 3 different warning level.

Based on the experience, the hidden nodes need to satisfy $r > m$. Since the sample of this paper is 30/r, so $n = 5$ and that is there are 5 nodes in the hidden layer.

Because the inputs are continuous variable and the outputs are Boolean discrete vector, the inputs need to be normalized. The values of 15 indicators are calculated according to the enterprise and the actual inputs are got from the formula: actual inputs = weighs + (actual value ÷ standard value).

This paper used $15 \times 5 \times 3$ network topology and neuron function was Sigmoid characteristic function. 30 sample data form the risk management of the Bank of Communications were selected as learning samples. Based on BP algorithm training $15 \times 5 \times 3$ network topology by error of 0.001 and $\eta = 0.3$, $\alpha = 0.3$, the weight matrix initial value of 15×5 matrix and 5×3 matrix. Their Element is subject to the normal distribution N(0,1) random number. The initial weight matrix as follows:

$$W_{ji} = \begin{bmatrix} -0.2427 & -0.2413 & 0.2081 & -0.1830 & 0.0147 \\ 0.0901 & -0.1048 & -0.2811 & 0.1314 & 0.5624 \\ 0.5822 & -0.3793 & -0.7520 & -0.1062 & 0.2693 \\ -0.4744 & -0.6353 & 0.3661 & -0.1845 & -0.5756 \\ -0.3779 & -0.1617 & 0.0515 & -0.1249 & 0.2876 \\ -0.2813 & 0.2614 & 0.7770 & 0.4042 & 0.1909 \\ -0.5744 & 0.6788 & 0.6617 & -0.4776 & 0.1127 \\ 0.5807 & -0.2216 & -0.0054 & -0.3411 & 0.4825 \\ -0.1050 & 0.3261 & -0.6540 & 0.3844 & 0.0116 \\ -0.2017 & 0.0330 & 0.2862 & 0.2691 & 0.1298 \\ -0.2799 & 0.1881 & 0.3858 & -0.3980 & -0.7337 \\ 0.0899 & 0.5024 & -0.0665 & -0.0466 & -0.0082 \\ -0.3810 & 0.4057 & -0.3596 & -0.1064 & -0.1235 \\ -0.2628 & -0.6725 & -0.0637 & -0.0069 & 0.2094 \\ 0.0145 & -0.1619 & 0.1098 & -0.4591 & -0.4392 \end{bmatrix} \tag{132.8}$$

$$W_{kj} = \begin{bmatrix} -0.2600 & 0.3673 & 0.0131 \\ -0.7522 & -0.3582 & 0.4839 \\ -0.6554 & -0.0651 & -0.4563 \\ 0.6005 & -0.1832 & -0.3781 \\ -0.5545 & -0.2828 & 0.2891 \end{bmatrix} \tag{132.9}$$

The PC training took about 8 min and after 9,065 times, it meets the requirement. The final value of weights matrix are W_{kj} and W_{kj}. Noticing that different initial value can be trained into different final value, but this will not affect the final warning output. The coincide rate of the original input–output data is 95 %.

$$W_{jh} = \begin{bmatrix} 1.5447 & -1.6211 & 0.7020 & 2.3729 & 2.2117 \\ -11.2659 & -3.7252 & 3.5588 & -21.3867 & -18.2992 \\ -5.7659 & -0.7725 & -1.3400 & 4.0820 & 2.0921 \\ 23.1046 & -3.4426 & -24.4115 & -19.4779 & -11.5019 \\ 5.2303 & -2.2591 & -4.1776 & -6.2449 & -4.2933 \\ 7.0783 & -2.9613 & -10.2205 & -18.7865 & -13.5627 \\ -19.5395 & -1.1361 & -4.2272 & -9.2150 & -11.2725 \\ 29.1984 & -0.7366 & -13.8896 & -7.1715 & -0.9966 \\ -5.9162 & -3.5135 & -16.7223 & -32.8327 & -27.8172 \\ -17.3507 & -3.7378 & 1.1523 & 23.9371 & -22.0060 \\ -7.7016 & -4.7926 & -8.30098 & -33.5136 & -30.0967 \\ 19.1718 & 0.3578 & -19.5454 & -6.2621 & -1.3512 \\ 4.7370 & -0.0494 & -8.6073 & 0.4380 & 1.5085 \\ 2.3017 & -2.4674 & -16.6633 & -24.4167 & -19.3385 \\ 18.5184 & -0.3945 & -10.7106 & -0.7802 & 3.2665 \end{bmatrix} \quad (132.10)$$

$$W_{hi} = \begin{bmatrix} 14.1739 & -23.7384 & 17.9570 \\ -4.0861 & -4.4634 & 1.7070 \\ -24.6918 & 23.3329 & 3.5381 \\ -11.2089 & -26.5356 & 29.5935 \\ -7.3141 & -17.3059 & 25.1014 \end{bmatrix} \quad (132.11)$$

In the learning process, for overlearning will introduce much noisy signal into the weights set, prediction results are not necessarily the better when the control errors of learning termination are smaller. We should pay attention to it.

From the Table 132.3 we know that, the actual output is very close to our expected output except some specific sample.

132.5 Outcomes and Prospects

Commercial loan risk early warning index system is built in this paper, on which a BP neural network loan risk early warning model based on multi-output is established. Artificial neural network structure of 3-level, 3-node and algorithm process are introduced. In the end, existing data of the Bank of Communications are used to verify the validity of the system, and the results show that the system meets the requirements of the risk warning.

Table 132.3 Test result

Output layer Node1	Output layer Node2	Output layer Node3	Output layer Actual output Node1	Output layer Actual output Node2	Output layer Actual output Node3	Output layer Error Node1	Output layer Error Node2	Output layer Error Node3
1	0	0	0.9966	0.0016	0	0.0034	0.0016	0
1	0	0	0.9312	0.006	0	0.0688	0.0060	0
1	0	0	0.9621	0.0006	0	0.0379	0.0006	0
1	0	0	0.9598	0.0077	0	0.0402	0.0077	0
1	0	0	0.9876	0.0014	0	0.0124	0.0014	0
0	1	0	0	0.999	0.0021	0	0.0010	0.0021
0	1	0	0	1	0	0	0	0
0	1	0	0	0.9998	0	0	0.0002	0
0	1	0	0	0.9944	0.3233	0	0.0056	0.3233
0	1	0	0	0.9991	0.0006	0	0.0009	0.0006
0	0	1	0.0035	0.0006	0.9841	0.0035	0.0006	0.0159
0	0	1	0	0	1	0	0	0
0	0	1	0	0	1	0	0	0
0	0	1	0	0	1	0	0	0
0	0	1	0	0.0001	0.9999	0	0.0001	0.0001

Further researches on refining risk early warning standard of commercial bank loan and expansion and integration of candidate sets are needed, which will attach great significance to clarify the boundary of the pattern space of all loans, and then solve the distribution problem of learning samples.

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Chapter 133
Research of Educational Resource Sharing Mechanism Based on Grid

Wen-guang An, Hong-jun Li and Tao Wang

Abstract The current educational resources distribute disorder, it can't give full play to the role of the underlying network. This paper briefly describes grid architecture, carries out a theoretical study of educational resources construction based on grid, and discusses some issues in depth, such as resource management, resource description, discovery and transmission of resources.

Keywords Grid · Educational resources · Sharing · OGSA

With the improvement of network technology and the popularization of information technology in education, online education has been paid more and more attention. Each school is building its own network of educational resources, which not only enable the students to keep learning at any time, but also give full play to the effect of various kinds of educational resources. However, the current sharing of educational resources is very low; there is a lack of communication between various schools. How to integrate and manage the dispersed resources effectively, make a balanced distribution between the schools, play the role of online education, and meet all kinds of resources requirements of school to maximize? It has a very large practical significance. Grid technology can better solve this problem.

W. An (✉) · T. Wang
Department of Information Management and Engineering,
Hebei Finance University, Baoding, China
e-mail: anwenguang@126.com

T. Wang
e-mail: hbjrwt@gmail.com

H. Li
Foreign Languages Department, Great Wall College,
China University of Geosciences, Baoding, China
e-mail: hongjun_lee@126.com

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133.1 Introduction of Grid

Grid is an emerging technology, which is in constant change and development. It is the proposed concept that borrows from the power grid (Power Grid). In its viewpoint, all resources on the Internet will achieve interoperability, connectivity, each of information and Resources Island will be connected, which can provide people with geographic position, specific resources irrelevant transparent service. Grid is the third milestone after the Internet, World Wide Web in development of the Internet (Foster et al. 2001).

133.1.1 The Concept of Grid

Grid is a kind of infrastructure. It connect geographically dispersed computing hosts together to form a "super computer" on the basis of the Internet, and achieve a comprehensive, controlled sharing of physical resources, software resources, and storage resources (Foster and Kesselman 2004). Be known as "The father of grid computing", Ian Foster, in "The Grid: Blueprint for a New Computing infrastructure" to the grid made such a definition: "Grid is a group of emerging technology that be built on the Internet, it will integrate high-speed Internet, high-performance computers, large databases, sensors, remote equipment, and offer more resources, functions and services for technical personnel and ordinary people. The internet primarily provides E-mail, web browsing and other communications functions for people, and Grid function is stronger, which make people more transparent use computation, storage and other resources."

133.1.2 Characteristics of Grid

1. Resource distribution: The distribution of grid is reflected in the distribution of grid resources. Grid is composed of geographically distributed computers and storage devices.
2. Resource sharing: Grid completes the computing tasks by focusing the dispersed resources, and resource sharing is a means of resource focused. It can eliminate Information Island, and realize the application's interoperability. Grid and computer network is different, computer networks is hardware connectivity, while grid achieve application-level connectivity.
3. Dynamic diversity: Grid can provide a dynamic service, and adapt to change. Grid devices increases and decreases without affecting grid are other parts of function and performance.
4. Low cost: Using a variety of existing hardware and software resources to support various applications, it not only save costs, but can promote the rapid increase in the level of interdisciplinary research.

133.2 The Grid Architecture

The establishment of grid architecture is a prerequisite to realize the application of grid. Being involved in all aspects of grid technology has gradually formed the corresponding norms and agreements. Grid system built by in strict accordance with the standardization technical means is the key to realize data versatility and cross-platform.

So far, the mainstream of grid architecture mainly has three types and follows.

133.2.1 Ian Foster's Five Hourglass Structures (Five-Level Sandglass Architecture)

The most basic idea of Five-Level Sandglass Architecture is: the protocol as the center, emphasizing service and the importance of API and SDK. Five-Level Sandglass Architecture is divided into application layer, convergence layer, resource layer, link layer and structural layer (Foster 2006) shown in Fig. 133.1.

From the above figure we can see, the core protocol is stored between resource layer and link layer. Core layer must first accept the mapping of the various agreements from the top, and then map core agreement to the lower. And all the host of grid computing must adapt to these agreements. So the number of the core protocol should not be too much, and make the structure become an hourglass structure.

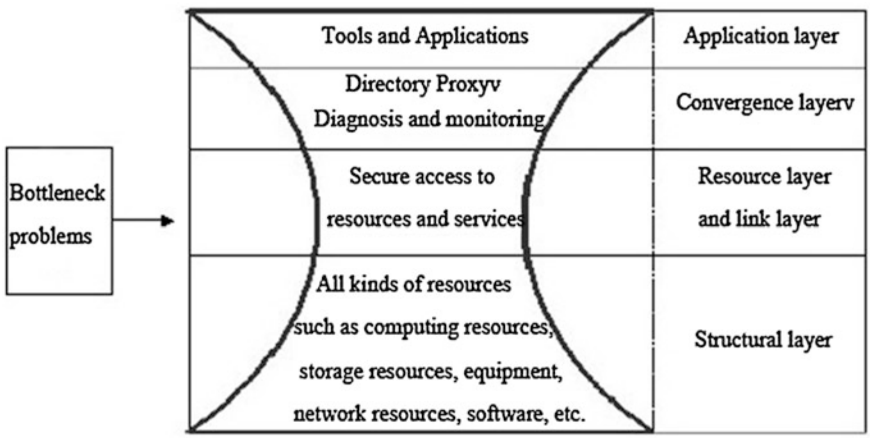

Fig. 133.1 The level of division of hourglass structure

133.2.2 Ian Foster, etc., Put Forward the Open Grid Services Architecture (Open Grid Services Architecture, OGSA) Based on the Web Services and Five-Level Sandglass Architecture

The most basic idea of OGSA is emphasize “service”. In OGSA framework, all are abstracted for service, including a variety of computing resources, storage resources, networks, programs, databases and so on. In short, all are services. This concept is conducive to manage and use gird through the unified standard interface (Geng 2007). A brief description of grid services is shown in Fig. 133.2.

OGSA achieve all of the core grid services by a set of relatively uniform interface, and can easily construct a hierarchical structure, higher level of service.

133.2.3 Globus Alliance’s Web Services Resource Framework (Web Service Resource Framework, WSRF)

WSRF adopts a completely different definition with grid services: resources are state, services are stateless. According to the specific information exchange and related XML, WSRF defines Web service resources (WS-resource) (Czajkowski et al. 2004). Through the establishment of method of the relationship between a state resources and Web services, it defines the description specifications and extended standard of Web Services Resource (WS-Resource) in certain message exchange and related XML mode, thus makes effective management for the service states, life period, services and other service groups, accelerate the integration of the grid and Web services, and the research community and industry standards.

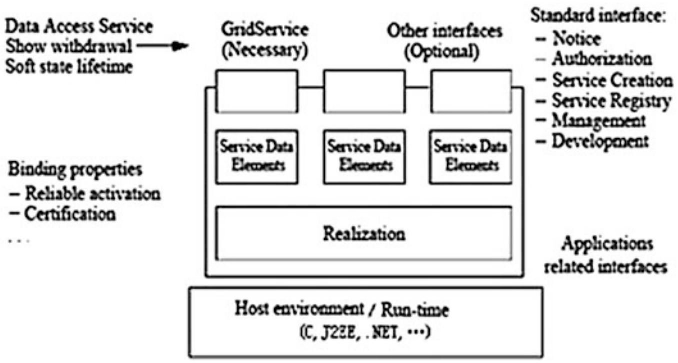

Fig. 133.2 Schematic diagram of grid services

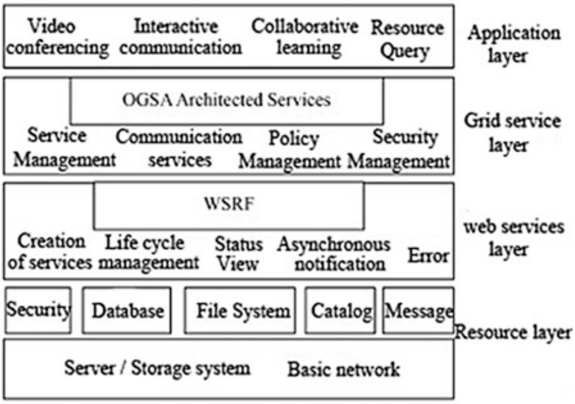

Fig. 133.3 Education resource grid architecture based on OGSA

This paper considers constructing the grid architecture of educational resources based on OGSA. OGSA architecture consists of four main layers, from bottom to top as follows: physical resources and logical resources layer, Web services and WSRF extend layer of definition grid services, service layer based on OGSA architecture, and the application layer. Here describes the hierarchical structure of educational resources grid shown in Fig. 133.3.

According to this hierarchy structure, we make clear the current main task: management of resources, description and discovery of resources, and transmission of resources, etc.

133.3 Management, Description and Discovery of Resource

Description of educational resources relates to the content of educational resources, applicable resources objects, teaching method requirements, and process requirement. Here we mainly introduce the content of educational resources. The type of education resources is abundant. It includes text, audio, video, PPT, multimedia courseware, etc. Of course, there are other application services, such as paper, e-books search system, video on demand systems, real-time communication system. OGSA and SRF abstract it as services that all of these storage resources, information resources, databases and so on. In order to realize the sharing of educational resources, we must firstly manage these services in grid of educational resource.

The task of grid resource management is to manage a variety of scattered resource in gird, so that more resource requesters can share the same resource in grid (Zhang 2008). According to business needs, the resource requester can use multiple resources in gird simultaneously or successively, without the need that the resource requester pays extra labor. The objectives of resource management include the following.

133.3.1 Provide Users with a Simple Interface to Access Resources

The actual use of resource management module hides the complex technology details of resources, physical resources are abstracted as logical resources and it provides services for users.

133.3.2 Coordinate Shared Use of Resources

Resource management module uses queuing strategies, time-sharing strategy or other strategies to determine how requesters to use the same resource. These strategies are to determine. Based on the characteristics of the resource itself and the owner of the development of strategies. At the same time, Resource management module also supports a need that the requester asks the use of multiple resources.

133.3.3 Replaces the Requester to Use Resources, and Establish a Secure Mechanism that Uses Grid Resources

As the super user, resource manager work in the resources instead of gird users. When user requests, resource manager creates an activity place–user container for the user in the local resource, container allow user to use resource in the container. Container strictly defines the rights and the operating owned by user (Sun 2009). By this way, it avoids the hidden trouble that a number of grid users are active in the same local account of the resources. When requested, containers can be dynamically created, and when request is over, containers can also be automatically revoked. The number of user container in the same resource is little; it won't bring a large administrative burden.

In addition to other using process of management of resource, the more important is the entire life-cycle of management of resource, namely the whole process from the registration and sharing of resource to the cancellation (Zhao 2006). At this point, resource manager needs to have the basic functions, including resources registration, resource discovery, deploy resources, resources agency and resources for cancellation.

The current service discovery mechanism mainly is UDDI (Universal Description, Discovery and Integration, Universal Description, Discovery and Integration) (Wang and Zhai 2006). UDDI is a set of the standard specification of information registration Centre based on Web, distributed, web services drafted by UDDI.org, it also contains a set of method that service providers can register their

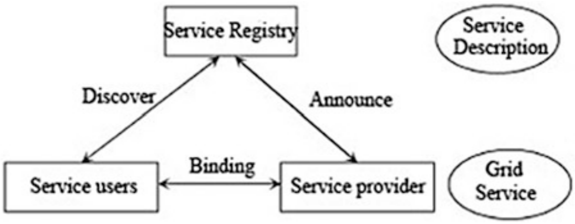

Fig. 133.4 service structure diagram

Web services, so that service user can discover these services realization standards of accessing protocol. The core component of UDDI is registration center. It describes the Web service by using WSDL (Web Service Description Language), it is the definition language of interface of web service, and it can describe three basic properties of the web service:

1. What services do: the operations (methods) provided by services;
2. How to access services: interactive data formats with services and the necessary agreements;
3. Where services locate: protocol-related addresses, such as the URL.

Figure 133.4 is the simple service structure diagram built between service providers, service registration center, and service users.

133.4 Transmission of Resources

On the basis of effective resource management, the use of resources is essential to transmit resource from the hands of provider to user (Zhu 2005). Grid environment requires a fast, safe, efficient and reliable transport mechanism. GridFTP is a common data transfer protocol of data management in computing environment of Globus gird. It supports GSI security mechanisms, three controls, parallel transmission and other functions, it supports the following features:

(a) *Parallel data transmission*: large bandwidth with use multiple TCP streams over a single TCP flow, parallel data transfers is provided support by the FTP command extensions and data channel extensions
(b) *Grid security infrastructure* (*Grid Security Infra-structure, GSI*) *and Kerberos authentication support*: The user controls all kinds of data integrity and confidentiality level setting. This feature provides the robust and flexible authentication, integrity and confidentiality mechanisms for transmission of documents.
(c) *Third-party control of data transmission*: Support for large distributed community management of data sets. It makes the third party to control the transmission between the storage servers.

(d) *Block data transmission*: There exists the ability to place the data split across multiple servers, thereby enhance the aggregate bandwidth. GridFTP supports sub-block data transmission through the extended definition in the Grid Forum (Grid Forum) draft.
(e) *Part of the file transfer*: Different from standard FTP application program transferring the entire file, new FTP commands support sent the certain areas of files.
(f) *Reliable data transmission*: Recovery method can handle transient network failures and server failures, and can restart a failed transfer.
(g) *Manual control of TCP buffer size*: maximum support for TCP/IP bandwidth.
(h) *Integration testing* (*Instrumentation*): support to return to restart and performance marker.

133.5 Conclusion

The emergence of grid technology provides the technical support for the widespread development of educational resources. On the one hand, it provides a new solution to solve distributed, dynamic and magnitude of information processing, and on the other hand, it can make the existing network resources more fully utilized. The development of grid-based environmental education resources greatly promote the development of education information, but its application is still in its infancy, it still need more in-depth research in order to make it better promote and use.

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Chapter 134
A Research on Evaluating the Competition Power of Creative Industries in Heilongjiang Province

Hai-chao Li and Shi-jie Fan

Abstract Basing on the view of 5C evaluation index and the baud competition theory, this article establishes the creative industrial evaluation index system, evaluates the competition power of creative industries in Heilongjiang province through fuzzy comprehensive evaluation. The analysis result indicates that intelligence resources and social environment should be regarded as the fundamental basis, and forming accumulative industry effect, expanding the development investment on scientific research, exploring new consumer demands and integrating with the economy development can enhance the competition power of creative industries.

Keywords Heilongjiang province · Creative industries · Competition power · Evaluation

134.1 Introduction

Heilongjiang province is a part of the old industrial based with rich technology and education resources, profound culture as well as geographical advantages. However, for a long time, the development is too dependent on the energy along with the problems of low additional Value of Industrial products and irrational Economic structure. On one hand, it urgently demands to promote the development, popularization and application of the new product, technology and equipment through independent innovation in order to poses some independent intellectual property, famous brand and superior enterprises of international competitiveness (Liu and Liu 2005); On the other hand, a lot of methods must be taken to develop

H. Li · S. Fan (✉)
Department of Economics and Management, Harbin Engineering University,
Harbin, People's Republic of China
e-mail: fanshijie7157@163.com

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industries with high value-added industry which accelerate the transformation of economic growth mode.

After 10 years' development, the creativity industries economy is engulfing the entire world by the vigorous potential. It can not only improve additional value of original products by fusion and penetration of the industry through cultural creativeness, but also transform economic growth by developing industries with high additional Value and innovation. Some developed countries have made it as the prop industry. In our country, some developed cities also started to make the creative industry development as the new round the economical growth spot and to bring it into the development overall plan. Therefore, vigorously developing creative industries is an inevitable trend in the future development of Heilongjiang province, Meanwhile, it is a wise choice to create an innovative industry.

134.2 The Conception of Creative Industries

The conception of creative industries was first proposed by British Government (Sui and Zhang 2008). The Creative Industries Task Force proposed by British Labor Party Government puts forward the conception of creative industries in Creative Industries Mapping Document for the first time in Nov. of 1998. Then they issued creative industry special report in which creative industries are defined as industries that origin from individual creativity, skills and abilities with the potential of creating wealth and employment through developing and using intellectual property (Li and Wang 2006).

With human society entering the era of knowledge economy, creative industries rapidly become driving force in promoting economic development and become the major ways of shaping international image in the developed countries. At the same time, academic group also lifted the upsurge of research on development of creative industry. From the perspective of culture economy, R. Caves gave a further definition that creative industries are industries that provides products and services with the value of broad culture, art or only entertainment (Guo et al. 2009). While from the perspective of intellectual property J. Howkins extended the Category that creative industries are composed of industries which are corresponding to intellectual property law including copyright, patent, trademark and design (Xiang and Zhou 2010).

In reference to related concepts on the basis of creative industry, this paper holds that creative industries can be defined as economic department to achieve commercialization through penetrating and remodeling traditional industries which is based on culture and emphasizes on close combination of creativity and high-tech.

134.3 Establish Competitiveness Evaluation Model of Creative Industries

134.3.1 Establishment of Evaluation Index System

The most famous competitiveness evaluation index of Creative industries is Florida's 3Ts (Technology, Talent, Tolerance) (Liu and Liu 2005). Then Cultural Policy Research Centre of Hong Kong University based on 3Ts drafted 5Cs including creative benefits, structure and system capital, human capital, social capital and cultural capital, which is more suitable to Asian point of view. This paper absorbs the main idea of Hong Kong evaluation Index which is factors' Interaction human capital, social capital and cultural capital is manifested as creative results or output (Li and Wang 2006).

Considering conception quantization, maneuver ability and heilongjiang's actual situation, this part drafts theoretical model of five key indexes including industry scale, human capital, research and innovation, social environment and creative benefits by using Porter Competitive Theory (such as Fig. 134.1). The dimension identification of creative industry competitiveness is the key to competitiveness evaluation. These five indexes not only reflect the close relation between creative industries and economic development, but also fully consider the inherent links among creativity growth, economic development and social-cultural values.

Fig. 134.1 Competitive power evaluation theory model of creative industries

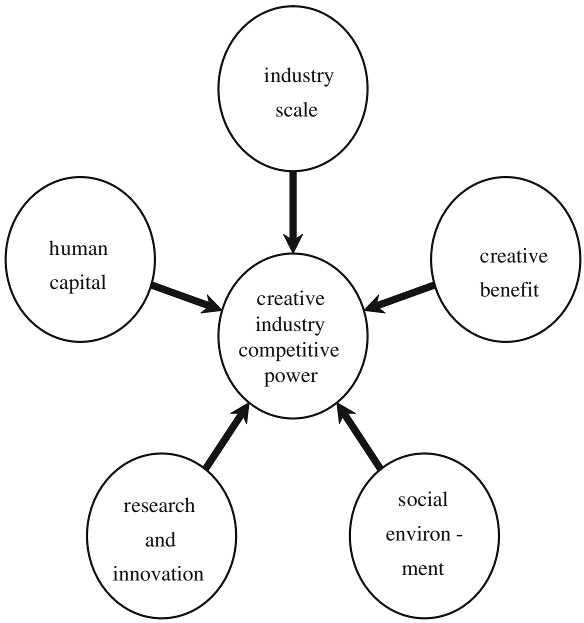

Table 134.1 The competitive power evaluation system of creative industries

Target layer	Criterion layer	Index layer
The competitiveness of creative industries U	Industry scale U_1	Number of institutions U_{11}
		Number of personnel U_{12}
		Fixed assets investment of urban creative industry U_{13}
	Human capital U_2	State financial education expenditure U_{21}
		Per capital education and training expense U_{22}
		Number of college students per 10,000 persons U_{23}
		Number of full-time college teachers U_{24}
	Research and innovation U_3	Research and development expense U_{31}
		The proportion of research and development expense in GDP U_{32}
		Full-time equivalent of R&D personnel U_{33}
	Social environment U_4	Official budgetary expenditures of cultural industry U_{41}
		Per capita annual expenditure of urban resident culture service U_{42}
		Per capita annual expenditure of urban resident culture goods U_{43}
		The proportion of per capita annual expenditure of urban resident culture services in total U_{44}
	Creative benefits U_5	Total profits and taxes U_{51}
		Sales revenue of new products U_{52}
		Industrial added value U_{53}
		The increase rate of industrial added value U_{54}
		The proportion of industrial added value in GDP U_{55}

Based on the dimension identification, this paper establishes evaluation index system (Li and Zhang 2009; Yu 2005; Liu and Wang 2009; Aoyama 2007; Banks et al. 2000) which explains various economic activities including social activities in creative industries competitiveness. Layer 1 (target level) is competitiveness evaluation, directly reflecting the development level of creative industries; Layer 2 (criterion level) describes industry scale, human capital, research and innovation, social environment and creative benefits these five aspects, Linking up with theory model; Layer 3 (index level) is the specific support index of the five components, linking up with domestic Statistics (Table 134.1).

134.3.2 Weight Determination in Entropy Method

(a) *Basic principle of entropy method*

Weight determination of every index is an important part in the process of competitiveness evaluation. In this paper, the method used to judge the weight is entropy. Entropy origins from the basic principle of information theory–information entropy is a measurement of uncertainty, it can judge the discrete degree of indexes and the random of an event, and it can also measure the disorder degree of the system in entropy.

According to the characteristic of entropy. The smaller the information entropy of the index is, the greater the amount of information provided is, the more important effects are made on the comprehensive evaluation, and the higher weight should be Xiang and Zhou (2010). As the evaluation index dimension existence difference and the data are discrete in this paper, entropy method (Zhang and Li 2011; Xu 2011) is more objective, which uses the difference degree among every data to determine the evaluation status in evaluating the target index, and to form index weight of the element.

(b) *The calculation process of weight determination in entropy method*

1. Data standardization processing

Suppose x_{ij} as the original value of the ith year and the jth sub-index under one class, in which $i = 1, 2, \ldots m; j = 1, 2, \ldots n$. Create $M * N$ matrix of X, In this text, all the indexes are positive indexes, namely the bigger the index is, the better it is, so pre-process the data x_{ij}, make x'_{ij} equal to $x_{ij} \Big/ \max\limits_{i} x_{ij}$ and define the matrix after Standardized: $P = (p_{ij})_{m \times n}$ in which

$$p_{ij} = x'_{ij} \Bigg/ \sum_{i=1}^{m} x'_{ij}, \quad 0 \le p_{ij} \le 1 \tag{134.1}$$

2. Calculate the Entropy e_j of index j

$$e_j = -k \sum_{i=1}^{m} P_{ij} \ln \ P_{ij} \tag{134.2}$$

in which $k \ge 0$, $k = \frac{1}{\ln m}$, $0 \le e_j \le 1$.

3. Calculate the difference coefficient h_j of index j

$$g_j = 1 - e_j \tag{134.3}$$

From the formula, the smaller the entropy value e_j of index j is, the greater the difference among the index j is, so the greater the evaluation effect on the objectives is.

4. Calculate entropy weight w_j of index j

With normalization processing on difference coefficient it can be obtained the weight of each index and weight vector $W = (W_1, W_2, \cdots W_n)$, in which

$$w_j = \frac{g_j}{\sum\limits_{j=1}^{n} g_j} \tag{134.4}$$

134.3.3 Fuzzy Comprehensive Evaluation of Competitiveness

(a) *Basic principle of fuzzy comprehensive evaluation*

Fuzzy comprehensive evaluation Method is a very effective multi-factor decision method which makes comprehensive evaluation on things influenced by many factors. The method has not only rigorously quantitative characterization, but also subjectively qualitative description on fuzzy phenomenon which is difficult to quantitatively analyze. It combines the quantitative analysis with the qualitative description closely which is widely used including subjective and objective indexes (Jijian and Chengping 2000; Zhu et al. 2007; Liu 2011; Wu and Zhong 2011). It mainly uses fuzzy math and fuzzy statistical method to make scientific evaluation on the advantages and disadvantages by comprehensive consideration about various factors affecting the things.

(b) *Factor and evaluation set*

According to the previous analysis, evaluation index system is divided into three levels: Level 1—target layer of the creative industries competitiveness U; The specific layer structure of competitiveness evaluation index system of Creative industry shows as Table 134.1.

Evaluation set is a kind of language description on evaluation of the various levels. It is comment set which is given by evaluation staff. To different evaluation objectives, its comment level has different meanings. According to the characteristics of creative industries, build comment set $V = \{V_i\}$. Establish five evaluation levels namely $V = \{V_1, V_2, V_3, V_4, V_5\}$, in which $V_1 =$ (good), $V_2 =$ (fair), $V_3 =$ (common), $V_4 =$ (poor), $V_5 =$ (bad), so the evaluation set is $V =$ (good, fair, common, poor, bad).

(c) *Single-Factor fuzzy comprehensive evaluation*

Make single-factor fuzzy evaluation and set up single-factor evaluation matrix $V = (V_{ij})$ and single-factor fuzzy evaluation subset:

$$V_i = (V_{i1}, V_{i2}, V_{i3}, V_{i4}, V_{i5})$$

It represents the possibility of each evaluated object in different comment level after using weighted average method that experts score according to each evaluation index. Fuzzy evaluation matrix V is as follows:

$$V = \begin{array}{c} \begin{array}{ccc} \text{Good} & \cdots & \text{Bad} \end{array} \\ \begin{bmatrix} V_{11} & \cdots & V_{15} \\ \vdots & \vdots & \vdots \\ V_{n1} & \cdots & V_{n5} \end{bmatrix} \end{array}$$

V_{ij} means the possibility that the ith index choices the jth evaluation.

(d) *Fuzzy comprehensive evaluation*

According to the weight and the single-factor evaluation previously got, generate fuzzy comprehensive evaluation vector A by processing data

$$\begin{aligned} A = WV &= (W_1, W_2, \cdots, W_n)\begin{bmatrix} V_{11} & \cdots & V_{15} \\ \vdots & \vdots & \vdots \\ V_{n1} & \cdots & V_{n5} \end{bmatrix} \\ &= (A_1, A_2, \cdots, A_5) \end{aligned}$$

A_j $(j = 1, 2, \cdots, 5)$ is called fuzzy comprehensive evaluation membership degree. At the same time, choice the maximum of A_j as the evaluation level of object index.

134.4 The Competitiveness Evaluation of Heilongjiang's Creative Industry

134.4.1 A Raw Data

In accordance with the evaluation index system, this paper chooses some related data about the development of Heilongjiang's creative industries in 2008 and 2009 from "Heilongjiang Statistical Yearbook 2009", "Heilongjiang Statistical Yearbook 2010" and some related statistics annual report. The reasons for choosing economic data of two years ago are two. The one is to avoid overestimate the evaluation capacity of the model for short interval. The other is that, based on the actual situation in Heilongjiang, creative industries competitiveness recognized by reality is always published after comprehensive data of past year, so using past year's data has little effect objectively.

134.4.2 Weight Calculation

Determine the weight of index layer. Use entropy method to determine the weight of 3 sub-indexes in Industry scale factor U_1. According to step (1), calculate 3 sub-indexes' Standardized data P in 2 years.

$$P = \begin{bmatrix} 0.4913 & 0.4747 & 0.5631 \\ 0.5087 & 0.5253 & 0.4369 \end{bmatrix}$$

According to step (2), calculate the entropy vector

$$E_1 = (0.9998, 0.9982, 0.9885)$$

According to step (3) calculate the difference coefficient vector

$$G_1 = (0.0002, 0.0018, 0.0115)$$

According to step (4), it can be obtained weight vector of industry scale sub-index after Normalization processing.

$$W_1 = (0.0148, 0.1333, 0.8519)$$

Similarly, calculate weigh of the human capital sub-index $W_2(0.4912, 0.0043, 0.0133, 0.4912)$;

Weight $W_3(0.4144, 0.4297, 0.1559)$of Research and Innovation sub-index U_3;

Weight $W_4(0.6907, 0.0186, 0.2689, 0.0218)$ of social and cultural environment sub-index U_4;

Weight $W_5(0.6742, 0.0390, 0.0737, 0.138, 0.0751)$ of creative benefits sub-index U_5.

$$A_j = \sum_{i=1}^{n} W_i V_{ij} \quad j = 1, 2, \cdots, 5$$

134.4.3 Fuzzy Comprehensive Evaluation on the Competitiveness of Creative Industries

(a) *Fuzzy comprehensive evaluation of industry scale* U_1

Suppose that factor set $U_1 =$ (number of Institutions, number of Personnel, fixed assets investment of urban creative industry). Meanwhile suppose $V_1 =$ (good, fair, common, poor, bad) as comment set. Focus on each factor in U_1 to form industry scale index evaluation of creative industries competitiveness. Invite 10 experts in related fields to score and evaluate via interviews, e-mail, establishing single-factor evaluation matrix V_1 after weighted average.

$$V_1 = \begin{bmatrix} 0.2 & 0.2 & 0.3 & 0.3 & 0 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0 \\ 0.1 & 0.2 & 0.2 & 0.4 & 0.1 \end{bmatrix}$$

As the weight vector $W_1 = (0.0148, 0.1333, 0.8519)$, so

$$A_1 = W_1 \times V_1 = (0.0148, 0.1333, 0.8519) \times \begin{bmatrix} 0.2 & 0.2 & 0.3 & 0.3 & 0 \\ 0.2 & 0.4 & 0.3 & 0.1 & 0 \\ 0.1 & 0.2 & 0.2 & 0.4 & 0.1 \end{bmatrix}$$
$$= (0.1148, 0.2267, 0.2148, 0.3585, 0.0853)$$

This shows that as to industry scale index good membership degree is 0.1148, fair membership degree is 0.2267, common membership degree is 0.2148, poor membership degree is 0.3585, bad membership degree is 0.0853. Because the poor membership degree is maximum, so evaluated from this index, the industry scale of Heilongjiang's creative industries is poor.

(b) *Fuzzy comprehensive evaluation of human capital* U_2

Using the same process, the single-factor evaluation matrix V_2 after weighted average of human capital U_2 is

$$V_2 = \begin{bmatrix} 0.3 & 0.4 & 0.2 & 0.1 & 0 \\ 0.3 & 0.5 & 0.1 & 0 & 0.1 \\ 0.2 & 0.2 & 0.3 & 0.3 & 0 \\ 0.1 & 0.3 & 0.3 & 0.2 & 0.1 \end{bmatrix}$$

So the Fuzzy comprehensive evaluation of human capital

$$A_2 = W_2 \times V_2 = (0.2004, 0.3487, 0.2500, 0.1514, 0.0496)$$

This shows that the maximum of fair membership degree is 0.3487. So evaluated from this, the human capital of Heilongjiang's creative industries is fair.

(c) *Fuzzy comprehensive evaluation of research and innovation* U_3

Using the same process, the single-factor evaluation matrix V_3 after weighted average of research and innovation U_3 is

$$V_3 = \begin{bmatrix} 0.1 & 0.3 & 0.4 & 0.1 & 0.1 \\ 0.1 & 0.4 & 0.3 & 0.2 & 0 \\ 0 & 0.1 & 0.5 & 0.2 & 0.2 \end{bmatrix}$$

$$A_3 = W_3 \times V_3 = (0.0844, 0.3122, 0.3746, 0.1594, 0.0734)$$

This shows that the maximum of common membership degree is 0.3746. So evaluated from this, research and innovation index of Heilongjiang's creative industries is common.

(d) *Fuzzy comprehensive evaluation of social environment* U_4

Using the same process, the single-factor evaluation matrix V_4 after weighted average of research and innovation U_4 is

$$V_4 = \begin{bmatrix} 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \\ 0.1 & 0.1 & 0.5 & 0.2 & 0.1 \\ 0.1 & 0.2 & 0.1 & 0.4 & 0.2 \\ 0.2 & 0.3 & 0.2 & 0.1 & 0.2 \end{bmatrix}$$

$$A_4 = W_4 \times V_4 = (0.2403, 0.2694, 0.1787, 0.1825, 0.1291)$$

This shows that the maximum of fair membership degree is 0.2694. So evaluated from this, the social environment index of Heilongjiang's creative industries is fair.

(e) *Fuzzy comprehensive evaluation of creative benefits* U_5

Using the same process, the single-factor evaluation matrix V_5 after weighted average of research and innovation U_5 is

$$V_5 = \begin{bmatrix} 0 & 0.1 & 0.3 & 0.4 & 0.2 \\ 0 & 0.2 & 0.5 & 0.2 & 0.1 \\ 0.2 & 0.4 & 0.2 & 0.2 & 0 \\ 0.1 & 0.3 & 0.3 & 0.2 & 0.1 \\ 0.2 & 0.3 & 0.3 & 0.1 & 0.1 \end{bmatrix}$$

$$A_5 = W_5 \times V_5 = (0.0436, 0.1686, 0.3004, 0.3273, 0.1600)$$

This shows that the maximum of poor membership degree is 0.3273. So evaluated from this, the creative benefits index of Heilongjiang's creative industries is poor.

(f) *Fuzzy comprehensive evaluation of the competitiveness* U

According to the fuzzy comprehensive evaluation matrix of industry scale, human capital, research and innovation, social environment and creative benefits, it can be obtained that

$$X = \begin{bmatrix} A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{bmatrix} = \begin{bmatrix} 0.1148 & 0.2267 & 0.2148 & 0.3585 & 0.0853 \\ 0.2004 & 0.3487 & 0.2500 & 0.1514 & 0.0496 \\ 0.0844 & 0.3122 & 0.3746 & 0.1594 & 0.0734 \\ 0.2403 & 0.2694 & 0.1787 & 0.1825 & 0.1291 \\ 0.0436 & 0.1686 & 0.3004 & 0.3273 & 0.1600 \end{bmatrix}$$

Use entropy method to determine weights of U_1, U_2, U_3, U_4, U_5. Transposing the evaluation matrix, and then calculate the weight vector according to step (1), (2), (3), (4).

$$W = (0.1862, 0.2216, 0.2986, 0.0496, 0.2440)$$

Meanwhile suppose $V =$ (good, fair, common, poor, bad) as comment set. Invite experts to score to form creative benefits index evaluation of creative industry competitiveness, establishing single-factor evaluation matrix V after weighted average.

$$V = \begin{bmatrix} 0.1537 & 0.2688 & 0.3230 & 0.1812 & 0.0733 \\ 0.1499 & 0.2520 & 0.2595 & 0.1620 & 0.1766 \\ 0.1022 & 0.2984 & 0.3815 & 0.2029 & 0.0150 \\ 0.1812 & 0.3661 & 0.2634 & 0.1519 & 0.0374 \\ 0.0435 & 0.1766 & 0.3009 & 0.3338 & 0.1452 \end{bmatrix}$$

At last, it can be obtained fuzzy comprehensive evaluation of the competitiveness U.

$$\begin{aligned} A = WV &= (0.1862, 0.2216, 0.2986, 0.0496, 0.2440) \begin{bmatrix} 0.1537 & 0.2688 & 0.3230 & 0.1812 & 0.0733 \\ 0.1499 & 0.2520 & 0.2595 & 0.1620 & 0.1766 \\ 0.1022 & 0.2984 & 0.3815 & 0.2029 & 0.0150 \\ 0.1812 & 0.3661 & 0.2634 & 0.1519 & 0.0374 \\ 0.0435 & 0.1766 & 0.3009 & 0.3338 & 0.1452 \end{bmatrix} \\ &= (0.1120, 0.2562, 0.3180, 0.2192, 0.0945) \end{aligned}$$

The final results shows: on complete and comprehensive consideration on the creative industries competitiveness, the maximum of common membership degree in the evaluation is 0.3180, so the competitiveness of Heilongjiang's creative industries is common.

134.5 Policy Suggestion

Creative industries are major in sunrise industries Characteristic with lower energy consumption and pollution, helping to pull the green GDP, and are consistent with the strategic objectives of Heilongjiang's transition. Empirical analysis shows that although Heilongjiang has abundant human resources, social and cultural environment, it hasn't formed creative industry scale and has been lack of research innovation. So improving the competitiveness of creative industries should be the new power in revitalizing city economy in Heilongjiang.

Firstly, unveil and implement some creative industries policy as soon as possible to form industry cluster effect. In recent years, some cities such as Beijing, Shanghai, Chengdu and others have been exploring on the development of creative industries. In comparison, Heilongjiang is relatively backward in the development of creative industries. Exception from holding "cartoon week" and few other activities, there is little input in technology, human and capital. Heilongjiang should make long-term plans on creative industries based on Northeast China and actively build creative industry cluster (Zhang 2010), to form new growth point of economy.

Secondly, strengthen cooperation with universities and encourage creative achievement transformation. A group of colleges led by Heilongjiang Institute of Technology, Harbin Engineering University and Heilongjiang University provide strong and firm guarantee for professional talents training and technical support. Through diverse kinds of cooperation forms such as government contract, two-way participation of college and business, intellectual resources are fully utilized to accelerate the transformation of creative achievement.

Thirdly, enterprises should increase R&D investment and enhance property rights protection consciousness. Transforming creative ideas into products is the key to develop creative industries. On one hand, as technology-intensive enterprises meet the development conditions of creative industries, it is necessary to encourage innovation; on the other hand, powerful protection of intellectual property rights is also indispensable, which is beneficial to form creativity.

Fourthly, rely on the exceptionally natural and cultural environment and tourism resources to establish creative industries with distinctive characteristics. Based on the resources of river tourism, snow, chinese and western culture (Wang 2006), Heilongjiang should develop into creative industries garden area taking culture, tourism, software development, computer services, fashion design, sports, handicraft and new media as main bodies, establishing creative industries chain of high additional value in wide extension.

Finally, stand on the tertiary industry and explore new consumption demand. As the per capita disposable income improves, people are increasingly pursing quality of life, which brings new opportunities to the development of creative industry. Stimulate Consumption to promote the development of creative industries, thus optimizing industry structure to form virtuous economy circle.

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Chapter 135
Some Thoughts on Educating Professionals for Mining Industry

Si-qing Liu, Shu-ming Wen, Dian-wen Liu, Xiong Tong and Zuo-yue Lan

Abstract With the fast development of economy, the mining industry in China has become seriously concerned about the future supply of its professionals in mineral processing and allied disciplines. Educating mining professionals become the more and more important thing. This paper outlines the mining education background in the Kunming University of Science and Technology (KUST). This paper then summaries the current situation of educating the mining professionals in the university, which shows that the professionals shall be trained by multiple ways. At the same time, some new thoughts on educating the mining professionals in KUST are put forward.

Keywords Mining industry · Professional · Engineering education

135.1 Introduction

With the recovery of global economy and the fast development of Chinese economy, the mining industry enters to a blooming period. According to the report, the need for minerals and energy in the coming 10 years will be surely gets increased, as the per capita GDP reaches over 1,000 USD (Xu and Li Xu and Li 2006; McDivitt 2002; Xu 2011). Generally, a few students from the remote countryside with low-income families tend to choose such subjects as mining and metallurgy to study, due to the low tuition fee, which are about one-fifth of those for normal subjects. However, the contradiction between the minerals industry's demand and the supply of its professionals is obvious. On the other hand, mining industry is facing with the problems to mine and process the ore characterized by low grade, finely dissemination and

S. Liu · S. Wen (✉) · D. Liu · X. Tong · Z. Lan
Department of Mineral Processing Engineering, Kunming University of Science and Technology, Kunming, China
e-mail: sam647@163.com

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high impurities, which challenges the mining practitioner at present and in the future. In order to realize the sustainable development for mining industry, the supply of talents that grasping relevant knowledge in other discipline becomes more and more important (Guo et al. 2011; Shuming et al. 2011).

135.2 Mining Education in Kust

Kunming University of Science and Technology is located in the beautiful "Spring City" of China, which is the largest university in Yunnan province and one of the well-known universities in China. With the current 21 faculties (schools), covering the fields ranging from science, engineering and economics to management, arts, law and education, KUST offers a complete list of degree programs.

KUST recruits students from all over China, including Hong Kong, Macao and Taiwan. In addition, KUST is authorized to recruit international students for degree programs ranging from bachelor to master and Ph. D. There are over 40,000 students currently studying at KUST, and among them over 3,000 are graduate students. KUST presently offers 67 bachelor programs, 74 master programs and 24 Ph.D. programs. There are four state authorized post-doctoral stations, a state-level key academic subject and 18 provincial level key academic subjects.

Mineral processing engineering department was early originated in the former Dept. of Mining and Metallurgical Engineering, Donglu University in 1925 (present Yunnan University). Mineral processing dept. was authorized to recruit the postgraduates and PhD students in 1965 and 1986 respectively, by the National Education Commission. In 1998, the mining discipline got the authority to launch the Center for Post-Doctoral student; and in 2009, it was listed as a distinguished discipline to be constructed by the State Ministry of Education.

Through several-decades development, the department has become a comprehensive discipline covering all aspects of mineral processing, and involving in environment and extractive metallurgy disciplines. Each year, the department recruits 60 undergraduates, 35 graduates and 10 PhD students. Currently, it has become the only one and important professionals training base in western China at full levels from undergraduate to postdoctoral fellows in mineral processing. It enjoys a good reputation both at home and aboard.

135.3 Current Situation in Educating Mining Professionals

135.3.1 Professional Shortage

Given an example for the coal industry in China, about 96, 90, 88 and 80 % of the enterprises are in short of electrical and mechanical engineers, ventilation and safety engineers, mining engineers and manager, respectively. This situation seems to be better in metallic, nonmetallic and oil exploration industries. Yunnan province is called as a "Kingdom of Nonferrous Metals", but the education background of mining practitioners is not promising, only 10 % mining practitioners have the bachelor degree. According to the statistics from China University of Mining and Technology, number of total undergraduate were 3,696 persons, among which 440 persons served for coal industry only, accounting for 11.9 % in 2002. By the year of 2011, the number increased to 4,587 persons (Sanqing 2007). Many universities expand their enrollment scale to meet the unceasing need. Some unknown universities begin to recruit mining students to occupy the talent market. However, mining enterprises are mostly located in remote areas under poor working and living conditions with bad salary, so the graduates are not willing to stay in the remote areas for a long time. On the other hand, most of the enterprises cannot cultivate professionals by themselves. Furthermore, the rapid mining development demands more mining professionals. Therefore, it is necessary to adopt a feasible strategy to balance the contradictions between talents supply and demand.

135.3.2 Professional Demand at Different Levels

In a view of enterprise, the need of professionals can be divided into three types, i.e., upper management, middle skeleton, and labor force. The current situation is that labor force is easy to get, but the upper and middle are different. At present, the labor forces in the state-owned mining enterprises mainly consist of the fixed employee and the casual laborer. However, the employee in private enterprises is mainly the seasonal workers. Due to most of the mines and concentrators are not well-equipped by automation, the quality requirement on labor forces seems to be low. In this case, short-term training is effective, and the labor force is not the key problem in mining industry.

Currently, the serious situation is short of talents at upper and middle levels. The situation is more serious for the demand of middle skeleton in management because the education background would better be technician college degree or above. Since those talents have relatively strong professional knowledge and executive ability, they often shift their working sites from remote place to crowded towns or cities, from state-owned enterprises to private ones for a higher salary (Chen and Zhang 2006).

Limited by working location and different management system in the state-owned and private enterprises, the high quality talents are not willing to work in the remote areas. With the retirement of the old generation, the supply of upper manager becomes serious in the state-owned enterprises; as for the private enterprises, most of the upper managers have poor education background, and they are lack of practical experience and professional knowledge. Therefore, it is necessary to upgrade the upper leaders' idea and quality.

135.4 Discussion

135.4.1 General Thoughts on Educating Minerals Professional

The main objectives of educating mining professionals cover following aspects, i.e., well-developed in morality, intelligence, physique and art; broad and deep foundations; strong ability in engineering practice; innovative consciousness and capacity. The graduate shall be able to engage in production, management, engineering design, scientific research etc. Professional requirements for engineering students mainly include three aspects (Tapsall and Ryan 1999; Flatt et al. 2006; Zhu 2007a, b):

(1) *Knowledge*: It is necessary to know well in fundamental knowledge on theory and engineering, and to comprehend the state-of-art technology in engineering.
(2) *Ability:* Ability training includes applying basic theory and professional knowledge to: analyze and settle the existing engineering problem; conduct technological innovation in new process and technique; organize production and analyze the techno-economic index.
(3) *Engineering Skills:* Basic engineering skill a requirement includes: the experimental skills, engineering practice, computer application, scientific research and engineering design; understanding the policy, laws and regulations on mining industry, safety production and environmental protection.

135.4.2 A Case Study in Educating Minerals Professionals

(1) *Course reviewed in educating mineral processors in KUST*

Department of Minerals Engineering in KUST has formed its characteristic in offering following courses, and each course corresponds to a certain credit points. Four year Bachelor degrees generally require the completion of 240 credit points. Double degrees may require additional credit points.

Common training courses for university of science and technology in China include basic courses, practice connections, and quality and innovative education.

Basic courses mainly include the political and theoretical subjects, college English, college physics and chemistry, higher mathematics, computer foundation, C-programming language, physical education, etc.

Practice connection courses mainly include the higher mathematics, experiments on physics and chemistry, computer application practice, engineering practice, etc.

Quality and innovative education courses refer to the courses in Management Introduction, Economics, Information Retrieval, Military Theory and Training, Career Development, etc. (Zhu 2011; Kennedy Library 2007).

Professional foundation and specialized courses on mineral processing can be divided into two categories, i.e., compulsory and selective courses.

Professional foundation covers Engineering Drawing, Auto CAD, Organic and Inorganic Chemistry, Physical Chemistry, etc. Selective courses include Engineering Mechanics, Technological Economics, Surface Chemistry of Flotation, and the mining industry chain courses covering mining, metallurgy, and environment engineering.

Main specialized courses offered in mineral processing engineering in KUST are (1) Comminution; (2) Gravity Concentration; (3) Magnetic and Electric Separation; (4) Flotation; (5) Ore Beneficiation Experiments; (6) Mineral Processing Plant Design; (7) Mineral Processing Technology (English version, B.A. Wills, 7th edition). The former four courses are mainly focused on the training of basic skills in conventional mineral processing; Ore Beneficiation Experiments focuses on the training of basic skills and innovative ability, in which students can learn to process some specific ores by different separation methods, and design the test procedure by themselves; plant design course focuses on the training of engineering abilities in research and design through field trip connection to different concentrators. The said department in KUST also offers the Mineral Processing Technology (original latest English edition) course to improve students' English language skills in reading and writing. The main purpose is to train students to be international professionals.

(2) *Compulsory course and its reform in KUST*

With the blooming in mining industry, mineral processing engineering discipline has become a combined subject of environmental and hydrometallurgical engineering. It is necessary to build such a system in educating the mineral processors with wide scope of knowledge, strong ability in practical skills like research, engineering design and management. However, there is disharmony to great extent in educating the minerals professionals. First, most of the domestic universities that run mineral professional business lack of a platform for undergraduates and graduates, where students practical skills and engineering quality cannot be trained effectively; second, traditional professional courses are disjointed with engineering; third, laboratory equipment is of manual operation lacking of a platform to demonstrate some modern technique in mineral processing industry.

Besides, limited by long lasting shortage in financial support as well as laboratory rooms, most of universities cannot meet the requirement of internal intension and extensional development, which makes students have difficulty in taking in the abstract knowledge. Therefore, it is difficult to realize the connection between theory and existing engineering or technical questions. The course (e.g. Ore Beneficiation Research) teaching cannot effectively connect with pilot tests, not to mention the promotion and application of scientific and technological achievements for minerals industry.

In recent 5 years, the department in KUST conducted a compulsory course reform.

Compulsory courses mainly include Chemical Treatment, Flotation Chemistry, Solid–Liquid Separation, Technological Economics and others. Others refer to the courses extended to in mining and metallurgical industry, including introduction to mining and metallurgy, computer application in mineral processing industry, and advances in mineral processing engineering. The main purposes are to extend the students' knowledge in the chain of mining (upstream) and metallurgy (downstream) industry.

Some compulsory courses are specially designed for the four year Bachelor degrees in the forth year, which aims to develop the students' career in obtaining employment. Three packages are available as follows:

(A) *Package One* for environment engineering: Environmental Protection; Solid Waste Treatment and Disposal; Secondary Resource Utilization.
(B) *Package Two* for automation and computer application: Control Theory and Automation; Industrial PLC; Mineral Processing Testing Instrument and Principle.
(C) *Package three* for minerals material: Comminution Engineering; Nonmetallic Material; Magnetic Material

Through above courses reform, the graduate's career get developed and extended, the graduate can easily find jobs in mineral processing and related discipline.

135.4.3 Education Knowledge in Multiple Ways

The mining talents education and training system includes three levels, i.e., primary, secondary and tertiary levels in depth and width. In depth, the relationship of education and training is just as that of "Learning" and "Practice". "Learning" refers to educating knowledge and thoughts for students in the colleges and universities. However, "Practice" is mainly focused on the onsite mining practitioner, which covers the cultivation on skills and abilities through teaching and self-training process.

Educating mining talents includes three levels, i.e., base, middle and upper levels. Educating base level refers to impart information, basic theory and knowledge, and to cultivate the basic skills. Students in technical secondary school, technical school, and vocational school can acquire above skills. The main purpose to educate the base level professionals is to supply employee for operators for mining industry.

Educating mining students at meddle level refers to impart knowledge for students and let students know mining techniques, management, and scientific research, etc. Students in colleges and universities can acquire above skills. The main purpose at this level is to train students to be chief engineers or general managers for the mining industry. The key points lies in awakening the wisdom to form an active thinking system. In this way, students' research and percipient abilities can be trained.

Educating mining talent at high level is mainly focused on training the percipient abilities, and let the undergraduates and postgraduates grasp the research methods and advances in development. The main purpose at this level is to train students to be chief engineering, scientists, and general managers.

At present, KUST has formed a complete system in educating above talents at different levels. But the supply of the talent cannot meet the need of blooming mining industry. Therefore, self-training talents by enterprises become important.

Australian educators have been early adopters of information and communication technologies (ICT) for teaching and learning purposes (Zhu 2007a). Based on the fact that the mining scale of China lists the third in the world, and China has the largest exploration teams, with more than 21 million employees, there is a great need for formal university training and continuing education of professionals, Considering the different areas with different levels of economic development, and the imbalance of science and technology in China, top priority should be given to upgrade the skills of those already employed at mine-sites. This could be achieved by using the Hi-tech education approach-distance education and/or on-line teaching (Zhou 2011).

In recent ten years, mineral processing engineering discipline was supported by JPY and Germany loans, the joint financial support from Yunnan and the central government, etc. to meet the rapid development in mining industry. The finance was used to update and make up some equipment and instrument for teaching. At the same time, teachers in the department have developed some new equipment by themselves, such as suspension electrostatic separator, vibrating tower separator, self-circulation grinding mill, ultra-critical rotation speed ball mill, to meet the extended need of teaching and scientific research activities.

Currently, the said department owns four laboratories for mineral processing fundamental research, 33 laboratory rooms for teaching professionals, and one mineral resource high-efficient utilization center affiliated to the Ministry of Education China. The department has formed four academic groups in following aspects: new equipment development and fundamental research; selective grinding theory and applied research; low grade complex ore beneficiation; precious metals processing and extractive metallurgy. Through Year 3–4 students' participation in above groups, students' abilities get developed in all-around way.

135.5 Conclusion

In order to balance the supply and need of the professionals for the modern mining industry, different engineering education shall be conducted at different levels. A case study on educating the mineral professional was suggested that spreading the knowledge (including mining, metallurgy and other disciplines) on the mining industry chain might be important to the undergraduate students. Through reforming and optimizing the courses, the mentioned three packages of the compulsory courses not only widen the students' knowledge, but also expend the students' career, which sets a good example for other disciplines. At the same time, considering the imbalance of science and technology in China, top priority should be given to upgrade the skills of those working in remote areas through short courses and online teaching.

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Chapter 136
Discussion on Harmonious College Teacher–Student Relationship

Ju-ling Qiao

Abstract Teacher-student relationship is the basic relationship in educational activities of universities. Connotation illustration of teacher-student relationship, significance analysis of establishing harmonious college teacher-student relationship in the new period and suggestion of corresponding countermeasures are of great practical significance to harmonious development of education and construction of harmonious society.

Keywords Teacher-student relationship · Harmony · Countermeasures

136.1 Introduction

Teacher-student relationship is a critical issue of educators' research and an eternal topic in university campuses. It represents the interpersonal relationships in the teaching process of higher education, as well as a special social relationship formed due to certain tasks to be completed by teachers and students in educational and teaching activities. Such relationship directly influence teaching, scientific research and other work of colleges, even development of subjects. Since colleges have been expanding their enrollment in recent years, higher education of our country has developed from elite education to massive education, creating variations in the teacher-student relationship (Xu 2010). Specific to this new situation, discussion of countermeasures against harmonious college teacher-student relationship has already become an important project for higher educators in the new period.

J. Qiao (✉)
School of Management, University of Jinan, Jinan,
People's Republic of China
e-mail: Qiao58@126.com

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136.2 Connotation of Teacher-Student Relationship in the College

The teacher-student relationship existing in educational and teaching activities of colleges is a relationship system involving a number of elements, which reflects political, economic, cultural and moral relationships in the society, also involves teaching and learning relationship generated aiming at achieving educational objectives and finishing teaching tasks, meanwhile, involves psychological relationship in emotion, behavior, etc. College teacher-student relationship is a complicated relationship system composed of several levels. An accurate mastery of its connotation would lay down foundation for construction of harmonious teacher-student relationship.

(1) *Analysis in psychological level*

College teacher-student relationship mainly includes relations in recognition, emotion, etc. among teachers and students in colleges. A better recognition and emotional relationship among teachers and students are represented as integrity in dream, belief, interest and value and as emotional compatibility. This relationship is the one among adults, and emotions in between are established on the basis with certain maturity. Effects of emotional interaction upon teaching results would not be underestimated.

(2) *Analysis at educational level*

College teacher-student relationship is mainly represented in educational and teaching process. The working relationship formed among college teachers and students, who are aiming at finishing certain tasks together, is also called teaching relationship. Due to diversities in student characteristics and differences in independent consciousness and ability of distinguishing right from wrong, in educational and teaching activities, they hope to participate in equal communications with teachers. Specific to this feature, teachers must leave certain space and chances for students' independent thinking, and cultivate their ability of active participation and self-culture.

(3) *Analysis at ethnical level*

Teacher-student relationship in colleges represents the relationship between moral obligations that should be fulfilled by both teachers and students, which consists of two aspects. On one hand, it is represented as teachers' respect upon students and strong sense of responsibility of cultivating students into talents, faithfully imparting knowledge and educating people. On the other hand, it is represented as students' respect upon their teachers' sweat and dignity, meanwhile maintaining prestige and reputation as a teacher.

(4) *Analysis at legislative level*

As the society is under rapid development, the teacher-student relationship in college educational activities maintained on dependence of moral ideas has failed to adapt to requirements of modern higher education development. Those special social relations formed among various elements in educational activities are legislatively represented as the legal relationship between each element and statutory rights and obligations. This legal relationship refers to rights and obligations between college teachers and students in the process of teaching and learning.

(5) *Analysis at interpersonal communication level*

Since teachers and students in the college have similar aspirations and interests, a kind of non-official personal relationship with strong affective characteristics could come into existence, by which the teachers and students could carry out in-depth two-way communications freely. Through such communication, teachers would gradually become scholarly mentors and beneficial friends. This personal relationship meets the needs for teacher-student communication, and covers deficiencies at other levels, thus playing a coordination role.

136.3 Significance of Harmonious College Teacher-Student Relationship Establishment

A harmonious teacher-student relationship plays an essential role in higher education, higher teaching and student growth, as well as avails student in fresh knowledge acceptance and application, fostering of creative spirit and growth of college students; if this relationship is inharmonious, efficiency of teaching and acceptance would be impacted, thus negatively influencing the students in establishing harmonious interpersonal relationship when they step into society, and finally their occupational growth. Therefore, construction of harmonious teacher-student relationship is of great significance to college teaching and educational activities.

(1) *Harmonious teacher-student relationship contributes to overall quality improvement of college students*

Research shows that, harmonious teacher-student relationship could cultivate college students to study hard, and contribute to their accurate understanding of interpersonal relationship, promotion of communication ability, development of individuality and improvement of overall quality. Under such a harmonious relationship, teachers and students could enjoy equal discussion and independent communication. As the leader and promoter, teachers should play the role of initiator, conducting students to apply what they have gained into practice, developing their potentials and contributing to fostering of their thinking and creativity. Teachers' manners could unconsciously guide their students in accurately understanding the society, thus resulting in healthy psychological quality. Teachers permeate their caring and passion upon students in teaching and management and try their best to create harmonious teaching and learning atmosphere, which contributes to students' emotional resonance and positive emotional experience, thus improving healthy development of emotional education.

(2) *Harmonious college teacher-student relationship contributes to achievement of educational mission for college teachers*

The duty as a teacher is imparting knowledge and educating people, not only meaning transference of knowledge and skills, what's more important is fostering of students' morality, improvement of their overall quality and excavation of their potentials in every aspect. A harmonious relationship promotes teachers to love their work and be devoted in it, be meticulous with knowledge and be concerned of their students. Mutual understanding and mutual trust between teacher and student would narrow their psychological distance, enhance students' sense of trust and identity upon teachers, which contribute to a good style of teaching and studying. Teachers would be comforted and pleased with respect and support from students, so that their passion for teaching and education is thus enhanced, which contributes to successful accomplishment of their tasks. The harmonious relationship between teachers and students could strengthen teachers' role as moral example, improve students' morality and overall quality, so that quality of teaching and education would be improved and teachers' task be better fulfilled.

(3) *Harmonious college teacher-student relationship contributes to construction of harmonious campus*

Construction of harmonious teacher-student relationship is the requirement of college educational reform and of harmonious campus construction. A harmonious campus emphasizes the educational conception of "people oriented", focuses on student ability cultivation and intellectual development, which is the environment that both teachers and students are eager for. It is a brand new educational style emphasizing internal peace and external smoothness, coordinated development, integral optimization, and congruous and integrated campus atmosphere, which reflects comprehensive effects of making development of students, teachers and schools as purpose. During the process of teaching and learning, understanding, mutual trust and equality between teachers and students would create harmonious and pleased campus atmosphere and would surly produce good educational result. Construction of such a harmonious relationship is the basic condition of harmonious campus construction. Only if teachers and students are in harmony could campus atmosphere be in harmony, could educational elements inside colleges be mutually depended, coordinated and promoted, could a good style of teaching, studying and school spirit come into being, and could useful talents meeting era needs be cultivated.

(4) *Harmonious college teacher-student relationship contributes to constriction of harmonious society*

Construction of harmonious teacher-student relationship is the requirement of times development and harmonious society construction. As a social component, college is also the microcosm of harmonious society. With a harmonious relationship, teachers and students could present democratic roles in teaching and learning and show an atmosphere in harmony, only through this could the platform of mutual respect be built, could teachers and students be mentally corresponded and connected, thus a sincere relationship between teachers and students would take shape. In harmonious teaching and learning, students acquire knowledge and skills, and their overall quality is improved; through such activities, teachers could help their students feel the harmonious atmosphere and being respected, which contributes to students developing into talents to better adapt to society. Colleges transmit qualified graduates cultivated under harmonious environment to every branch of the society and distribute the conception of harmony in every corner of the society, which has laid down firm foundation for construction and development of harmonious society (Wu 2007).

136.4 Countermeasures for Harmonious College Teacher-Student Relationship Construction in the New Situation

(1) *Establish new style of teaching philosophy*

Traditional education philosophy emphasizes “teacher’s dignity” and “teacher centered”, etc. However, as a cultural phenomenon, it still exits in modern society. Therefore, educational staff should update such philosophy on the assumption of harmonious teacher-student relationship establishment. First, the philosophy of student oriented should be established. The relationship between teachers and students, which is democratic, devoted, interactive and suitable for students’ overall development, shall be created, with teachers and students being infected and pleased. The new style of educational model, which demonstrates “teacher as leader, student as subject, active and mutual participation”, shall be founded, with implementation of humanized management. Second, the philosophy of caring students should be established. As the mental bridge connecting teacher and student, teacher’s love is the spring of educational power and cornerstone of educational success. Teachers should communicate with students depending on their love, being oriented by students, and open their hearts with warm current full of love, adhere to the idea of treating people with sincerity, convincing people by reasoning, and affecting people with emotion, thus win the respect and esteem from students, as well as create the teacher-student relationship atmosphere in harmony (Zhang et al. 2011). Third, the philosophy of interaction between teachers and students should be established. Only if teacher and student were both transformed in conception, could they gain a good state of mind, to improve interaction and give full play to teachers as the leading role and to students and subjects, and to dynamically achieve “teaching and learning benefit each other” (Fan 2010).

(2) *Improve quality of college teachers*

Educational informationization has brought unprecedented challenge to the traditional teacher-student relationship. To be better adapted to needs of situation development, college teachers have to take great efforts in improving their own quality, and make teaching process as the platform for harmonious teacher-student relationship construction. First, teachers should have good moral integrity. In recent years, educational authorities pay close attention to construction of professional ethics, contributing to establishment of harmonious teacher-student relationship. To improve moral traits of college teachers, it is necessary to demonstrate the spirit of selfless dedication, view on students with equality and trust, community spirit of unity and cooperation, strong sense of responsibility, tough willingness, rigorous attitude to science, and harmonious sense of humor (Feng 2008). Morally qualified teachers are able to educate students effectively, deal the relationship accurately, and are able to have easiest access to closeness, trust and acknowledgement from them. Usually, they become their examples unconsciously to encourage them in quality improvement. Second, teachers should be profound in knowledge. In the process of harmonious teacher-student relationship construction, the power of teaching is infinite. Teachers shall be broad and profound in knowledge, timely master edge knowledge of their own major and relevant branches and integrate them into their teaching. Only through this could teachers be strong in appealing, and the students could be easier convinced, so that their words and behaviors would be conducted. Third, teaching methods need to be constantly updated. The environment of educational informationization requests teachers to integrate time elements into traditional style, and to reach the objective of improving students' ability of problem analysis and resolution. They shall be centered by students, transfer the teaching mode of negative acceptance into the one of active exploration, from purely focusing on textbooks to improve ability of practice, integrate the method of inspiration and discussion into the whole process of teaching, and finally foster students into useful people for social development. Teachers also need to make full use of internet, to achieve online discussion with students and answer their questions on line. As for students, they should actively develop thinking activities depending on tools e.g., computer, and communicate with teachers and other students. They should think actively and participate in teaching practice, be initiative in exploration and bold in questioning, consult with teachers when encountered with problems. In the joint research and exploration, the new type of harmonious and equal relationship would be developed between them and their teachers (Yan et al. 2010).

(3) *Cultivate college students to respect teachers*

In harmonious relationship construction, neither the teacher nor the student can be dispensed with. On one hand, teachers function in such construction should be emphasized; on the other hand, students should be motivated. After all, construction of harmonious college teacher-student relationship is just cultivation of qualified college students. First, students should cultivate their respect towards teachers. Qualified college students shall respect, esteem, understand and trust teachers. To show respect to teachers and attach great importance to education is one of the traditional Chinese virtues, as well as basic code of conduct of modern college students (Wan and Rao 2010). Students ignorant of respecting or appreciating teachers are short of traits that college students have to be possessed, and do not meet basic moral requirements as college students. Students should respect teachers and their character and labor, and learn to be tolerant. If teachers and students could mutually be better understood, trusted, tolerant, considerate and positive, misunderstandings and barriers between them could be eliminated much easier (Wang and Yang 2010). The core of successful teaching and learning lies in the relationship between teacher and student. Since association is the elementary condition and channel for construction of this harmonious relationship, modern college students need to enhance their consciousness of initiatively communicating with teachers. They shall believe that teachers really care about them and play an important role in their life and study. Communication between teacher and student not only benefits students intellectually and academically, but casts great influence on their outlook on life and value as well as on attitude about how to get along with people. During this discussion and communication, students could acquire more knowledge beyond class and textbooks, learn about teachers' rigorous scholarship and scientific thinking, and even assist them in educational affairs, so as to further improve mutual understanding and friendship.

(4) *Expand time and space for communication between college teachers and students*

Harmonious teacher-student relationship is established in activities and association, which has laid down foundation for perfect relationship between them. First, teachers and students should communicate with each other more frequently. To establish such a harmonious relationship, communication and contact between teachers and students must be strengthened, inside and outside classroom. In the classroom, traditional patterns and methods for teaching and learning have to be changed into more flexible and diversified methods. Mutual communication between teachers and students should be enhanced. Education inside and outside classroom should be integrated, with implementation of various methods, to expand activity field and social association scope, as well as increase communication frequency. Second, a channel for communication should be constructed. Practical and online virtual communication should be combined to establish stereoscopic association channels combining virtueless and reality. Realization of Internet breaks through possible barriers due to practical problems, caters to students' pursuit of freedom, democracy and equality, and really presents humanistic care in college campus (Yang and Xiang 2010). Providing students with more opportunities for participating in educational reform with online resources would help thought communication between teachers and students and building of a broader platform for harmonious relationship construction. Third, a wonderful circumstance should be created for communication, which is the need for harmonious teacher-student relationship (Huang and Feng 2008). Colleges should build the communication platform for democratic and equal talks, complete incentive and supervision mechanism for harmonious teacher-student relationship construction. They should take efforts to create harmonious campus environment diversified in culture, outstanding in academic atmosphere, perfect in cultivation circumstances and enthusiastic in humanistic care, so as to improve construction pragmaticality. Meanwhile, attention shall be paid to informal association between them. Within such kind of association, since there is no restriction of teaching and being taught, communication then would become more casual and lively, filled with emotions. Through informal association, teachers could better understand thoughts, emotions and requirements of students, and could be active in participating in student activities, so as to shorten the distance between their thought and mind.

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Chapter 137
Research on Teaching Methods of Public Table Tennis in College and University

Li Wang

Abstract Table tennis is an important public course in college and university. This paper first discusses the current teaching situation and existing problems from the following five aspects: (1) relatively lower teachers' quality, (2) unvaried teaching mode, (3) imperfect methods of examination, (4) limited funds and fewer facilities, and (5) shortages of extracurricular activities. Then this paper discusses suggestions on reforming table tennis teaching from corresponding five aspects: (1) strengthening the construction of teacher's team, (2) reforming teaching methods, (3) standardizing examining system, (4) strengthening sport facilities construction, and (5) developing extracurricular activities of table tennis according to student's requirements.

Keywords Reforming · Table tennis · Teaching methods · University and college

137.1 Introduction

Table tennis has been playing a decisive role in our country, and is well-known as "national ball". Compared with other sports, table tennis has a very deep basis in the masses with its fitness, practical, interesting and other characteristics, and most people, especially students in university and college, love it very much. Teaching students table tennis not only can make them have a strong body and gain pleasure, but can improve their attainment and moral quality. Teaching table tennis in college can improve the students' table tennis techniques and skills and form their exercise habits gradually. Students can learn to participate in the activities positively, and their lifelong sports consciousness is cultivated. Teaching table tennis can let every college student master a kind of positive, healthy and good sports

L. Wang (✉)
School of Physical Education and Cultural Industry, Shandong Polytechnic University, Jinan, China
e-mail: 630663860@qq.com

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skills. These make students insist to exercise themselves for lifelong. Through this way, the university sports can have a better connection with the social sports, so that students can adapt to society much better. Table tennis sports let college students have a close connection with sports after their graduation. In addition, teaching table tennis in college can contribute to enhance the campus sport culture atmosphere and enrich our traditional sports culture (He et al. 2010).

Although table tennis is a main course in the college sports teaching and extracurricular physical exercise, and it is carried out quite popular, there still exist some problems. Since the college expanded enrollment, the number of college students increases quickly, so there are much more students who choose table tennis course. During the table tennis teaching, we have found that the training space and facilities is limited. The ratio of students to teachers, the teachers' level, curriculum setting and other factors restrict the development of table tennis It is imperative to improve the table tennis and its teaching methods.

This paper discusses the current teaching situation and existing problems, and then proposes corresponding suggestions on reforming table tennis teaching.

137.2 The Current Teaching Situation and Analysis of Existing Problems

137.2.1 Teacher's Quality is Relatively Low

Teachers' quality is an important guarantee in table tennis teaching in college and university. At present, table tennis teachers are mostly graduates from sports' college. Although they have learned for four years or even longer, most of them don't major in table tennis, and acquire the skills by self-study after graduation. Compared with professional athletes, they have a big disparity. So it is difficult to meet students' desire, and is difficult to guarantee the quality of teaching and training, which is bad for table tennis development. Moreover, the construction of university teacher's team has lagged behind the expansion of students' enrollment. Teacher's quality and numbers are relatively weak. The ratio of students to teachers is not harmonious, that is, fewer teachers but more classes, which is bad for table tennis teaching. These situation make teachers always overwork but get less extra payments, which affects the P. E teachers' enthusiasm. Without professional athletes, it is very difficult to let students experience fun in their exercise, and to learn basic table tennis skills (Song 2007).

137.2.2 Teaching Mode is Unvaried

Influenced by traditional physical education and exam-oriented education, teaching effect becomes a standard of measuring whether a kind of teaching mode is good or not in university. We found that in most table tennis teachers' interaction with students, it still helplessly follows the traditional physical teaching mode, students have little interest and their learning enthusiasm is not high. So their special and comprehensive ability is hard to improve. During the table tennis teaching, teacher only emphasizes the unity of teaching process. Teacher, not students, is the center of class so that the whole teaching process is relatively rigid, and the atmosphere is duller. It only emphasizes the teacher's leading position, ignores the students' subjective. Now we just focus on education not learning, focus on uniform not variety, so a multilateral interaction mode is not formed. The method of cramming is usually used in the teaching process. The teacher's explanation, demonstration becomes the most important and commonly method. The repeated explanation and demonstration of the teachers make students only concentrate on the results mechanically. They only practice it, according to the teachers' requirements. The students' intelligence is not developed and their thinking mode is restricted in the teaching process (Song 2007; Liu and Ni 2010). The students receive the education passively, lacking of positive exploration and aggressive spirit. Therefore, it cut the throat of the students' active ability cultivation, and to a great extent it influences teaching effect.

137.2.3 Methods of Examination is Imperfect

In college, the table tennis teaching aim is to test what they have learned. The only aim for students learning is for examination. The teaching content is not comprehensive enough, which only put too much emphasis on physical and technical skill test. As in the test of table tennis, most teachers emphasis on the skills and numbers of defending and attacking the ball, while the students' learning ability, their progress and attitude to it are not comprehensively evaluated. Obviously, it is not consistent with the cultivation of lifelong sports consciousness and habits (He et al. 2010). And the exam results are most concerned by college students, which is also an important source of their pressure. For most students worry about their limited ability to exercise and they can not pass the exam, which will let they lost their scholarship and excellent ratings. The table tennis is a kind of sports which need special techniques, but students cannot master it in a short time, so the examining methods can affect students' enthusiasm of choosing table tennis course (Jiang and Xie 2010).

137.2.4 Limited Funds and Fewer Facilities

In recent years, with universities continuing to expand their enrollment scales, the construction of sports facilities is hard to meet the present teaching needs. Fewer facilities seriously restrict the curriculum reform process and the development of amateur training. Sports facilities construction is the basis of researching the results analysis in college table tennis education and its sustainable development. If the facilities are not good, the development of table tennis teaching will be restricted. The relative shortage of table tennis facilities reflects the bottleneck problem in current college table tennis development, which has already become the major barriers that prevent its development. In our country, because the increasing number of college students, the rapid development of table tennis and the growing number of loving it, the table tennis facilities cannot meet the needs of it in colleges and universities (Zhang and Li 2010). Although some colleges and universities have table tennis stadium, students need payment to use it in extra-curricular time, which affect the students' enthusiasm.

137.2.5 Shortages of Extracurricular Activities

Extracurricular activities are the most important sports activities in colleges and universities. The situation that students who participate in the extracurricular activities can reflect a college's sports development, therefore playing table tennis is important parts of college extracurricular activities. Many students like table tennis. But in extracurricular time, they play it rare. This maybe caused by lack of teacher's guiding, less table tennis facilities, and less knowledge of practice skills. In students' spare time, their participation in table tennis is not only related to their interest and activities, but to the college's management on extracurricular activities. Most colleges and universities have not organized extracurricular activities, such as table tennis club or association. This phenomenon leads to choose item randomly to do exercise, which will gradually make them lost interest in table tennis.

137.3 Suggestions on Reforming Table Tennis Teaching

137.3.1 Strengthening the Construction of Teacher's Team

Colleges and universities should train and educate teachers regularly so that teachers can improve their qualities. Management should pay for the teachers' on-job training. Teachers' training should be standardized, objective, systematic and reasonable. The training can carry out through various forms like lectures, seminars, and special reports. Some outstanding teachers should be organized for a short-term training abroad if possible. By training, teacher's professional quality and ability can be improved.

In addition, teachers' introduction should be improved too. On one hand, colleges and universities are short of table tennis teachers. On the other hand, college enrolment expansion leads to the increasing number of students who choose table tennis course year by year. So we should introduce new teachers that can inject some fresh blood to the present teaching team, which is undoubtedly a very important channel. In the process of new teacher's introduction, some masters and doctors should be introduced firstly in order to meet the cross-century development needs, base on the principle of open and justice.

137.3.2 Reforming Teaching Methods

With the development of teaching reform in colleges and universities, table tennis teaching mode shouldn't rigidly obey the traditional teaching mode and methods. Teachers should get rid of the shackles of traditional modes and methods and carry out reform and innovation.

1. *Reforming Content of Courses*

Reasonably assigning the time for theory teaching and physical exercise in each semester can let students learn techniques skills, theory and relative health care knowledge simultaneously. This can continuously enhance the students' physique and various physical qualities (Wu and Su 2005). Thereby, students can form the habit of physical education for whole life. At the same time we should pay attention to the quality of real competition, in which students can practice their learned knowledge. Young people like to show their talents in competition, which is the charming of table tennis.

2. *Encouraging Varied Teaching Modes*

Varied teaching mode, such as dividing different classes according to different learning objects and different levels, should be encouraged. By this way, different students can do their best to play the table tennis according to their own level. The principle of students-oriented should be strictly implemented. The people-oriented education idea should stress in table tennis teaching (Chen 2000; Gao and Shi 2008). Teachers should advocate the mode of inquiry and open education, which can stimulate the enthusiasm of students and provide opportunities for students to engage in inquiry activity. It is good for students' independent exploration, cooperation and communication.

3. *Expanding Teaching Methods*

Teaching methods should be adjusted according to teaching aims, content of courses and teaching objects. During teaching, teachers should use the methods of "induction", "help-type", "create-type" and etc. At the same time, teachers should use multimedia and teachers' fixed-point or flow guidance in certain times and other teaching methods. In order to stimulate students' interest, and build a relaxed and teaching pleasant atmosphere, students can actively take part in physical activities, changing passive learning to active participation (Zhang and Liu 2006; Zhang, Shi 2011). These methods can help students master the knowledge comprehensively, improve their sports abilities, and get a regular exercise habit.

137.3.3 Standardizing Examining System

Examining system should connect the content of exam with the daily teaching in order to stimulate students' enthusiasm and initiative. Three factors should be included in the examining system. The first is basic theory and its application ability, the second is the students' basic skills in playing table tennis. The third is the students' performance in or after class for a semester or one year (Li and Xue 2010). By this way, teachers can master every student's condition accurately and give a right score to each student.

137.3.4 Strengthening Sport Facilities Construction

Indoor table tennis teaching has many advantages over that outdoors. It not only can avoid the direct influence of weather, but it can make the content of courses last for long time, which can fully meet students needs of learning table tennis and will stimulate their learning interests. And the teaching effect will be enhanced. So the number of indoor table tennis table should be increased, which requires much money should be invested.

137.3.5 Developing Extracurricular Activities of Table Tennis According to Student's Requirements

Various forms of table tennis activities have good effect to improve the student's skills and interests. In recent years, table tennis clubs and associations have been set up. These clubs and associations hold competitions every year and gradually become a main group that table tennis enthusiasts in different levels like to take part in. The organizer of these clubs and associations should introduce coaches to guide students' training to develop the college table tennis in a healthy and sustainable way.

In addition, various forms of daily table tennis matches are another best way to attract student's attention. Small and medium matches can be held in a regular and planned way, which will be better for the spreading of table tennis. The students' need and their hobbies should be combined together. We should make best use of the function of each department. In order to expand the table tennis propaganda, we should set up clubs and associations of table tennis, and hold table tennis training classes, lectures and other academic activities, to improve students' understanding of table tennis. In students' spare time, some matches between different classes, grades, and departments, even among different colleges in different grades, levels and forms should be arranged. This can not only enrich students' extracurricular life, but also can improve the student's enthusiasm in table tennis.

137.4 Conclusion

This paper has discussed current teaching situation and existing problems from five aspects and discussed suggestions on reforming table tennis teaching from corresponding five aspects: (1) strengthening the construction of teacher's team, (2) reforming teaching methods, (3) standardizing examining system, (4) strengthening sport facilities construction, and (5) developing extracurricular activities of table tennis according to student's requirements.

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Chapter 138
Based on the Engineering Thinking Perspectives to Analysis "a Plan for Education and Training Outstanding Engineers" (PETOE)

Ning Liu, Yan-tong Zhang and Xiao-fei Wang

Abstract General thinking is different from engineering thinking which based on the reality of individual and collective as main body, it found that the existence of objectives and the internal rules for the purpose of scientific logic thinking. Engineering thinking are engineers who look at the world and deal with problems way of thinking. It has the characteristic of nonlinear, the coordination of logic. The purpose of this article is based on the perspective and interpretation of engineering thinking of "A Plan for Education and Training Outstanding Engineers" (PETOE) to provide a new thinking way for engineering education reform.

Keywords Engineering thinking · Outstanding engineers · Engineering education

138.1 Introduction

Engineering is a creative practice of human being, on the basis of people's purposes and goals exist as the premise. According to certain programs that use subject of raw materials for series of tools to operate process, produce qualified material products process. Engineering thinking is the core of mode for conduct engineering activities, directly impact on molding for engineering abilities, is internal sources and ties of engineering practice feeling and behavior model.

It is distinguished from science, humanity way of thinking, but to emphasize the engineering knowledge for material, engineering ethics for Framework, engineering behavior for catalyst, philosophy of engineering as core element and combining with the four essential factors to form engineering thinking.

N. Liu (✉) · Y. Zhang · X. Wang
Institution of Higher Education, Bei-hang University, Beijing, China
e-mail: liuningmail@hotmail.com

X. Wang
e-mail: wxf@hss.buaa.edu.cn

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As the Era developing of science and technology, complex engineering project emerge endlessly (JIA Guang-she and CAO Li 2008). Traditional engineering education mode could not meet the requirement of modern engineering talent abilities and engineers qualities. High engineering education is not only a process of knowledge spreading, but pays more attention to cultivate engineering thinking. For the sake of adapting the current social requirement for engineering talents, enhancing quality of engineering training, China Ministry of Education proposes “The program of PETOE is based on the features of times, social demanding, aiming to cultivation and innovation ability, to adapt to the need of economic and social development of the high quality each type of engineering and technical talents” (Zhang 2010). PETOE is not only an important educational revolution, what is an important; it will provide a new path for engineering cultivation and model. So, to research on “PETOE” which influences on path of logic evolution for engineering thinking will be a realistic significance of implementing and developing PETOE.

138.2 Desiderated Engineering Thinking Characteristic in Modern Engineering Background

138.2.1 Engineering Thinking Further Emphasizes Complicity and Integration

Currently human being civilization is from industrial mechanical civilization to information-ecological civilization. For a long time, reductionism, empiricism and classical theory which are based on Pure Science (QIN Shu-sheng 2005). Nevertheless, now, are attracting complicated science which consists with system theory, rationalism and human elements. Not like traditional engineering paradigm, modern engineering, of which field becomes wider, which faced problems are more complex, which are more systematic methods of solution. Modern engineering environment is formed by natural science, social science and engineering science and become a complex engineering system. So, as a subject thinking of realizing engineering activities, modern engineering thinking need transform Newton’s scientific paradigm of linear thinking. Especially, we should reflect the combination of humanities spirit and science rationality in the process of engineering education and feature of complex thinking in the course of practical teaching model to meet need of current engineering project.

138.2.2 Engineering Thinking is Combination with Rational Thinking and Practical Thinking

The traditional engineering thinking emphasizes rational thinking, which aims to explore the inner essence and deep principle, which is linear and single dimension thinking to guide practice. In the traditional engineering thinking which is main rational thinking. Although it contributes to understand the logic of formation for engineering practice, it will lead to separation between theory and practice. Then it results in passivation by linear thinking of theoretical knowledge. So the contemporary engineering practice needs multidimensional and paratactic nonlinear thinking for engineering talents. It is necessary to take measures to broaden our thinking, to analysis internal relation of engineering practice for promoting theory and practice to merge together.

138.2.3 Outstanding Engineering Creative Thinking

Practice essentially is creative activities, which is revealed by Marx's scientific practices, which is integrated. Even more surmount predecessors. Creation is the soul of engineering practice, the engineering practice in essence is a kind of innovation activities, and engineering thinking is innovation thinking directing source. The basic meaning of engineering is to create, to invent, to design and build, according to purpose of human being to develop and apply knowledge of scientist and technology. With the restriction of economic, human, political, legal and cultural to meet the requirements of society in a creative practice activities. With the current engineering techniques becoming more mature, engineering design skill which reflects creative thinking is named "the most beautiful flower" by Friedrich Engels.

138.3 Traditional Higher Engineering Education Training Mode is Lack of Engineering Thinking Training in China.

138.3.1 Isolation Between Rational Thinking and Experience Thinking Results in Engineering Integration Missing

Nowadays, the engineering project is composed by various factors of complexity the system, a single discipline knowledge system could not explain and cultivate the modern engineering practice (Beder 1999). As M.N Ehdi and R.R Ehan think "technology of knowledge is no longer guidance for engineering profession success, but it should be synthesized by a large number of professional knowledge" engineering education should not only master solid scientific theory knowledge and engineering ethics, but require profound qualities of humanities. Under the circumstance of traditional engineering education model, science and engineering generally are called natural discipline, and then at the level of thinking which concentrates on theory training. However, humanities science is based on premise of personal growth and the social individual participation, which embodies human experience' concise and experience thinking reflection in term of thinking. In the engineering teaching process, the traditional engineering education pays more attention to grasp knowledge and theory of science and engineering courses. In contrast, cultivating qualities of humanities is shown to be supplements between science and technology knowledge. Most of humanities curriculums come from selective courses. The goal of humanities courses in china is to just extend the student's vision of knowledge, the role of humanities course was serious ignored, and cannot play a part in knowledge construction and integration. This trend of independent among disciplines will cause Chinese engineering education and engineering project to become utilitarian.

138.3.2 Based on the Thinking, the Engineering Practice Training of Linear Thinking

The world is in essence nonlinear, though, the basic theory is summarized from natural phenomenon, and it is adaptive for the social phenomenon as well. Since nonlinear reflect the stipulation of complex things, and social phenomenon and natural phenomenon are also complex, even more, to some extent, which is more complex than natural phenomenon (Xiao-Yu 2008). The traditional engineering education model is based on the premise of logic of discipline which guides engineering practice. Engineering education deems that engineering knowledge is premise and basis of engineering practice, only to grasp or master knowledge of engineering practice, which could promote individual engineering practice, then resolve engineering problem. From the angle of cognitive, although it is reasonable, it confuses the relation between two kinds of thinking and misapprehends the relation between practice and theory. The famous educationist and engineering scientist, Rogers thought that if you do not understand the scientific, it is impossible to study science, because science is knowledge (Xue 2005). However, even if you do not understand engineering science, it is possible that you can engage in engineering or technical activities, because engineering and technology are both relative to production manufacturing. When you know nothing, practice knowledge can exist; when you are clumsy in the way of practice, the theory exists as well." the core of the theoretical thinking is to understand and construct theory, and engineering thinking mission is to design and test engineering practice. The mastered theoretical knowledge is to supple principle and direction for engineering practice, however, engineering thinking incompletely depends on logic relation, it is integration of various entity and attribution. So the characteristic of engineering thinking is non-logicality and compound thinking. With the theoretical thinking to design engineering, engineering will not be practical. With the thinking to construct theory, theory will be short of potency, For example, traditional engineering courses emphasis on theoretical teaching of discipline and competence of logic reasoning. It is correct to text practice and theory by mean of theoretical frame, which will result in lagging of practical courses. This leads teaching into a logic linear thinking that causes confusion with theoretical thinking and engineering thinking.

138.3.3 Based on Para Consistent Logic on Engineering Thinking Feature of Creativeness from the Perspective of Thinking

Para consistent logic is presented by a modern logic founder whose name is Priest. Lotrinsky. He admitted that logic thinking is a kind of contradiction existence thinking in essence. At the course of engineering thinking, no matter who is decision maker or designer, when engineers face to engineering problems or contradiction, Engineers always deliberate problems according to their own mode of logic thinking. Nevertheless, by and large engineering exists with confliction and contradiction. Judgments and choice in the process of engineering activities are not an all-or-nothing proposition. Usually, engineers judge and weigh engineering activities among contradiction of non-logicality at the course of thinking engineering problems. In china, engineering universities always explore and construct various mode of teaching to promote students creative ability but the effect is limited and indistinctive. So, the main reason is traditional engineering education which core models are based on logic thinking to design and construct, and to pursue each step is reasonable especially, the revolution of instruction and training lie in the logic of "contradiction law". The teaching materials of the present engineering education are out-of-date and the mode is simple and crude. Courses of engineering are the same. The barriers of disciplines are obvious and lack of cohesion, the engineering knowledge is instilled into student's head. Throughout the process of instruction, learning and teaching are not persuaded to have logic tradition, which restrict and block the engineering thinking of directors, teachers, and students. So it decreases their competence developments of exploration and awareness of creativities.

138.4 Engineering Thinking Training of "a Plan for Educating and Training Outstanding Engineers (PETOE)"

In view of the above problems, "a plan for educating and training outstanding engineers (PETOE)" breaks the constraints between the theory and practice, emphasizes on the cooperation between higher education and industry, strengthens the culture of quality and social responsibility and enhances students' engineering and innovative ability training. It has the following characteristics from the angle of thinking:

138.4.1 Depth Cooperation Between Schools and Enterprises, for Forming the Non-Linear Thinking from Practice to Theory

In the background of modern engineering education, the separation model between school education and enterprise training is not conductive of future engineers. The new training mechanism should take the educational thought of "engineering view" as the guide, and emphasizes on the combination of engineering practice training model between schools and enterprises. PETOE focuses on the establishment of depth cooperation mechanism between schools and industry enterprises, through jointing training to increase students' learning and practice opportunities in enterprises and make them master theoretical knowledge in a real engineering practice solidly. Through theoretical knowledge, PETOE guides the non-linear thinking ability of practice teaching effectively, and trains students the ability of systematic, comprehensive solution to the problems of engineering practice in accordance with the principles of "industry guidance, school-enterprise cooperation, classification of the implementation and various forms. Specifically, in the four-year school system, students spend the first three years for the school courses and the last year for enterprise practice trained by industrial engineers including graduation design, examination and etc. Students are both guided by the school teachers and enterprise engineers, so that students participate the actual project in every learning sector, and then form the schools—enterprises cooperate training model. Part of the specialized courses will be learned in the enterprise, and experienced engineers will be hired as teachers for site teaching at the same time to achieve the mechanism of interaction between schools and enterprises. In short, PETOE abandons the traditional higher engineering education theory and practice dualism linear thinking, and lets students learning engineering, understanding the project, understanding engineering in a contextualized environment. Depth cooperation between schools and enterprises forms an engineering education system, and the non-linear thinking can guide the engineering practice, thereby improving the overall engineering capability.

138.4.2 Emphasizing on Para Consistent Logic in the Teaching Approach, and Improving Engineering Creative Thinking Ability

PETOE breaks the original mode of education and training, combines "teaching" and "learning" at the same time, integrates courses content, updates teaching methods, and converses teaching evaluation focus, so it can provide good mapping environment for innovative thinking. "First of all, we should change the past single classroom teaching methods, establish teacher-leading student-centered teaching concept, build student-centered organization of teaching activities in the teaching process, give full play to students of subjective initiative to promote heuristic, cooperative learning, exploratory learning" (Li Bo-Cong 2002). Adapting teachers and students to enrich students' critical capacities in the environment of the "Law of Contradiction", and make ways of thinking changed from the static absorbed to the dynamic generation, then to inspire students' initiative and enthusiasm of engineering practice innovation.

In addition, PETOE emphasizes capacity-building and personality development in accordance with the requirements of training objectives and combined with the features and advantages of the potential of every student, and highlights the training of project creativity. There are several aspects: enhancing students personalized guidance, encouraging students to choose a professional personality development, guiding students to develop a personalized training program, choosing the course, self-paced learning progress, independent development of individual expertise, encouraging students' awareness of innovation, expansion of the subject content and practical training to stimulate personal interests and hobbies, encouraging to study engineering problems in the dialectical perspective and developing students' creative thinking in the teaching process of the law of contradiction.

138.4.3 System and Conformity of Curriculums, and Highlighting Integrated Thinking

From the perspective of curriculum system and thinking relationship, curriculum system construction should be reflection of thinking law and structural carrier of the law of thinking. They are complemented with each other to achieve common goals of education. It is divided into two categories "the level course system" and "the modular curriculum system" from the angle of typical advanced engineering education curriculum system structure. The former Soviet Union is the representative structure of level curriculum system curriculum system, but also is the main reference mode of the traditional Chinese engineering education curriculum system. Curriculum system consists of three parts: basic courses, specialized basic courses and specialized courses with the purpose of training "specialist", in which conflict with modern engineering talents characterized "integrated" obviously. From the angle of thinking, modular curriculum system breaks the traditional level curriculum system: decentralized combination mode of thinking, and has system, comprehensive thinking pattern throughout the entire education process, highlighting the complexity and integrated features of thinking. PETOE undertakes conformity recombines by "the modular curriculum system curriculum system", and breaks the boundaries among disciplines. Specifically, changing the category of past humanities, social sciences and natural sciences are in accordance with the teaching time to set a course for segmentation of teaching, which breaks away from restricting of disciplines knowledge system, and emphasizes the comprehensive of courses contents, integrates the system of courses through an interdisciplinary approach. For example, "cooperation mechanism between colleges and enterprises, building the curriculum system and teaching together, cooperative participation to bring the engineering educational resources of cooperative enterprise into play, especially pay attention to develop those integrated courses and teaching material" (Lin 2011), through student cross-school choosing course and mutual recognition of credits mechanism, advantage courses in all kinds of school discipline can be complementary. There are many measures to be carried out, such as: system integration, organization of various types, various forms and different levels of extracurricular activities and credits. At the same time, strengthen students extracurricular activities guidance measures with teachers who have richen practical experience, high level and strong sense of responsibility. Finally, the purpose is to format a thick foundation, practical, systematic curriculum system, and meet the need for modern engineering ability.

138.5 Conclusion

In short, "a plan for educating and training outstanding engineers (PETOE)" is not only a change of mode of Higher Engineering Education and an innovation and development of traditional engineering education model, but also the culture beyond the traditional engineering thinking. This transcendence is not to abandon past thinking, but combine with the trend of our era given the inherent requirements of the proposed project thinking. Marx said: "With the discovery of each era in the field of natural sciences, material is mis bound to change their form." So "a plan for educating and training outstanding engineers (PETOE)" grasps the pulse of the times, highlights the flavor of the times engineering way of thinking, fits the characteristics of the project development, and provides engineering talents an effective way to set off a revolution of higher engineering education.

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Chapter 139
Discussion on the Beginning Education of the School Year About University Freshmen

Men-ji Shou, Chun-pin Ding, Cai-bin Ruan and Long-fei Zhu

Abstract The beginning education of the school year about university freshmen is an important part of the talent education in colleges and universities, which has a great significance for college new students in adapting to the college life, setting up the scientific career aims, and striving for them. It mainly involves three levels: adaptability and nurturance education, cultivation of sense of belonging and sense of responsibility, and establishment of right view of the making of talents and right view of ideals. The successful new students' beginning education of the school year will have a positive and profound influence on the growth and development of college students.

Keywords Freshmen · Beginning education · Entrance education

139.1 Introduction

The beginning education of the school year about university freshmen is an educational activity. According to their features, this activity sets a goal for the freshmen to develop themselves comprehensively, which guide the freshmen to adapt and integrate into the educational activities of college life (Gonzalez and Padilla 1997; Freeman, Anderman, Jensen 2007). When the freshmen say "good-bye" to their high school and come into the college, their living environments, interpersonal relationships, teaching mode, ideal goals etc. have changed a lot. This stage is not only a new starting point on their growth and development but also a major turning point of their life. The beginning education guide the freshmen to grasp the laws of college life, distinct their achieving aims and plan

M. Shou (✉) · C. Ding · C. Ruan · L. Zhu
College of Clothing Technology, Zhejiang Sci-Tech University,
Hangzhou, People's Republic of china
e-mail: smj79@163.com

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their college career reasonably. It is an integral part of university education. And the establishment of a scientific and efficient system for the beginning education is of great significance for university personnel training.

139.2 The Necessity Analysis of Beginning Education

139.2.1 The Beginning Education is an Objective Need of the University Personnel Training

The beginning education is an important part of Quality Education for college students. It plays a fundamental role in personnel training and ideological and political education (Wang 2003). New comers' gradually established values, thoughts and behaviors will have a direct impact on the development of their four years of college (Wang et al. 2003; Cheung and Hui 2003). And the beginning education will help freshmen know and grasp not only the talent education but also the features of college life. It can also help them to adapt the college life gradually. What's more, it gives a profound understanding of university personnel training objectives and helps to form goals with self-consciously coordinated interaction. The freshmen' views of the world have not completely set. There is a strong plasticity, especially in a case of the complex social environment. They are faced with the impact of the multi-cultural trends and values. Carrying out the beginning education of the year strengthens the students' ideological and political education (Gale et al. 2004; Tian 2004). And it also improves their ideological and political quality, training them into builders and successors of socialism with Chinese characteristics.

139.2.2 The Beginning Education is the Practical Needs of Freshmen to Adapt to College Life

When freshmen come into the new environment and begin a new life, they are both exciting and longing, but they will feel lonely and puzzled (Zhou 2005). They need much more guidance and help. As they are gradually getting rid of the dependence on their parents, they may often come across difficulties on daily life. In high school their interpersonal relationship is narrow and their demands were not so strong. At the time they coming into the college, the association scope expands suddenly. As they come from different regions, they have different customs and diverse characters. Especially when they live together, they often meet interpersonal barriers. Many freshmen are lack in the knowledge of the differences between the university and the high school on learning. They are lack in understanding the professional training objectives and curriculum system. They don't know how to plan for their education. Not only the gap between their imagination of perfect college life and the reality, but also the errors in self-evaluation and the lost to the dominant position in the group, especially in the talented new environment, they may not feel suited mentally. Whether new students can completely adapt to the period of the changing role as soon as possible will affect all levels of entire college learning. It can also affect the completion of university studies, even the realization of their goals in life. So, it is very important to grasp the beginning education of the school year.

139.3 The Main Content of the Beginning Education

The content of beginning education is very broad. It needs to be synthesized considering talent education and the needs for adaptation and development.

139.3.1 Adaptability and Nurturance Education

Adaptability education is to guide new students to familiarize themselves with the new environment, be aware of the characteristics of university life, and improve the capacity for self-development, complete role changing rapidly and formate fullest confidence to the life (Goodenow 1992; Zhang 2006). “Adaptability” mainly refers to regulate the state when the physical and mental change in external circumstances. Therefore, making themselves familiar with the changes in the environment and the formation of the corresponding level of competence and psychological state is an adaptive education in the new life. Firstly, the new students are faced with the new campus of the physical environment, such as the different functions of the building community. They should be customed to learning everything in a short period of time, knowing the place to live and so on. These are the basis to enjoy the smooth commencement of university life. At the time new students come across the reception of the University, they will be able to feel the campus cultural environment. And it can guide the new students to accept the institutional culture and the concept of culture as soon as possible, helping them begin a new life in a timely manner to make a consistent aim with the campus culture-oriented and incentive efforts. The new students are away from home and their loved ones, when they enter into a new interpersonal environment, they may feel lonely. And they desire to exchanges. They want to build a harmonious and friendly relationship with the people around. Good adaptation of the environment can promote the socialization process of college students and establish right self-awareness and evaluation. It can also help develop and perfect their personality. What’s more, it may help them grow. Training objectives, curriculum and teaching methods are different from high schools. Learning how to adapt to the environment helps the new students to know their learning objectives.

It also improves their autonomy and efficiency learning. The beginning education should guide the new students to improve self-care ability to adapt to the changes of living environment.

Good adaptation is carried out for nurturance education. Nurturance education is in the daily learning, work and life (Li 2007). It is to teach ideological and political education through formal training, strict management and systematic inculcation by a variety of means of guidance and training for individuals to form good habits. Then their words and actions are in line with the relevant regulatory requirements of the Ministry of Education what college students should regulate. The emphases of nurturance education are on discipline, study and safety education. New students are guide to master and practice what a college student should know, such as the 'should know should do'. It also guides students to enhance ethical awareness, legal awareness and safety awareness, and develop good behavior and study habits. Nurturance education helps enhance the students' consciousness, improve their words and deeds and develop good habits of lifelong education. Strengthening students' nurturance education is also the base of training qualified students and maintaining the normal order of teaching, campus harmonious and stable foundation.

139.3.2 Cultivation of Sense of Belonging and Sense of Responsibility

Sense of belonging is human's basic psychological needs. The new students' sense of belonging is their rapid recognition and commitment on the school, faculty, class and professional in their thoughts, emotional and psychological (Goodnow and Grady 1993; Coopersmith 1967). They are willing to assume the responsibilities and obligations and participate in various activities. When the new students come to a new environment, it is important to be one of the new collective, make others to accept themselves as valuable and an emotional experience with others as a whole. It closes the students and schools in the formation of a new collective sense of belonging, even with the emotional distance of the faculties. It helps new students adapt to the new environment and promote the conscious recognition of objectives and relevant requirements of the school culture. It also promotes the concept of collectivism and collective pride. What's more, it improves ideological and political education.

Cultivation of sense of belonging helps new students understand their own social relations and roles, and lay the foundation for responsible behavior and carrying out Cultivation of sense of responsibility. As a moral emotion, responsibility refers to a phenomenon that the competence has an attitude of bearing social responsibility and mission in a certain historical condition. It is the union of cognitive, action and emotion. As socialist builders and successors, new students are responsible for social responsibility. Firstly, the change of being a college student guides the freshmen to be responsible for themselves. Secondly, it is important to grasp the change of the students when they come to the campus. Their responsibility for family and college should be strengthened. And they should bear the pleasure to do something as children and students. Thirdly, the new students should know the difference between high school and college. The attitude of the responsibility for the country and social should be strengthened. It makes the social responsibility a high level and it is also what the college students should do.

139.3.3 Establishment of Right View of the Making of Talents and Right View of Ideals

The freshmen come to the college with fantasy. They are longing to be perfected. But they are lack in targets and responsibilities. There is a deviation in their view of making talents. It is general that they often come across confusing. Many students don't have a clear aim. Thus, establishment of right view of the making of talents is very important (Baumeister 1993; Brown 1993). It can help students make a clear aim and enjoy their learning. And it will guide the new students make a right choice and become a person that agree with personal and the social needs. It makes them brave enough to bear the heavy historical responsibility. Then, it drives students to stick to their aims. Even when they come across difficulties, they won't give up. What's more, it helps students make a more clear aim which processes with the progress of the times.

Establishment of right view of the making of talents is linked to right view of ideals. The view of ideals react the students' view of world, life and values. It reflects students' political direction. It is important to their ideological and political quality and overall quality. The report 'CPC Central Committee on strengthening and improving the ideological education' says it is important to strengthen and improve students' view of world, life and values. College students achieve the short goal of their life to receive the talent education. They lose themselves at a short term. Right view of ideals should be thought to them. Lofty ideals and beliefs are necessary for them. The strict sense of being talent, fighting for the motherland and strong mission are needed as well.

139.4 The Ways of the Beginning Education

139.4.1 Combine the Stages of Education with Deepening Education

Entrance education is the regular work of the talent education. It is an important part of the beginning education and it is also basic work. Entrance education includes school discipline and history education, professional study and education, mental health and safety education. Scientific planning and careful implementation are needed. It may help new students' preliminary understanding of the school, profession and college life in a short period of time. The students should initially identify a way of thinking and a way of life suited for them. It can lay a solid foundation for future growth and development. However, entrance education is contains a short time and heavy task. Students are lack of perceptual. It is difficult to complete objectives and requirements of the beginning education. Thus, after the focusing education time, plans should be made to organize special events. 'Ideological and Moral Cultivation and Legal Basis' should be applicated. Above all, those can guide new students to understand the university, adapt to the University, beyond themselves, grow and success.

139.4.2 Combine the Theoretical Education with Practical Activities

The beginning education should give full play to the role of "Two Courses", and gave lectures, group lesson system of education in Marxist theory and ideological and moral education. It is to guide students to aware a correct theory, so that the new students can understand the characteristics of higher education and personnel training objectives. It makes them shoulder historical mission. That a clear way should be made and the motivation should be enhanced. Students should be thought to use the Marxist stand, viewpoint and method to analyze and solve problems. They should establish right view of world, life and values. Combine the personal ideals with the country's future and destiny. At the same time, adhere to the combination of the philosophy of education and practice, plan carefully and organize meticulously. And new students should be guided to participate in the practice of the campus cultural construction and social welfare services. Students should strengthen thoughts and behavior in practice. And they should enhance the ideological level in the practical experience.

139.4.3 Combine Ideological Education with Strict Management

The beginning education has two important parts. One is ideal and belief education. Patriotism is very important. Ideological and moral constructions are bases. Ideological and political education should be strengthened. The other is strict management. New students' daily behaviors and details should be care. Strict requirements and timely corrections are needed. It is very important to obey the disciplinary norms. Military Training is a good opportunity to start the beginning education. Patriotism, collectivism and caucus construction should be considered. Combine the company formed in military training with the students' characteristics is necessary. A company Student League branch should be created. The construction of the ideological, organizational, work style should be strengthened. Students are subject to strict organizational discipline and exercise the will of character. It guides students to be politically qualified, in a good style and enter into the disciplined direction. It helps students form ideological characters and behaviors.

139.4.4 Combine the Teacher' Guide with Self-education

In the exploration of new life, students often make the excellent teacher or the high grade student as a role model. It is important to strengthen and focus on the effect of the guiding role of the teachers and seniors. Teachers' academic standards, learning attitudes, moral characters and demeanors play a profound, direct and subtle role to the students. It is necessary to carry out the academy of sciences and the principal special report for the new students. Teachers should play an exemplary role of words and deeds. And teachers should also lead the students to learn how to learn and how to be a student. At the same time, personal experience and neonatal exchange should be organized by outstanding students. They should play a mentoring role. Their good deeds will inspire new students to make progress in their study. Students' organizations should play a role. The subjective consciousness of the college students should be strengthened. The new students' enthusiasm of self-education should be fully mobilized. New students should be made to participate in self-education activities for growth and success actively.

139.4.5 E. Combine the Talent Education with the Actual Predicament

The beginning education should help new students solve their practical difficulties and ideological combined with political education in the psychological, economic and taught education. Not only guide the student to fight for their aims, but also help them come across difficulties. There may be a lot of problems to do such things. Guiding and helping students out of negative psychological and emotional is also difficult. Student activities should be held. Students should be helped to understand the channels of party. Government as well as schools should open up economic systems for poor students. Making the students feel that Party and the government are care for them. So they can feel the warmth of the new extended family. Solving practical difficulties helps new students adapt to the new environment and formate a sense of belonging. It helps new students overcome the temporary difficulties on the growth and win a strong spirit. What's more, it can improve the ideological and political education and the beginning education.

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Chapter 140
Evaluation of College Students' Innovation Concept Case Analysis Based on Taiyuan Institute of Technology Robot Team

Jun-qing Wu, Hong Zhu, Jian-ping Zhang and Jing-hua Huang

Abstract Through the literature review, this paper presents the framework of college students' innovation concept, thereby establishing the evaluation index of college students' innovation concept, Taiyuan Institute of Technology Robot Team for interviews, ultimately gives constructive suggestions based on the conclusions.

Keywords Innovation concept · Developing environment · Robot team

140.1 Introduction

Through the literature review, we have found that the keywords about the research of college students' innovation concept are fall into the following Table 140.1.

In Table 140.1, the difference between innovation and doing a pioneering work is not clear, and here the former is equated with the latter. Some scholars (Wu et al. 2011) have pointed out that one of their common characteristics: both of them are based on students as the main body and the other is: both are based on process management. As the key point while doing a pioneering work is characterized by innovation. Concepts include philosophy and ideology. From the view of connotation and denotation, the differences between innovation and innovation are reflected as below: innovation focuses on industry-what to do, how to do, what is like. And it is reflected in the organization, team, project, results and

J. Wu (✉) · H. Zhu · J. Zhang
Corporate Governance Research Laboratory of Taiyuan Institute of Technology, Taiyuan, China

J. Huang
Environment and Safety Engineering Department of Taiyuan Institute of Technology, Taiyuan, China

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Table 140.1 Keywords for college students' innovation concept

Concept, consciousness, attitude, spirit, interest, personality, concept, atmosphere, thinking, inspiration, agility, mentality, thoughts, awareness, public opinion, security, mood, confidence, enthusiasm, expectation, will, risk, adaptation, need, motivation, ability, knowledge, intention, method, environment, policy, guidance, training, satisfaction, effect, fund, experience, respect, value, quality, emotion self-fulfillment and sense of responsibility, practicalness

effectiveness.[1] But innovation focus on the new, for instance, the structure, process, technology is new or not and how about the degree, which are reflected in the new ideas, new techniques and new technologies. As some scholars (Zhang 2011) have pointed out that the essence of innovation is innovation, and through the literature review, we found that the understanding of innovation and innovation also has a certain similarity. Therefore, the concept of college students innovation framework is based on the combined analysis of innovation and innovation.

140.2 The Structure of the Students' Innovation and Venture Concepts

The essence of students' innovate ideas is to find a clue. From a bunch of concepts in Table 140.1, we can identify the research ideas. The concept is of philosophy and ideology, and the formation of concept depends on the main qualities concept. The concept of the main part is reflected in the its the main action, and the action is ultimately reflected in the effect (Wu 2010). In the process of the origin and final effect on concept, the environment and the psychological quality of the principal always constraint and have an impact on the concept of the main part (Li 2006).

In this way, the connotation of students' innovation and innovate activity must be aimed at establishing the mode centered in college students innovation and innovation and the form of college students' interests and independent practices, that is "interest-driven, student body process-oriented, the pursuit of practical results (Lin 2010).

I suggest the architecture of the concept and its factors, shown in Fig. 140.1. This architecture applies to the students' innovative ideas and innovate ideas (Zhu and Zhang 2007), searching for differences from the interview.

140.3 Evaluation of Students' Venture Concept

Based on above, we can demonstrate the concept and its related facts in detail as Table 140.2.

[1] http://baike.baidu.com/view/65157.htm

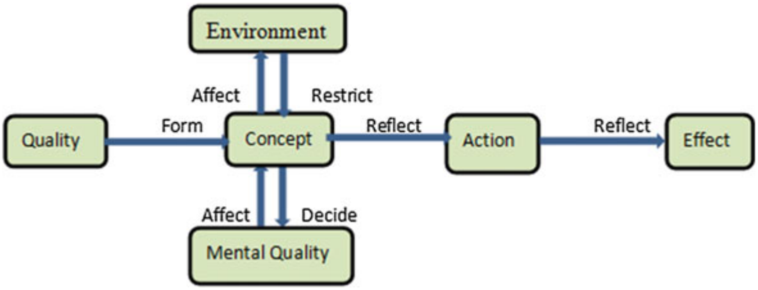

Fig. 140.1 Schema of the concept and its related factors

Table 140.2 Evaluation index of Students innovation concept

Level Indicators	Secondary index
Quality	Professional knowledge (theoretical knowledge), experience, knowledge (practical application), ability (five elements)
Environment	Funding, policy, atmosphere (including family, school, social atmosphere), guidance
Mental quality	Interest, confidence, risk and adversity quotient, cognitive. innovation focuses on risk and adversity quotient, innovation focused on interest
Action	Objectives, modalities, training
Effect	Self-satisfaction (the degree of respect, responsibility, self-realization), social, economic

140.4 An Analysis of the Interview of the Robot Team Taiyuan Industry Institute

Based on Table 140.2, I design the interview questionnaire on the concept of college students innovation, a total of 18 interview questions to do the interview to members.

140.4.1 Points of the Interview

140.4.1.1 How About the Role of Professional Knowledge in the Innovate Process, and Why?

Most of the students think professional knowledge is important to innovation. Professional knowledge can guide research method and thinking direction, ensure that research is not tricky question, have the feeling of leading the way, the study of fast. They get online retrieval relevant knowledge or communicate with the foreign teachers when lack of professional knowledge, then apply the theoretical knowledge of learning to study.

140.4.1.2 Do They Have Innovate Experience Before or Now, Why?

Some students participated in school robot competition in the freshman year when electronic CAST, some students interested in electronic toys that a considerable portion of students in the past research or practical experience by participating in the robotics team, then tired, some experience, minimum system such as seniors teach micro controller programming, electronic components usage.

140.4.1.3 Have Your Comprehensive Abilities Like Planning, Organizing, Coordinating, Controlling and Leading Been Improved During this Process? Why?

Some students believe that capacity are improved, especially the team's ability. The members do each one, and do well, affecting the process of others and the entire team. This division of labor makes teamwork skills to enhance self-learning ability. Study, first put forward the goal, and then to discuss the program, and finally produce the program, communication skills and group interaction capabilities have been enhanced.

140.4.1.4 Do You Have a Financial Problem and Why? What's Your Opinion on How to Get the Required Financial Support?

The school's support for specific performance in the lower: First, funds more slowly; sometimes buy a new device, the results bought the old devices. Sometimes directly on the demolition of the old device, used to do the transformation, because to buy the old. Concept on how to obtain funds, the students did not think there is a utilitarian concept, patent applications, and so on do not do it, can be financed by the hospital, thought do not want the business of raising funds.

140.4.1.5 Does the College Introduce Any Incentive Policies? What's Your Opinion on this?

Almost all students are not clear what incentive policies in schools, but I hope the study sites can be fixed, working conditions can improve. Schools to establish a special department, the introduction of formal management mechanism for the robot team.

140.4.1.6 Are there a Good Atmosphere of Family College and Society for Starting a Business? How Much and How do they Help You?

The school atmosphere is gradually formed, can participate in various training to develop and create. Various competitions, such as the Undergraduate Electronic Design Contest, Asia–Pacific Robot Contest, Free scale Cup competitions. The results show that the atmosphere of family, school and society is based, and help students.

140.4.1.7 Have the Teachers Offered Any Guidance and How Much do the Guidance Help?

At the beginning, the teacher taught the theory, basically rely on self-and foreign exchange to obtain the relevant knowledge, to complete the design and research. Things of design and developed to give teachers a look at, to checks by the teacher. Greater compared to the teachers, the old players mentoring role.

140.4.1.8 What is Your Interest in What You're Working on and How Much is it?

The interest of each student interested in the circuit in the algorithm in the programming, hardware, but each student doing their own interest, interest led to the design and research easy results.

140.4.1.9 Do You Have Confidence in What You're Working on and Why?

Students are of confidence. First, when they are learning, design and research in the fun, pay will be rewarded. Second, the team's strength and accumulation, especially in this aspect of the robot manually, pre-team has made some achievements. Sometimes impossible to start, but interested in design and research objectives, before also had a successful experience. Hands-on design and research, is easy to accept the theory of knowledge.

140.4.1.10 What is the Risk of Starting a Business and How do you Avoid it?

The risk of innovation in the following aspects: First, automatic robot design and research at risk, because the accumulated knowledge and experience poor students fear of failure. Second, in Taiyuan Institute has been made several times into the

16 results, now the students both hope to be the one of top 8, it is feared can not surpass the previous. On ways and means of risk aversion, the students need to take seriously the design and research carried out in-depth investigation of new activities, in order to avoid and resolve risks.

140.4.1.11 Have You Ever Encountered Any Difficulties or Problems and How Do You Solve Them? What Was Your Opinion Then?

In the process of design and research, and difficulties and problems, the solution is: resolved before, if they can not be resolved on the Internet to retrieve relevant knowledge or students and other school online exchange, and then retrieve or communicated try to come to the knowledge and experience in practice.

140.4.1.12 What's Your Opinion on Starting a Business?

Engaged in innovative activities in the team can broaden their horizons, plans, and direction to guide the study, design and research activities. The only innovation in order to have the salient points, resulting in learning, design, research, employment and other aspects of competitiveness.

140.4.1.13 What's Your Purpose of Participating in Starting a Business and Why?

The main goal of students to participate in robot teams is: First, the accumulation of practical experience, practical ability and theoretical knowledge can be applied in practice. Second, enhance the awareness of innovation and practical awareness projects, and prepare to become an excellent electronic engineers. Third, find a good job, to reflect the competitive employment.

140.4.1.14 In What Way do you Participate in Starting a Business? Why not Try Other Ways?

Students mainly related competitions in the robotics team division of the team do a good job, or participate in school organizations, and other innovative activities have not tried, do not know what innovative activities they can participate in.

140.4.1.15 How do you Train Yourselves When Participating in the Pioneering Process?

In the process involved in innovation activities, the students training in their own way: First, the given task, a clear deadline, every day in order to protect the new harvest. The second, more reading, more than the Internet to find a solution to the problem. Stay up late to get up early, seize the time, engaged in the design and research activities, except for school work in the laboratory. Fourth, collective running, both physical exercise, but also enhances the sense of team.

140.4.1.16 Have You Got Any Self-Satisfaction Like Being Respected, Sense of Responsibility and the Achievement of Self-Values During the Process?

By the robot team innovation activities, the students self-satisfied: first, life and learning tension, but feel full, great sense of accomplishment. Second, learning a lot of things, let other students know what to do to admire, to feel that they have something to do. Third, the enhanced sense of responsibility, to feel their own role in the team can not be ignored if they do well, it will affect the whole team. Fourth, caused by the interest of fun, hope to be able to continue in the future in-depth study, with the desire to study.

140.4.1.17 Do You Think Engaged in Innovate Activities, Whether There are Social Benefits, Reflected in What Place?

Certain social benefits, mainly reflected in: First, as the only one to participate in robot competitions universities in Shanxi Province, Shanxi Province, is relatively large. Second, have a certain impact on enrollment, some students because we know that the schools to participate in robot competition in the entrance examination for entry to Taiyuan Institute. Third, compared with other students, the students participate in the robot team is easy to access to employment, higher remuneration package.

140.4.1.18 Do You Think that Engaged in Innovate Activities, Whether or not There are Economic Benefits, Reflected in What Place?

Students did not have any economic benefits, neither the commercialization, industrialization. First, if we consider the economic benefits, worried that innovative activity will be bad, will affect the views of others on the team. Second, the business requirements of the design results in accordance with the needs of enterprises, enterprises do things, they will devote their time and energy to worry about the outcome of the robot team. Third, even if the results out of their own design and research can be commercialized and industrialization, there is no channel and energy to engage in commercial and industrial activities.

140.4.2 Interview Conclusion

Through the analysis of 18 questions interview, we can draw the conclusion:

140.4.2.1 The Effect of "do and Study" is Better than "Teach and Study"

From the experience of Robot Team, we can know that researchers of the team are mainly the students of grade 2, who haven't started systematically studying the special knowledge. In the beginning of joining the team, the teachers would focus on teach lectures and researches related to professional knowledge. Mostly what professional knowledge is used, what knowledge will be taught (Chen and Xu 2007). When the students meet with difficulties in the process of design and research, firstly they can try to solve, then they can surf the Internet and communicate with related members. It is a "do middle school" way of learning, and is a way of self-learning. But it has produced a good effect and achieved the goal of train application talents, so it serves to show that the effect of "do middle school" is better than "teach high school".

140.4.2.2 The Learning Method of "Team Work" is Better than "Single Work"

In the process of team learning, designing and researching, the teachers play an important part. But the boys' "team work" has great demonstrating and guiding function is also important. Due to the long time they have got along with each other in the team, they have more opportunities to discuss and exchange, thus many problems can be solved in the senior's help. The senior students help reflects not only in the guidance, but also in the demonstrating function. The senior's cognition and behaviors directly affect the boy's. From the effect of robot team's match, the learning method of "team work" is better than "single work".

140.4.2.3 "Interest" and "Experience" is the Source of Innovation

Interest of team members are quite different. But no matter what the members are interested in, it is the interest that leads they to designing and researching on their own position constantly, and finally they got the innovation achievements. In the process of design and research, the members accumulated a plenty of experience which includes theoretical aspects, the practice, and the team cooperation. On the contrary, accumulated experience can help design and research, thus the healthy circulation of innovation appears.

140.4.2.4 "Atmosphere" and "Policy" is the Innovation Accelerators

The biggest difference between key universities and normal university is the atmosphere, key universities have good teaching and scientific research atmosphere. To produce atmosphere, it needs a fertile soil and connecting link between the preceding and the suffering of time. Robot team's atmosphere is produced in such conditions, CCTV and the support of the schools provided the soil, successive games achieved time efforts. This kind of atmosphere also influenced the innovation of next members. The support of the school is mainly embodied in the policy, the school sets up a complete and stable team system, including specific team goal, reasonable personnel structure, perfect daily management system, strict finance system, and a long-term technology exchange and training system.

140.4.2.5 The Consciousness of Commercialization and Industrialization Needs to be Enhanced

The consciousness of research achievements' commercialization and industrialization is weak, and it needs to be further strengthened. When enterprises are seeking the cooperation with the team, team members worry that it may influence the game and thus give up the opportunity of commercialization and industrialization. Of course, they also won't make match designs and research results commercialized and industrialized. Without the operation of commercialization and industrialization, can any research results be only limited in the stage of experiment. It isn't good for students to the further study and accumulate experience of commercialization and industrialization.

140.4.3 Measures to Change Innovation Concept

According to the interview conclusion, it puts forward measures to change the innovation concept:

140.4.3.1 Reform the Teaching Mode and Introduce CDIO Engineering Education Mode

Some scholars summarize the development trend and problems in the current engineering education, which conclude that professional settings are wide but not outstanding, the combination of teaching content and enterprises' facts isn't close, training method is single, the links between students' engineering design and practice education is lost, engineering team of teachers is in the trend of non-engineering, evaluation system and degree design are dislocated, the lack of course cross and so on.

In order to solve the problems existing in the engineering education, since 2000, the Massachusetts Institute of Technology, the Royal Swedish Institute of four universities composed the international research organization, thus established CDIO engineering education concept (Chen and Xu 2007). The reform prospect is to provide students with an engineering education (Hao et al. 2009) that emphasizes on engineering foundation and is based on real product's idea, design, implementation, operation process (Xiong and Yue 2009). Through the essence of the robot team's work, it is a kind of the application of CDIO teaching pattern, and it has made the actual effect. Therefore, we should reform the teaching mode and introduce CDIO engineering education mode.

140.4.3.2 Encourage and Organize Students to Form Study Group and Change its Way of Learning

The information management and information system profession in Taiyuan Institute of Technology have practiced the constructivist teaching mode in the process of teaching practice. Information feedback survey after class showed that the students agree with team learning approaches. The nature of robot team's learning is a kind of team learning method. Therefore, we should be encourage and organize students to form study group and change its way of learning.

140.4.3.3 Find Out and Cultivate Students' Interest and Achieve Individualized Teaching

Many scholars think that the one who can have an innovatively thinking activity on a particular things generated a strong interest in this thing (Yu et al. 2010). The strong interest in innovation is one of most important psychological conditions to create. Along the activities of the interest, interest's satisfaction does not make this interest disappeared but rich, deep and strengthen interest (Chang 2011). Each student has his own growth environment and personal qualities, thus they have different interest. Schools and teachers should find out and excavate the source of students' interest according to the characteristics of students. Depend on the difference of each student, undertake personalized teaching to cultivate students' innovation consciousness, and carry out innovation activities to promote the output of students' innovative achievements.

140.4.3.4 Publish Relevant Innovation Policy to Create Innovative Atmosphere

Environment is the important conditions to improve innovation ability. Environment quality affects the speed and level of the development of individual innovation ability (Jiang 2010). The most important characteristic of innovation environment is innovation policy and innovation atmosphere. Since the rise of creation and innovation atmosphere in 1970s, it rises a cross field that uses "atmosphere" as the core to explore creativity and innovation (Chen 2012). Groups creativity atmosphere is the objective environment factors and general feelings of the combined members that creates the effect on group's behavior (Wang 2007). At present the study of atmosphere is limited in the theoretical research and it cannot make the objective existence, subjective understanding, difficult concepts and connotation quantified, but it is certain that atmosphere plays a very important role in the process of innovation. While the produce of the atmosphere need policy to lead and the policy is executed correctly under a stable situation. At last, we will create the atmosphere of innovation with the support of the environment. Therefore, various colleges and universities should publish relevant innovation policy to create innovative atmosphere.

140.4.3.5 Enhance the Consciousness of Commercialization and Industrialization, Transform it into a Real Action

Practice is the standard to examine the level of innovation ability and the achievements of innovation activities. College students' innovation achievements should be shown in the real application ultimately. The Robot team in Taiyuan Institute of Technology has made some progresses, but because of the shortcomings of the concept and consciousness of commercialization and industrialization, the creative work of design and research stays in the game and can not convert into a practical action. So actions can be carried out from two aspects: one is to make the existing achievements of innovation commercialized and industrialized directly, examine the achievements in the practice, and continue to perfect and improve when we find that it is insufficient; the other one is that design and then study the innovation achievements according to the experience of commercialization and industrialization of enterprises, so we can use the practice experience of design and research to review the innovation achievements. Thus experience is accumulated, and innovative perspective is broaden.

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Chapter 141
Constructivism of Teaching Idea and Practice

Hong Zhu, Jun-qing Wu, Hui-fang Li and Yong-qin Yuan

Abstract We elaborate eight points of constructivism and develop three of them in terms of team change, mechanism of encourage and restriction, and innovation ability to improve the constructivism idea in teaching. What's more, the teaching course of Information User Service which applies our ideas in Taiyuan Institute of Technology class 0920931 can be regarded as a case to test its feasibility and effect.

Keywords Constructivism · Case analysis · Team teaching

141.1 Teaching Idea of Constructivism

141.1.1 Constructivism Points in Teaching

Teaching methods is directly related to teaching effectiveness. Therefore, the reform of teaching methods is a question to which has always been paid close attention by administrations and teachers in universities. No matter how reform of teaching methods goes, it must focus on two key points: one is how to arouse the students' enthusiasm participating activities in class; the other is how to promote teaching effect. Constructivism is born to solve these problems, and it has already been widely applied in several majors in universities (Carlsson and Hansen 1982).

Constructivism educational theory developed by Piaget, Dewey, Bruner and Vygotsky has a profound impact to the world's education (Fengchun 2010). The influence of constructivism has flowed to fields like education, sociology, philosophy and so on. However, in terms of its development and popularity, it is the

H. Zhu (✉) · J. Wu · H. Li · Y. Yuan
Institute of Corporate Governance, Taiyuan Institute of Technology, Taiyuan, China
e-mail: hollyzu8@163.com

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field of education that constructivism has the largest influence (Juan 2009). Constructivism teaching focus on several points as followed:

(1) Learning theory. Constructivism is a kind of self-learning theory which focus on students' initiative inquiry, initiative discovery and initiative construction (Enquan and Zuokui 2009).
(2) Interchange between teachers and students class. Constructivism centers on students (Xu 2010). The traditional teaching mode in which students have to listen to whatever the teacher says has upgraded to a teacher-students interaction mode in which students can hold the class and the teacher's role is to guide them.
(3) Teamwork. Constructivism emphasizes fostering spirit of teamwork by teamwork learning. The team should be small, whereas the team's structure must be sound. The leader of a team can be regarded as an academic leader who organize the team and guide others.
(4) The reform of case-based teaching. The team's activities should focus on some specific themes which can also be regarded as a case. The team can understand much better by case study (Zhi 2009).
(5) Class discussion. The theme is often chosen by teachers. In this way, scientific thinking can be soundly introduced into class. The combination of science and teach can be achieved.
(6) Open teaching. Constructivism holds that a colorful and open learning environment is needed to promote students' spirits of independence and innovation.
(7) The teaching process is an information process. Students construct their own knowledge from his background knowledge, experience and external information (Zhu 2011).
(8) The reform of exams. The transformation of teaching method has a great impact on the reform of exams which is no longer the traditional exams, but a new type of exams scoring students according to their performance and speech records in class.

141.1.2 Constructivism Mode of Teaching

According to those teaching points, we assume that there are two teams. Each team has only two members. There are two scientific themes for discussion. This constructivism mode of teaching can be described as Fig. 141.1.

141.2 Constructivism Practice of Teaching

To apply constructivism ideas of teaching, we need to focus on the following aspects:

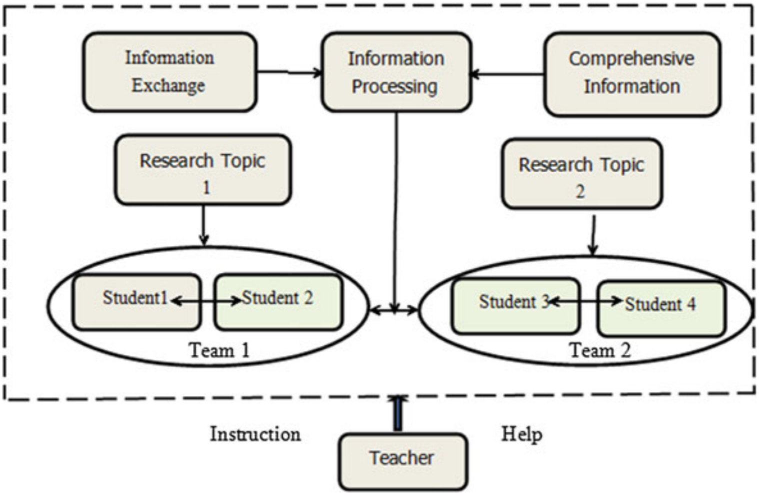

Fig. 141.1 Constructivism teaching model

(1) Stratified constructivism

There are different teaching targets and tasks between undergraduate teaching and postgraduate teaching. Therefore, the constructivism practice of teaching is stratified. The undergraduate teaching would focus on the skeleton. Thus teaching can be easily finished by teamwork.

(2) Dynamic teamwork

Constructivism teaching should be dynamic. In every aspect of teaching, themes can change along with the development of teaching; team can restructure along with the change of theme; members can return to their own teams after the discussion.

(3) In the classroom. Themes

The mechanism of stimulation and restraint. Without stimulation and restraint, each team is inclined to laziness. Therefore, constructivism should be built on a compatible basis of stimulation and restraint, through which teams can be stimulated to finish learning tasks and some lazy members can be restrained to cooperate with others.

(4) Fostering creativity

The ultimate goal of constructivism teaching is to foster students' creativity through their participation in class activities. The core of creativity is to cultivate students' abilities of discovering and solving problems. Those qualities such as thinking, psychology, attitude, trust, communication, leadership, ethics, etc. are also included. In fact, creativity is a kind of comprehensive quality.

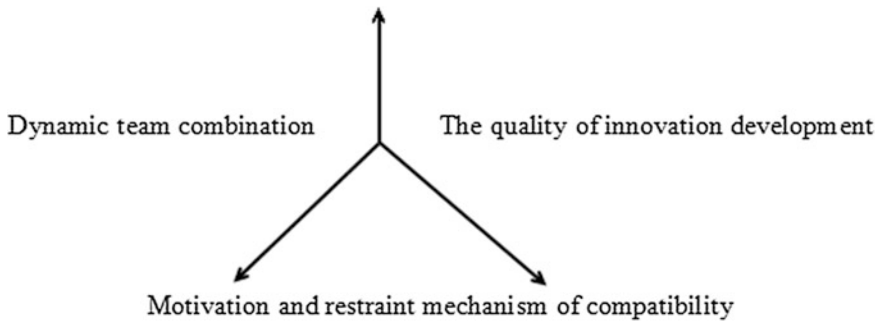

Fig. 141.2 Based on the improvement of the teaching idea of constructivism

As a conclusion, in view of undergraduate students, we introduce dynamic teamwork, the mechanism of stimulation and restraint and creativity fostering into the constructivism practice of teaching (see Fig. 141.2).

141.3 Case Analysis on Teaching *Information User Service* in Taiyuan Institute of Technology

This article takes the course of Information User Service in class 0920931 major Information Management and Information Systems in the first semester of the 2011–2012 academic year as a case, and concludes the experiences and results of constructivism practice of teaching.

141.3.1 The Characteristics of the Course of information User Service

(1) In the view of informational decision, teaching should be developed into advisory. Based on some specific decisional target, decision-maker should gather, regulate, reconstruct and analyses information to work out one or several alternatives, according to which he can make choices. The advisory services range from decisional target to alternatives. Thus teaching should change its content according to social needs (Wu 2010).

(2) From the perspective of the user service, the teaching should move towards innovative services. China Social Science Information Society held in Shanghai in 2010 academic year which based on three elements of “knowledge • services • Innovation” (Knowledge services innovation—China social science information association 2010), the knowledge applies in the service, thus causes the innovation, the development direction of the intelligence is necessarily a knowledge-based to provide users with innovative services.

(3) From the perspective of personnel training, the teaching should move towards the applied talents. Unlike the engineering education of social sciences applied talents equal attention, on the one hand, the application of the results of social science is a long process, on the other hand, the social scientific talent is relatively small, therefore, the social sciences should be more training applied talents. Information management and information system itself is a practical discipline, the cultivation of talents is facing the decision-making consultation service innovation (Wu et al. 2011).

141.3.2 "Information User Service" Course Teaching Needs

(1) The determination of research topics. A scientific research topic selection is a consulting service theme. According to consulting service theme of teacher for school (Zhu and Zhang 2007), government and business, we determine the research topics.
(2) Grouping. In accordance with the voluntary combination of the principle of grouping, each group is a learning team. Each group in accordance with the interest to select a research topic, as a course of study content.

141.3.3 "Information User Service" Course Teaching Practice

(1) Learning forms

By retrieving relevant information to complete the speech. Each team member should tell their speech as the keynote speaker in the classroom and other students ask questions, keynote speaker answer. If the keynote speaker can not answer the problem, the panel members can give help (Li 2006).

(2) Learning content

The research theme is learning content. By external stimuli in the environment, when a new topic appears, we does not disrupt the original group and will re-screen the students to the newly formed team of dynamic learning. They will return to their respective team after completing the study topic and dissolute, we call it a matrix model teams.

(3) The role of the teacher

The teacher and the student role exchange, the student leads the classroom, the teacher coaches pupils in the middle of the entire learning process. The teacher plays the role of guide, the host, comment and controls the favorable development of the entire teaching and order. Thus, the teacher who can play the role of good teacher, teachers must have some experience and quality in leadership, management, research, teaching.

(4) The encouragement and constraint mechanism

In order to develop students to participate in team learning enthusiasm and creativity, we also need some incentive and restraint mechanisms to motivate students toward the desired direction of teachers learning and restrict inert students with team learning (Possajennikov 2004).

(5) Effectiveness

Under the guidance of the teacher, the interaction between teachers and students, students and students produced an unexpected effect, they has completed the scientific research subject proof and the deliberation activity smoothly through adjusting the research subject unceasingly and taking advantage of the strength in student's wisdom.

141.3.4 "Information User Service" Curriculum Teaching Experience

According to the practice of constructivism teaching of Taiyuan Institute of Technology 0920931 class, the lessons learned is as follows:

(1) From the student perspective, experience is to choose a research topic in accordance with the interest on the basis of the voluntary combination of learning team, have a collecting, collating, processing information, to speak in class, discussion after class and finally get comprehensive course examination results.
(2) From the perspective of teacher, experience is mainly according to the present research situation of teachers' scientific research team, proposing the alternative scientific research subject, adopting motivation and restraint accommodating mechanism, enhancing enthusiasm of the student team study, and finally giving full range of course examination results (Ghoshal and Barlett 1988).
(3) Ability perspective, mainly students in accordance with the interest to choose the research topic and cultivate teamwork skills through team-based, mutual aid (Bourdieu 1972; Hazel and Kitayama 1994); the ability to access information through the collection, sorting, processing information and the skill to identify problems and solve problem through classroom to speak and the way of discussion.

141.3.5 The Educational Model of "Information User Service" Curriculum

According to the summary experience, this article has constructed Taiyuan Institute of Technology 0920931 class constructivism teaching model, as shown in Fig. 141.3.

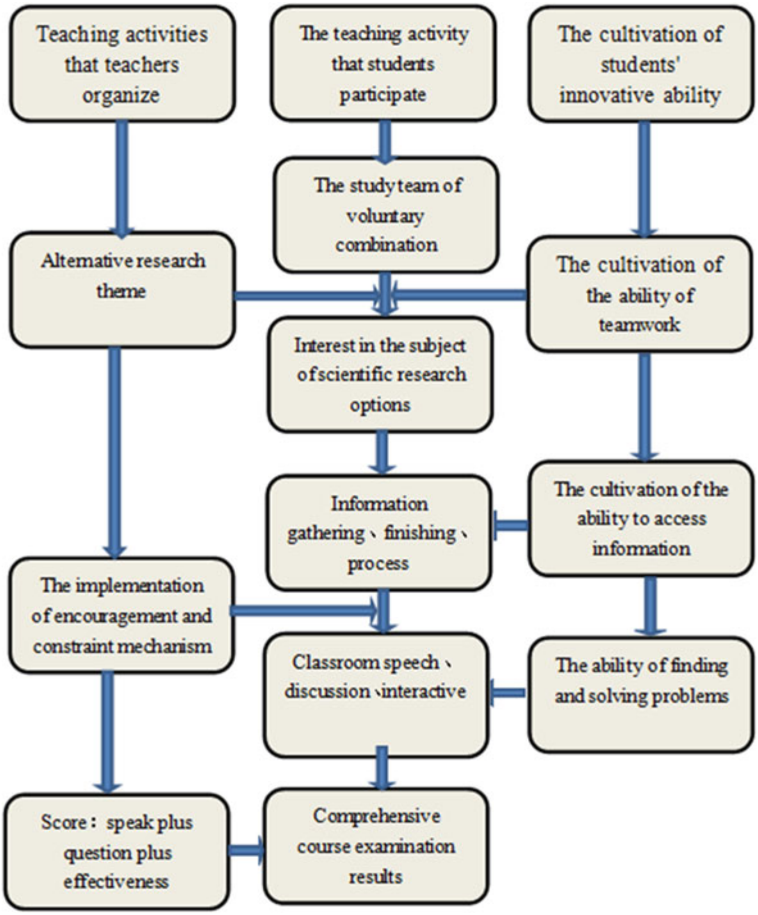

Fig. 141.3 Taiyuan institute of industrial 0920931 class constructivism teaching mode

141.3.6 The Teaching Feedback of "Information User Service" Curriculum

After the course, we have a survey for the students of class of 0920931 to get the feedback information of the students for the teaching mode of constructivism.

(1) Teaching activities that teachers organized.

32 students thought the difficulty of teachers teaching increases many or increase. It shows that the majority of students approve the reform of constructivism educational model, the performance of teachers in teaching of constructivism is also approved (Table 141.1).

About the difficulty of the options set forth in the research topic, one student chose the difficult, 19 students chose the more difficult. Obviously on the basis of difference among students' scientific research literacy, alternative research topics are generally biased to some degree of difficulty, it is quite applicable to the constructivism teaching.

About the implementation of encourage and restraint mechanism, 18 students thought that it is very essential. Obviously in constructs in the middle of the principle teaching, the drive and restraint mechanism adopting is very essential. At present, obviously regarding the drive and restraint mechanism which adopts, the majority of students approve, also it has quite part of students do not satisfy with it, analyzing the reasons, it is possible related with that this kind of educational model, benefit many students occupy proportion little, also possible related with the mechanism which itself adopts to wait for the improvement.

Inspects the result about the comprehensive course giving, the way they adopt is the speech result, the inquiry result, the actual effect result synthesis. 3 students thought are very good, 19 students thought well. The results are more accord with actual situations. Generally speaking, it receives the majority of students to approve.

(2) Students participate in teaching activities

25 students chose a will or more willing to accept constructivism teaching mode. It shows that only about 50 % of the students agree with constructivism teaching mode, there are quite a big part of the students hold on the fence, although not against, and also not really sure. It is high related with that constructivism teaching mode reform practice is relatively short, in addition, increasing study difficulty also related, 37 students thought that the difficulty of study increases many or increases. However, the teachers' attitude to the effect is quite satisfied.

In the study team combines in the question, 23 students chose that it has related with group. Obviously, majority of students pay more attention to the team' concordance, but not the interest, this had certain deviation with the constructivism according to the interest choice subject's original intention, and finally caused the

Table 141.1 Taiyuan Institute of Technology class 0920931 constructivism educational about questionnaire content

Category	Subdivision	Questionnaire	Category	Subdivision	Questionnaire
Teaching activities that teachers organized	Overall	The difficulty of teaching	The teaching activity thai students participate	Overall	Constructivism willingness to accept
		The effect of teacher play			The teaching effect of constructivism
	Alternative research topics	The difficulty of alternative research topics			The difficulty of the students learning
	The mechanism of encourage and restraint	The necessity of incentive and restraint mechanism		The voluntary combination of the team	The reason of joining team
		The measure of incentive and restraint mechanism		The select of scientific research topic	The reason of selecting scientific research topic
	Curriculum test results	The effect of achievement given the way		Classroom speech, discussion, and interaction	The effect of speech
The cultivation of innovative ability of students	Overall	The effect of constructivism partem			The effect of discussion
	The ability of team cooperation	The improvement of team cooperation			The effect of question
	The ability of obtaining information	The improvement of collection information ability			
		The improvement of analyzing information ability			
	The ability of finding and solving problems	The improvement of finding the problem ability			
		The improvement of solving the question ability			

dynamic sub-team's actual effect to be bigger than the fixed group, because the dynamic sub-team is completely according to the interest of the combination of the team.

In the scientific research topic selection, 12 students are interested in it. Obviously, Students' attention in the application of is more than the attention on points of interest, analyzing the reason, it is possible that as the engineering college of Taiyuan Institute of Technology takes more attention to application.

28 students thought that the function of the speech in the classroom is very big or big. 31 students thought the classroom discussion displays the function is very big or big. 32 students thought that the function of the inquiry in the classroom is very big or big. Obviously, regarding the classroom speech, the discussion, the interactive link, Students are recognized it.

(3) The cultivation of the innovative ability of students

27 students thought that the ability of collecting the information enhanced. 31 students thought that the ability of analyzing information enhanced. It indicated that the students' ability of information collection, reorganization, processing, analysis has obtained the big enhancement.

23 students thought that the ability of finding the problem got bigger rise or more. 24 students thought that the ability of solving the problem gets bigger rise or more. Obviously through the construction principle educational model's reform, majority of schoolmates' ability of finding the problem, solving the question have the certain extent enhancement.

23 students thought their teamwork ability has been greatly or improved. It shows that although the team cooperation ability has been enhanced, it also has quite a part of students have not received good results.

31 students thought that the reform of constructivism teaching mode is useful or more for the enhancement of their innovation, nine students chose the general. It shows that most students endorse teaching effectiveness of constructivism teaching model, at least in the innovation ability cultivation of several issues, only two students had a poor choice in solving problem skills.

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Chapter 142
Engineering Education in China: Status Quo, Problems and Countermeasures

Mei Wang, Min-min Wei and Chang-hao Dai

Abstract Higher engineering education in China outputs a great number of qualified personnel for the country, while there are still some highlighted problems in this sector, which restricts the training of engineering personnel and development of the society to some extent. This paper analyzes causes of the problems and whereby comes up with corresponding countermeasures, including implementation of large-scale engineering concept, change of assessment method, encouragement of production-teaching combination, etc.

Keywords Higher engineering education · Qualified personnel training · Engineering practice · Combination of production and teaching

142.1 Introduction

Higher engineering education is a special education branch with science and technology as the main foundation, aiming at producing engineers that can transfer scientific technologies into productivity, and it is the fundamental guarantee for driving science progress and technology innovation (Yuanzhang 2010). As the globalized economy and modern technology develops radically, the new technology revolution marked by IT, biological technology, energy technology, etc. has caused great revolution of economic structure, industrial structure and social structure. The engineering technological personnel at all levels of different

M. Wang (✉) · M. Wei
School of Education, Tianjin University, Tianjin, People's Republic of China
e-mail: wangmei@tju.edu.cn

C. Dai
Suzhou Industrial Park Institute of Vocational Technology Suzhou, Suzhou, People's Republic of China

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categories produced through engineering education will become the main force to drive the development of national economy and guarantee the international competitive edge of China. This brings new developing opportunities and severe challenges for higher engineering education. However, in recent years, Chinese engineering education has been of less high quality so that the output of engineering personnel is in great shortage and the competence of graduates can hardly meet the quickly developing and increasingly complex engineering technologies. Such problem has aroused more and more concern (Haisheng et al. 2010).

142.2 Problems with Current Engineering Education in China

142.2.1 The Mode of Engineering Education is Less Diversified and Adaptive

The stage of economic development differs from area to area, and higher education institutions at different levels have different teaching schemes for students. However, most institutions do not have an evidently engineering-characterized training mode. The students are cultivated under a uniform standard, without opportunities to achieve differentiated development and further bring into play their potentials and innovation abilities.

Current teaching mode is academic-oriented, which highlights the teaching of professional knowledge and overlooks the development of ability and comprehensive caliber as well as the configuration of such subjects as social development and economic environment including humanities and ecological view. For so many years, this has significantly hindered the development of Chinese engineering education, and as a result the students produced have narrow range of knowledge, poor innovation and learning abilities. Moreover, the colleges and universities ignore the training of students in team spirit, communication skill, systematic control ability, sense of responsibility, professional ethics, etc., so that the graduates are often confronted with a great many difficulties when they go into the real world.

142.2.2 Engineering Education does not Involve Enough Practical Training, Which does not Link Personnel Training with Social Demand

On the one hand, the concept of former engineering education in China emphasizes "knowledge" while overlooks "skills" (Defangng et al. 2009), i.e., teaching of knowledge is paid much more attention to than training of practical ability. The rapid expansion of student population further weakens the necessary practice involvement in engineering education. In addition, there are a very limited number of teachers who have rich practical engineering experience. The engineering technological personnel produced by higher engineering education cannot apply theories to practice. After they go into the real world, they cannot directly take up jobs, but have to spend much time, energy and resources on learning practical operation. On the other hand, in terms of management, concept, teaching force, etc., Chinese engineering education runs counter with the general principles of higher education and deviates from social development. Although lots of investment is put in manpower, property and capital, few excellent human resources are outputted. The quality of the produced engineering personnel can hardly meet the demand of social economic development.

142.2.3 There is not a Clearly Identified Training Aim for Higher Engineering Education in China, Leading to a Sharp Conflict Between Supply and Demand

In China, many academic-oriented personnel specialized in engineering have been produced through higher engineering education, which can basically meet the need of enterprises for senior professionals. However, the development of application-oriented personnel is neglected, so the urgent need of senior application-oriented personnel for economic and social development cannot be met well. Enterprises urgently need a large number of engineering technological personnel with practical competence to be put to production frontline to promote technological progress, transformation and innovation.

142.3 Reasons for the Existing Problems

142.3.1 Different Higher Education Institutions Adopt Undiversified Training Standard and Identical Training Mode

After many engineering colleges are upgraded into comprehensive universities, engineering education are attached less importance to, and the former engineering-focused feature of engineering education almost disappears (Gaofeng 2007). What is more, the government carries out evaluation of academic universities and apply technology institutions with the same standard (Wang 2011). This unreasonable orientation greatly bypasses the differences among institutions and differences among students, as well as the differences among areas with different stages of economic development. Therefore, the undiversified education modes of higher education institutions cannot deliver qualified personnel that can meet the needs of the society.

142.3.2 Practical Training is Overlooked in Engineering Education; Teaching in Colleges and Practice in Enterprises are not Closely Related

The assessment system applied in engineering education in China lays weight on thesis and graduation project as well as teaching of scientific knowledge but makes light of practical training, which constrains the development and improvement of practical ability of students. Both the higher education institutions and teachers do not put enough value on development and improvement of practical engineering ability, and there are a very limited number of teachers who hold rich practical engineering experience.

Enterprises and colleges and universities are expressly separated, without an effective joint mechanism formed for joint training of personnel. Higher education institutions train students with a uniform assessment standard, and do not adjust their training directions and modes according to actual social demands, resulting in gaps between personnel's competences and enterprise's requirements. Enterprises attach little importance to participation in personnel training, because enterprises in the market economy environment aim at profit maximization and fear that undertaking of personnel training may affect production and operation to some extent. In particular, if any safety accident happens to any student, it would generate an enormous negative impact on the enterprise, not only leading to poor KPIs of the enterprise, but also overwhelming public criticism upon it (Liu and Tiexiong 2011).

142.3.3 Higher Education Institutions do not have a Definite Positioning of Engineering Education

Engineering technological personnel are divided into four levels: scientists, engineers, senior technicians and common technical workers. Engineering education should aim at training different levels of personnel. In recent years, higher education institutions at different levels in China do not adopt diversified assessment standards, and they do not have a definite positioning in terms of training target, specialty setting, training program and management system.

142.4 Countermeasures

142.4.1 Implementation of Large-Scale Engineering Concept

In the environment of emphasizing on intensive development and realizing a harmonious society, if engineering education really takes the future development of the nation as the basis, the large system and large-scale engineering concepts must be highly valued, and training should target at producing all-around engineering technological personnel with the guidance of ecological, social and human concepts (Chen and Zhu 2006). The essence of the new engineering education philosophy is such a large-scale engineering concept that calls for balance between human beings and social development and balance between prosperity of natural ecology and engineering technology progress, and training people to achieve individualized development based on scientific construction and social demands as well as in favor of industrial interests. Engineering education in China's higher education institutions should experience further transformation, and science and technology education and humanities education should be integrated. Engineering technology should be regarded as the core, with humanities courses serving as supplement, to break the boundary of specialty and broaden knowledge range. Students should be trained for comprehensive, integrated and systematic thinking, and rich engineering knowledge background and enhanced comprehensive engineering application ability (Deng 2010).

142.4.2 Improve the Way of Assessment

The government should cancel the uniform assessment standard for engineering education, actually implement the autonomy of higher education institutions, provide legal assistance, capital facility, policy guidance, information service, etc., and enhance the flexibility of education (Haisheng and Zhou 2010). In terms of assessment of learning results, teamwork, communication, coordination, comprehensive ability and other forms should be introduced into let students change their attitude towards learning and life through self-assessment and mutual assessment. Diversified assessment forms also allow the diversity of learning modes of students, which is good for improving students' comprehensive ability on engineering technology (Yang 2010).

142.4.3 Encourage the Combination of Production and Teaching

First, renovate concept, promote institution-enterprise cooperation, and understand that high quality engineering personnel should be produced jointly by higher education institutions and enterprises. Providing internship sites for students by enterprises will necessarily benefit the training of industrial personnel and also is a way for enterprises to fulfill their social responsibility. Enterprises should be more active to undertake engineering personnel training. Higher education institutions possess much scientific and technological human resources, so technological cooperation between with higher education institutions and enterprises can strengthen R&D and innovation capacities of enterprises, enabling them to achieve better competitiveness (Wei 2010).

Second, use case study to improve the quality of practical teaching. In the process of teaching, teachers guide students through case study, with active participation of the students, to make students more active in learning before, during and after classes and trained for practical skills; students are required to complete tasks in groups, so that they gain communication and cooperation abilities and develop good sense of responsibility; also, students are required to find ways to solve problems by making good use of the knowledge they learnt and careful study, so that they get diverse thinking, the ability of knowledge learning and application as well as solving practical problems (Weizhe 2010).

Finally, improve the practical engineering abilities of teachers.

First is to employ “bi-teachers” to provide students with relevant cases and personal experience. Most of the teachers specialized in engineering education are academic type, while CDIO requires “bi-teachers”. Bi-teachers have rich experience of work in enterprises and engineering practice, so they can easily get students on track during engineering training. Second is to reduce the teacher-student ratio. Generally speaking, the teacher-student ratio of engineering faculties in teaching-oriented higher education institutions is about 1:18 (Li et al. 2011), so that the teachers have to bear heavy teaching tasks and completely devote themselves to teaching and scientific research. This limits the time and opportunities of the teachers to improve their own engineering abilities.

142.4.4 Determine the Targets of Training According to Social Demands

The higher engineering education in China should be adapted to the requirements of social development. The key features of senior engineering technicians needed in the future should be identified, and the higher engineering institutions in China should set their education targets according to their own positioning, and they should avoid blindly imitating others or bypassing the reality. In the future, there will be great demand for diversified higher engineering personnel, which include not only scientists but also technology-oriented, application-oriented and comprehensive engineering technical talents. The higher engineering education should commit itself to outputting high quality engineers suitable for the future development of China (Li et al. 2010).

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Chapter 143
Lean Production Education: A Prerequisite Course Designed for Industrial Engineers in China

Jian-sha Lu and Zhi Pei

Abstract Lean production related education has been integrated in the training programs for undergraduates, graduates and engineering masters in Zhejiang University of Technology during the past several years. The fundamental curriculums are based on the framework of the Toyota Production System. And developments have been achieved by introducing modern manufacturing conceptions, with case studies of real production systems in the local areas. In this paper, the configurations of the course are demonstrated, and then a series of in-depth analysis are performed via the progresses accomplished by the students engaged in the course. Consequently, from the students' point of view, a tighter grasp on the knowledge of lean production after this course enlightens them well into their future engineering career paths. And that fact reminds the teaching team that the lean production education is a prerequisite course in industrial engineering training, and it should be extended to other colleges and universities in China.

Keywords Curriculums · Engineering education · Education reforms · Industrial engineering · Lean production

143.1 Introduction

As Toyota Production System (TPS) (Monden 2008) claims itself to be a successful revolutionary improvement in the area of factory management and production system optimization, the framework inherent the system has been widely spread

J. Lu (✉) · Z. Pei
Department of Industrial Engineering, Zhejiang University of Technology, Hangzhou, China
e-mail: ljs@zjut.edu.cn

Z. Pei
e-mail: peizhi82@163.com

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throughout the world. Meanwhile, Lean Production (LP) is another way to express the methodology involved in TPS. And in this paper, for simplicity, LP is used as the primary terminology. The LP mode of production has led Japan out of economical depression in the last century, and poses great impact on the world economy as well. Since the essence of LP is largely within the domain of industrial engineering (IE) subject, for the aim of better understanding of the knowledge in modern manufacturing systems, a course titled Lean Production is organized in Zhejiang University of Technology (ZJUT).

The education of industrial engineering in China is experiencing a tremendous reform in the present time (Kuangdi 2008; Ye 2010; Gao 2011; Li 2012). The domestic prestigious universities, such as Tsinghua University, are conducting programs of importing photocopies of foreign textbooks into the undergraduate courses. It is undeniable that the major of industrial engineering is more advanced in the developed countries, e.g. the USA (Elam et al. 2005; Bidanda et al. 2006; Kheir et al. 1996; Massay et al. 1995; Torgersen and Torgersen 1997), Europe (Giurgiutiu et al. 2005; Saleh and Pendley 2012; Fabregas et al. 2011; Oprean et al. 2010) and Japan. To embrace the advantages of the IE discipline in operational research and operations management, a better understanding of the foreign advancement should be accomplished. Compared with the photocopied textbooks in Tsinghua University, we composed our own textbook (Liu et al. 2009) based on the TPS developed in Japan. The textbook is written in Chinese, and the prototypes of the production systems discussed are automobile manufacturing systems located in No.1 automobile manufacturer in China. The textbook consists of the several most important sectors mentioned in LP framework, such as the pull and push production systems, JIT, one-piece flow, TPM, SOP and VSM. Since the LP course is designed for the senior undergraduate students majored in industrial engineering or above, and they already have solid background knowledge in mechanical engineering and operational research, thus this course is more of a comprehensive training for the impending engineering design and improvement jobs in a real production system.

To fully convey the configurations and specialties of this LP course, this article is divided into the following segments. In the second section, a description of the LP course is depicted; In the third section, the effects of learning this course are revealed; And in the fourth section, several possible prospects of the current teaching methods are open for discussion; Finally, the fifth section concludes the paper.

143.2 The Current LP Course

The location of ZJUT is in Hangzhou, where the aforementioned LP course is given. And it is in the east coast province of China, where the manufacturing plants are widely spread, and people there are fervent in operating businesses. Therefore, it is an urgent call upon our educators in local universities, which is how to impart students with the state-of-the-art scientific management methods. Also, most undergraduates in ZJUT discontinue in pursuing higher diplomas, and the job seeking after graduation is their first choice. Thus the knowledge of LP becomes a prerequisite to the requirements of the local employers.

The curriculum is set in the first semester of the senior year for college undergraduates, and the first year for the graduates and engineering masters. The students are required to attend a 90 min lesson once every week. And the quality of the study is guaranteed by the assigned homework every three weeks, and random pop-up quizzes.

1. *Contents*: As was mentioned in the first section, the contents of this LP course have twelve key sectors of the LP framework. Each of these components is imparted in a separate lesson, such as in the first lesson we introduce the general guidelines of the LP course to prepare the students with the upcoming semester. During the first class, students attend this lesson on a voluntary basis, which means they could drop this course if they are not interested. However, from the second lesson on, the attending students should be obliged to complete the course to get credits. Therefore, it is quite tricky for the teaching team in dealing with the first lesson. In which it should be interesting enough to attract the students, but also let those unqualified students realize the difficulty. In the following weeks, the LP course is organized as the actual operational styles in the automobile plants. For example, the concepts of JIT and the principles of Kanban systems are introduced in the second lesson. These tools are core components and very typical for a mature LP based manufacturing system, but still many factories in Zhejiang province and throughout China have not recognized their importance. So in the following weeks, the detailed description of how to implement the Kanban systems, the balanced manufacturing, the one-piece flow production and so on are imparted.
2. *Format*: The LP course is given with a series of multimedia courseware prepared with careful dedication. And the tedious calculation processes are accompanied with animated movies, the hard to remember production conceptions are combined with actual scenes taken from the real manufacturing systems. An observation is made that most of the students in this course are concentrating on the teaching subjects 80 % of the time. Meanwhile, other unrelated activities are taken place during the class, hence the teacher should be alerted to such distracted behavior. As the course organizer, professor Lu himself has been involved in the consulting programs for many manufacturing systems, ranging from the chip-set plant to the refrigerator factory, and from engine plant to the automobile manufacturer. The experiences possessed by the teaching force are quite a fortune, because the LP curriculum is more of a comprehensive application level course, and the case studies introduced here will serve as an enrichment for the students to grasp the key points. Besides, video clips taken from real manufacturing floor could be imbedded into the slides, while watching the video, the students could feel as if they were standing behind the streamline workers and observing. This video based education

approach works well for the students to have a deep impression on the abstract production phrases introduced, and also, as it is demonstrated in the third section, the students are learning to use downloaded manufacturing video clips to present their final group projects.

3. *Evaluations*: This LP course is set to have one final examination, four to five times of homework, randomized pop-up quizzes, project presentation (each project team is composed of four to five students), and an academic term paper on LP related topics (the format of the paper is strictly following the standards provided by the university transactions). According to our experiences, the papers composed by the undergraduates occasionally bring interesting and fresh viewpoints toward the manufacturing systems, and sometimes the service industry. Some of these findings are worthy of digging, and even developed to real academic papers published by the university transactions. The course lays a rather heavy burden on the senior and graduate students, when they have huge pressure in job seeking and preparation with graduate school entrance examinations. This contradictory will be further discussed in the fourth section.

143.3 Effects of the Course

The effects of the LP course could be displayed by the group presentations and the academic term papers composed by the individuals. For group presentations, they reflect the team work of the small groups of students during the entire semester. With the knowledge learned from the course, the students are encouraged to extend the LP methods to other application areas, and they could also use this opportunity to make complements for the lessons already given. For instance, some groups are engaged in the drawbacks and limitations of the traditional LP framework, which brings judgmental thinking to the class, and poses questions as how to regard an existing theory in a more objective way. Also during the presentation, each group has to select one representative to demonstrate the findings of the group in front of the class. This activity is also counted in the final grades of the group, and the person who gives the presentation is informed in advance to imagine that the circumstance is an interview scene, and the audiences are his/her HR officers. As it turns out, we find that the students paid more attention in preparing the slides, and the practice helps the students well into his/her upcoming actual interviews.

For instance, in the year 2011, the senior students who attend the course selected the presentation topics as shown by the chart below.

As Fig. 143.1 illustrates, half of the student groups selected the presentation contents which are closely related to the textbook chapters. And those groups believed that the introduced parts were not discussed in adequate detail during class. Some of the important issues were simply omitted, therefore they asked the classmates to pay more attention on such issues. Besides, another portion of student groups worked on the lean production related conceptions beyond the

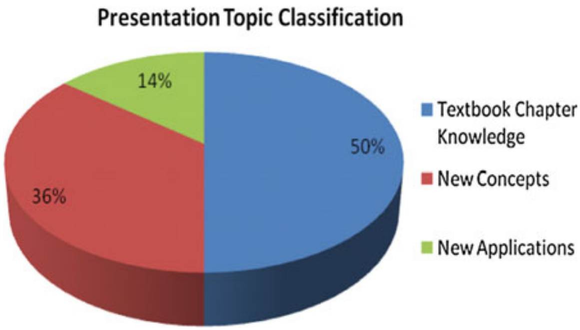

Fig. 143.1 Presentation topic classification

textbook, such as the lean logistics, lean inventory management and so on. These groups found new industrial fields where the very meaning of lean could be applied. Furthermore, a small amount of groups were concentrating on the relationship between lean production and modern manufacturing enterprises. The detailed subtopics are listed in the following table (Table 143.1).

As mentioned in the Format subsection, Section Two, there are two groups out of the overall fourteen groups, who used video clips and animated movies to depict their themes. And also, most group presentations have delicate workspace photos and tables in their slides, which make their performance stronger and more attractive. These phenomena, as we observe, are by-products of the multimedia teaching methods which have been employed during the course.

Compared with the slides show, the academic term paper is another highlight in the effects of this LP course. The term papers are required to be accomplished by the students themselves, thus the contents are far more diverse than the presentation. In order to have parallel comparisons, the senior students in the year 2011 are again selected as research samples. Figure 143.2 shows the topic distribution in the areas related to LP.

Table 143.1 Detailed subtopics selected by student groups

	Textbook related	New concepts	New applications
One-piece flow	√		
Stream line design	√		
One-minute die change	√		
OJT training	√		
Continuous improvement	√		
TPM	√		
5S management	√		
Group technology		√	
Lean logistics		√	
Bottleneck management		√	
Lean inventory		√	
Lean limitations		√	
LP in Boeing			√
LP in Lenovo			√

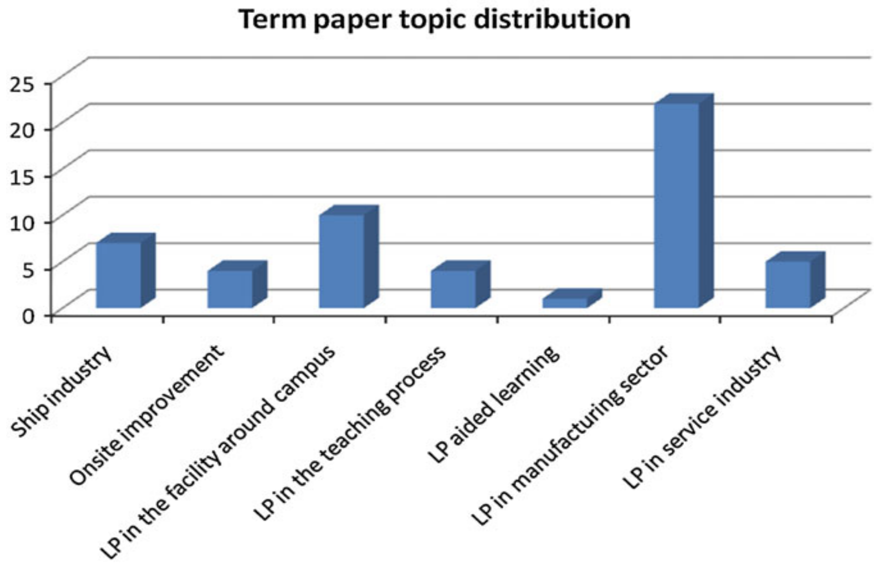

Fig. 143.2 Term paper topic distribution

From Fig. 143.2, an interesting fact could be perceived, the topic distribution of the term papers is largely denser in the manufacturing application sector. Different from the presentation proportion, this LP concepts used in real manufacturing industry is surprisingly higher, while during slides show, the 50 % presentations are more about a theory study rather than an application research. The reason for this phenomenon is because during presentation, the students have not gathered enough materials for a real manufacturing business, such as the onsite photographs, video clips and so on. And the requirements of the presentation are that the groups should introduce to the audiences something new, which better has not been heard of before. Therefore, the obvious discrepancy between the presentation and the term paper emerges.

Noticeably, another amount of papers concentrate on the LP conceptions used in the daily campus life, such as the bathroom, the canteen, the post service and the express delivery service around campus. These papers are very interesting according to the general reader's perspective, and the lean production knowledge used in these papers is not intensive, which is probably the cause for the students to select these topics. Also observed from Fig. 143.2, there are substantial amount of term papers are focused on the ship industry, which is quite related to the policy of the government, and the specialties within the local region. As the central government calls to develop the ocean related business, and at the same time, Zhejiang has large quantity of ship manufacturing plants, therefore, students mostly from native areas are much more familiar and enthusiastic about the ship building and ocean based logistics.

143.4 Discussion

Although the LP course has been imparted for several years, there are still some problems existed and baffle the teaching team, as we would like to perfect this set of curriculums. And currently we are exploring our way into the darkness. The following controversial topics are the things we would like to improve, and incoming advices and suggestions from our colleagues are warmly welcomed.

- As this course is quite popular in the local universities and enterprises, still much an undertaking it is to extend the course as a nation-wide prerequisite for both undergraduates and graduates majored in industrial engineering. According to the past experiences of the authors, the manufacturing plants, service enterprises in the local areas are thirsty to drink the wisdom of this LP related knowledge. Meanwhile, the consulting firms provided a price most businesses could not take. Universities, on the other hand, could rise up and help the smaller sized businesses to understand LP, and train more industrial engineers with abundant knowledge of LP. Therefore, the LP essence could be cultivated and nurtured. As a famous Japanese industrial engineer has said, the key of implementing the LP lies not on the concepts or the techniques, but the culture it grows.
- As discussed preliminarily in the second section, this LP course is set in the first semester of senior year. But during that time period, the students might have a lot of pressure in job seeking and graduate school application. The teaching team regards this course as a necessary training for the future industrial engineering, so the possibility of adjusting the semester of this course is placed onto the table. And a possible alternative is to switch the course to junior year, when the undergraduates have completed their fundamental engineering training courses and begun to learn the real manufacturing processes.
- The large discrepancy between the topics of the presentations and the term papers is another deep concern. As pointed out by the above paragraph, the learning pressure during this course is observable, and it could be reduced by moving the course to an earlier semester. On the other hand, to synchronize the contents of slides show and the term paper could also achieve this goal. For now, as it is derived from Figs. 143.1 and 143.2, there are little correlations between presentations and the term paper topics, the students are spending their limited time in two totally different tasks. A compromise could be figured out by letting the students compose their term paper and contribute to the group presentation at the same time. Ergo, the time could be saved and the students are better trained toward one unique aim, and it will cause the work more intensive and delicate. Meanwhile, different term papers from the students in the same group could help the teaching team differentiate which part of the overall task is accomplished by which student. Therefore, a more clear scoring method could be obtained.

143.5 Conclusion

In this paper, a description of the current ongoing LP course has been introduced. And an outline of the contents, the format and evaluation methods are discussed in detail. From the teaching process, some distinguished facts have been revealed via the statistics gathered from the students' slides show and term papers. Judged by the local markets and the students, this course is one highly regarded training program for the future industrial engineers in China. And we would like to share some discussions with our colleagues, both about its limitations and possible improvements. Finally, after more and more industrial engineers are trained by this course, a lean culture is believed to be formed, and this culture is much more important than making just one or two manufacturing plants to earn more profits. This is the reason why the teaching team leads this research and drives this course to be a prerequisite for every industrial engineering professional in China.

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Chapter 144
Construction and Development of Entrepreneurial Curriculum System Based on Entrepreneurial Process

Kun-yi Li, Xin-ping Shi and Zhong-li Ji

Abstract Entrepreneurial curriculum is the basis for colleges and universities to realize the objective of entrepreneurial education. Students' entrepreneurial knowledge, ability, and quality structure is determined by scientific and reasonable entrepreneurial curriculum system in certain degree. However, seen from current situation of entrepreneurial education in domestic universities and colleges, there is not mature and effective entrepreneurial curriculum yet. Creative thinking of entrepreneurial curriculum system development for universities and colleges is put forwards by combining basic rule of teaching activity from the perceptive of entrepreneurial process. Meanwhile, entrepreneurial curriculum system based on entrepreneurial process for university students is developed according to three-dimensional construction model of entrepreneurial curriculum system.

Keywords Entrepreneurial process · Curriculum · Colleges and universities · Entrepreneurial education

144.1 Introduction

Entrepreneurial curriculum is the core link of entrepreneurial education, and the bridge to realize the objective of entrepreneurial education and cultivation (Huang 2010). Seen from the setting of entrepreneurial education

K. Li (✉) · X. Shi · Z. Ji
Department of Management, Changzhou Institute of Light Industry Technology, Changzhou, China
e-mail: leekey@czili.edu.cn

X. Shi
e-mail: chutianyu2003@hotmail.com

Z. Ji
e-mail: gzl@czili.edu.cn

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Curriculum in current universities and colleges, most universities and colleges regard entrepreneurial curriculum as a part of vocational counsel, with no mature and effective entrepreneurial curriculum system, which cannot satisfy the demand of university students in entrepreneurial practice (Tao 2011). Therefore, the construction of scientific and effective curriculum system for entrepreneurial education in colleges and universities becomes urgent and necessary, while the problem is how to develop entrepreneurial curriculum system suitable for domestic entrepreneurial education (Haizong and Yudan 2010). There is no authoritative guidance in this aspect (Gang and Lihua 2009). Some creative explorations are made in the paper for the construction and development of entrepreneurial curriculum system in universities and colleges.

144.2 Development Thinking of Entrepreneurial Curriculum System Based on Entrepreneurial Process

Curriculum development theory based on work process is the advanced theory put forwards by Chinese education experts based on successful experience of vocational education curriculum development in various countries and abundant achievement of domestic curriculum reform (Dayuan 2009). Curriculum system developed based on the theory changes from subject system to work system; curriculum development changes from mainline of knowledge logics to mainline of vocational activity. By learning from curriculum development experience based on work process, the development thinking framework of entrepreneurial curriculum system based on entrepreneurial process is put forwards with the mainline of entrepreneurial activity, as shown in Fig. 144.1.

Entrepreneurial education is a comprehensive interdisciplinary education activity (Huang 2010), which has effectiveness relying on two aspects: the first is the profound understanding and correct transmission of entrepreneurial activity;

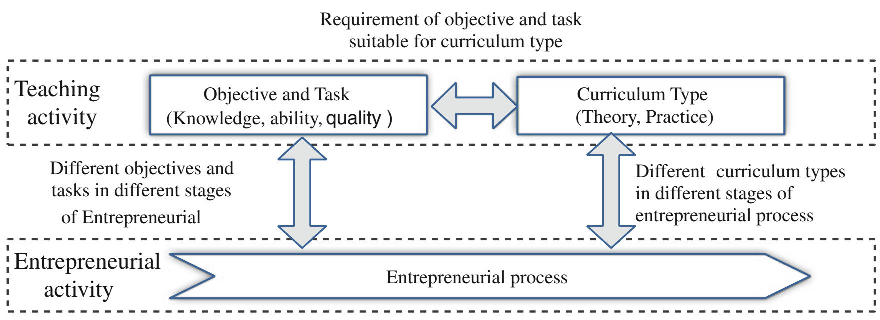

Fig. 144.1 The development thinking of entrepreneurial curriculum system based on entrepreneurial process

the second is the effectiveness and pertinence of the educational activity implementation. Therefore, entrepreneurial education shall combine commercial activity and educational activity.

According to entrepreneurial activity, as a complex commercial behavior, it has different tasks and vocational features in different entrepreneurial stages, leading to different entrepreneurial objectives and tasks of entrepreneurial curriculum. Meanwhile, for teaching activity, in order to realize different teaching objectives and tasks, different teaching models and methods are applied, which is reflected in different curriculum types.

144.3 Review and Analysis on Theory of Entrepreneurial Process

Many entrepreneurial process theoretical models are set up by the theoretical circles to discuss the logic order of relevant entrepreneurial activities. Representative opinions include: from the perceptive of enterprise life cycle, D.H.Holt suggested that "entrepreneurial process includes pre- entrepreneurial stage, entrepreneurial stage, early growth stage, and post- entrepreneurial stage". According to Olive, from the perceptive of personal career development, entrepreneurial process is divided into 8 stages including: determining to be entrepreneur, selecting entrepreneurial opportunity, performing initial analysis, constructing management team, formulating entrepreneurial plan, completing action plan, operation and growth in early stage, and obtaining personal success and company success (Xudong 2009).

Action flow of entrepreneurial process is drawn from different angles according to the theory, which provides direction for the entrepreneurial practices. However, for university students, these theoretical models lack of pertinence in certain degree. According to the case study on university pioneering work, with combination of higher education feature, it is suitable for entrepreneurial education of universities and colleges to consider the entrepreneurial process from the individual perceptive, which is reflected in basic paradigm of entrepreneurial educational curriculum in entrepreneurial curriculum of American universities, the Babson College in America. University students shall consider core problems including: whether to do pioneering work, what ability and quality they shall have, how to identify and judge opportunity, how to establish a business, and how to operate the business. Universities shall help these university students to look for answer of the question from the above aspects (Baohua and Shaoxiang 2010). Therefore, in the development of entrepreneurial curriculum, the entrepreneurial process can be divided into five stages including: generation of entrepreneurial intention, opportunity identification and evaluation, entrepreneurial planning, entrepreneurial launch, and enterprise growth.

144.4 Construction of Three-Dimensional Entrepreneurial Curriculum System for Entrepreneurial Education

In line with development thinking of entrepreneurial curriculum system based on entrepreneurial process in universities and colleges, the construction model of entrepreneurial educational curriculum system is put forwards. The model is consisted of three dimensions. The first dimension refers to objective and task. Seen from the aspect of curriculum design, the objective and task of curriculum is divided into entrepreneurial knowledge, entrepreneurial ability, and entrepreneurial quality; the second dimension refers to curriculum type. Seen from the angle of teaching mode, the teaching method and teaching means is considered based on how to cultivate entrepreneurial feature, how to teach entrepreneurial knowledge, and how to improve entrepreneurial skill, which is divided into entrepreneurial theory teaching, entrepreneurial single training, entrepreneurial imitated performance, and actual operational experience; the third dimension is entrepreneurial process, which considers the basic process that the enterprise shall go through from the angle of entrepreneurial activity rule, consisted of five stages including entrepreneurial intention formation, opportunity identification and evaluation, entrepreneurial planning, entrepreneurial launch, and enterprise growth. Three dimensions have considerations from different directions, which are separated from each other and closely related to each other, as shown in Fig. 144.2.

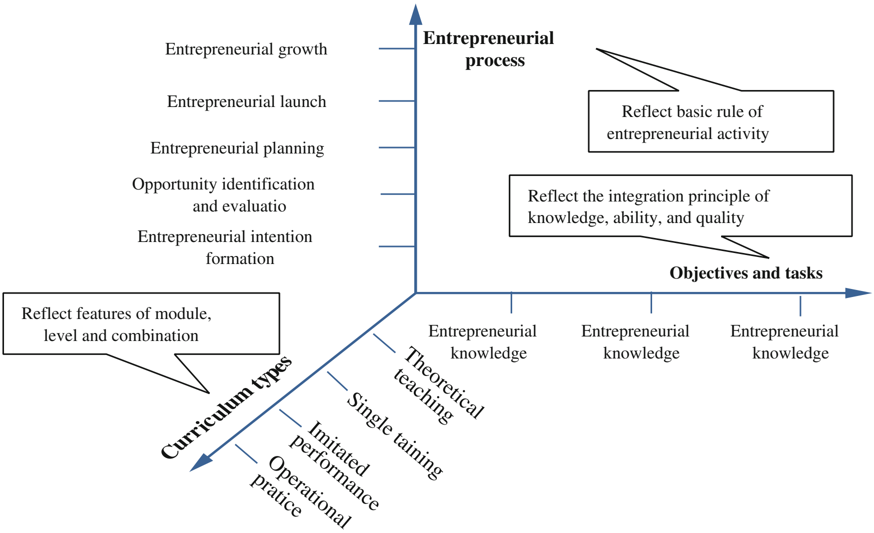

Fig. 144.2 Construction model of three-dimension entrepreneurial curriculum system

144.5 Development of Entrepreneurial Curriculum System Based on Entrepreneurial Process

144.5.1 Development of Entrepreneurial Curriculum Based on Entrepreneurial Process

With mainline of basic entrepreneurial process, by analyzing commercial activities in every entrepreneurial stage, extracting necessary knowledge for entrepreneurial process, summarizing core entrepreneurial ability, and integrating comprehensive quality of entrepreneurs, the curriculum suitable for entrepreneurial education in universities and colleges is developed in line with construction model of three-dimension: objective and task– curriculum type—entrepreneurial process.

Seen from Fig. 144.3, entrepreneurial educational curriculum based on entrepreneurial process development in universities and colleges includes 6 entrepreneurial theoretical courses (become entrepreneur; analysis on commercial opportunity; entrepreneurial marketing plan; entrepreneurial policy and law; newly-established enterprise management; industry and product knowledge) and 6 practical courses (entrepreneurial thinking training, teamwork training; entrepreneurial skill training; enterprise operational sand table training; entrepreneurial imitated performance; entrepreneurial practice).

144.5.2 Structure of Entrepreneurial Curriculum System in Universities and Colleges

For implementation of the differentiated entrepreneurial education, entrepreneurial curriculum system is designed according to levels to satisfy entrepreneurial education demand of students with different levels, different abilities, and different entrepreneurial demands, and realize multiple-level and diversified teaching mode. Entrepreneurial education curriculum is divided into theoretical course and practical course, including 3 levels and 12 courses, resulting into entrepreneurial curriculum system with modules, levels, and combination.

The entrepreneurial curriculum is divided into three levels. The first level, “entrepreneurial basic course”, is the popularization of entrepreneurial consciousness and basic entrepreneurial knowledge, which can be regarded as the required course for all students; the second level, “entrepreneurial practice course” refers to entrepreneurial skill training course for students with strong entrepreneurial interest and intention, which can be regarded as required course or elective course according to different subject features, or be combined in subject course; the third level, “entrepreneurial management course” refers to entrepreneurial improvement course for students with entrepreneurial basis or entrepreneurial experience, which can be regarded as elective course according to industrial feature.

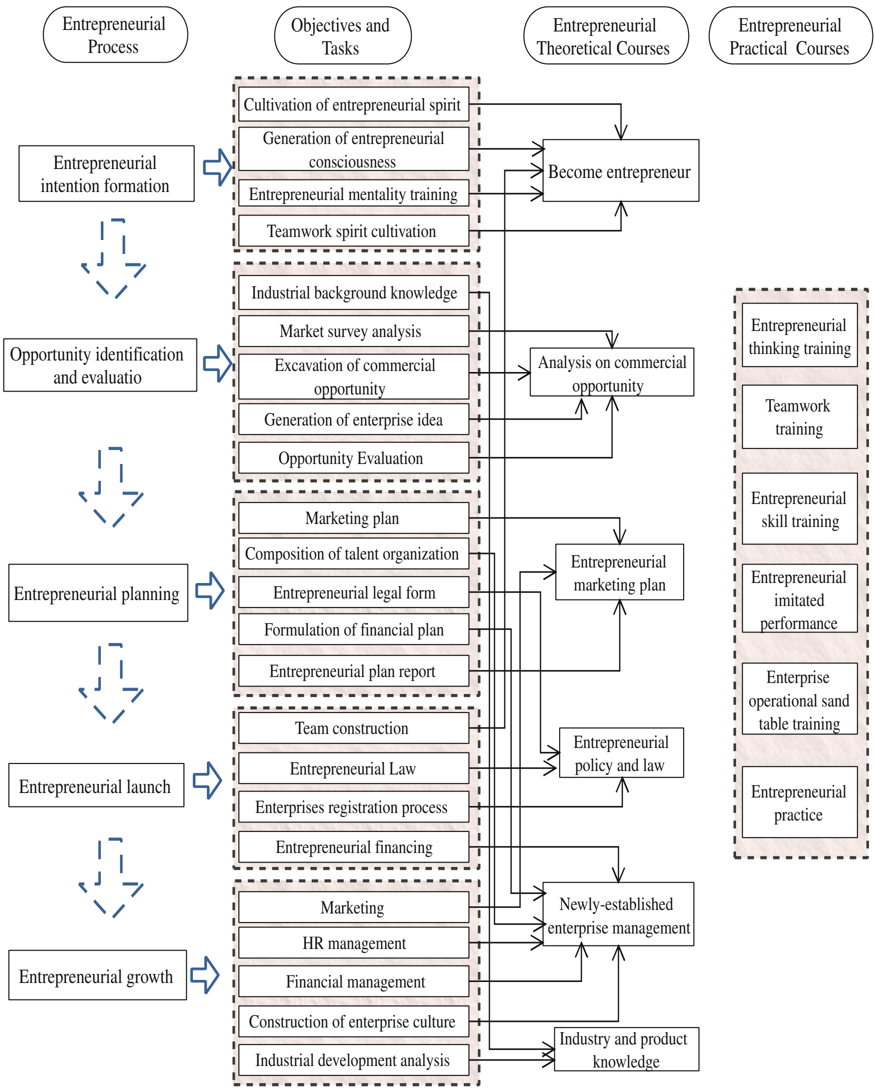

Fig. 144.3 Development of entrepreneurial curriculum system based on entrepreneurial process

144.6 Conclusion

Curriculum system construction, which is the weakest and the fatal in entrepreneurial education research field, is taken as the research object in the paper. Creative thinking of entrepreneurial curriculum system development for universities and colleges is put forwards by combining basic rule of teaching activity from the perceptive of entrepreneurial process. Meanwhile, entrepreneurial curriculum system based on entrepreneurial process for university students is developed according to three-dimensional construction model of entrepreneurial curriculum system. It is hoped that these research results will enrich current entrepreneurial theory and provide beneficial reference to the effective implementation of entrepreneurial education in universities and colleges.

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Chapter 145
The Reform of Engineering Education Based the CDIO Approach

Jin Zhang

Abstract For the construction of innovation-oriented country, a large number of high-quality engineering talents are needed. Current engineering education in China, to a large extent, prioritizes teaching of theory, while it does not pay enough attention to practice which emphasizes the ability cultivation. This paper will propose a CDIO-based engineering education model with the perspective of the collaboration between industry and university, after summing up the problems and challenges of engineering education in china. The positive effects of the model to the reform of engineering education will be illustrated in the term of curriculum design, teaching, workspace, students learning assessment. It is expected that CDIO-based engineering education model can meet the requirements of modern industry in China.

Keywords Engineering education · CDIO approach · Collaboration between industry and university · Engineer

145.1 Introduction

Engineering education is an important part of modern education, it is crucial to the construction of an innovation-oriented country in China. Development of engineering education and national industry are mutually reinforcing and restraining, so the reform of engineering education has to be carried out according to the needs of industries. Etzkowitz (1998), Geisler and Rubenstein (1989) point out that build new alliances between universities and industry has become a cornerstone of research throughout the OECD area (Etzkowitz 1998; Geisler and Rubenstein

J. Zhang (✉)
School of Management and Economics, Beijing Institute of Technology, Beijing, China
e-mail: zj4023@yahoo.com.cn

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1989). Fransman and Tanaka (1995), Ahn (1995), Sanchez and Tejedor (1995) emphasize the mechanisms that have been developed for the interaction between universities and industry, and the benefits which can be derived from such collaborations (Fransman and Tanaka 1995; Ahn 1995; Geuna 1998; Sanchez and Tejedor 1995). With the arrival of the knowledge-based economy, (Etzkowitz and Leydesdorff 1997, 2000; Bettis and Hitt 1995; Hwang et al. 2003) stress that the role of university as a source of new knowledge has become more important than in the past, universities not only discover knowledge, but also aid in industrialization (Etzkowitz and Leydesdorff 1997, 2000; Bettis and Hitt 1995; Hwang et al. 2003).

China is currently in the process of industrialization, national economy, security and people's daily lives closely rely on the innovation of science and technology, and engineering is a key component. The cultivation of various engineering talents at all levels is not only to solve specific problems, but also to create and disseminate the knowledge. In this situation, traditional model of engineering education faces great challenges and modern engineers have to be trained as specialists who master increasing levels of knowledge, personal and interpersonal skills in a range of technologies for dealing with complicated and comprehensive engineering issues. It is very important to find a new model for the reform of engineering education. The CDIO approach is an international cooperation plan based on the CDIO concept in the reform of engineering education; it includes CDIO concept, the corresponding syllabus and standards, and a series of theory and practice resources. Based on the successful experiences of implementation of CDIO in other institutions in the USA and Europe, the College of Engineering should consider adopting the CDIO Initiative and redevelop engineering education.

In this paper, based on reviewing the development of engineering education in china, the problems and challenges are analyzed and the CDIO-based engineering education model is developed to describe how to effectively support the talent training in engineering education. The positive effects of the model to engineering education reform are shown in different aspects.

145.2 Problems and Challenges of Engineering Education in China

Engineering education in China started in 1904; the Qing government promulgated the first modern Chinese education system "Guimao Education System". After more than 40 years, science, engineering, agriculture and medicine education had been developed significantly in the scale and speed (Sunyu and Jiqing 2009). To the time of the founding of new China, a major action in 1952 was mass adjustment in colleges and universities to learn "the Soviet model" of higher education, which had timely trained a large number of engineering and technical personnel.

Because of the contradictions between economic development and education have become more and more prominent since 1990s, gradually the reform of engineering education has been the most urgent task.

In 1994, the reform plan for the 21st century teaching content and course system of higher education was formulated, which opened the prelude of Chinese engineering education reform (Zhiqiang 2005). Especially since 2010, national program for Medium-to long-term educational reform and development (2010–2020) and the Training Plan for Excellent Engineers had demonstrated the national determination to speed up the promotion of engineering education in the new round of reforms.

Today, experiencing a sustained and rapid economic development in reform and opening up, China has become the 2nd largest economy in the world, however, the extensive development mode of China is a low-value and low-profit growth, the industrial structure mainly is resource and labor intensive. To maintain steady and rapid economic development in the future, China must change the mode of economic development and speed up industrial restructuring and upgrading.

The root of the upgrade industries is to rely on talents. Total number of Chinese engineering graduates reached 2,770,808 in 2010 which ranked first in the world, but their qualities are very far from the developed countries'. Number of graduates of higher engineering education in China is about 4 times higher than United States and 10 times than Germany, but GNP (gross national product) was created by Chinese engineers average is 5–10 % of United States and Germany engineers (Zhiyi 2008).

Under the influence of traditional culture, social value of the engineering behinds the development of new-type industrialization that influences the development of engineering education and reduces the social status of engineers. Although national educational expenditure has been increasing in recent years, the percentage of educational expenditure to gross domestic product has been below 4 %, which is lower than the developed country and many developing countries. Per capita educational expenditure even decreases, due to increase in infrastructure costs.

It is a tendency that many universities blindly pursue and upgrade to a higher level, and characteristics of the various training levels are similar. Feifan (2010) points out the program are usually supported by a single discipline in the traditional engineering education that is facing great challenges. Modern engineers have to be trained based on interdisciplinary environment to develop the abilities for dealing with complicated and comprehensive engineering issues (Feifan 2010). Specially, teaching system of engineering education has been lagging behind in China. Disciplinary curriculum is divided too thin and lack of interdisciplinary curriculum. Students are suffered from "narrow" knowledge which is harmful for students to develop their abilities in interdisciplinary environment. The proportion of classroom teaching is too large, engineering practice and "double-qualified" teachers with abundant engineering and academic backgrounds in teaching are lacking.

Collaboration between industry and universities is very important to the reform of engineering education. (Gassol 2007; Siegel et al. 2003) consider the cultural differences between industry and university are often portrayed as barriers to collaboration and a constraining factor on the transfer and diffusion of knowledge (Gassol 2007; Siegel et al. 2003). First, universities and industry do not pursue to one consistent goal, which is not conducive to the long-term cooperation. Second, it is difficult to assess performance of collaboration between industry and university.

All these studies point out the fact that modern students are limited in their knowledge and abilities required from industry, we have to find solutions to traditional model of engineering education. The reform of designing curriculum, teaching, workspace facilities, as well as teaching assessment should be paid more attention.

145.3 Method

CDIO (Conceive-Design-Implement-Operate) was created by MIT and several Sweden universities under the financial support from WALLENBURG Foundation in 2004. This educational pattern is set in the context of conceiving, designing, implementing, and operating products, processes, and systems. The CDIO syllabus and standards allow students to acquire the knowledge and ability initiatively which include personal scientific and technical knowledge, lifelong learning, communication and teamwork skills, as well as building products and systems under the environment of the society and enterprise (Crawley et al. 2007).

The CDIO syllabus and the CDIO standards will meet needs of students in a program. The syllabus is a rational, relevant, and consistent set of skills for an engineer. Specific learning outcomes for graduating students are set jointly by the stakeholders who include industry, university faculty, and society, which codified in the CDIO syllabus form the basis for an integrated curriculum design. The features of this integrated curriculum are active and experiential learning and are continuously improved through a robust, quality assessment process, which is reflected in twelve CDIO standards.

145.4 The CDIO-Based Engineering Education Model in China

The CDIO-based engineering education model is designed to highlight the common participation of industry and university in terms of curriculum design, workspace, teaching and learning assessment, according to the provisions of the ministry of education and demands of the industry. Figure 145.1 shows the structure of the CDIO-based engineering education model.

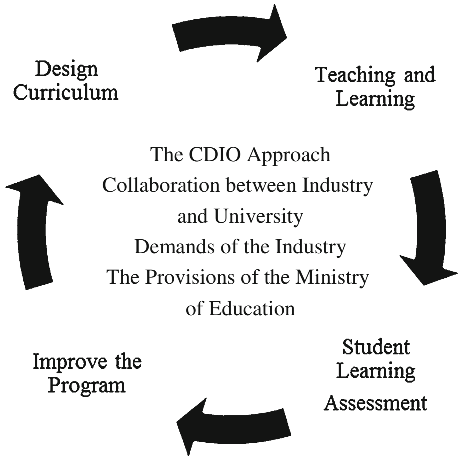

Fig. 145.1 Structure of the CDIO-based engineering education model

This model is conducive not only to train technical skills, interpersonal and professional skills which are required in engineering career for students, but also to contribute to realize the win–win result between industry and university.

145.4.1 Curriculum Design

Based on the CDIO approach, the best way to design curriculum should be consistent with learning outcomes which are validated by faculty, students, alumni and industrial representatives, according to the provisions of the ministry of education and demands of the industry.

Students are expected to achieve a comprehensive set of learning outcomes, so curriculum content not only include fundamentals of mathematics and the sciences, engineering science, and practice courses, but also have humanities and social sciences. General education and training of engineering practical ability are important to solve the practical problems. Clear about the position of major, condense theory courses and strengthen application skill courses. Having established the curriculum content and learning outcomes, the key aspects of curriculum design are structure, sequence, and mapping.

The curriculum structure must allow the disciplinary courses to be mutually supporting, and it must allow the personal and interpersonal skills to be interwoven in the engineering curriculum. Sequence suggests the appropriate progression of learning outcomes, and mapping is their assignment to specific courses and learning experiences. The result of the curriculum design will ensure that students learn full set of knowledge, skills, and attitudes that engineering students should possess as they leave the university.

145.4.2 Workspaces

Workspaces are indispensable components that support the CDIO initiative, and they are the basic condition for promoting CDIO personnel training model. With the support of industry, university can establish the infrastructure and facilities to support educational initiatives. Workspaces will be designed to actively engage students in creative and experiential learning and support the entire curriculum.

Students will have an opportunity to learn from each other, interact with groups, and use modern engineering tools, software, and laboratories to develop the knowledge, skills, and attitudes in the workspaces. Because of this important role in engineering education, practical experiences must be integrated into the curriculum. It has dual impact, first, it can teach students teamwork spirit and communication skills, at the same time reinforce knowledge which they have learned. Second, it can be motivating and attracting students to engineering practice.

145.4.3 Teaching

About teaching, teachers are very important for students. In the engineering education based on the CDIO approach, teacher team consists mainly of teachers and professional engineers with rich experience in industry. In order to meet the requirements for training "double qualified" teachers, young teachers need opportunities to improve their engineering experience by going into the industry to solve practical problems.

The CDIO-based teaching has the characteristics of openness, synthesis and practicality, it requires teacher to impetus student's learning initiative in teaching process, enlighten his positive thinking and lead his exploring new knowledge. Practical elements have been significantly added in the teaching to allow students to develop their ability to utilize and apply knowledge to practical problems. Through active and experiential learning methods, such as discussions with partners or small groups, practice by project-based learning, simulations, and case studies, engineering education based the CDIO approach integrate the learning of personal and interpersonal skills, and disciplinary knowledge is more attractive to students.

145.4.4 Student Learning Assessment

Student learning assessment measures the extent to which each student achieves specified learning outcomes. The process of assessing student learning has four key phases: the specification of learning outcomes, the alignment of assessment methods, the use of a variety of assessment methods to gather information of

Fig. 145.2 The process of assessing student learning

student learning, and the use of assessment results to improve teaching, which is displayed in Fig. 145.2. In the CDIO-based engineering education, industry and university should participate in learning assessments jointly. Learning assessment not only focuses on disciplinary content, but also an equal emphasis needs to be placed on assessing the personal and interpersonal skills.

Teachers can use many methods for collecting information that students are achieving intended learning outcomes, such as, written and oral questions, performance ratings, product reviews, and other assessment measures. These methods can collect information of student progress and achievement in a variety of teaching–learning environments. Appropriate learning assessment methods contribute to know what students have learned and improve teaching and learning in the process of designing disciplinary curriculum.

145.5 Conclusion

It is obvious that this CDIO-based engineering education model will be implemented effectively. Different resources from industry and university can be integrated for an engineering program in order to meet new challenges and rapid changes in the engineering education.

Furthermore, it is more important to conduct such a reform for engineering education in China, because the CDIO-based engineering education model is set in the context of conceiving, designing, implementing, and operating products, processes, and systems can make engineering students master knowledge and skills to survive in modern engineering environment.

In addition, there are two other advantages that are discussed in following:

The first advantage of this model is that the CDIO initiative supports internationalization and mobility by providing a well-developed international model, because it is developed in collaboration by leading universities around the world. Participating universities will develop materials and approaches to share with others, so all university engineering programmes can adapt to their specific needs. With internationalization of engineering education, universities should strengthen international exchange and cooperation with famous universities, research institutions and enterprises in the world through establishing jointly Sino-foreign educational institutions, setting exchange programs, recruiting overseas students to create international campus atmosphere and promoting international accreditation of engineering education.

The second advantage of the model is a close connection between international accreditation and the CDIO syllabus. Because part of the syllabus in CDIO directly corresponds to the requirements of ABET EC2000 which is a famous accreditation criteria in the world attracted many international programs to apply for accreditation. From the above, it is expected that the CDIO-based engineering education model can boost the qualities of the engineering students and improve the international competitiveness of Chinese engineering education.

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Chapter 146
An Empirical Research of Influencing Factors About Entering Adaptation of University Graduates

Qian-bing Li and Su-ning Huang

Abstract It has become a research focus about how to enhance entering adaptation ability of university graduates and how to help them change from "people inside school" to "people inside organization". However, the previous researches have emphasized especially on practice education, and ignored some influencing factors of the university graduates themselves and of the employing organizations. So, this paper does an empirical study of influencing factors of the entering adaptation of the university graduates themselves and the employing organizations through a survey on some graduates of a local university. The result shows that the gender, self-adjusting and vocational recognition of university graduates have negative correlation with their entering adaptation ability. The organization related factors such as position promotion and employee training have positive correlation with entering adaptation ability, but colleagues' guidance has negative correlation with entering adaptation ability.

Keywords University graduates · Entering adaptation · Influencing factors

146.1 Introduction

In recent years, the question of the working ability and the entering adaptation ability of university graduates has gradually aroused the concern of the society. According to the monthly follow-up survey conducted by Michael, named "the

Q. Li (✉) · S. Huang
School of Economics and Management, Huaiyin Institute of Technology,
Huai'an 223001, People's Republic of China
e-mail: liqianbing1996@163.com

S. Huang
e-mail: huangsuning@sina.com

E. Qi et al. (eds.), *The 19th International Conference on Industrial Engineering and Engineering Management*, DOI: 10.1007/978-3-642-38433-2_146,

fresh employee", 97 percent of 2009 university graduates suffered occupational problems, of which a large extent was caused by their unsuitableness when started their career. During their early career, the graduates will usually experience an adaptation process marked by excited—lost—confused—relieved (Li and Wei 2006). When entering the areas of work, the graduates have to face things including the change of role and environment, the complexity of human relationships and the differences between expectations and the reality, which needs graduates to have the ability to adapt it psychologically and physiologically. But many graduates can not effectively self-adapted, and fail to get the concern and guidance from the colleagues, resulting in greater psychological gap and pressure, and hence a high resignation rate. This graduates' unsuitableness when starting career not only directly affect the quality of employment and personal growth, but also put the employers into the cycle of recruitment—loss—re-recruitment, which seriously affects the operational efficiency of the organizations. The adaptation of new employees is a common problem faced by the organizations. The researches on the new employees' adaptation are now mostly conducted in North America or the English-speaking countries. China's research in this area is still in its infancy, mainly conducted by colleges and universities, which focuses on how to improve students' practical ability through teaching. Due to the political, economic and cultural differences, if the conclusions reached by the Western countries were used in the context of Chinese culture without any tests, it may cause negative consequences. Therefore, based on the local situation, the study aims at this special group's employment adaptation has important theoretical and practical significance. This paper investigated part of the graduates of a local university, and studied the factors existing in the students themselves and the employing organizations that might impact the graduates' adaptation.

146.2 Literature Review and Research Hypothesis

As an important aspect of the adaptation to the society, the entering adaptation to employment means the harmony formed and maintained between vocational attitude, vocational ability, vocational relationship and the occupational labor and the environment, guiding and governing by positive and vocational values (Jin 2004). It is the progressive realization of the employees and organizations in the interactive process (Feldman 1981). Due to the differences of the ability of individual self-adaptation, the individually held values, psychological tendencies and experience, some of the individual characteristics become important factors affecting university graduates' entering adaptation. In addition, according to the theory of organizational socialization, organization environmental factors like the effective guidance of the organization, the concern of colleagues can effectively stimulate the potential of college students to be actively engaged to work and accelerate the pace of adaptation. As a result, we built one model based on factors of the students themselves and the organizational environment (Fig. 146.1).

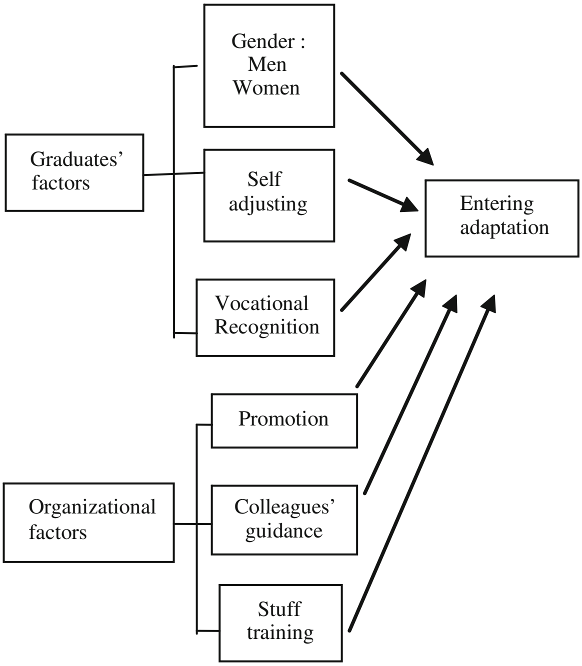

Fig. 146.1 The model of the impact of graduates' factors and organizational factors on the entering adaptation

146.2.1 Graduates' Factors and the Entering Adaptation

The graduates' factors include demographic characteristics and its inherent psychological characteristics. Here we mainly consider three variables of gender, self-adjusting and vocational recognition.

1. *Gender*: In the study of implicit stereotypes of college students, Zhi-fang He, Jian-ping Liu, and Li-feng Yang found that men tend to be more bold, self-reliance, creative, and more likely to succeed, while women think they are more patient, gentle, cautious (He et al. 2006). Compared with men, women are more able to bear the trials and tribulations in daily life and work, have a lower psychological satisfaction, and comply with discipline. Relative research also shows that men are more vulnerable to them, while women are more susceptible to the positive impact of the organization. Therefore, women are more able to follow the organization, and adjust themselves to adapt to the organization as soon as possible, while men are vulnerable to their own emotion, and may have emotional reverse psychology even resign the job. So we propose the hypothesis:

Hypothesis 1: the entering adaptation ability of the women graduates is higher than that of men graduates

2. *Self-adjusting*: Self-adjusting is the graduates' controlling and adjusting their behavior to improve performance or learning after entering into the organization,

Ashforth and Saks pointed out that the self-adjusting of new employees includes self-observation, self-goal setting, self-reward, self-punishment as well as a preview. They explored the relationship of self-adjusting of new employees and the anxiety, pressure and other variables. The results showed that, within one month as the graduates enter the organization, active employees in self-adjusting had less anxiety and stress, and after six months showed a more positive work (Ashforth and Saks 1996). After entering the organizations, graduates will face the pressure of the changing role and tasks. If they can't adjust their mind well and hence to adjust their behavior, they will fell unfamiliar with work environment for a quite long time and can't suit the job, thus even affects their own life (Filstad 2004). Accordingly, we propose the hypothesis:

Hypothesis 2: Graduates' self-adjusting ability is positively related to the entering adaptability.

3. *Vocational recognition*: Vocational recognition is the positive attitude and a strong sense of involvement of the individual, which reflected by the individual's aspirations to maintain the career and the liking for the career (Blau 1985). Vocational recognition is an important factor of job satisfaction, affecting the individual's resignation and job performance (Aryee and Tan 1992). Meyer, Allen, and Smith believed that the vocational recognition included three factors: emotional recognition, continuous recognition, and regulation recognition. Emotional recognition is the emotional attachment, recognition and psychological input of the individual to the career, thus forming the desire to maintain a career. If the vocational inputs can enhance the individual's job satisfaction, the emotional recognition will be formed. The continued recognition means the individual realized the cost he has to bear if he leaves his job, and will have to continue the job. The regulation recognition indicates the individual's loyalty sense for occupation caused by the regulation of loyalty, or the reciprocity principle of benefit form the occupation (Meyer et al. 1993). Therefore, the vocational recognition of graduates will directly affect the entering adaptation. Accordingly, we propose the hypothesis:

Hypothesis 3: the vocational recognition of university students and entering adaptability are positively related.

146.2.2 Graduates' Factors and the Entering Adaptation

According to the theory of organizational socialization, the organization can use a number of ways to guide college students in their concept changing, and to improve the employability of graduates, thus contributing to the better adaptation. Here we mainly study three factors: position promotion, colleagues' guidance, and staff-training.

1. *Position promotion*: Valsecchi stated that the position promotion usually is the position change and wage increase of the individual in the organization (Valsecchi 2000). The position promotion arrangement is an organization's source of power to keep the long-term incentive to employees and the team stability. Through position promotion, different types of people are configured to the appropriate positions, and the adaptation process is speed up. It will not only improve individual's productivity, but also can improve the employment relationship. Macleod Bentley, Malcomson, and James proved that, in a repeated game environment, position promotion is an effective incentive mechanism for individuals to choose and work hard (MacLeod et al. 1998). Under the incentive mechanism of the organization's position promotion, the graduates will coordinate with the organization as soon as possible, to achieve greater development. So we propose the hypothesis:

Hypothesis 4: position promotion of organization and graduates' entering adaptation ability are positively correlated.

2. *Guidance of colleagues*: Reciprocal Colleague tutoring is a cooperative work proposed by Fantuzzo, Dimeff, and Fox from the University of Pennsylvania. It is to let the colleagues' help, discuss tasks, and share experiences with each other so as to reduce work pressure, increase enthusiasm for work, and gradually form a sense of hard work (Fantuzzo et al. 1989). Most researchers believed that mentoring relationships between colleagues will benefit the guidance giver, receiver, and the organizations. When first entering the job, the graduates will be able to adapt faster with the guiding of predecessors or leaders in terms of career direction, experience and knowledge, than those without the help. Accordingly, we propose the hypothesis:

Hypothesis 5: Organizational colleague's guidance and graduates' entering adaptation ability are positively correlated.

3. *Staff-training*: Training is the organized, planned, and continuous learning behavior or process. It aims at directional improvement in staff knowledge, skills, attitudes and even behavior, ensuring that employees can complete task as the expected standard or level. Just after graduation, the training provided by the organization can enable the graduates quickly grasp the knowledge and skills needed for the work, and understand the corporate culture, which will help to improve their sense of belonging and sense of ownership of enterprises, so that their attitude will change from "passive" to "active", and the students can merge into the organization as soon as possible. Accordingly, we propose the hypothesis:

Hypothesis 6: The staff-training of organization and the graduates' entering adaptation ability are positively correlated.

146.3 Research Methods

146.3.1 Data Collection

We prepared a questionnaire based on the literature of home and abroad. The questionnaire includes two aspects: One is the measurement of the factors of the graduates' entering adaptation. The other aspect is the measurement of graduates' entering adaptation ability level. The survey aimed at graduates of a local university who had graduated for 1–3 years. Among the total 260 questionnaires distributed, we got 200 copies of feedback. After removing the invalid ones, we got 135 valid questionnaires, which accounted for 67.5 %.

After finishing the questionnaires, we need to consider whether the questions can identify the degree of response of different subjects, and whether it is necessary to delete the question, which means we need a project analysis. Project analysis is to calculate the "critical ratio" (CR) of each items. The method is to calculate each feedback's score of the pre-test sheet, and list them in descending order. Then we put those list among the first 27 % into a group, named as "High score group", those in the last 27 % in a group of "low score group". After that, we conducted the mean difference significance test on each question score of those two groups. If the CR is significant, it means that this item can identify the degree of response of different subjects. Otherwise, the question items should be deleted. After the item analysis, seven items have been finally deleted.

146.3.2 Variable Measurement

1. *Entering adaptation*:

Based on the study of CORBELL and KRISTEN ANNE about the new teachers' entering adaptation, we chose and tested three entering adaptation variables: interpersonal adaptation, cultural adaptation, and ability adaptation. Each of them has three or more measuring indicators. The three variables was measured by using Likert five-point scoring method, of which "1" means "completely disagree" and "5" means "completely agree". The score of each variable is calculated by the average of the indicators' scores. The score of the entering adaptation is the sum of the average of the three variables.

Through detecting KMO value and the x^2 value of the Bartlett's test of sphericity, it can be judged whether we can conduct factor analysis on entering adaptation variables. According to Kaiser (Kaiser 1974), if the KMO value is less than 0.5, it is not suitable for the factor analysis. The KMO value we got was 0.558, which was suitable for factor analysis. In addition, the x^2 value of the Bartlett's test of sphericity was 197.458 (DF 78), indicating the existing of the common factor in the correlation matrix of the parent groups, which also suited for factor analysis.

Using SPSS16.0, we conducted factor analysis on all the entering adaptation measuring items, and finally extracted three factors, which were interpersonal adaptation, cultural adaptation and ability adaptation. The Cronbach's Alpha coefficients of these three factors were 0.731, 0.790, and 0.796 respectively. According to Nunnally, an Alpha coefficient, greater than 0.7, has relatively high reliability of the measurements (Nunnally 1990). These three factors explained 82.91 % of the total variance; therefore, they had a high reliability in measuring the graduates' entering adaptation.

2. *Factors influencing the graduates' entering adaptation*:

Demographic characteristics. As the object of our study is just fresh university graduates, they have similar age, educational background and marital status. So the main factor of demographic characteristics, which may affect their entering adaptation, is gender. To measure the gender, we set a value of 1 and 0 respectively to the men and women.

Individual psychological factors. Based on the study of Saks and Ashforth and Blau (Ashforth and Saks 1996; Blau 1985), we have chosen two individual psychological variables: self-adjusting and vocational recognition. Likert five-point scoring method was used to measure these two variables: "1" and "5" means "completely disagree" and "completely agree". The score of each variable was got by calculating the average of the measuring indicators.

Organizational factors. Based on the previous organizational social studies, we choose position promotion, colleague guidance, and staff-training variables to analyze the organizational factors of entering adaptation. These three variables were measured by using Likert five-point scoring method, "1" and "5" means "completely disagree" and "completely agree". The score of each variable was got by calculating the average of the measuring indicators.

Through testing KMO value and the x^2 value of the Bartlett's test of sphericity, it can be judged whether we can conduct factor analysis on entering adaptation variables. The KMO value we got here was 0.648, which was suitable for factor analysis. In addition, the x^2 value of the Bartlett's test of sphericity was 1187.740 (DF 231), indicating the existing of the common factor in the correlation matrix of the parent groups, which also suited for factor analysis.

Using SPSS16.0, we conducted factor analysis on all the measuring indicators of the individual psychological factors and organizational factors influencing entering adaptation, and finally extract five factors, which were self-adjusting, vocational recognition, position promotion, colleagues' guidance, and staff-training. The Cronbach's Alpha coefficients of these five factors were 0.781, 0.820, 0.792, 0.816, and 0.754 respectively. An Alpha coefficient, greater than 0.7, has relatively high reliability of the measurements (Nunnally 1990). They explained 90.10 % of the total variance. Therefore, these five factors have a high reliability in measuring the graduates' entering adaptation.

146.3.3 Analysis Method

Using SPSS16.0, we conducted exploratory factor analysis on all the measuring indicators, and analyzed the reliability by calculating the Cronbach alpha coefficient of factors. We then made descriptive statistical analysis on all variables in the model, and calculate the correlation coefficient between the variables. Based on this, we conducted a further regression analysis to study the relationship between the factors of the students themselves and the organizational environment.

146.4 Results

146.4.1 Descriptive Statistics and Correlation Coefficient Analysis

Table 146.1 shows the result of descriptive statistics and correlation coefficient analysis on the relationship of graduates' entering adaptation and Influencing Factors. The standard deviations of self-adjusting and vocational recognition are not big, indicating that graduates' own characteristics were not significant. The standard deviations of position promotion, colleagues' guidance, and staff-training are not big, which means the systems within the organization are similar. The correlation matrix shows that the position promotion, staff-training and the graduates' entering adaptation are positively correlated. The gender, self-adjusting, vocational recognition, the guidance of colleagues within the organization are not highly relevant to the entering adaptation.

Table 146.1 Descriptive statistics and correlation coefficient analysis on the relationship of graduates' entering adaptation and influencing factors

Variable	Mean	Standard deviation	1	2	3	4	5	6	7
Gender	0.65	0.48	1						
Self-adjusting	3.18	0.38	0.151	1					
Vocational recognition	3.23	0.39	−0.025	0.001	1				
Position promotion	2.94	0.44	−0.011	−0.021	0.024	1			
Colleagues' guidance	3.48	0.71	0.096	−0.039	−0.056	0.236	1		
Staff-training	3.10	0.62	0.037	0.155	0.061	0.042	0.121	1	
Entering Adaptation	10.19	0.32	0.133	−0.053	−0.101	−0.178*	0.087	0.204*	1

Note *means "p" is correlation coefficient significant at 0.05 level
**means "p" is correlation coefficient significant at 0.01 level

Table 146.2 The result of multiple regression analysis of the relationship of graduates' entering adaptation and influencing factors

Variable	Entering adaptation: model 1	Entering adaptation: model 2
Gender	0.085	0.079
Self-adjusting	0.073	0.064
Vocational recognition	0.093	0.080
Position promotion		0.323*
Colleagues' guidance		0.011
Staff-training		0.413*
Adjusted-R^2	0.246	0.358
F	1.452	3.738*

Note *means "p" is correlation coefficient significant at 0.05 level
**means "p" is correlation coefficient significant at 0.01 level

146.4.2 Regression Analysis

Table 146.2 shows the result of multiple regression analysis of the relationship of graduates' entering adaptation and Influencing Factors. We divided the affecting factors of graduates' adaptation into two groups of the graduates' own characteristics and organizational factors, so two models were used in the regression analysis. From the regression results in Table 146.2 illustrates, that in model 1 the gender and entering adaptation are not highly correlated, so Hypothesis 1 was not supported. That also occurred in the correlation between Self-adjusting and entering adaptation, so Hypothesis 2 was not supported either. The low correlation between vocational recognition and entering adaptation also reflects that Hypothesis 3 was not supported. In Model 2, the position promotion within the organization and the entering adaptation were positively correlated ($P < 0.05$), which passed the test of significance, assuming that the Hypothesis 4 was supported. That is, the more opportunity of position promotion the graduates got within the organization, the stronger ability of the graduates' adaptation. The colleagues' guidance and entering adaptation were not highly correlated, so Hypothesis 5 was not supported. The staff-training within the organization and the entering adaptation are positively correlated ($P < 0.05$) and passed the test of significance, indicating that the Hypothesis 6 was supported. It means the more opportunity of training the graduates got within the organization, the stronger ability of the graduates' adaptation.

146.5 Discussion

In summary, the position promotion within the organization and the entering adaptation ability are positively correlated, which is consistent with the expected assumption. Position promotion within the organization will generally enhance the employee's position and increase their income, so the employees will feel having got a safe work and stable occupation. Meanwhile, the level of income can reflect a person's work capacity. High-income people are more likely to accept themselves and recognize themselves, which will help them treat their work and life with a peace, actively mind, and a virtuous circle will be formed. Therefore, position promotion can increase employees' self-confidence, and improve their psychological level of well-being, making them more adaptable and thus trust the organization. The organization should therefore establish a fair system of position promotion. As expected, staff-training within the organization and the entering adaptation ability are positively correlated. Training new recruits can make employees more aware of the organizational culture, corporate objectives, so that new employees can quickly adapt to the corporate culture. In addition, the training for staff can improve staff capacity, and make them more efficient in fulfilling organization's tasks. Therefore, organization should strengthen the training of new graduates to help them better meet the needs of the work, and achieve win–win situation of organization and graduates.

Contrary to the expectation, the guidance of colleagues of organizational factors and the entering adaptation are not highly relevant. Although the Guidance of colleagues form the coordination, communication and joint action between employees and hence complete the assigned tasks, studies show that the current colleagues' guidance in organization are offered by the predecessors with a certain years of working experience, in which problems are likely occur, such as the two parties are in unequal status; the guidelines lack of experience and ability; and the guidance tends to be formalized. Due to these problems, the guide giver may not be comprehensive, but be superficial, the guidance of colleagues within the organization and the entering adaptation are not absolutely positively correlated. This tells us that the organizations need assessment methods to ensure the guidance is really implemented.

In addition, not as expected, the correlation of graduates' own characteristic factors and entering adaptation ability is not high. Although men and women differ in character, and men may be more likely than women to adapt to the strong pressure of the environment, the women have more endurance and are not as impulsive as men, which reflect the women are more likely to adapt to the environment. Therefore it is difficult to determine who is more adaptable only from gender. Graduates' self-adjusting ability can be concluded as that they have different self-awareness and self-expectations, thus affecting the perception and analysis of their self-evaluation and external environment. Researches show that external expectations (such as, work allocation by leaders) are often not a clear indication of encourage and support to staffs' work, which is easier to make employees to percept work as the pressure instead of power (Boheki 2000). So the graduates' self-adjusting ability is not in absolute favor of their adaptation. Psychology studies have shown that, regardless of the occupational prestige level, the adverse experience associated with low socio-economic status will result in a low occupational performance, and low occupational performance will not only reduce the individual's vocational development motivation, but also affect the employees' work attitudes and work behavior (Rachel et al. 2005). Besides that the wages of new graduates in recent years are generally not high, the object of our research are basically working in small and medium-sized private enterprises, most of whom linked with a lower socio-economic conditions, resulting in a low correlation of their vocational recognition and the entering adaptation.

Finally, due to the samples of this study were collected at a local college graduates, the research findings can't avoid some limitations.

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Chapter 147
Analysis of Motivation for Young College Teachers' Development from the Perspective of Two-Factor Theory

Wen-qi Chen

Abstract Taking the analysis of the behavior dynamics of the intellectuals as the background, the two-factor theory achieved the motivation principal and strategies with remarkable practical value. For the young college teachers, who are, as a whole, a part of the intellectuals, the two-factor theory which emphasizes on the motivation factors and the hygiene factors has corresponding value of practical application. By the analyzing these factors, the management can find out the motivation that drives the professional development of young college teachers. These motivation may be embodied as attentions paid to the hygiene factors such as economic hygiene and health protection, and effective implementation of the motivation factors such as assessment regulation, career path formulation, allocation of reaching and teaching resources, development of professional characteristics.

Keywords Two-factor theory · Young college teachers · Hygiene factors · Motivation factors · Development motivation

147.1 Introduction

The professional development of the young college teachers plays a most important role for the future development of colleges. However, more and more young teachers, especially those in the less developed areas, lack of development motivation and thus remain unconcerned for their professional development. As a well-known motivation theory, the two-factor theory to some degree overlaps with the colleges from the research perspective. Therefore the college management

W. Chen (✉)
Department of Psychology, Beihua University, Jilin City, Jilin Province 132013, China
e-mail: rqr000719@126.com

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tried to analyze the professional development of young college teachers from the perspective of the two-factor theory. This will provide a lead for guiding the development of young college teachers.

147.2 The Professional Development of Young College Teachers Lack Motivation

The professional development of young college teachers is critical for the future development and quality of the colleges. However the young college teachers often suffer the conflict between the traditional and modern profession concepts and are often confused by the uncertainty of their positions. Even worse, many teachers present the "role marginalization" characteristics (Yu 2009), such that they have less or even no motivation for professional development, which are correspondingly related to the self-positioning of the young teachers.

147.2.1 Employee Tendency

Under the current circumstances, colleges usually set up their principals in alignment with the economy, profit and efficiency, and accordingly become enthusiastic of maximally interfering and utilizing all resources and even pursuing uniformly selecting teaching materials and courseware. The colleges may also introduce competition mechanism so as to adapt the career paths of the teachers in accordance with the demands of the colleges. Quick outcomes are more favorable, and salary and remuneration are paid in accordance with the achievement and professional title. In this scenario, teachers are more likely the employees of colleges, and they have no energy to develop their own advantaged ability. Lots of young teachers have no time and energy to make self-orientations; therefore the professional development is passive.

147.2.2 Pragmatic Tendency

The prime problem that young teachers are going to face when they first start their career is to earn their lives. They hope that their social reputation could be well maintained, and at the same time they also hope to improve their income. Some teachers choose to take part-time jobs and seek for other approaches to get rich. Unavoidably, their profession development will be deterred by the pragmatic tendency, and the development motivation is fading.

Such an abnormal condition of teacher's professional development shall be attributed to failure of the colleges and the society to effectively take care of the psychological situation and demand and the pressure overloaded on the shoulders of the teachers. Viewing from the perspective of the two-factor theory, the management of the colleges could be helped to find out the motivation factors for driving the professional development of the young teachers, thus adopting corresponding measures and eventually stimulating the young teachers to proactively, enthusiastically develop their professional career paths.

147.3 Analysis of the Psychological Motivation of Young College Teachers from the View of the Two-Factor Theory

There are many related theories in management psychology and each has its advantages and disadvantages and application object. However, the two-factor theory is particularly adapted for the professional development characteristics of young college teachers on the research background and research content. This theory has an active application value for the profession development motivation of young college teachers.

147.3.1 Main Concept of the Two-Factor Theory

The Two-factor theory (also known as motivation—hygiene theory and TWO-Factor Theory) was proposed by Frederick Herzberg, a US behavior scientist. According to the two-factor theory, Herzberg adopted "key affair method", in which he inquired many engineers and accountants (Herzberg et al. 1959), and finally he concluded that job characteristics related to what an individual does—that is, to the nature of the jobs he takes—apparently have the capacity to gratify such needs as achievement, competency, status, personal worth, and self-realization, thus making him happy and satisfied. However, the absence of such gratifying job characteristics does not appear to lead to unhappiness and dissatisfaction, the motivation factors are needed in order to motivate an employee toward a better performance (Herzberg 1966), and these factors result from internal generators in employees. Instead, dissatisfaction results from unfavorable assessments of such job-related factors as company policies, supervision, technical problems, salary, interpersonal relations on the job, and working conditions, the hygiene factors are needed to ensure an employee not becoming dissatisfied, and they do not lead to higher levels of motivation, but without them there is dissatisfaction (Herzberg 1964).

Thus, if management wishes to increase satisfaction on the job, it should be concerned with the nature of the work itself—the opportunities it presents for gaining status, assuming responsibility, and for achieving self-realization. If, on the other hand, management wishes to reduce dissatisfaction, then it must focus on the job environment—procedures, supervision, and working conditions (Herzberg 1968). On the surface, the motivation factors seem to be important, but the precondition that these motivation factors can function is that employees didn't show dissatisfactions in the hygiene factors.

147.3.2 The Two-Factor Analysis Addressing Young College Teachers

147.3.2.1 Assurance Factors of Young College Teachers

The hygiene factors are important precondition to realize the profession stability of young college teachers. Most of young college teachers in our country have high education background, and when they start their careers, they are going to be thirty. After starting working, they have to face a series of problems of marriage, bearing babies, supporting parents, heath caring and so on. They have to take the family responsibility. The young teachers are thus very likely made dissatisfied by the reality (Xu and Wang 2009). A recent research shows that 75.18 % of teachers are dissatisfied with their salary, while 55.04 % of teachers would consider job-hopping because of the dissatisfaction with the salary.

(a) *Economic embarrassment* (Xiaona 2006)

After years of hard studying, young teachers are always in an embarrassing economic circumstance, and even need help from their parents. Therefore, after starting the job, the primary subject is to seek for the return of capital investment, and get the desired salary and compensation. However in China, salary is primarily correlated with the profession title and the working years. The fixed amount part of the salary remains the largest part of the teachers' income, and therefore no matter how hard they try, they will face the problem of low income or poor compensation. A monthly salary of young college teachers in some less developed regions may be even less than 2000 RMB. Should the salary fail to meet their expectations and needs, "dissatisfaction" factor occurs, and this would easily lead to the problems such as that the professional loyalty reduces, even the full-time job and the part-time job are reversed, off-campus part-time job is considered, and professional development motivation virtually disappears.

(b) *Insufficient housing provision*

Housing is a basic living need for everybody. It has been well known that one should have been provided with habitation before he can develop his career. The rising price of the real property market makes young teachers unaffordable for the housing demand. The government has established the housing accumulation fund system to ease the pressure of buyers. However, it is far from a sufficient solution for young teachers and that probably because the calculation of housing fund is also linked with the profession title and seniority of teachers. Young teachers didn't work for a long time and they have lower titles, so that they have little housing fund to use. The housing problem remains a heavy burden on their shoulder, and the weight of which makes young teachers feel out of their breath.

(c) *Health distress*

A human resource survey shows that it is very popular for college teachers, especially young teachers, to work overloaded. They are burned out, and suffer from malignant disease in an earlier age. The tragedy cases of sudden death because of work pressure occur here and there. During the four days before the Spring Festival of 2005, two teachers from Tsinghua University who were no more than 45 passed away. The Chinese Academy of Science 32-year-old scholar Xiao Liang was hit by sudden death. In 2011, a 32-year-old teacher Yu Juan from Fudan University died from cancer. There are many examples. Long-term pressure and tire can cause the sub-health condition of many young teachers. They lack sleep, hurt in arms and back, have poor eye-sight, high blood pressure, heart, brain, and blood vessel diseases, gastric ulcer and so on which are caused by upset and anxious. This is because young teacher teaches more classes or even overtake classes or do part-time jobs in order to get higher payment, and sometimes they have to abandon their ideas and interests and work passively to enlarge the economy benefit.

147.3.2.2 Motivation Factors of Young Teachers

The hygiene factors are preventive, and function for maintaining the working condition, and thus are also called "maintenance factors". The motivation factors drive the young teachers for professional development. The motivation factors are corresponded to the teachers' passion and loyalty to the career, and are further corresponded to their expectation toward the job and the desire for personal achievement. The motivation factors can motivate the teachers to work actively. It is led by the college policy, academic atmosphere and achievement space (Xiaona 2010). Once they are dissatisfied, they will feel profession laches, with low working enthusiastic, or teach less seriously and even cheat in academic activities. In March, 2006, the Supervisor Committee of the National Natural Science Foundation of China issued that in the twenty negative falsification cases, there were fifteen college cases, which were done mostly by young teachers.

(a) *The deficiency of the assessment system and assessment system*

The management strategies that colleges have introduced in recent years have negative side-effect on the profession development of young teachers. Taking the evaluation quantization of teaching research as an example, when calculating the teaching workload, young teachers may feel being exploited considering that the number of classes takes the profession title as the coefficient. They also feel that their contribution is not reasonably paid back. Teachers' researching conditions are taken seriously. Profession title assessment, research fund, grade evaluation and the famous teacher nomination are based on the thesis and research project, while the number of teaching classes is only required to reach a certain limit. "Student cultivation" becomes unreachable target. The professional development of young teachers is dull and fuzzy or even lost.

(b) *The absence of profession guidance*

When young teachers start their careers, few colleges will designate experts to help them define their career paths. Young teachers don't know the college development blue print and have no idea about their future development space. They have to explore and try to find out their ways and methods to develop. This makes their profession development lack of target motivation.

(c) *The unequal distribution of the teaching and researching sources*

Colleges distribute the academic sources such as the application of the use of the experiment equipments, visit scholars, the attendance of the academic meetings on the basis of age, positions and professional titles. Young teachers are facing the embarrassment that elder teachers' needs shall be satisfied before theirs. Young teachers have to undertake the teaching responsibility while colleges ignore that they should also be provided with different development space. This unfair allocation of the teaching and researching resources is called "Stronger ones have all resources" by the researcher Xu Jilin from the Cultural and Ideology Institution of Huazhong Normal University. This is a kind of robbery utilization of young teachers. Even more, it will leave undiscovered trouble in the future professional development of young teachers.

(d) *The unstableness of professional characteristics*

The professional characteristics of teachers focuses more on the professional characteristics tendency of teachers, such as teaching, cultivating, modeling, devoting, sacrificing, enthusiastic, strong sense of responsibility and mission, persistency and so on. These profession personalities which are respectable are fading away from young teachers. It seems that young teachers have more modern characteristics; however teacher is a special career which has higher criteria for professional characteristics. The replacement of teachers' personality with teaching and researching level and ability is a kind of backward of the society. Young teachers feel confused between the economy desire and the profession ideals. The formulation of the professional characteristics is always interrupted by the outside environment factors. The guidance and regulation provided by the society and colleges would be critical for establishment of the professional characteristics.

147.4 Two-Factor Motivation Strategies of Young College Teachers in the Process of Development

147.4.1 The Hygiene Factors Ensures the Stability of Young Teachers' Profession Development

147.4.1.1 The Economy Security

Necessary conditions shall be provided to ensure young teachers' economic condition. Young teachers need more support in the manner of policy and material treatment at the beginning of the career. Their living condition should be cared and the problems they meet in life should be solved. As to the salary, young teachers should be paid equally with others without considering the working ages and profession title, but taking the quality of class, evaluation of students, principles of teaching, high level of teaching as the standards of high salary. On the basic living needs, such as housing, the government should provide more policies to ensure young teachers having a house to live in, such as on the down payment, mortgage rate, and common reserve funds subsidy, and the government is expected to implement more favorable policy to help young teachers to ease their burden and meet their housing need.

147.4.1.2 Health Care

Health is not only a personal matter of teachers, but also a matter of the colleges. Colleges should provide more health care measures, such as regular physical examination, sports competition, the advertising of positive and healthy living ideas, publicizes of various kinds of body building activity, necessary body building equipment, the opening of the necessary psychology consulting lessons or institutions to ease teachers' inner pressure and so on. This is the real "people oriented" which can make young teachers feel more humanistic care.

147.4.2 Motivation Factors Motivate the Intrinsic Motivation of Young Teachers' Professional Development

The motivation factors have more relations with the inner feeling of young teachers. It is the cognition of self-effectiveness, self-evaluation and the possible developing space during the profession development. It is also the judgment of career path design and major interest value. Therefore the changing of motivation is in the young teachers' hearts. However, from the point of view of management, the motivation approaches are extrinsic which are adaptable and changeable.

147.4.2.1 Improve the Assessment System

The assessment system of colleges is a vane, which can direct the teachers to make some efforts. Teachers' own profession development interest can not rival the college assessment system, which often leads to the profession advantages being pressed and overwhelmed while disadvantages being outstanding. The optimal solution is that the assessment system cope with the profession development needs of young teachers, such as, in the profession title evaluation in some colleges, "teaching title" is concerned, the teacher who devote his energy and profession advantages to the teaching and educating students and also get high evaluation and fame, can also be promoted. Therefore, the assessment system should consider the current condition and development needs of young teachers and provide possibilities for their success (Zhang 2007).

147.4.2.2 Provide Instructions of Professional Development Plan to Help Young Teachers Draw the Professional Development Future Blue Print

No target means any motivation. Professional development plan can help young teachers realize their life target location better and make them analyze their advantages and strong points rationally to form the potential motivation of their own profession development. College managers should provide the schooling aims and purposes and the relevant policies information of colleges, together with which they can form the proper young teachers' professional development plans.

147.4.2.3 Fairly Allocate the Teaching and Researching Resources

More difficulties in the process of young teachers' profession development are originated from the insufficiency of development resources. In fact, young teachers are the potential developing power for colleges, whose development needs the continuously resources supply from the colleges, and more opportunities to get further studying and training, and to attend academic meetings. This will help young teachers develop and study more on the professional aspect. If colleges can not provide proper opportunities to study and train, at least the academic information resources from the elder teachers should be conveyed and shared with young teachers.

147.4.2.4 Formulate Positive Professional Characteristics

The professional characteristic of teachers is the soul of teachers' profession development. The loss of teachers' professional characteristics is equivalent to the loss of the career as a teacher. In such a desiring society, young teachers should not be criticized because of chasing of material and treasure. However this should be assessed upon the bottom line of the profession and knowledge moral principles. Colleges should provide a positive cognition environment to individual teacher, and make it clear that college teachers' belief and duties through the pre-service and in-service educational theory and practice. Young college teachers should improve their introspection to formulate stable professional characteristics. Facing the outside world negative temptations and the expectations from students and the society, the professional characteristics will be stable on the state of mind and inflexible on the chasing of the career. As a matter of fact, with various kinds of imperfect systems, the professional characteristics are vital in the process of teachers' profession development.

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Chapter 148
The Exploration and Practice of Teaching Method "Descriptive Geometry and Engineering Drawing" for Art Students

Yu-ping Pei and Shao-feng Yan

Abstract "Descriptive geometry and engineering drawings" is the theoretical teaching and the engineering practice ability training combination of courses. It is to cultivate students' space imagination, creativity, drawing skills for the purpose. And the first class for environment art design, industrial design, landscape and other professional engineering design; It is inseparable from the students' subsequent specialty courses of study and work in the professional and technical jobs. Therefore, we strengthen the curriculum construction because it is particularly important to enhance the art students' knowledge structure and characteristic.

Keywords Art · Drawing · Engineering · Education

148.1 Foreword

"Descriptive geometry" and "Engineering Drawing" are important professional courses for design specialty. In addition to being professional basic course of technology in architecture, they are also basic courses for the are specialties, such as environmental art design, industrial design, landscape and other art. The courses are essential, for the art students to do related work and do research after graduation in this major and engineering. To technology research and exchange, engineering drawing is the only language.

Art students are good at art and literature but their science learning ability is weak.

They are good at in image expression and weak in the grasp of the theory. And because of their knowledge structure they have more difficulties in learning those courses. Therefore, how to help art students to master these courses becomes a hot issue.

Y. Pei (✉) · S. Yan
Liaoning University of Art and Design School of Architecture, Jinzhou, China
e-mail: LNJZpeiyuping@126.com

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"Descriptive geometry" and "Engineering Drawing" aim at training students' skills of drawing and reading the engineering drawings. They have close relationship with the engineering practice. Therefore teachers are required to objectively strengthen the theory teaching and practice by penetration and fusion method. The theory and practice are both important to ensure students can apply it to work to reach the ultimate goal of teaching (Jin 2002).

Exploring the engineering graphics teaching mode in accordance with the training objectives, and improving college students' ability to apply the theory into practice are the educational reform subjects we discuss and problems to solve.

Through the teaching research and teaching practice, and the students' notes discussion, we can find that problem, we will be able to solve the problem.

148.2 "Descriptive Geometry" and "Engineering Drawing" Teaching Situation and Existing Problems

"The descriptive geometry" and "engineering drawings" course teaching situation and the existing problems.

"Descriptive geometry" is a basic compulsory course for undergraduate students of science and Engineering for Bachelor's degree.

It is an important part of the engineering graphics, not only is independent, but also practical. Such a problem has existed for a long time as the students has acquired a lot of "Descriptive geometry" theory, but their drawing expression ability in subsequent courses might be poor. This problem must be resolved urgently (Wang et al. 2003).

Due to the knowledge structure of the art college students, they find it more difficult to study descriptive geometry.

Thinking of our teaching methods and objectives of cultivating talents, we should strengthen practical and innovative talents training. We deeply realized that the traditional teaching model has its advantages, but it is inadequate. The traditional "teaching" and "learning" target of "Descriptive geometry" is positioned in the pure theoretical discussion and learning. It can be said to be the research process from theory to theory. Teachers speak more and dominate teaching in class. However, they lay particular stress on theoretical knowledge and pay little attention to link theory with engineering practice. It is proved that traditional teaching often results in students' low ability in subsequent courses. They might get high scores but show low capacity (Hou 2003).

Therefore, we should better handle the relations between theory teaching and engineering practice. We should establish reasonable teaching objective and suitable curriculum. Through the long-term teaching practice and thinking, we deeply recognize that we should adjust the "Descriptive geometry" method of teaching. Improving the teaching effect is our major task of current research and educational reform. And this course teaching reform is to strengthen the training of engineering application ability.

This reform is an important task. We should conduct the teaching content reform to strengthen students' engineering application ability. Teaching methods and means must be adjusted and improved (Sun and Xiao 2000).

148.3 Explorating Teaching Methods Closely Connected with Training of Engineering Practice Ability

148.3.1 Strengthening the Importance of "Geometry" in the Curriculum

At present many teachers of art specialties attach importance to engineering drawing but ignore the learning of basic knowledge of "Descriptive geometry". Therefore, we must emphasize the importance of "descriptive geometry" (Liu et al. 2001).

"Engineering Drawing" is the "language" in Engineering and "Descriptive geometry" is the "grammar"; "Descriptive geometry" is one of the compulsory fundamental courses for students majoring in architecture, environment art and industrial design engineering. It is an important part of engineering graphics; only by learning "Descriptive geometry" theory knowledge can students lay a good foundation to draw and read engineering drawings. If not, they cannot draw engineering, let alone engineering design. Therefore, doing a good job in Descriptive Geometry Teaching is the first step to train practical engineering talents.

Thus, "Descriptive geometry" is the solid foundation of "Engineering Drawing". We must emphasize the cultivation of students' ability of innovation and at the same time emphasize the curriculum construction (Dingyi 2002).

148.3.2 Displaying Students' Talents and Promoting Teaching in Connection with Engineering Practice

The students majoring in environmental art design, industrial design and landscape features are mostly art students and they are poor in science and engineering courses. They show less interest in such courses. However, "Descriptive geometry" and "Engineering Drawing" are the courses in science and engineering and also professional required courses for students because they will draw engineering drawings in their future work. Thus, at the beginning of school education, we should strengthen the importance of the courses and inspire students to be interested in related courses. At the same time, according to the characteristics of students, we arrange the course content and progress of courses explain profound theories in simple language and help art students to learn these courses smoothly (Zhu et al. 2002).

148.3.3 An Overview of Engineering Examples to Stimulate Students-Interest in Learning

The teacher who can stimulate the students' learning interest in their subject is the-first-class teacher.

"Descriptive geometry" course is to train students' basic ability to express 3D. The drawing of engineering graphics is quite different from other courses, such as sketch, preliminary architecture, and architectural history. Therefore, the cultivation of interest in learning in the course of teaching is very important. After our teaching exploration, we found a feasible teaching method. Before a detailed study of the theory, the engineering examples of "Descriptive geometry" are demonstrated to students. Such a teaching method is popular among students. They gradually realize the practical importance of theories and understand the theories better. In order to stimulate their enthusiasm for learning and their interest in learning, we turn abstract teaching into vivid description. Most students take the initiative to acquire knowledge and received very good teaching results (Wang and Yu 2008).

148.3.4 "Geometry" in the Teaching of Theory Focuses on the Practice of the Curriculum Contents Design

In the process of teaching, we choose theory topics that are combined with engineering practice. Through the application of theory and classroom discussion, we receive good teaching effect (Li 2004).

For example: ask the distance from point to line theory, we choose related issues from engineering practice. Not only can we enhance students' understanding of theoretical knowledge but also strengthen the corresponding theoretical application ability. At the same time, the practical engineering problems are introduced into the classroom. We try our best to strengthen the students' ability to solve the engineering problems (Xu 1998).

Topic 1: "From point K to outdoor wire AB lap tenants into line, is connected to the AB where the incoming line is the shortest? And how many is actual length of the wire?
And the result is to fill in the brackets.

1. Then AB () can be introduced into the line at the point of the shortest.
2. Introducing lines long (). (Line name).

As shown in Fig. 148.1a, b.
Solutions:

1. Then AB (K) points to the shortest lines are introduced.
2. Introduction of long lines (Cb0).

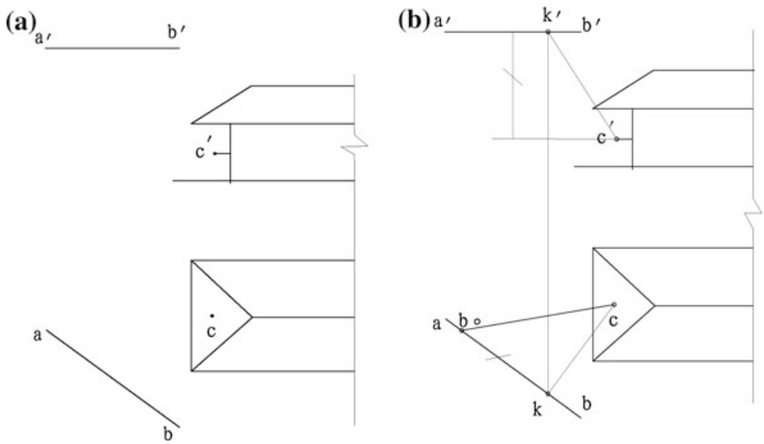

Fig. 148.1 **a** The original title. **b** Solutions

The students have learned to apply theories to practice and their practical abilities have improved substantially.

As shown in Fig. 148.2a, b.

In theory teaching, we do not neglect students' practical training (Chen et al. 2005).

148.3.5 Strengthening the Perspective Theory Learning and Improving the Students' Art Sketch Ability

"Perspective" theory is based on the "Descriptive geometry" (Xie 1998). It is the center of the projection. "Perspective" is the main pattern of engineering practice in a wide range of applications. "Perspective" theory is also the basis of for students to improve their sketch ability. We choose teaching topics in relation with engineering practice, such as slope roof house, steles and the teaching effect is very good (Huang 1995).

148.3.6 Strengthening the Construction of Curriculum

After students have learnt the "Descriptive geometry" and "Engineering drawing" courses, we began to strengthen the course design of "Engineering Drawing". We spent 2 weeks training drawing basic skills to strengthen the role of drawing ability. Through practice, students could consolidate and deepen their

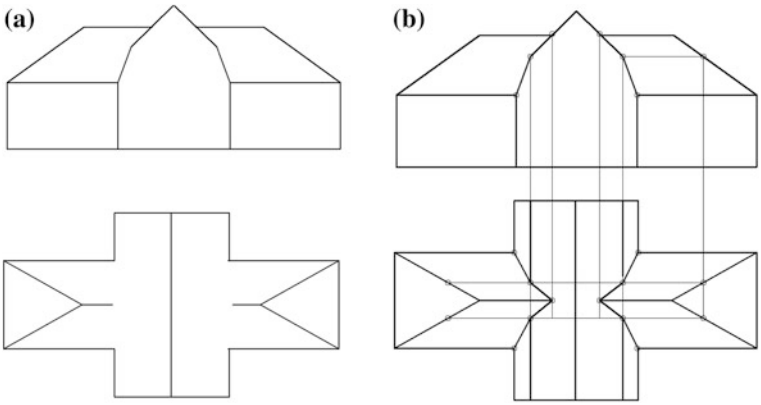

Fig. 148.2 **a** The original title. **b** Solutions

understanding of the course- related knowledge of "Engineering Drawing" and promote the practical application ability.

We organize the student to measure the decorated hall. After that, according to the measured drawings and related data, they painted a set of interior architecture decoration construction drawing. This initiative has led to a good teaching effect.

The reform of teaching of engineering drawing in the introduction of curriculum design experimental teaching has brought about very good teaching effect. We have paid more attention to course design and experimental measurement. Students have become more flexible in learning theories and their practical abilities have upgraded. They have made more progress in creativities and innovation (Yan and Wang 2005).

148.4 Ending

Descriptive geometry is a course using 2D graphics to accurately express the 3D graph theory. Such a course is of great importance and benefit for students to improve their engineering drawing abilities. This reform is feasible, necessary and possible. We will improve our teaching method in the future teaching work in accordance with the features of engineering graphics courses (Yan and Wang 2005). We will strengthen our course design and enhance our students' all round abilities with CAD software teaching, multi-media teaching and network teaching. Only in this way can we cultivate more creative and innovative talents for our country (Ye 1999).

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Chapter 149
Study on Innovation Teaching for Industrial Engineering

Xiao-qing Huang and Xing-shan Qian

Abstract This paper first discusses the relationship between innovation and industrial engineering. The nature of Industrial engineering is innovation—continuous innovation. So based on this, this paper puts forward the cultivation aim of IE should train the students' innovative ability. Then, this paper focuses on studying how to train the students' innovative ability and continuous innovative ability that major in IE. There are four methods to train innovative ability, and that is: strengthening practice link, introducing project-guiding cultivation mechanism, training creative thinking and carrying out innovative teaching methods experiments. For training continuous innovative ability, this paper puts forwards that the educators should have teaching thoughts of continuous innovation and explore the system of innovative quality education. Finally, this paper studies what the innovative team consists of and how to operate it in colleges or universities. The methods have made good results and have always been received praise by the students.

Keywords Innovation · Innovative ability · Industrial engineering · Training

149.1 Introduction

In the 21st century, advanced manufacturing technology (Guo-zhu 2005), advanced management technology and information technology are constantly emerging, and especially the development of world economy transforms from manufacturing economy towards innovation economy (Gang 2010). Modern industrial engineering should follow the trend of the times to train innovative

X. Huang (✉) · X. Qian
Department of Business, University of Shanghai for Science and Technology, Shanghai 200093, China
e-mail: yelleen@163.com

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talents for industrial engineering, to improve the students' innovation ability and to stimulate the students' creative thought. This is becoming a focus of concern in all kinds of enterprises, social organizations and universities. Especially, colleges and universities as producers of talents must try to explore teaching method to train innovative talents for IE, with high comprehensive quality and strong innovation ability.

149.2 Relationship of IE and Innovation

The nature of Industrial engineering is innovation—continuous innovation.

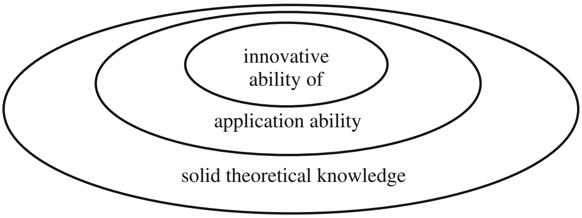
The core of IE is that "improvement never ends", which is to innovate upon the operation of the system continuously around the target. Industrial engineering is the creative solutions of various complicated contradictions, which can integrate production factors effectively and form an organic whole process. It can innovate upon the system management through technical means, and meanwhile promote technological innovation efficiency through the system management.

From the date of birth, IE has emphasized continuous improvement and innovation, which is the essence of IE and professional spirit. The philosophy of the talents for IE is there is "No best only better". So IE has been reforming, innovating and developing endlessly by finding problems, analyzing problems and seeking countermeasures.

Now information technology has become a fundamental tool of technical innovation, management innovation and business model innovation. But a lot of information technology, such as CIMS, MRP, ERP and SCM and etc., is closely related to IE or is developed based on IE. Enterprise informatization expands the vision and touch of managers, and makes managers gain real-time information of market or/and production site. Then managers can timely respond to it. In addition, through IT we get the unprecedented ability of resource planning and management. But in order to ensure the real-time and accuracy of data exchange, enterprise informatization must be established under the environment of standardized operations and standardized management. Those can be only provided by IE. Nowadays, people pay more and more attention to how enterprise informatization brings benefit. But only enterprise informatization involved in IE can make greater benefit. This is because IE provides system optimization theory and method to enhance and improve enterprise efficiency. Meanwhile, IT provides tools and methods for the implementation of IE.

In summary, IE plays an important and irreplaceable role in promoting enterprise innovative ability and increasing benefit. IE is also the essential key tool for sustainable development of enterprise innovative ability.

Fig. 149.1 Reorientation of cultivating objective for IE



149.3 Training Mode of Innovative Ability

149.3.1 Reorientation of Cultivating Objective for IE

Because IE engineers need to have strongly "improvement awareness" and "incremental innovative ability" (Fan-sen 2009), especially under the call of construction of an innovation-oriented nation, people attach more and more importance to "innovation". The training objective of IE engineers should be embodied in the training of innovative talents with creative thinking, and integrating innovation education into profession which is the inevitable extension of innovative education and injects intension into the professional innovative talents.

Therefore, the cultivation aim for IE major is to train the talents with innovative ability of modern IE and application ability of Classical IE, and with solid theoretical knowledge and basic technical skills for engineering and management. See Fig 149.1.

149.3.2 Innovative Ability Training

149.3.2.1 Strengthening Practice Link

Innovation is not without foundation, which is obtained through continuous practice. IE is a practical subject. Only applying basic method of IE to practice can make profit. According to many years' observation, at least 90 % of domestic enterprises are urgent to have localization talents for IE. It makes higher request for practical ability of IE major. It's imperative for IE to do research on strengthening practical innovation teaching.

On the hand, strengthen experimental teaching. University laboratory, as the important base of production, study and research, is the main place to cultivate students' scientific experiment ability and innovative ability, the main place to produce high level of scientific research and the main place to serve economic construction. University laboratory plays a significant role in promoting all-round education and cultivating innovative talents. Because IE starts relatively late in China, coupled with many factors of its subject characteristics, capital and technology, most construction of university laboratory is not very satisfactory.

IE laboratory construction is hard to keep pace with specialty construction, far behind the classroom teaching. It makes professional practice difficult to become a system. It also leads to students' worse practical ability, against the cultivation of innovative IE.

The construction of Innovative IE laboratory is to build a bridge between theory and practice (Hu-ji 2006), which can provide students with practical training platform and can train students' project practical ability, innovative ability and other comprehensive qualities. Thus, it can deepen the students' understanding of the theory of IE and improve the students' operational ability.

On the other hand, strengthen social practice. Colleges and universities should create the opportunity of social practice for the students. And they can also encourage students to participate in innovation and self-employment. But in fact, in many colleges and universities of China, it's hard to develop social practice of IE major effectively. Colleges and universities arrange short-term practice as far as possible, but the students are required to solve long-term practice, which results in that social practice becomes a mere formality. Schools should strengthen the construction of practice base, and should actively explore practice mode of combining visit practice with production practice. Social practice should be involved in the actual operation of manufacturer. Through visiting, listening to reports or interviewing, make the students know production process, processing methods and management method, and then further let the students analyze and discuss them.

In addition, schools can provide simulation practice on the basis of computer application technology, which can replace part of the tradition practice inside and outside school. Some colleges and universities have made some attempt on it.

149.3.2.2 Introducing Project-Guiding Cultivation Mechanism

Colleges and universities should provide a good research platform to students, adhere to the coordinated development of knowledge, ability and quality, and pay attention to combining theory with practice and combining teaching with research. High-grade undergraduates of IE should take active part in the related scientific research of professional teachers, and try their best to make possible improvement and innovation based on the research of previous students. It's very important to strengthen process specifications, knowledge management, project management and version management. High-grade undergraduates of IE can also apply for innovative research project themselves and participate in expert lecture and academic report regularly.

In general, the mechanism is to cultivate the students' creative thinking and ability to analyze and solve problems, because it puts all the knowledge they have learned together.

149.3.2.3 Teaching Creation and Training Creative Thinking

Colleges and universities can pay attention to teaching Creation and open an "experimental class of training innovative ability". It offers intensive training of divergent thinking, one of creative thinking. The goal of all is to make the students learn and use creative techniques systematically.

About creative thinking training, colleges and universities should emphasize making it more interesting (Li-ying et al. 2004), train trainee operational ability and avoid it boring. It means that the trainee uses all kinds of creative techniques to achieve certain or potential target based on a certain thing. There are some effective training methods, such as games, experiments, discussions, gizmos, small creations and etc.

149.3.2.4 Carrying Out Innovative Teaching Methods Experiments

Innovative teaching methods experiments will make students become masters in schoolroom and train their innovative abilities through research assignments and SRT. Experiments also develop the students' group learning behavior and establish the unique professional culture of IE. Teachers can design intercrossing student teams according to teaching contents, and manage student's learning process through electronic information platform. In the experimental teaching method, one-third of class time for every course will focus on students' discussion.

Before class, the teachers provide the syllabus and information about how to deal with in-class problems, such as how to guide students to ask questions and how to assign homework and etc. Then through the classroom record, the teachers analyze students' reaction. Class discussion does greatly enhance the students' satisfaction to the teaching, strengthen their learning interest and doesn't reduce their understanding of knowledge.

149.3.3 Continuous Innovative Ability Training

The nature of Industrial engineering is innovation—continuous innovation. Colleges and universities must cultivate IE talents with continuous innovative ability.

First, change the teaching thoughts. Educators should have teaching thoughts of continuous innovation. To meet the needs of the nation and enterprises, teachers should constantly modify, update and add to the teaching contents, using the latest method. Many teaching material is the old version, far behind the times. Teaching thoughts of continuous innovation requires teachers to inject new content into teaching continuously. Of course it also requires teachers to grasp the latest knowledge and the latest information continuously. To evaluate a student can appropriately add the measure of encouraging the students to innovate, such as science and technology paper award, invention award, enterprise planning game, stock market simulation game and etc. In addition, encourage students to choose optional courses from other department, other academy and other school.

Second, explore the system of innovative quality education gradually. During 4 years at college, innovative activities have been going on constantly, a line from in-class courses, experiments, after-class innovation to graduation design. Pay attention to teach students in accordance with their aptitude, and promote their personality education and innovation education. Continuous innovative quality education should be penetrated to the whole education process and to every link of teaching. We need to explore the construction mode of teaching team with high teaching quality and reasonable structure. An effective mechanism of team cooperation should be established, in order to promote the reforms of teaching content and methods, promote the teaching research and teaching experience exchange, and build innovative teacher teams with solid professional knowledge, reasonable knowledge structure, and strong scientific research ability.

149.3.4 Application Effect

The above mentioned methods have been adopted by some colleges and universities in China. For example, about strengthening practice link, many colleges and universities have built human factors engineering laboratory, logistics engineering laboratory and fundamental industrial engineering laboratory. Based on these laboratories, the universities pay attention to innovatively design some experiments. About teaching Creation, Anhui University of technology has adopted this way. As for carrying out innovative teaching methods experiments, it has been used by Tsinghua University.

Using these methods has made good results and has always been received praise by the students. They do deepen the students' understanding of the theory of IE and improve the students' operational skills. And more importantly they do improve the students' innovative ability.

149.4 Operation of Innovative Activities for IE Major

149.4.1 Members of Innovative Team

In innovative team for IE, the backbone is young and middle-aged professional teachers, while the main force of it is undergraduate students (Deng-feng and Mei 2005). Based on scientific research and academic exchange, innovative team realizes the interactive growth of the individual and organization and plays a whole role by cooperation. According to the knowledge and skills, innovative team can be divided into three and form a pyramid. See Fig 149.2.

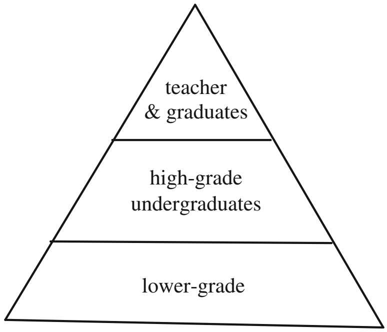


Fig. 149.2 A pyramid of innovative team

The first level consists of young and middle-aged teachers and graduate students, responsible for the overall design and team leadership. The second level, which is composed of high-grade undergraduates, carries out research according to project progress and provides project introduction or project technical support to lower-grade undergraduates. The third level is a group of lower-grade undergraduates, who under the lead of high-grade undergraduates, strengthen knowledge and skills with direction and purpose and gradually enter the second level.

In vertical direction, teachers, graduate students and undergraduate students form a pyramid of team cooperation mode. Graduate and undergraduate students make innovations by division of labor and cooperation, around of the project. There is no limit to ages and degrees, and students in different grades or different degrees work together to achieve common development and common innovation.

In horizontal direction, innovative team members for IE come from different universities, different majors or different degrees. The team not only conforms to the needs of the development of cross subjects, but also matches the development characteristics of knowledge production with multidisciplinary and interdisciplinary. Meanwhile, the team cultivates the students' team spirit and cultivates the students' ability of communication and collaboration, under the multicultural environment.

149.4.2 Operation of Innovative Activities

The subject of IE should hold all kinds of competitions and innovative experiment projects, in order to make the students in a state of innovating and exploring.

Now, Science and Technology Contest for undergraduate and National Undergraduates Innovating Experimentation Project are important ways to promote the students to engage in science and technology innovation. Meanwhile, they are also important means to train the students' creative ability of science and technology. But those are not enough.

The students' science and technology innovative activities should become both the foundation and the core of the student's cultivation. The innovative activities should be designed to fundamentally inspire the students' insight, imagination, thinking, judgment, and flexibility, and should be designed to encourage the students to innovate constantly (Pin 2011). It can make students transform from "letting me create" to that "I want to create". The operation of innovation activities for IE should also pay attention to the following questions.

First, colleges and universities should attach importance to the innovative activities for IE (Tao et al. 2009), and organize high-level innovative activities. They shall establish the students' innovative activities platform and provide the necessary resources to advertise activities, declare achievements, and evaluate and announce results. They should carry out the construction of teacher team, enhance their service consciousness for the students and improve the level of organization for science and technology innovative activities.

Second, colleges and universities should build the academic research environment, which is good for innovation and full of life. They should strengthen infrastructure construction and establish sites and facilities suitable for the students' learning and research. It's good for academic research and communication to create loose, harmonious, democracy and open atmosphere.

Third, colleges and universities should set up the special teachers to strengthen innovation guiding (Wei et al. 2011). Of course, colleges should formulate the responsibilities of teachers and formulate how to determine the amount of work. The assessment between the teachers must be conducted, in order to improve the teachers to positively participate in guide students, hold academic lectures and publicize science and technology.

Fourth, colleges and universities should let innovative activities become the students' own (Xiao-fang et al. 2005). Colleges should organize experience exchange activities, which invite the students with outstanding performances in the innovative activities and let them provide practicable advice to the other students interested in taking part in science and technology innovative activities.

149.4.3 Application Effect

University of Shanghai for Science and Technology pays attention to the operation of innovative activities. The leaders of the university and Institute support the innovative activities, and even some of the leaders guide the innovative project of the students. Now more and more professional teachers participate in guiding the innovative activities of the students. A example of one innovative team, the number of the teachers guiding the students has increase to 6 from, who include one professor, two associate professors and three lecturers with two having Doctor degree. And the number of the students attending this innovative activity has increased to more than 50 people. Now this innovative team has more than 10 innovative activities under study. Most of innovative activities are combined with graduation thesis of undergraduate or postgraduate, and some are combined with college students' innovative projects, and the others are reserve project determined by the teachers themselves.

In the future, we will strengthen the cooperation with other professional teachers and expand the innovation space of IE.

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Chapter 150
On the Differentiated Performance Appraisal for Young Teachers in Institutions of Higher Education

Jing-kun Zhou, Hao Qi and Bing-cai Yu

Abstract This paper firstly divides young teachers in institutions of higher education into four types: novice teacher, adaptive teacher, proficient teacher and problem teacher, based on years of teaching, mental and professional maturity; and then in accordance with different characteristics of the performance appraisal for these four types, it constructs the subjects, cycles, models, etc. of differentiated performance appraisal for young teachers in institutions of higher education, hoping for providing a reference for the perfection of differentiated young teacher performance appraisal in institutions of higher education in China.

Keywords Institutions of higher education · Young teachers · Differentiation · Performance appraisal

150.1 Introduction

With the ever-increasing number of higher education students, young teachers gradually become the main force of teaching and scientific research in their colleges and universities, thus it is a pressing problem for institutions of higher education in China to conduct effective appraisal of young teachers' performance level and promote their professional development. In recent years, many experts and scholars have realized the importance of young teachers' performance appraisal and have performed some exploratory researches into this field. For example, Liu (2008) holds that college and university young teachers have to go

J. Zhou (✉)
Hunang University of Science and Engineering, Yongzhou, China
e-mail: zhoujingkun@163.com

J. Zhou · H. Qi · B. Yu
Jingdezhen Ceramic Institute, Jingdezhen, China

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through the stages of adaptive period, growing period and proficient period in their development. Lu (2010) divides the professional development of college and university teachers into five stages: induction period, adaptive period, capability improving period, career maturation and taking-off periods; Liu Danping et al. believe that young teacher performance appraisal shall be integrated with their career development plan, and their personal development objective shall be combined with the development objectives of their college or university. Song (2008) proposes that periodical characteristics of young teachers shall be reflected in their performance appraisal, and attention shall be paid to their individual differences; Wang (2007) puts that classroom observation, open lecture and other methods can be employed in the performance appraisal of young teachers in institutions of higher education. However, currently, these researches mostly concentrate on a few aspects, and few have engaged in a systematic study on the differentiated performance appraisal of young teachers in institutions of higher education.

150.2 Architecture of Young Teacher Differentiated Performance Appraisal System in Institutions of Higher Education

Differentiated performance appraisal system is a method to ensure the constant professional development of young teachers in institutions of higher education, which conducts targeted appraisal through constructing the subject, indicator, cycle, method and procedure, etc. of appraisal, in light of young teachers' performance characteristics at different development stages. This system consists of appraisal organization and responsibility system, appraisal indicator development system, appraisal process system and appraisal basis guarantee system, which together develop the dynamic cyclical relationship shown in Fig. 150.1. Herein, the appraisal indicator development system covers the division of appraisal targets, the differentiation of appraisal subjects, models, cycles and indicators, etc.; while the appraisal process system includes four important links—development of performance plan, performance implementation, performance assessment and application of performance appraisal result.

150.3 Division of Young Teacher Performance Appraisal Targets

Currently, indicators in a specific dimension are widely adopted in China for dividing the types of performance appraisal for young teachers in institutions of higher education, which is simple and directly-perceived but fails to effectively

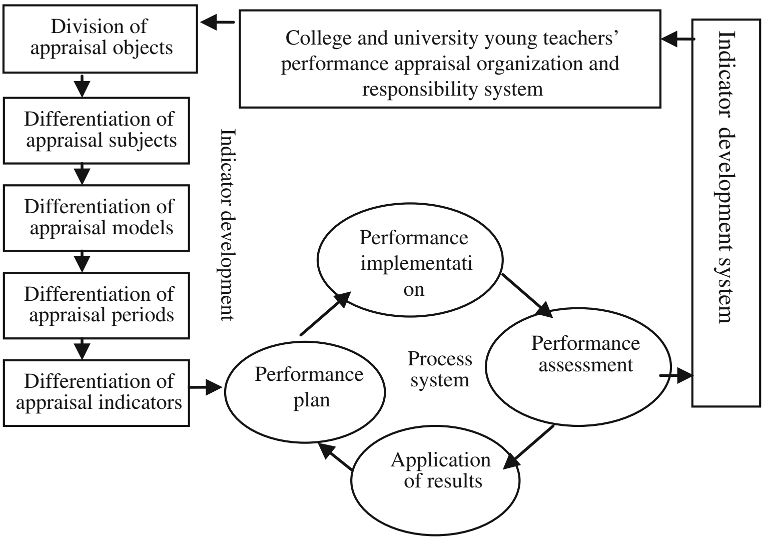

Fig. 150.1 Model of performance appraisal system for young teachers in institutions of higher education

reveal the multi-factor law of teachers' professional development, thus rarely obtains desirable results. Consequently, this paper adopts a method to divide indicators in a comprehensive dimension. It divides young teachers in institutions of higher education into four types of performance appraisal: novice teacher, adaptive teacher, proficient teacher and problem teacher, based on indicators from three dimensions—years of teaching, mental and professional maturity. Novice teachers refer to those young teachers, who have less than 3 years of teaching, and are far from maturity in their mentality and professionalism; adaptive teachers are young teachers who have 3–10 years of teaching, and their mentality and professionalism has reached a certain degree of maturity; proficient teachers are those who have taught for more than 10 years, with mature mentality and professionalism; problem teachers refer to young teachers who have taught for over 3 years, but still have serious problems in both their mentality and professionalism.

150.4 Differentiation of Young Teacher Performance Appraisal Subjects

Appraisal subjects are those who participate in the performance appraisal for young teachers in institutions of higher education. And there must be different appraisal subjects for different appraisal types. See Table 150.1 for details. Owing to short teaching period and the lack of experience in higher education, novice young teachers are not mature in their mentality and professionalism, so their

Table 150.1 Differentiation of young teachers performance appraisal subjects

Type	Appraisal subject	Notes
Novice	Direct leader, teaching fellows, supervisor and students	First priority is appraisal from supervisor and teaching fellows
Adaptive	Direct leader, teaching fellows, students and supervisor	First priority is students' appraisal, with supervisor's second
Proficient	Direct leader, themselves, teaching fellows, and students	First priority is appraisal from themselves and students
Problem	Direct leader, teaching fellows, supervisor and students	First priority is appraisal from supervisor

appraisal subjects shall include direct leaders, teaching fellows, supervisor and students, but their appraisal shall be dominated by appraisal from supervisor and teaching fellows and supplemented by that from direct leaders and students; adaptive young teachers have some teaching experience, but still lack in the ability to handle practical problems with professional knowledge, thus their appraisal subjects shall be direct leaders, teaching fellows, students and supervisor, but the first priority shall be given to students' appraisal, with supervisor's appraisal second; proficient young teachers have relatively long teaching career and mature mentality and professionalism, so their appraisal subjects are direct leaders, themselves, teaching fellows and students, but for them, the highest priority is students' appraisal, while supervisor's appraisal is unnecessary; problem young teachers, who may possess some experience of higher education, but have serious problems in their ability and level of teaching and scientific research, shall be given timely help and guidance by supervisor and others, and their appraisal subjects are direct leaders, teaching fellows, supervisor and students, amongst which supervisor will provide the most important appraisal.

150.5 Differentiation of Young Teacher Performance Appraisal Cycles

Appraisal circle is the time interval between performance appraisals, which will vary with the appraisal type. And the appraisal can be conducted in both formal and informal ways. For novice young teachers, informal appraisal is between two formal appraisals and with no limit on the frequency, usually twice to four times a quarter, while formal appraisal is conducted once a quarter, students and teaching fellows can give their appraisal on the basis of an academic term, and direct leaders on the basis of an academic year; for adaptive teachers, formal appraisal once every 2 years and informal appraisal once a year is preferred; for proficient teachers, formal appraisal can be conducted once every 3–5 years, with the time interval decided according to the result of last appraisal; for problem teachers, informal appraisal shall be conducted between two formal ones, better once a

Table 150.2 Differentiation of young teachers performance appraisal models

Type	Appraisal model
Novice	Formal classroom observation, appraisal by teaching fellows, teaching journal, teaching portfolio, professional dialogue, etc.
Adaptive	Teaching reflection, teaching portfolio, teaching journal, students' appraisal, etc.
Proficient	Appraisal by professional team, appraisal with goal orientation, self-assessment, etc.
Problem	Systematic classroom observation, test, appraisal by fellows, the elimination system to the last teacher, teaching journal, teaching quality appraisal by students, etc.

month, and formal appraisal once a quarter. Students and teaching fellows can give their appraisal on the basis of an academic term; while direct leaders on the basis of an academic year.

150.6 Differentiation of Young Teacher Performance Appraisal Models

Appraisal model refers to the way to conduct performance appraisal to young teachers in institutions of higher education. And different appraisal types will have different appraisal models. See Table 150.2 for details. Owing to short teaching career and a lack of teaching experience and ability, novice young teachers may confront with many problems in their work, and need the timely guidance and help from teaching fellows and others, hence appraisal methods, such as formal classroom observation, appraisal by teaching fellows, teaching journal, teaching portfolio and professional dialogue, etc., are appropriate in the appraisal model for them; adaptive young teachers have possessed some teaching experience and skills, but their ability to adapt to new environment is limited, thus teaching reflection, teaching portfolio, teaching journal, students' appraisal, etc. can be adopted in the appraisal model for them; proficient young teachers are both good in teaching experience and scientific research, so the appraisal model for them can adopt appraisal by professional team, appraisal with goal orientation, self-assessment, etc.; problem young teachers may confront with many problems in their work due to low teaching skill and level, and need the timely guidance and help from supervisor and others, consequently, systematic methods, such as classroom observation, test, appraisal by fellows, the elimination system to the last teacher, teaching journal, teaching quality appraisal by students, etc., are appropriate in the appraisal model for them.

150.7 Conclusion

This paper has designed the differentiated performance appraisal system for young teachers in institutions of higher education based on their characteristics, hoping for providing a reference for the perfection of differentiated performance appraisal for young teachers in institutions of higher education in China. However, what needs to be pointed out is that, since the research on this topic is still in its early stage, its scientificity requires a further perfection in the future researches and practices.

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Chapter 151
Research on Talents Training Mode of Service Outsourcing in University

Rui-ying He, Yue Liu and Yu-jie Hua

Abstract Lack of talents is the major reason that restricts the development of service outsourcing industry in China. Universities form important base of training talents on service outsourcing; therefore it makes good sense for research on talents training mode in Chinese universities. In this paper, the authors analyze the supply and demand of talents in service outsourcing, then discuss the reform on talents training mode including course system,teacher education,practice teaching, etc. Finally, the authors propose measures relating to talents training.

Keywords University · Service outsourcing · Training mode

151.1 Introduction

Since the 21st Century, service outsourcing has been developing quickly around the globe with a rate of 30–40 % (Wu and Fu 2009). The developers of the service outsourcing have outsourced its non-core business to the professional service providers in a long term, while they diverted their attention to their core-business and the nurturing of their core competence. Therefore, service outsourcing has become an important mode for multinational corporations to improve their competitiveness through the resources outside their company. Service outsourcing has characteristics of high-tech, high value-added, environmental friendly and employment promoting, and the Chinese government has made it an important way to speed up modern services development, optimize economic structure and promote college students' employment. After the project of "a thousand, a hundred and ten" by Department of Commerce, Ministry of Education and

R. He (✉) · Y. Liu · Y. Hua
Tianjin Foreign Studies University, Tianjin 300204, China
e-mail: hrysjz@163.com

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Department of Commerce further clarified to "launch the nurturing of service outsourcing talents in relevant majors of tertiary institutions and educate high level service outsourcing talents in vocational institutions, undergraduate studies and graduate studies and try to have 1.2 million talents within 5 years" (Ministry of Education 2009).

The development of service outsourcing industry needs large amounts of service outsourcing talents. However, there exists a gap between the talents nurtured by universities and those needed by enterprises. On one hand, lots of college graduates cannot find a job; one the other hand, service outsourcing businesses cannot have the right employment. In order to fill the gap, universities need to change their concept of nurturing the talents and reform the pattern.

151.2 Supply and Demand Analysis of Service Outsourcing Talents

151.2.1 Demand of Service Outsourcing Talent

The demand of outsourcing talent is divided into three levels, that is, the superior, the middle and the lower level (Qu 2009; Yu et al. 2011; Shen et al. 2009). The superior refers to the comprehensive talents of the outsourcing enterprises, who are in charge of strategy making, market exploration, and gaining outsourcing orders which involve competing with foreign peers. The middle refers to project managers and professionals, who are responsible for organizing and implementing the orders and the management of the project. The lower level refers to the workers who carry out single technical and operative work. According to the survey of domestic service outsourcing talent demand and related analysis, the talent demand of service outsourcing (including ITO and BPO) concerning all levels represent the "Pyramid" structure, that is, the highest demand is the lower level, which accounts for 60 % of the whole demand, the middle accounts for 35 % and the superior only 5 %.

The technology that different levels of outsourcing talent required is different. Table 151.1 shows the technology requirement that different levels of outsourcing talents have. As the decision-makers, the superior not only knows technology and management, familiar with the general knowledge of the outsourcing industry and culture, custom and international practice of client countries, but also grasps the ability of market exploration as well as fluent English. The middle talents are required to basic knowledge of outsourcing, such as professional skills, English skills and management skills. Besides, they should have some experience of outsourcing project management and the ability to solve problems during organizing and coordinating the project. The lower level is required to have English skills and professional skills. Meanwhile they should know the rules of the outsourcing project and remain good team-workers. Based on the above-mentioned,

Table 151.1 The skill requirements of services outsourcing talents

Level	Responsibility	Required skills	Demand (%)	Typical posts
High-level talents	Outsourcing decision making and market exploration	Familiar with the development of the industry and the regularities and customs of outsourcing;	5	Senior manager; senior consultant; system engineer
Middle-level talents	Organizing, monitoring and controlling of outsourcing projects	Rich in outsourcing experiences, strong in analyzing and solving problems	35	Project manager; line manager; Senior engineer
Low-level talents	Operation of outsourcing	Having relevant technology and operation skills of outsourcing; good at team work	60	Programmer; business operator

the skills of service outsourcing talents are highly comprehensive and practical. The ability of cross-cultural communication, team work, professional skills, the knowledge of industry code and English are required of all levels.

151.2.2 The Supply of Service Outsourcing Talents

The supply channels of service outsourcing talent of our country include college education system, government training, enterprise training and talent introduction. The different channels have their unique characteristics, while complement each other (Xu 2010; Zhong et al. 2011).

1. College education. Higher education and vocational and technical education are main channels of domestic service outsourcing talents supply. Take software outsourcing as an example, nearly 80 % of our software talents come from universities and vocational and technical colleges. Putting much emphasis on basic theory education, universities are good at fostering talents with high comprehensive quality, solid theory basis, all-round knowledge and development potential. Therefore, higher education should focus on fostering of the superior outsourcing talents. However, universities pay much attention to theory education; the graduated talents have poor operating ability and adaptation ability, which cannot meet the practical need of outsourcing enterprises. Vocational and technical colleges are good at fostering talents with high operating ability. With single professional skills, their graduated students can handle simple and repeated outsourcing matters (e.g. Programming, testing and marketing). It is such a pity that current vocational and technical colleges try to foster the same kind of students as universities, which leads to the lack of graduated students with high operating ability.
2. Training institutions. Social training institutions can adjust talent training plan according to the demand of market, so they can train outsourcing talents with general and practical skills in large quantities in a short period of time. Social training usually targets at the training of new skills on the primary talent or the pre-service training on the new recruits. Such training operates in accordance with the market-oriented mechanism, and has many advantages. For instance, training period is short; training pattern is flexible and targeted, etc. Hence it is becoming another important training channel for service outsourcing talents except for degree education. The shortcomings of social training are that applying it in large scale is difficult due to high training costs and that the trainees' professional theoretical foundation is so weak that the potential of career advancement and development is limited.
3. The outsourcing of corporate training. The supply from outsourcing talent market is in shortage, as a result, it is difficult for enterprises to recruit suitable employees, and the majority of outsourcing enterprises solve this problem through internal staff training. Outsourcing enterprises develop training courses based on their

internal demand with sufficient flexibility in setting training time, training location and the form of training. Therefore, such training should be targeted in the repetitive job positions in which the skill requirement is low and the added value is low. The disadvantages of corporate training are the lack of standardized staff training and the high cost and high risk that enterprises have to bear.

4. The introduction of qualified personnel. Outsourcing enterprises attract overseas talent through extensive international exchanges and cooperation, which can not only compensate for the shortage of high-end outsourcing talents in our country, but also get the international advanced management concepts and technologies, and thus lays the foundation for the training of international outsourcing management personnel.

In summary, colleges and universities is becoming an important base for outsourcing senior talents because colleges and universities can cultivate professional technical personnel with a solid theoretical foundation and high integrated quality due to their sound teaching system and qualified teachers. Vocational and technical colleges should focus on the cultivation of low-end outsourcing talents because such schools are good at cultivating personnel with strong practical ability in operation.

Social training is an important supplement to the academic education, dedicating to the standardized and industrialized cultivation of general primary personnel. The internal customized training of outsourcing corporations may meet the lack of market supply and attracting overseas talent is an important way to compensate for the shortage in high-end outsourcing talent in China.

Various channels of outsourcing talent training should have a rational orientation and develop the pattern of training talents with skills in different fields. Table 151.2 compares the characteristics of a variety of personnel training channels.

151.2.3 Comparison of Supply and Demand in the Service of Outsourcing Talents

China has annual college graduates of more than 6 million since 2008, which has laid a huge human resource base for the development of outsourcing service industry. However, China’s outsourcing talent is in a serious shortage and the supply and demand ratio is 1:7. Mckinsey predicts that in the next 5 years China’s offshore outsourcing services will face a shortage of 340,000 qualified personnel, particularly high-level personnel (project managers, process managers, marketing personnel, IT specialists).

Service outsourcing talents have not only a shortage in total number but also structural imbalances. Take software outsourcing talents training as an example: the demand for talent in software industry is in the shape of a pyramid, while the current structure of software talents in China was “olive”. That means that software architect and system designer that are located in upper level of the software industrial structure is in a severe shortage, blue-collar software engineer who is at

Table 151.2 Various training channels for outsourcing talents

Channel	Advantages	Disadvantages
Academic education	Personnel have reasonable knowledge, solid theoretical foundation and huge potential for development	The cultivation of talent is not well oriented. Theoretical teaching and practical are not connected. Personnel trained are lack of adaptability
Social training	Personnel training are applicable and well-targeted. Appropriate skills can be obtained in a short term	Training cost is high. The theoretical foundation is weak. Personnel trained are lack of potential for sustainable development
Corporate Training	Customized training is well targeted, has high flexibility, and contributes to the improvement of both personal and business value	Training is not standardized. Cost is high. Training has high risk
Introduction form abroad	Convenient access to high-end outsourcing talent, the latest international technology, finance and management philosophy	The introduction of talents is costly and need the support from government policy

the base of software industry is very rare and system engineer in the middle of the pyramid is in a relative surplus (Shen et al. 2009). In addition, according to the statistics of China's software industry development report conducted by the China Software Industry Association, 68 % of software talents are from domestic universities and research institutions, 13 % from the returned overseas students, 10 % from vocational schools and private training institutions, 7 % from in-service staff receiving job training, and the remaining 2 % from the expatriates. But reasonable percentage of software talents training should be 25 % from domestic universities and research institutions, 20 % from vocational schools, 37 % from social training institutions, and 18 % from the returned overseas students.

It can be seen that in China more than three-fourths service outsourcing talents are from the graduates of national universities and research institutes. The rich teaching resources, strong teaching force of colleges and universities lay a solid basis for the outsourcing training of technical personnel. Therefore, academic education in institutions of higher learning will remain the main channel of China's talent training in outsourcing service for a long period of time in the future.

151.3 Revolution of the Mode of Service Outsourcing Talent Cultivation in Universities

Colleges and universities are the main source of service outsourcing talent cultivation. But more importance is attached to specialized theoretical training than to the cultivation of practical skills, operative skills or problem-solving skills, which subsequently leads to the imbalance of supply and demand and the insufficiency of such talents. This discrepancy requires universities to establish a definite objective and talent cultivating mode.

151.3.1 Renovate the Talent Cultivating Concept of Universities

Service outsourcing, as a sunrise industry, has naturally become the ideal job-seeking tunnel for college graduates, with its high-technology, high added value and high employment rate. By renovating the concept of talent cultivation, universities should investigate and study enterprises thoroughly to grasp the latest developments in technological revolutions and market demands, on the basis of which the objective and program of talent cultivation can be determined. Timely adjustment of the curriculum design in light of the demands on the working skills of outsourcing enterprises will be conducive to the perfect match between the output of university talents and the demand from enterprises.

151.3.2 Identify Objectives of University Talent Cultivation

Currently, service outsourcing enterprises have demands of advanced, secondary and primary personnel, each with different responsibility, skills and training tunnel. Take software outsourcing industry, the fastest developing one of all, as an example. Through skills training in technical schools or brief and intensive training in similar institutions, the trainees will be able to reach the demands on skills and knowledge necessary for primary personnel. Secondary personnel, usually the core force outsourcing, are mostly cultivated in colleges and universities, and at the same time, should accumulate related experiences in practices. Advanced personnel, who cannot be found domestically, can be introduced from abroad or through international exchanges. Table 151.3 demonstrates the various cultivating objectives through various cultivating tunnels.

Experiences from the outsourcing enterprises indicate that secondary and advanced personnel, the core force, are usually the backbones of management and skills and supposedly command multiple knowledge and skills (Fig. 151.1 shows the basic skill modules of compound outsourcing talents). As the important base of service outsourcing talent cultivation, colleges and universities should focus on the training of students' ability in communicating with foreign languages and expertise knowledge, skills and qualities on outsourcing. Pitifully, there exists the acute shortage of compound talents that are skillful, experienced with managing, and proficient with foreign languages around the country. This shortage has handicapped the advancement to a high-level business process outsourcing and

Table 151.3 Cultivating objectives through various cultivating tunnels of service outsourcing talents

Tunnels	Objectives	Typical position
High education	Positions in need of higher professional knowledge and skills	Project manager, process manager, secondary or advanced software engineer
Society training	Personnel with general skills	Primary technicians, trainers of new staff or old ones for new skills
Business training	Positions with lower-skilled, repetitious, and low added value performance	Primary technicians, such as programmer, clerks
International exchange	Positions with high-level management and skills	Senior managers, senior advisors, framework designers, system analysts

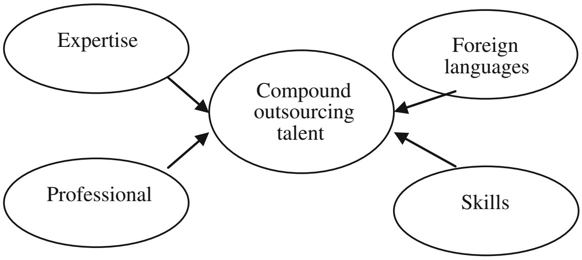

Fig. 151.1 Compound abilities of service outsourcing talents

knowledge outsourcing expansion. Considering this, universities should renovate traditional curriculum system following the demands of the outsourcing market, and focus on the cultivation of compound talents with multiple abilities in foreign languages, computers, expertise and management coordination.

151.3.3 Reforming Curriculum System

To realize the cultivation of compound outsourcing talents, universities need to reform the old curriculum system in the following aspects:

1. Formulate flexible teaching program. Rigid and out-dated course design and teaching program have been lagged behind the constantly evolving technology. Flexible teaching plans enable adaptability of talents training and quick response to market needs. One efficient method currently adopted by many universities is the “2 + 1+1” instructing mode. Under the mode, students have their regular study of the fundamental courses offered by university teachers during the first 2 years. Specialized basic courses in the junior year can be adjusted slightly, taught mainly by teachers and partially instructed by experts from enterprises. In the senior year, universities and enterprises should

collaborate with each other in course instruction and internship guidance. This mode is helpful to the channeling between talent cultivation and enterprise demands.

2. Cultivate interdisciplinary knowledge and skills. To adapt to the enterprises' needs on compound talents, universities can adopt a dual degree cultivating mode which allows students to be able to study such courses as engineering technology, business management, intellectual property right, service outsourcing, so that qualified compound talents can be cultivated.
3. Emphasize the cultivation of students' comprehensive qualities. Outsourcing talents should be the combination of both high expertise and professional qualities; whereas traditional higher education paid insufficient attention to such abilities as communication, cooperation, study and occupational habits. Therefore, universities can try to improve students' comprehensive abilities by some efficient methods like situational simulation, expansion training and internship at enterprises.
4. Enhance foreign language teaching. During international service outsource business, the personnel need to read, write and communicate in foreign languages fluently. Besides that, they have to be capable of comprehending deeply the cultural customs, social etiquette and moral codes of foreign countries. In light of this, universities need to shift the focus of foreign language teaching to the comprehensive application of the language. The cultivation of cross-cultural communication abilities have to be combined with traditional training of listening, speaking, reading and writing. Some specific methods include teaching bilingually, introducing foreign textbooks and instructors, developing international cooperative education, promoting international study and exchange.

151.3.4 Complete Ranks of Teaching

Practical and compound talents are required by service outsourcing. Therefore, university teachers should obtain high academic level as well as rich outsourcing experiences. However, it is hard for university teachers to undertake the task of fostering compound talents in outsourcing industry due to their absence of skills and experiences in this domain. The followings are some measures to implement in order to develop their practical ability:

Firstly, universities should encourage teachers to participate in outsourcing practices. For example, teachers can lead students to intern in enterprises or take crosswise tasks, etc. The assessment methods of teacher can also be changed in order to make the practices happen, which means shifting the assessment focus from longitudinal tasks and paper writing to practical teaching and crosswise tasks taking. Plus, a deduction of teaching workload should be applied and a fee-waiver should be given to teachers who participate in various kinds of professional trainings and authentication exams.

Secondly, university should foster outsourcing teaching team with international vision. On the one hand, teachers should be sent to international service sourcing enterprises to personally experience their languages, cultures and customs; on the other hand, an extensive international exchange should be carried out, which includes sending teachers to pursue advanced studies in university abroad and recruiting professionals from outsourcing enterprises to set up professional courses or train teachers.

Thirdly, university should recruit outsourcing professionals to aid teaching. A long-term and stable talent-fostering base should be established between university teachers and outsourcing enterprises and universities should employ administration supervisors to occupy part-time teachers' position and lecture outsourcing knowledge and professional course. At the same time, they can help train teachers and students.

151.3.5 Enhancing Practice Teaching

In order to meet the gap of theoretical teaching and enterprise requirement, universities should introduce practice teaching complying with the features of service outsourcing. Universities can borrow the experiences from vocational schools and vocational training institutions and design a practice teaching system with 3 basic steps: acknowledgement, professionalism and position practice (Wang et al. 2010). The first step is accomplished by enterprise professionals delivering lectures and developing and analyzing outsourcing cases and the second one is implemented by letting students choose one outsourcing domain to carry out practical and creative design in order to improve their related abilities. The last one is accomplished by sending students to participate in real service outsourcing projects abiding by the contract signed by university and the enterprise and finish project-related design and report.

The procedures of carrying out outsourcing practical teaching are as follows: first of all, simulation. To be specific, university should create virtual outsourcing working environment and the students design outsourcing project, pop questions initially. Then the practical questions should be solved after analysis and discussion. Secondly, an on-campus practice base should be set up and the real outsourcing project and working environment can be introduced into teaching. Then the professionals can monitor students' practice for the purpose of helping them master the basic procedures of outsourcing. Last but not least is extra-curriculum practice, which means fostering the comprehensive qualification of students by carrying out venture contest, creative experiment, subject contest and social practice.

151.4 Suggestions for Domestic Service Outsourcing Talents Fostering

Multiple compound talents are required by domestic service outsourcing industry and university is the major cradle of such talents. For enhancing the practical skills of university students, universities need a market-needs-oriented fostering mode with a focus of developing their abilities such as communication, innovation, organization, and coordination and question analysis.

It should be highlighted that fostering service outsourcing talents is not only the job of university alone but a cooperation of each stakeholder. Firstly, university should exert a fundamental function in fostering service outsourcing talents. As the major carrier of fostering service outsourcing talents, university should shift its talents fostering goal on time for meeting the requirements of enterprises, which is changing from traditional theory focus into compound talents focus. Meanwhile, a set of reforms should take place in the aspects such as curriculum design, pedagogy, teaching and the knowledge structure of teacher. Secondly, enterprise should be responsible for the talents fostering since it is the ultimate taker of them. In order to match the teaching and requirements of enterprise, the managing and technical staff should take part in the designing of fostering scheme, teaching and practice mentor initially. Thirdly, government is the major backbone of the talents fostering, therefore, it is imperative for the government to be supportive. The purpose of service outsourcing talents fostering aims at compound talents with multiple knowledge and skills, so the education cost will be increased dramatically. The fund owned by the university will be far from enough, therefore, funds should be raised by the local government, trade union, outsourcing base and enterprises and supportive policies should be issued as well for motivating the reform of outsourcing education.

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Chapter 152
Study on the Competency of College Elitists

Li-qun Gu, Xiao-rong Zhao and Xue-ying Tong

Abstract The current selection of college elitists covered the appraisal of internal competency such as personal qualities, motivation and value. By factor analysis to the questionnaire data, 7 competency factors were chosen to build up the competency model, including achievement orient, innovation ability, academic exchange ability, team-leading ability, teaching ability, academic research ability and teaching profession. Also, a selection indicator system of college elitists was established.

Keywords College · Elitists · Competency

152.1 Introduction

Education plays more and more critical effects on national development. Since college teachers are the core of promoting technology and science, the management towards them, especially the college elitists, is pretty important. However, the current selection of college elitists emphasizes mainly on the external performance results, for instance, the scientific research and existing rewards, rather than the performance-related competency such as personal qualities, motivation and value. Therefore, to establish a competency model of the college elitists may perfect the original selection methods and provide scientific and reasonable references to selecting and cultivating the potential college teachers.

Based on the investigation to college teachers in Liaoning Province, by factor analysis, a competency indicator system of college elitists was established in this paper, which may provide references to teacher selection in colleges.

L. Gu (✉) · X. Zhao · X. Tong
School of Management, Dalian Polytechnic University, Dalian, China
e-mail: gulq@dlpu.edu.cn

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152.2 Literature Review

In 1973, McClelland proposed the method of measuring competency instead of the traditional intelligence test (McClelland 1973). Fletcher (1992) supported that competency is behaviors that is specific, and can be observed and confirmed. Spencer pointed out that competency is personal potential features related to effective or outstanding job performance, including five levels: knowledge, skills, self-concept, characteristics and motivation (Spencer and Spencer 1993). Sandberg (2000) suggested that competencies were not all the knowledge and skills but that used at work. Based on the above views, the following three characteristics of competency are proposed here in this paper: (1) it is related to certain job requirements or work situation; (2) it can predict job performance and distinguish the outstanding employees from the common ones; (3) it can be shown by behaviors observed and measured, and the use of knowledge, skills, attitudes, motivation in a specific context.

Carloolson and Wyett (2000) pointed out that teacher competency model included the elements of professional knowledge, skills and attitudes of an individual teacher that are closely related to successful teaching and research. Stemberg (2003) suggested that there were three common characteristics among teachers: the special knowledge, creativity and insight. Kabilan (2004) divided teachers' competency evaluation criteria into five aspects: motivation, skills, knowledge, self- learning, interactive and computer ability. In summary, the studies on competency of college teachers have been relatively comprehensive and mature, yet none competency model has been universally acknowledged.

The personality-job fit assessment for selection focuses mainly on the relationship among personality characteristics, job orientation and career choice (Wang 2004a). In the application areas of competency model at present, the most effective one is the competency-model-based selection (Guan 2010). Peng Jianfeng suggested the recruitment and selection steps should be based on the competency (Peng and Xing 2003). The competency-model-based selection concerns the competency that can produce high performance (Xu and Ding 2007).

152.3 Methods

152.3.1 Questionnaire

There are mainly two ways to build competency model: behavioral event interview and questionnaire (Spencer 2001), and the latter was applied in this study. Based on the job analysis, some competency elements were obtained from the college questionnaires towards students, and the Behavior Event Interview (BEI) towards 30 college teachers. Then 2 experts and 3 doctors studying on competency were invited to select the competency elements above by merging related items, deleting unimportant items and adding missing items. 37 competency elements of college elitists were finally extracted. The competency questionnaire towards college elitists was designed according to Likert five-point scale, including 52 items that are described as behaviors. The respondents were requested to grade in keeping with the standards that to what extent they corresponded with the behavior as described. 1 = extremely not competent, 2 = not competent, 3 = common, 4 = competent, 5 = very competent.

With the method of random cluster sampling, 200 samples were distributed and 184 were recovered, of which 180 samples were valid, therefore the rate of valid samples was 97.83 %. Among the valid samples, college elitists and common teachers were 55 and 125, respectively. By using SPSS18.0 statistical software, 52-item discrimination was analyzed to select items, of which 16 were deleted as their no significant differences. The left 36 items were reserved as the sig. = 0.000 < 0.05, which implied that there were significant differences between the "college elitists" group and the "common teachers" group. Then another two experts on areas of psychology and competency were invited to modify the 36 items, and finally the study designed the formal 30-item questionnaire towards the competency of college elitists.

152.3.2 Data Collection

The formal investigation distributed 1,500 samples to college elitists and common teachers among more than 10 colleges in Liaoning Province through either electronic or paper questionnaires, which involved many disciplines such as science, engineering, liberal art, economic, management, medical, education, etc. 957 samples were recovered, of which 901 were valid, and the rate of valid is 94.19 %. Among the valid samples, college elitists and common teachers were 327 and 574, respectively.

152.4 Results

152.4.1 Reliability Analysis

The reliability of all questionnaire items was analyzed and the results were as follows.

As shown in Table 152.1, the overall reliability Cronbach α was 0.945, which indicates that the consistency degree of respondents' grade is high, and therefore the result of the questionnaire is reliable.

Table 152.1 The overall reliability of the questionnaire

Cronbach's alpha	Cronbach's alpha based on standardized items	N of Items
0.945	0.946	30

152.4.2 Exploratory Factor Analysis

(1) Kaiser–Meyer–Olkin (KMO) and Bartlett ball test

Table 152.2 shows the results of KMO measure of sampling adequacy and Bartlett ball test. The KMO value was 0.917, higher than that of the lowest standard 0.70. The X2 and df of Bartlett ball test was 2,415.521 and 435, respectively, suggesting the high relevance among items. Moreover, the level of remarkable difference (sig.) was 0.000, which indicated together with the above data that the questionnaires are suitable for the further factor analysis (Xue 2010).

(2) Factor loading matrix

Factors with eigenvalue over 1 were extracted by principal component and transformation matrix to make the factor loading matrix of college elitists' competency. As shown in Table 152.3, there were 7 factors and the total variance explained was 69.287 %, which indicated that the competency extracted was effective and could explain most of the information about the competency of college elitists.

After the exploring factor analysis, the original assumed competency dimensions have changed, with 7 competency factors instead of 8 factors, and some elements were re-assorted. For example, Self-reflection and Persistence and Professional Research Interest belonged to the original factor 2 were assorted to the new factor 5 and factor 1, respectively. Planning Ability was transferred from the original factor 5 to the new factor 1, while Expression was assorted to the new factor 3 and renamed as communication skills. The new factor of Academic Exchange Ability contains Communication Skills, Teamwork, Awareness of Social Services, and et al.

(3) Factor classified and named

Each competency factor was named and defined in this paper, as shown in Table 152.4.

Competency factor 1: Achievement-oriented, the psychological tendency driving individuals to meet challenge and pursue achievements and high goals.

Table 152.2 The results of KMO and Bartlett test

KMO measure of sampling adequacy		0.917
Bartlett's test of sphericity	Approx. Chi square	2,415.521
	df	435
	Sig.	0.000

Table 152.3 Factor loading matrix

Factor	Component						
	1	2	3	4	5	6	7
X10	**0.925**	0.194	0.138	0.137	0.116	0.082	0.115
X11	**0.810**	0.134	0.117	0.138	0.110	0.141	0.098
X16	**0.874**	0.194	0.131	0.124	0.107	0.057	0.110
X20	**0.939**	0.187	0.139	0.144	0.120	0.102	0.116
X23	**0.939**	0.187	0.139	0.144	0.120	0.102	0.116
X27	**0.938**	0.183	0.138	0.146	0.121	0.108	0.116
X8	0.287	**0.592**	0.220	0.234	0.161	0.308	−0.166
X13	0.288	**0.862**	0.181	0.183	0.160	0.227	0.070
X18	0.214	**0.781**	0.049	0.105	0.183	0.185	0.109
X22	0.211	**0.749**	0.189	0.116	0.044	0.064	0.229
X26	0.178	**0.462**	0.432	0.121	0.087	−0.040	0.292
X3	0.103	0.179	**0.483**	0.451	0.115	0.238	−0.122
X5	0.313	0.093	**0.553**	0.197	0.304	0.247	0.011
X15	0.262	0.342	**0.448**	0.373	−0.059	0.060	0.109
X19	0.115	0.099	**0.733**	0.106	0.086	0.124	0.153
X24	0.093	0.198	**0.581**	0.058	0.276	0.123	0.305
X1	0.161	0.024	0.211	**0.553**	0.480	−0.014	−0.018
X9	0.391	0.143	0.138	**0.527**	0.164	−0.024	0.277
X14	0.165	0.161	0.297	**0.607**	0.037	0.168	0.176
X21	0.244	0.295	−0.024	**0.652**	0.023	0.335	0.223
X4	0.092	0.023	0.191	−0.062	**0.757**	0.235	0.160
X6	0.213	0.310	0.173	0.142	**0.660**	0.066	0.066
X7	0.225	0.168	−0.021	0.343	**0.507**	−0.003	0.275
X2	0.158	0.070	0.254	0.036	0.125	**0.738**	−0.157
X25	0.045	0.306	0.025	0.196	0.191	**0.615**	0.277
X28	0.168	0.289	0.368	0.023	−0.108	**0.477**	0.239
X30	0.147	0.168	0.085	0.287	0.148	**0.545**	0.373
X12	0.423	0.180	−0.102	0.184	0.376	0.117	**0.431**
X17	0.198	0.112	0.208	0.143	0.264	0.008	**0.606**
X29	0.216	0.140	0.342	0.145	0.060	0.215	**0.674**

It includes 6 competency elements, which are perseverance, enterprise, concentration, achievement desire, initiative and professional research interests.

Competency factor 2: Innovation capability, the capability of carrying out scientific explorations in unknown fields with scientific thinking and appropriate methods. It includes thinking critically, ability to analyze logically, thinking divergently, curiosity and research acumen.

Competency factor 3: Academic ability to communicate, the ability to conduct academic exchanges and communicate with team members, which is composed of 5 competency elements such as persuasion, teamwork, relationship building, communication skills and awareness of social services.

Table 152.4 Name and definition of competency factors of college elitists

Factor	V*	Competency element	Definition of the element
Factor1	X10	Perseverance	With a strong mind and never surrender even when encounter obstacles
	X11	Enterprise	Setting higher working targets; strong courage to meet challenges; desire to make excellent performance
	X16	Concentration	Concentrating on a special target and getting rid of any minor external influencing factors
	X20	Achievement desire	Setting challenging targets and making efforts to achieve excellent performance
	X23	Initiative	Making extra efforts even if there was no one asking for it
	X27	Professional research interests	Keen interests in his own major or discipline
Factor2	X8	Thinking critically	Identifying different ways to solve problems and the advantages and disadvantages of different results logically and inferentially
	X13	Ability to analyze logically	Dealing with issues and problems about work logically
	X18	Thinking divergently	The ability to predict and indentify unknown information and knowledge with that known
	X22	Curiosity	Strong desire to explore unknown fields
	X26	Research acumen	Acute ability to capture experimental phenomena and information about scientific research; adept in discover opportunities to further scientific research
Factor3	X3	Persuasion	The ability to convince others by persuading and demonstrating
	X5	Teamwork	Working together with cooperators to achieve the common goals
	X15	Relationship building	Building or maintaining harmonious relationship with people that relevant to work
	X19	Communication skills	Communicating skillfully
	X24	Awareness of social services	Researching social problems with professional knowledge and skills; the awareness and action to service society
Factor4	X1	Care for students	Communicating with students actively to concern about their study and life so as to meet their needs
	X9	Leadership	Setting a specific goal for team members and making efforts to achieve it
	X14	Influence	Earning trusts from team members with his own morality on academic, democratic style of work and personality charm
	X21	Develop others	Supporting others on study or work to help them get more independent and confidence

(continued)

Table 152.4 (continued)

Factor	V*	Competency element	Definition of the element
Factor5	X4	Teaching preparation	Preparing well before class
	X6	Self-reflection	Reflecting on his own performance so as to make improving solutions or remediations
	X7	Teaching methods	Adopting the appropriate teaching materials and methods; adjusting his teaching strategy according to the appraisal results
Factor6	X2	Academic influence	The ability to be a person of authority in his team with outstanding achievements in scientific research
	X25	Professional knowledge	Sensitive to the developing tendencies in his research areas; mastering the knowledge and skills of relevant disciplines
	X28	Collection information	Making efforts to obtain more information instead of relying on the existing ones
	X30	Awareness of law	Obeying disciplines and laws, especially that related to researches
Factor7	X12	Commitment	Keeping their promises and making any efforts to realize them
	X17	Honesty	The morals of practicing what he preaches
	X29	Academically rigorous	The feature of teaching precisely and researching originality without any misconducts

V*: Variable

Competency factor 4: Team leadership ability, the ability to team management, discipline construction, training others and interpersonal communication. This factor refers to care for students, leadership, influence and develop others.

Competency factor 5: Teaching ability, the ability to participate in education and teaching activities, including teaching preparation, self-reflection and teaching methods.

Competency factor 6: Academic research ability, the ability to master and use professional knowledge, to understand the latest development and trends of profession. In this part, 4 competency elements are involved such as academic influence, professional knowledge, collection of information and awareness of law.

Competency factor 7: Serve as role models, the ability to possess good teachers' professional ethics, fair and honest, to keep promises, stick to principles and promote trust and respect. It is comprised of commitment, honesty and academically rigorous.

152.4.3 Competency Model of College Elitists

According to the results of exploratory factor analysis and factor classification, the competency model of college elitists was here established. This model includes 7 competency factors and 30 competency elements, which constructed the index system of college elitists, second indicators and third indicators (Table 152.5, Fig. 152.1).

Table 152.5 Hierarchy of college talents selection indicators

First level indicator	Second level indicator	Third level indicator
Index system of college "million of talents" (Z)	Y_1 Achievement-oriented	X_{10} Perseverance; X_{11} Enterprising; X_{16} Concentration; X_{20} Achievements desire; X_{23} Initiative; X_{27} Professional research interests
	Y_2 Innovation capability	X_8 Critical thinking; X_{13} Logically analysis ability; X_{18} Divergent thinking; X_{22} Curiosity; X_{26} Research acumen
	Y_3 Academic ability to communicate	X_3 Persuasion; X_5 Teamwork; X_{15} Relationship building; X_{19} Communication skills; X_{24} Awareness of social services
	Y_4 Team leadership ability	X_1 Care for students; X_9 Leadership; X_{14} Influence; X_{21} Develop others
	Y_5 Teaching ability	X_4 Teaching preparation; X_6 Self-reflection; X_7 Teaching methods
	Y_6 Academic research ability	X_2 Academic influence; X_{25} Professional knowledge; X_{28} Collection of information; X_{30} Awareness of law
	Y_7 Serve as role models	X_{12} Faith; X_{17} Honest; X_{29} Academically rigorous

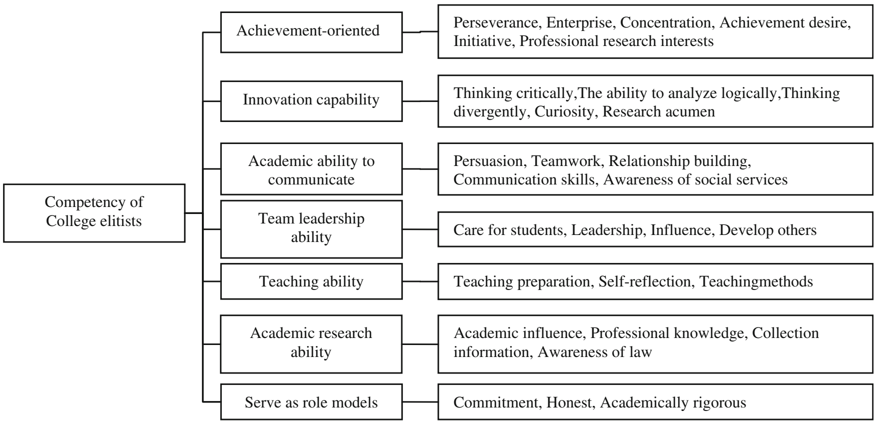

Fig. 152.1 Competency model of college elitists

152.5 Selection Indicators of College Elitists

Every competency element needs a classification standard and the description of its typical behavior (Lin 2007). Behavior anchored rating scale method (BARS) is a measurement system of defining and classifying the specific behavior of the competency. It designs rating scales for each competency, and identifies a number of behavior ratings for each of the competency. It is common to use a 3–5 grade score sheet separately for each competency elements, with the behavior on the rating listed in each grade. According to Hay Corporation "Quality of competency grading Dictionary" (Wang 2004b), in combination with job characteristics of college elitists, a behavior anchored rating scale for each competency elements was proposed.

152.6 Conclusion

By using factor analysis method, a questionnaire for competency of college elitists was formed, in which 30 competency elements were reduced to 7 competency factors including achievement-oriented, innovation capability, academic ability to communicate, team leadership ability, teaching ability, academic research ability and serve as role models. The weighing of second level indicators and third level indicators were acquired through factor variance contribution rate and factor score coefficient matrix, and the index system of college elitists was finally established.

This study enriches the theoretical system of the competency research field, and provides certain reference to the further study of competency and the selection of college elitists. Results obtained in the study could be used as a supplement and improvement for the college elitists' selection, and are also suitable for talents selection and training needs analysis. Meanwhile, in allusion to competency model and the selection criteria teachers can manage their individual career, so as to enhance the competence of their positions. The results can also provide training standards and directions for cultivating high-level talents of college, and inspire the work enthusiasm of university teachers and enhance their job performance.

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Chapter 153
Study on Reform of Public Physical Education Management in Chinese Universities

Lin-zhou Gao

Abstract With the spreading of the ideas of "safety first" and "sunshine sports" in universities, college sports are constantly in-depth reforming. The task of physical education is also varying and innovating. The standard, innovation and science of the management of physical education have become the important work of physical education project. In this paper, we study the management system of public physical education. By using literature study, data analysis, and survey research as the main methods, we analysis the major problems existing in the management system of public physical education, and propose suggestions for further reform and improvement, in order to establish an effective system of physical education and improve the physical education to be advanced, scientific, standardized and institutionalized.

Keywords University · Physical education · Management system · Reform

153.1 Introduction

In the period of social transformation, accompanying with major changes from exam-oriented education to quality education in Chinese education system, society needs high-quality people with good physical health, mental health and a certain technology expertise. The continuous improvement of the modernization gives birth to the lifestyle changes. Physical activity is no longer a single means of keeping fit. It has become one of the ways of entertainment and interpersonal communication, and it is also one of the hallmarks of civilized and healthy modern life (Sun and Qin 1996; Huang 1999; Evers and Lakomski 2001). Teaching is the

L. Gao (✉)
Division of Physical Education, Zhejiang University of Science and Technology, Hangzhou, China
e-mail: glz0214@163.com

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central task in the universities. Physical education is an important part of teaching, and is also the most basic activities of school teaching (Chen 2003). With the ongoing of the “safety first” and “sunshine sports” in universities, college sports are constantly in-depth reforming. The task of physical education is also varying and innovating. Because of the subjective and objective reasons, the concept, educational system, structures, personnel training mode, content and teaching methods of education is lagging behind, which affects the overall development of students and personnel training, and also the national quality. The formation of current quality education, innovative education, lifelong education, people-oriented ideas and new concepts, is driving the training mode of physical education in universities and the corresponding reform of management system of innovative teaching. Thus, to adapt the needs of the age, it is inevitable to carry out the study of the management system of physical education and its reform.

153.2 Problems Existing in Management System of Physical Education

153.2.1 System is Excessive Rigidity, Lack of Human Care

Establishment of a “people-oriented” teaching management system plays an important role in maintaining quality of teaching and training innovative talents. The flexible teaching management performed in universities should include abolition of repetition, flexible educational evaluation, the credit system, elective system and so on. Students are free to choose learning courses. The original aim is to desalinate process management and strengthen management and so on. But the implementing process hasn’t achieved such objectives. Some managers do not establish a “people-oriented” thinking. Managers often misunderstand the objectives, thus the formulation and implementation of the system are often carried on in a wrong way, e.g. one-sided emphasis on goals, objectives and results, regarding people as the opposite of the system, and emphasis on human constraints and management, so that the result is often counterproductive. The reason why many systems exist in name only and cannot effectively play its role is closely related to the starting point of “governing people” (Campbell et al. 1987; Sun 2004).

The present physical education management system is based on the thought of “scientific management”, and is a set of manager-based, teaching-centered ideas. The biggest loss of the system is the excessive rigidity and lack of human care, resulting in limit of students’ freedom of physical study. The so-called freedom of study is that students are free to choose subjects of interest, which is an important right of students. However, some requirements in the current management system of public physical education are not reasonable. Students are not enough respected for interests and hobbies. For example, for the elective course for the sports, some courses are not opened when the number of students is less than a certain one; the half-way switch is not allowed. This situation shows that in the crucial stage of learning sports skills, many students in universities can't choose their favorite sports. Some students select a course that they do not fully understand, and want to switch to another one after they realize that they are not suited to this project after learning for a while. However, in many colleges and universities, the half-way switch is not allowed. For the considerations of saving and ease, the universities harm the interests of students' physical education.

153.2.2 Lack of Service Consciousness and the Understanding of the Subject

The starting point of existing physical education management system is to ensure the so-called "normal" teaching order, i.e. no or less of "trouble". It has been less considered to allow students to grow lively with full freedom to develop. The "National Guidelines for Physical Education" demonstrates that students should be free to choose courses, teachers, and class time. However, now most universities cannot meet this requirement. In the operating systems of physical education, support to teaching is not perfect, and managements' awareness of services for teachers and students is weak.

153.2.3 Emphasis on Score Managements

Score is an important tool to evaluate academic achievement and teaching quality, but it has been considered as the absolute in current teaching. Scores should be used to improve the student learning and teaching work, but it has become the tools to control the students and teachers, deviating from the values of teaching. The "power-oriented" system still dominates in universities. School management cannot exist without power, but the "power first" goes against the thrust and mission of education (Evers and Lakomski 1996). Management authority serves the mission of universities, which is to train and educate people. Any power deviating from this mission will destroy the education, the spirit, and the culture. The "power-oriented" system forms a teacher-centered teaching mode, in which teachers are in the commanding position. In the existing physical education system, teachers are accustomed to the idea of "teacher-led", not "students-centered". The methods of teaching push out the dignity and power of teachers, but suppress the students' passion and initiative. Management model emphasizes unity of teaching. A unified curriculum, content, methods, standards, progress and a single means of teaching evaluation greatly stifle the creativity, responsibility of teaching and the initiative, enthusiasm of students' learning.

153.2.4 The lack of an Effective Incentive for Teachers

Sports "curriculum standards" is well developed in educational philosophy, target system, teaching evaluation and implementation of ways. It emphasizes the idea of employing the education thought of "people-oriented" and "health first" to guide the work of school sports. It represents the direction of the development of school physical education. However, in the specific operational aspects, it has been considered as a unit for education ideas, academic theory and practice. Current incentives for physical education teachers are still lack. Main features are described in the following aspects. First, inadequate system of motivation in physical education is weak. Some university administrators have developed a number of measures to mobilize the enthusiasm of teachers, e.g. by increasing class fees, regarding the quality of teaching as an important standard, and increasing the funds for physical education. However, these measures do not form a formal system, and haven't influenced physical education teachers, thus actual results are unsatisfactory. Second, physical education teachers have low coefficient hours than teachers of other subjects. Such a phenomenon exists in many universities. Third, more attention has been paid on scientific research but less on teaching. The job-classification, evaluation and salary of teachers in universities emphasis on the research capacity and achievements, while ignores the teacher's teaching ability and effectiveness, so that some physical education teachers focus on their research and publishing articles, while they neglect the physical education (Campbell 1999).

153.3 The Suggestions to Improve the Management System of Physical Education

153.3.1 To Improve the System of Physical Education Management

Standardization of physical education is based on the scientific rules and regulations. The quality of physical education is difficult to be guaranteed without a system of physical education. For perfection of the system of physical education management, all the rules and regulations should be strictly implemented. Based on characteristics of physical education, various regulations and rules should be developed. Specific and clear requirements should be made on the education plan, teaching operation, basic construction, teaching reform, teaching quality, work assessment and various staff responsibilities and so on, to reach the goal that each teaching units has its clear rule. Thus, management activities are standardized by the rules and regulations, providing guarantee to improve quality of teaching.

Currently, based on the characteristics of physical education, colleges and universities pay great attention to develop and improve various regulations and rules for physical teaching, and to standardize the management behavior of the physical education. The "compilation of teaching management rules and regulations" should be strictly implemented. With the actual sports rules and regulations, e.g. "annual work appraisal of physical teachers", "physical education teaching basic norms" and so on, job-responsibilities of categories of personnel should be specialized. This series of rules and regulations of physical teaching can be helpful to achieve more standardized and improved management and to provide guarantee for improving the quality of physical education.

153.3.2 To Establish a "Student-Centered" Teaching Management System

The 21st century is the century of competition for talent and education. Promotion of quality education and training creative people is the fundamental task of colleges and universities. College-trained people should have a solid foundation, extensive knowledge, innovation and high quality features. As the socialist market economy system and the knowledge economy era come, innovation of knowledge has become a decisive factor in the development of productivity. The ability to train a large number of creative talent that meet the social needs become the key to rapid development of countries. As the existing mode of education is difficult to ensure the development of individuality and creativity of students, in-depth reform of education and the establishment of the "student-centered" teaching management system has been the inevitable demand to train innovative talents (Huang 2003; Lu and Wan 2002). Meanwhile, in the market economy, the identity of college students has changed, and the students have become consumers of higher education, which requires the concept of teaching management to meet the "customer" needs, i.e. the system should be able to provide the required education for students, train students in accordance with students' different aptitudes, and provide students with comprehensive, high quality service.

153.3.3 To Establish a Scientific Evaluation System for Physical Education

The implementation of evaluation and assessment to the physical education teachers is the main basis for incentive and compensation of their teaching performance. Due to problems of thinking and operation, the teaching evaluation in practice has yet played its due role. We consider the following aspects, which should be gradually improved:

- The evaluation should be comprehensive, e.g. the evaluation should be performed based on many different aspects and multiple perspectives to check the quality of teaching in an objective and scientific way. Because different entities in the assessment of teaching quality activities are difficult to avoid their own limitations, in the implementation, one should make good use of students' evaluation and peer-evaluation of teachers.
- Evaluation tools and the choice of methods should be diversified. The combination of quantitative and qualitative evaluation should be adhered to. It is also necessary to strengthen dialogue in the evaluation process, and teachers should not be entirely in a passive position.
- To build a scientific evaluation system, we believe that when constructing index system for teaching quality evaluation, one should consider the combination of curricular and extracurricular, the combination of process and effect, the combination of teaching and research, and should make the evaluation specific, rich, with high discrimination, which should also have strong feasibility and credibility.

One should make the rational use of evaluation results. The evaluation of physical education teaching aims at improving the teaching activity of physical education and promoting the teaching task with high-quality. Therefore, in the use of the results of teachers' job-evaluation, one should focus on whether evaluation results help physical education teachers to achieve these goals.

153.3.4 To Further Improve the Quality Monitoring System for Physical Education

With the deepening of higher education reform and the continuing to promote quality education, it has been a general trend for physical education to implement scientific monitoring system. The aim is to improve the quality of physical education and promote the sport's status in school education, so that students can develop the habits of physical exercise and life-long sports thoughts, in order to fully realize the overall goal of school sports.

Improving the quality control process, strengthening quality monitoring system of physical education, and promoting standardized and scientific teaching management, are very important means to improve the teaching quality. To strengthen the management of quality control, one should inspect, supervise, and evaluate the teaching conditions, teaching order, the teaching process, teaching status, and other aspects of teaching effectiveness (Zhou et al. 2003).

- Education inspection system: To improve teaching quality, regular checks are the most basic means of teaching. The inspection should be throughout the teaching process. Once problems are found, they should be solved in time. One should also perform inductive analysis and get experiences to guide and improve the teaching.

- Teaching supervision system: Teacher who has management experience should form a steering group, and are responsible for the implementation of the teaching supervision. They should inspect, evaluate, review, guide and communicate for those that affect the quality of teaching.
- The regulation for managements lectures: Managers should stick to the first line of teaching, to keep abreast of teaching situation and to listen to opinions and suggestions of management in order to ensure the relevance of teaching and effectiveness.
- Teaching evaluation system: Teaching is the bilateral interaction activities between students and teachers. With teaching evaluation made by students, one can fully understand the teacher's classroom teaching and teaching quality, which is important for improvement of the teaching effectiveness.

153.4 Conclusion

University physical education is a united education, and is an important way to train highly qualified professionals with overall development. Establishment of the multiple teaching goals, which is to promote the quality of student health, humanities and social quality, is important for both physical education and social needs. Management of physical education is still at the exploratory stage. There are many problems needed to be studied. The management of physical education that we advocate should be based on the "humane" scientific management which includes teaching, research and management. Under the guidance of the new management philosophy of education, we should establish the "people-oriented" idea, respect for the academic, implement the trinity model including knowledge, ability, quality training, and make the physical education administration integrated into the great international background, thus continue innovating teaching management, and fully realize the innovation in the management system of physical education.

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Chapter 154
Discussion on How to Cultivate Interdisciplinary Graduate Students

Yan Liu and Lu-quan Ren

Abstract Education of interdisciplinary student has become an important project of modern universities education reforms, which is an effective way to cultivate high quality and innovative students. In this paper, the situations both at home and abroad education of interdisciplinary students are summarized. Furthermore, the four basic qualifications of cultivating interdisciplinary graduate students are proposed, and also students' cultivation of the bionic engineering interdiscipline is discussed in Jilin University of China.

Keywords Universities education reform · Interdiscipline · Graduate student

154.1 Introduction

Universities undertake the task of cultivating high quality and innovative students, and also it is an important project that how to cultivate the high quality and innovative students. All kinds of natural phenomena compose an associated integrity. Therefore, the human's understandings about nature have the integral character (Lu 2005). With the development of science and technology, multidisciplinary research became more and more important because interdisciplinary research is propitious to indicate natural truth. Furthermore, education of interdisciplinary students is the inevitable tendency of cultivating high quality and innovative students (Liu 2006).

Y. Liu (✉) · L. Ren
Key Laboratory for Bionic Engineering, Ministry of Education,
Jilin University, Changchun, China
e-mail: liuyan2000@jlu.edu.cn

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154.2 Understanding of Interdiscipline and Education of Interdisciplinary Students

At present, there is not a specific concept about interdiscipline. In generally, the concept means communication and cooperation of different disciplines. Since the 20th century, many scientific frontier problems and many complex issues have gotten breakthroughs due to cooperation of different disciplines' scientist. Therefore, interdisciplines are made progress and some new interdisciplines are set up after many universities renew discipline arrangement and break restrictions of original disciplines.

Mr. Qian Xuesen had made an authority definition about interdiscipline in his early age; he pointed "interdiscipline refers to be generated a series of new disciplines in the intersectant areas of natural science and social science". With the development of science and technology this definition apparently can not cover the signification of interdisciplines. The writer thinks that interdisciplines are a different expression form from traditional disciplines. They all can be called interdiscipline, which intercross two or more traditional disciplines. At present, interdisciplines have different formations in Universities such as two or more disciplines intercrossing between natural science and social science and from natural science or social science. The interdisciplinary education is relied on development of interdisciplines. The interdisciplinary education has become an effective way to cultivate innovative students. Furthermore, how to reform becomes an important project both at home and abroad.

154.3 Situation Both at Home and Abroad of Interdisciplinary Education

154.3.1 Origin of Disciplinary Education

Interdisciplines can break barriers of disciplines and enlarge understanding to science, which can meet the needs of development including the science and engineering technology. Therefore, interdisciplines show unique advantages not only in disciplines' construction but also in cultivating innovative students. In the United States, interdisciplinary education was called "general education" had developed after world war II. From the Second World War to the 1960s, the typical representative of interdisciplines education is "future change course", which was designed and developed by Boyer. From the 1970s to the present, the significance of interdisciplinary education gradually was revealed and went into the quickly growth period. Moreover, education scholars wrote monographs about it and founded academic organizations. Klein's monograph mentioned. "The strong knowledge and education value of interdisciplines made it become an important theme of modern education reform (Jerry and James 1997)" (Wang 2007).

154.3.2 Disciplinary Education in Abroad

The new course catalogue in the Unite States, the ratio of “interdisciplines” and “multidisciplines” is 7 % of the whole group (Wang 2008; Peter and Luchien 2012). Interdisciplines are added into teaching plan in University of Tsukuba of Japan, at same time, interdisciplinary researches are strengthened. Education reform is set up in some Britain’s universities and course contents and teaching methods are different from before. Main measures include that discipline areas are expanded, narrow disciplines are repealed and interdisciplinary courses are set up.For example two or more subjects are put into a major (like economics and engineering) in Oxford University.

154.3.3 Disciplinary Education at Home

Interdisciplinary Education is an important aspect of universities education reform in China. Some reform measures have been taken in Beijing University, Tsinghua University, Fudan University and other universities to cultivate interdisciplinary students such as a double degree system, setting up elective courses, allowing students to turn major and constructing majors with interdisciplinary characteristics. Since the 1980s, interdisciplinary students training practices have been set up such as intercrossing machine and materials in Jilin University of Technology. Since the 1990s, the liberal art base class and science base class have been set up in Beijing University and Fudan University, the liberal art base class including literature, history and philosophy subjects; the science base class including physics, chemistry and biology subjects (Chen and Yin 2011).

There is a unique advantage in interdisciplinary education and cultivating interdisciplinary students in Jilin University. Six Universities are combined into new Jilin University, which is the largest scale University of the China and has a complete range of disciplines covering all 12 major disciplines categories including philosophy, economics, law, education, literature, history, science, technology, agriculture, medicine, management and military. It is paid much attention in Jilin University that how to cultivate students of Interdisciplines, for example four categories of elective courses are set up and students are demanded must to select more than 8 credits. In the April of 2005, the file “some opinions on strengthening teaching work and constantly improving the teaching quality” is promulgated, clearly pointed out that “according to the needs of the development of economy and society the advantages of multidisciplines should be play attention and set up several new majors of interdisciplines and second bachelor degree. Moreover, teaching mode reforms should be carried out such as setting up ‘liberal art class’, ‘big science class’, ‘multidiscipline class’ and interdisciplines of liberal art and natural science; carrying out the elastic credit system, breaking through the barriers of departments and majors and encouraging students to select courses from others departments". Therefore, the cultivation of interdisciplinary students has become one of main goals in the education reforms in Jilin University.

154.4 Basic Qualifications of Cultivating Interdisciplines Graduate Students

Most of interdisciplines are new disciplines, which generally represent the development direction of the new knowledge and technology. The development of interdisciplines have their own internal rules, so they are some different from traditional discipline in cultivating students. According to characters of interdisciplines and mode of students training, we can find that it should be followed some basic qualifications to cultivate innovative students.

154.4.1 Scientific and Clear Direction of Discipline

Discipline direction is the premise of the existence of discipline and is the fundamental problem to decide the discipline's development. Traditional discipline has generally good development foundation and more mature development direction. The establishment of interdisciplines usually arises at the historic moment, generally in order to adapt to the needs of the development of science, or engineering and or social life. Therefore, interdisciplines must be guide for a scientific and clear discipline direction. The scientific and clear discipline direction is an important element that leads the students of different disciplines background to marching along a right direction.

154.4.2 Strongly Supportive System

Interdisciplines inevitably involve two or more disciplines. Generally, the traditional discipline have good supportive conditions. But the development of new interdiscipline need more powerful support such as having their own the necessary facilities, equipments and their own course systems. In addition, the basic conditions are needed which can meet the practical needs of the teachers and students.

154.4.3 Enough High Quality Students

Choosing talents is the key element including teachers and students. On the one hand, there need to have a certain number of high quality teachers with different disciplines' background. On the other hand, there need to have plenty of high quality students of different majors. Practices prove that the success of interdisciplines must be the result of the long-term cooperation between the teachers and students of the different disciplines. The success of the interdisciplinary graduate student training must be the result of encouraging and attracting more excellent students form other disciplines and majors to register for examination and participate. Therefore, school management sections should provide the policy support for teachers and students from different majors and departments.

154.4.4 Relaxed and Harmonious Academic Atmosphere

For interdisciplinary group, either teachers or students have different academic background and ways of thinking respectively. People from different majors can form thinking collision and have widely cognition and discussion but it is not an easy thing to intercross different subjects really. Therefore, there must be relaxed and harmonious academic environment to listen to different views, dare to tolerate failure and provide necessary sufficient development space for the students with different disciplines and different ideas (Hong and Yehuda 2010).

154.5 Student Cultivation Mode of Bionic Engineering in Jilin University

Some interdisciplines such as the medical law, zoonosis, information biology, biomedical engineering and so on were founded in Jilin University. Bionic engineering discipline is one successful example of the many interdisciplines. The new teaching mode was adopted during the process of cultivating graduate students "according to the characteristics of interdisciplines innovation education is put into the whole course of the students training, which is based on leading disciplines and considered on other disciplines (Liu et al. 2005; Ren et al. 2008)". The measures of cultivating students are carried out.

154.5.1 Students Training Based on High Level Projects

Development of bionic engineering discipline is based on the high level projects. The discipline is an important part of national key discipline "Agricultural Mechanization Engineering" and is support for "211" project. About 60 key national and provincial projects are undertaken such as National Basic Research of China, national 863 projects, Natural Science Foundation of China, the Key Projects of Ministry of Education and so on.

Bionic engineering discipline of Jilin University has gradually reached to the world's advanced level in field of terrain-machine bionics. Many well-known scholars are cultivated such as academician of CAS, academician of CAE, national experts with outstanding contributions, the Yangtze River scholar, the gainers of national science fund for distinguished young scientists, the new century excellent talents of the Ministry of Education and so on. Furthermore, some awards are gained such as second prize of National Technical Invention, second prize of National Teaching Achievement and more than 40 national, provincial and municipal Science and Technology Awards. More than 670 papers have been published including 220 papers for SCI index, 360 papers for EI index and 60 patents for invention. In 2000 the Key Laboratory for terrain-machine bionic technology (now the key laboratory of bionic engineering) of Ministry of Education was found.

154.5.2 Resource Support from Multi-Level Bases and Platforms

Some bases are established such as the first key laboratory of bionic engineering of Ministry of Education, China-British unite laboratory about function surface and fluid interface bionic, engineering bionic laboratory of Jilin province and so on. Furthermore, multifunctional base has formed with scientific research, talents training, disciplines' construction, technological development and product fabrication.

International cooperation platform for researchers and graduate students are provided to academic cooperation with international well-known universities in bionic engineering field. The international platform of cooperation has been formed through declaring international cooperative projects, participating in important international academic conferences and selecting excellent teachers to study abroad, which keep up with the latest progresses of the international bionic engineering and gradually formed its own characteristics and advantages.

In these years, more than 30 people have been sent to Oxford University, Nottingham University and other famous universities to research cooperatively; and more than 20 graduate students have been sent to study for their degrees (Li et al. 2005). In addition, high level academic journal is founded to provide the better academic exchange space and platform. In 2004, the journal named "Journal of Bionic Engineering" was founded with the editorial board which was constituted by international famous experts such as academician of CAS, academicians of Indian, members of FRS and so on, which indexed by EI in 2006 and indexed by SCI in 2007.

154.5.3 Cultivating Students According to Their Aptitude

In 1988, discipline barriers were broken because the bionics had an interdisciplinary character. Students were chosen from other sub-disciplines or discipline even across big disciplines such as biology, information, geoscience and management. Moreover, across discipline students have reached 70 %.

In the course of training students original major was considered firstly, then combined with research projects. The students' interests, hobbies and specialties were considered also. The corresponding personal cultivated plans were set up according to the students' major, research direction and foundation. Some method were used such as organizing the graduate students to select other schools' lessons and encouraging the teachers open interdisciplinary courses to overcome the shortages of original teaching methods and courses.

In the process of students training, bionics education is throughout the whole process including teaching including scientific research, social activities and so on. The students can be divided into different levels such as basic research, applicable basic research and technological development and then cultivate the students of different level in corresponding training base. For example, the students who have a better scientific research foundation can enter into the Key Laboratory to engage the basic research; the students who have engineering foundation can enter into pilot scale test base to engage the development of products; and the students who have good English level can enter into China-British Joint Laboratory to visit international communication and cooperation.

154.5.4 Building Good Academic Atmospheres

It is very important of cooperation of internationality, interschool and in research teams to develop bionic engineering discipline. Long-term effective system of academic activities has been set up for more than 20 years. Furthermore, "serious, conscientious, harmonious" academic atmosphere is formed based on the "innovation". The research team's leader carried out various academic activities such as expert forum, scholar lecture, and group discussion and so on. Through cooperation with more than 10 universities or research institutions and research together from different discipline researchers such as machine, biology, material, geology, management and so on bionic engineering discipline was developed quickly.

The harmonious academic atmosphere was built and good relationship of cooperation was keep during corporation. In the academic activities teachers and students express academic ideas, stimulate innovative thinking and improve research level.

154.6 Conclusion

The students cultivating mode of bionic engineering interdiscipline has gone through more than 20 years. Furthermore, more than one hundred of high level interdisciplinary excellent talents were cultivated who had important contributions in the positions of scientific research, teaching, enterprise and management. In 2009, the teaching research production—"the exploration and practice of cultivating high quality and innovative graduate students by interdisciplinary education" won the second prize of sixth national teaching achievement because of the outstanding achievements in cultivating high quality and innovative talents of Jilin University's bionic engineering teaching group. The high quality graduate students training mode's research and practice of engineering bionics discipline in Jilin University provide reference for interdisciplinary education of China.

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Chapter 155
Research on Teaching Method of Engineering Graph Recognition Course for the Computer Science and Technology Major Based on Creative Thoughts and Application Ability Training

Yu Wang, Ri-na Su and Guo-jun Li

Abstract The engineering graph recognition course studies on theory and methods of engineering graph systematically. The necessity to set up engineering graph recognition course in computer science and technology major and the teaching method based on creative thoughts and application ability training is discussed in this paper in order to developing new path and provides new way of thinking for the educational reform pilot project reform.

Keywords Application ability training · Computer science and technology major · Creative thoughts training · Engineering graph recognition · Outstand engineer cultivation plan

155.1 Introduction

The computer science and technology major of our university is one of the Ministry of Education educational reform pilot project. The major is to train and bring up the personnel with the wide scope of knowledge, strong ability, high-quality, innovative, and have the basic theory knowledge and application skills of computer hardware and software, with strong practical ability and technical to meet the needs of socialist modernization (Barrows 1986). The necessity to set up engineering graph recognition course in computer science and technology major and the teaching method based on creative thoughts and application ability training are discussed in this paper.

Y. Wang (✉) · R. Su · G. Li
School of Electronic and Information Engineering, Ningbo University of Technology, Ningbo, China
e-mail: wangyuwyt@163.com

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155.2 Training Objectives of Engineering Graph Recognition Course

The engineering graph recognition course studies on theory and methods of engineering graph systematically. The main study content is the basic theories and methods of projection, as well as mutual transform law between spatial and plane objects, and way to draw and read engineering drawings according to the projection law and technical requirements.

According to the teaching basic requirements of college, this course should develop students to express three-dimensional shape using two-dimensional planar shapes by the projection method, to have the ability of thinking in images, to have the creativity configuration design capabilities; to have the ability to draw engineering drawings by using drawing computer software and three-dimensional design, to have drawing ability with instrument, by hand and read professional engineering drawings, to have the engineering consciousness and implementation consciousness of national standards.

155.3 Necessity to Set Up Engineering Graph Recognition Course in Computer Science and Technology Major

Engineering drawings is the language must be mastered in the engineering industry (the other three languages are mother tongue, foreign language and computer languages) (Hao et al. 2010). From the surface, the computer major seems to have not necessary to set up engineering graph recognition course than machinery and architecture major. But as future engineers and technicians, students in computer major should have a unified standard language in order to achieve smooth communication because they will communicate with personnel in different areas when they are into the community. And, students can train creative thoughts and application ability through learning this course in order to lay a solid knowledge and competencies for students into the community in the future.

155.3.1 Establishment of a Drawing Thinking Way, Training and Development of Students' Spatial Imagination and Three-Dimensional Design Ability

This course based on engineering drawings knowledge and timely put thinking science and way into the various stages of the knowledge teaching. Consciousness of using different ways of thinking and good thinking habits of full diverging thinking and effective convergence can be formed preliminary during the learning of projection theory. In the teaching for the concept of basic objects, the training goal of the thinking ability is to have feeling ability for objects in the process of understanding and describe things. The drawing and recognition of combined body is to train ability of transformation and re-combination basic body knowledge accumulated in the minds from image thinking in order to improve the level of image thinking. Expression of engineering drawings through a variety of skills and technique is to transform the subjective intent of the designer into engineering drawings completely to communicate their imagination and creativity in engineering industry. The spatial imagination and three-dimensional design ability of student is to be trained by learning engineering graph recognition course, and this ability and quality is the basis of computer graphics in the computer major.

155.3.2 The Ability to Draw and Read Engineering Drawings with Moderate Complexity

Graphics is an important tool for human's expression and ideas exchange as text. Engineering drawings is to express structure and shape, size, quality specifications and assembly installation requirements of engineering and product. It is the main basis of the modern production and scientific experiment process from design to manufacturing, assembly and inspection. It is an important technical documents and technical communication tool for engineering and technical department. The basic objective of engineering graph recognition course is to enable students to master ability of the basic engineering drawings recognition and moderately complex engineering drawings drawing and reading.

155.3.3 Master the Ability of Computer Drawing

The main feature of the computer drawing is strong practical. We change the approach of existing textbooks with a chapter on computer drawing to allow students to study in the computer room with ten hours. The method is familiar with drawing commands and methods of computer drawing software (AutoCAD). It focus on training design and drawing skills of students and make a good foundation for the study follow-up professional courses or the use of advanced design methods and tools to carry out the engineering practice.

155.3.4 Developing a Serious and Responsible Work Attitude

Drawing and Reading of engineering drawings is a complex and tedious work. To do it must with strong patience and a responsible attitude. In order to ensure the consistent of expression pattern and achieve the unambiguous exchange, a large number of China national standards in engineering drawings need to be strictly abided. This course will help students to develop regulations to comply with GB and to have patience attitude and ability to deal with complex issues. That is benefit for the students' attitude development for hard and responsible work.

155.3.5 Students Development as a Starting Point to Promote Quality Education, Competency-Based Training with Employment-Oriented

Instruction set and reform with implement employment-oriented and competency-based can not be loss quality education as a condition. It's not simply to increase the percentage of major subjects and compression or cancel specialized fundamental course hours. The engineering graph recognition course is the specialized fundamental course in computer major. To pay great attention to the teaching of such fundamental course can be to enhance student's quality education. It is the foundation of follow-up course and the need to adapt to changes in the workplace for students. Workers' operation mode has transform from the simple single work to comprehensive team work or group work with the changes of the modern production structure. In order to meet the job needs, the undergraduate education should be to focus on the specialized fundamental course to train the professional quality and ability in addition to the professional competence training (Diana 2003; Acawley and Malmqvist 2009; Yu and Zhang 2010; Liu and Guo 2004).

155.4 Thinking Training and Capacity Building Integrated into the Teaching Process of the Engineering Graph Recognition Course

As the basic course, engineering graph education will be the best way to improve students' creative thinking ability with its unique way of thinking and practice process. The education system of middle school and high school is a kind of logical thinking from known to unknown as the definite solution form. The requirement of the times is that college student should have broad practical knowledge and skills as well as a variety of innovation thinking. Engineering graph recognition course is opened in lower grades in order to make connection from traditional confining stereotypes form to the divergent creative thinking and shorten the subsequent achievements in scientific research. Training of thinking and capacity should be throughout the whole process of engineering graph recognition course teaching.

To learn and master a variety of thinking ways is benefit to select an effective way of thinking according to the different practice needs to guide thinking activity, to reduce the thinking blindness and to improve the efficiency and success rate of the thinking. There are many kind of thinking way. We often use divergent thinking method, convergence thinking and analysis method and comprehensive thinking method in other courses. Here are several thinking way can be trained in engineering graph recognition course teaching.

155.4.1 Thinking Method can be Trained in the Teaching

1. Reverse Thinking Method

Reverse thinking is to solve the problem using a kind of reverse thinking from back to front in order to achieve understanding deepen. Used reverse thinking method in reading point projection image, the point location in space can be obtained by thinking the position of the horizontal plane upward rotation 90° back to the original space and the projection line through each projection point intersect to determine the results.

2. Migration Thinking Method

Migration thinking method will influence how to learn new knowledge and skills by the knowledge, skills or attitudes have learned. Learn by analogy and comprehend by analogy is the vivid reflection of the migration method. This method can lay a good foundation for future innovation. Used migration thinking, the problem of sectioning lines and intersection lines can be solute by the points-selecting method and lines-selecting method in the plane of the second chapter.

3. Imagine Thinking Method

The scientific imagination thinking method is a unique method of thinking and research which cleverly combine concept and image, concrete and abstract, reality and the future, science and fantasy. According to the characteristics and projection law of the basic body, the shape of the basic three-dimensional position cut by various plane can be imagined though the prototype of basic body and plane shape.

4. Integrated Use of a Variety of Thinking Method

During the learning, the ability to use a variety of ways of thinking should be mastered. For example, similar association and compared association can be used in the study of three-dimensional surface intersect. Visible three-dimensional intersecting instance in the daily life can be used to imagine the shape of a variety of three-dimensional intersecting and express them in the planar graph by dimension reduction method. To do more of this training will help students to develop creative thinking.

The scientific thinking way is the wisdom that people summed up from countless practical activities and lessons. Choose scientific thinking way to guide the activities of thinking according to the different practice needs is not only to reduce the blindness of thinking, to improve the efficiency and success rate of the thinking, but also to change tangible thinking way into the invisible wisdom instinct.

155.4.2 Should be Pay Attention to the Problems in the Teaching Process

1. To overcome the "inertia" of the fixed thinking modes and the "inert" unwillingness to challenge difficulties.

In the long-term life and work, everyone formed their usual relatively fixed thinking trends or patterns and attitudes including the purpose of thinking, values, form of thought, perspective, method and line. People usually put themselves into the accustomed frame of mind and rapidly associate old knowledge and skills to think and deal with them along accustomed thinking track when they face with a thing or practical problems. This habit is the fixed thinking modes (Jin 2006; Ning and Qinglin 2005; Zhang et al. 2011; Xiaofeng and Weijie 2009; Weiwei and Qinglin 2008). When dealing with everyday things and the general routine, fixed thinking modes can play an active role to treat the same or similar experience easily and save a lot of groping, tentative steps of thinking and improve efficiency. But when faced with new things, new problems and new situations, it will be a negative effect and become thinking shackles to hinder the generation of new ideas (Jun 2005; Qiwei 2005; Cheng and Zhou 2007; Chen 2005). Fully understanding the objective existence of the fixed thinking modes, and clarify their types, causes and bad effects in the innovation process in order to take the initiative to overcome these mental obstacles, eliminate the binding effect and explore one's own creative potential.

The inertia is the lazy nature of man. Encountering difficulties in learning, students often choose to give up because of the inert psychological. There are some difficult in learning a combined body lack of ability of spatial imagination and structure shaped. Teachers should provide method of solutions problems to help students build self-confidence to effectively overcome the inert psychological.

2. During the learning of the corresponding relations of space to plane, plane to plane, students should create a spatial thinking model firstly, and then complete thinking migrate through the various links between the different things (Lenovo). The habits of mind can be developed to change the direction of thinking in order to train flexibility of thinking.
3. The good quality of thinking is developed must follow the law of human cognition. In analysis the spatial relationships of geometric elements, not only need to apply the theoretical knowledge, but also with the visual means, for example look a pencil as a straight line, set triangle ruler or other cardboard as a plane, the book or the walls of the room as the projection system, and so on. This way can help students to build the space conceptual model by simulation.

155.5 Conclusion

Theoretical and practical of the engineering graph recognition course work for the cultivation of engineering and technical quality, spatial imagination, and innovation design capabilities. To design a variety of teaching methods from different perspectives has become a key issue in the course reform. Seeking new insights and sublimation is to promote deeply development of creative teaching. This paper discusses the intelligent training method of creative thoughts and application ability with learning of the engineering graph recognition course for students in computer science and technology major. The main goal of training is to improve the thinking quality of students and to help them learn and master a variety of scientific thinking way, to fully develop the brain potential of students, so that students have the basic qualities of excellent engineers.

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Chapter 156
Watching the Theoretically Educational Hysteresis Quality of Universities from the Historical Position of Marxism

Ya-wei Bao

Abstract The historical status of Marxism and the hysteresis quality of current university education in Marxist theory are closely related issues. Marxist theorists conducted a comprehensive research on the status of Marxist theory and explored a number of practical significance of Marxist theory. Ideological and Political Theory Teachers reflected on effect of Marxism Education in many different ways and revealed the existence of Marxist theory on various issues in education. However, both Practical Significance of Marxist theory problems and Marxist theory problems of lack of innovation in education are needed for further study, which can promote the historical process of Marxism in China and play ideological function of Marxism in the social construction in China.

Keywords Education of Marxist theory · Philosophy · Reality · Lag

156.1 Introduction

As a guidance and programmatic ideology of our country's politics, economy and society, Marxism has already deeply imprinted in all levels of Chinese society (He 2009; Li and Tang 2009; Zhao 2009). Marxist Philosophy in particular, the

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Y. Bao (✉)
Yancheng Institute of Technology, Yancheng, China
e-mail: 13056185666@163.com

Y. Bao
HoHai University, Nanjing, China

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great significance of its philosophical significance lies in its scientific, that is its world outlook and methodology's guidance on the social construction. Nowadays in China, with the wave of reform and opening up engulfed, not only economic prosperity, and diverse ideas come out, the more worrying is the faith and ideals, moral and spiritual loss. Marxism could not escape the robbery. Facing such a situation, training as a nation, the cradle—Colleges and Universities, should assume its responsibilities (Yuan 2007).

156.2 The Historical Status of Marxist Theory

May 4, 1919, sponsored by the May Fourth Movement of young students has greatly promoted the spread of Marxism in China and the Chinese labor movement combination. Communist Party of China was established in 1921, as the ideological weapon of the Chinese communist, communist world outlook and social revolution behalf of the Chinese revolution in the direction of ideological and cultural front. In modern China in a number of philosophical debate, Marxist historical materialism, with its practical, development and scientific victory, 20 to the 20th century, the late Marxist dialectical materialism spread from a time, dialectical materialism materialist method flood swept the country. Philosophical theories of Marxism with China's concrete practice of revolution, specifically the use of materialist dialectics to China's revolutionary war, the Chinese Communist Party achieved a great victory. With the victory of the Chinese democratic revolution, Marxist philosophy in China becomes the dominant philosophy of the mainstream (Yuan 2007).

Ancient Greek philosophy "philosophia" translation from the Greek is the meaning of love and the pursuit of wisdom. Ancient philosophers like claiming to be "philosophos" is the love of a wise man, which also have to learn the wisdom of philosophy in the world. As our guiding ideology, mainly in the field of social and political, economic and cultural fields, Marxist philosophy plays an important role. College students, as the builders of China's socialist modernization and successors, and its ideological and political quality of the healthy development of vital, therefore, the profound meaning of Marxism with the mark of their minds is the armed college students the importance of ideological and political education way.

156.3 The Significance of Marxist Theory for Young Growth

Growth and development of young students are always closely related with their own nation, the state's fate, and in different historical periods, they carry a different mission (Li and Wang 2005). May Fourth Movement, as a new force, young students pull off the new-democratic revolution. Fourth youth, they are patriotic, just; they support the truth, defy violence; their youth boosts, their spirit heritages. In the 91 years later, the students walking in the forefront of the times, in today's complex ideology, face the new challenges of healthy development of thoughts with acceptance of the baptism of higher education, and mastery of the advanced science and technology. Marxist theory, as the practice of the truth, is significant to the growth and development of college students:

156.3.1 Establish a Correct World Outlook, Outlook on Life and Values

Marxist philosophy is the unity of a scientific world outlook and methodology and practical, revolutionary and scientific unification, as well as most general science about the nature of society and thinking development. Through the study of Marxist philosophy, students are capable of understanding the modern society developing rules and having firm beliefs in socialist: "philosophical thinking contributes to link the past, present and future in an understanding vision to form a whole." University stage is a crucial period for young students to form the correct world outlook, the outlook on life and values. Reasonable use of Marxist philosophy makes college students correctly understand social phenomenon, edify moral sentiment, enhance the thought state, and finally realize the life's rapid development.

156.3.2 Improving Ability of Understanding Practice, and Critical and Argumentative Skills

"Dialectics of existing things in the certain understanding and contain the negation of existing things", "dialectic do not worship anything, their very nature is critical and revolutionary." Universal connection of things, the eternal development, progress and setbacks in unity are the universal laws of development of things. Conditional relative identity and unconditional absolute struggle constitutes the driving force behind all things. Materialist dialectics guide students in their daily study and work, to find and reveal the internal and external links between things, grasp the principal contradiction, understand the phenomenon and the nature of things, and have the temerity to question, to ask questions and criticize issues in order to achieve secondary awareness of the negative, to inspire innovation in practice, and foster the spirit of scientific speculation (Wang 2005).

156.3.3 *Improving Self-Discipline and Humanistic Quality*

The formation and promotion of human qualities is neither anxious, nor easy, but a gradual, subtle process. The key is to learn and practice all the time. People want to improve the quality of the human self must have some knowledge of the humanities. There are many, and unbounded channels to have an access to human knowledge. However, in the summary of the general laws of human society in many books, the general method of researching questions to the human spirit is even more difficult to be replaced by other forms, while Marxist philosophy is the essence of these refined.

156.4 Theoretically Educational Condition of Marxism Under the Background of the Modern Society

Cultivating good and healthy psychology need base on the chara Throughout our tests, the entrance examination, R&D and national and local officeholder exam, political theory, as a must subject, has occupied an important position. Marxist theory, as the basis and core of political and theoretical study, has been also drawn much attention. Colleges and universities have complied with the regulations of our country, listing the Principles of Marxism as a must for all the students from all majors in succession. The realistic situation is quite embarrassing which is hiding under the context of this prosperous implementation and learning (Cao 2007).

156.4.1 *The Oriented-Exam Education has Made the Contemporary College Students Learn How to Bluff Out the Marxism Exam*

When we type in some key words like the Principle of Marxism, the pre-exam guidance and those websites in this area will follow. Whenever R&D, officeholder exam, the Ads on the pre-exam remedial class are dazzling. In numerous subjects, politics and the remedial classes on the public basic knowledge are fairly tight these phenomena have put a serious problem into our vision (Peng 1998): exam-oriented education. In the late 1980s and early 1990s, China began to comprehensively transform from the traditional education to the quality education. 20 years have passed, our country got a group of high quality talents, however, we witnessed the bad consequences brought by the examination-oriented education. Exam-oriented education completely meets the requirements of examination, teaching and learning what we will test, neglecting “morality”, lack of “exercise,” devoid of “virtue”, getting rid of “fatigue”, we just set exam as the mere purpose, but never attach importance to students’ quality, which will lead to a misunderstanding among our college students and make us understand the philosophy and ideology of Marxism one-sidedly, but neglect the important role that the Principle of Marxism plays in the quality development of college students. All these can only add the quantity on the knowledge of the Marxism, but can not give a raise on the essance of their thinking methods and ability.

University students' have a widespread deviation on the understanding of the marxist principle, equating it to general education, the public basic education in universities equals to the "minor course" in primary and secondary schools, we just need to take some time to review before the examination, giving a perfectly individual play in the exam and acquiring complete liberation after that. University students' have a widespread deviation on the understanding of the marxist principle, equating it to general education, the public basic education in universities equals to the "minor course" in primary and secondary schools, pre-exam take time to back a back, exam by individual rendering play, exams can completely "liberation". The study of Marxist ideological quality is just the schoolwork burden for students by no means an enlightenment to their thinking.

156.4.2 The Market Economy Make the Utilitarian full of the College Campus

Marx pointed out: "The mode of production of material life restricts the whole process of social life, political life and mental life. "Since the reform and opening up, the construction of the socialist market economy has unceasingly developed, and the social transformation in China impacts many college students' values in many aspects, ways of thinking present pluralistic development, some students' thoughts have changes essentially. In the market economy system, personal ideals and goals have become more and more materialized. In such a social environment, college students' values produce deviation. They regard the material as the main standard, hedonism and money worship, these trends are eroding these immature youth; The brand new value practices from market economy have brought them with rich material comforts, the strengthening of personal interests made part of college students produce personal standard when they deal with the relations between the individual interests and that of groups as well as our country (Wong 2001).

Under the rules of the survival of the fittest, corruption can't be prohibited and the problems of distribution imbalance emerge endlessly, all of which have made them can not be able to understand the injustice phenomena of our society as well ad the existent historical reasons, the wrong social observation makes them be keen on meeting their own interests through speculation; Lack of lasting value experience make students cannot determine their lifestyle, the thoughts of pragmatism encroached on their minds and their lofty ideals gradually fade away. With the deepening development of market economy, the Marxist ideology is increasingly blurred, for university students who are in growth period, all of which are not good for setting world and life outlook.

156.4.3 Popularization of the Network Technology Make Various Ideology full of Contemporary College Students

In the process of economic globalization. The internet has become an important channel for college students to obtain information and resources. Though the internet bring people with great content, those mixed information and varied virus have caused great negative effect on college students who are in the period of developing their life and world view. The increasingly developing internet, the crash and conflict of multiculture as well as all kinds of thoughts and opinions impacting on college students' though are gradually changing their ways of thinking. Their ideologies are tending to be diverse and some ideas and values which are against Marxism are popular among college students. In the process of international corporation, the competition of economic system of different types, the main ideology of western society together with new liberalism have been constantly criticise our thoughts of Marxism. Some western countries try to assimilate us by the penetration of ideology. So the internet provides technological condition for the penetratin and expansion of different ideologies making the previous ideology face serious challenge. Some college students have poor awareness about morality, weak ability of telling what is wrong and right, can not recognize the values promoted on the internet. So it is quite easy for them to fall in the traps of relativism and individualism. Their ways of thing are gradually passive. Some thoughts whish are against Marxism are put forward which make the education of Marxism nearly extinct.

156.5 College and University Teaching is Akey Step to Establish the Historical Base of Marxism Theory

The teaching of is an effective way to ensure the status of Marxism theory and is a key step to maintain the mainstream ideology of Marxism theory. In turn, applying Marxism philosophy to the teaching of Marxism theory takes advantage to improve the teaching effectiveness of this political theory course and get rid of the present difficult position and the lag aspect. How the college and university establishes the Marxism theory in the theoretical teaching is to find the problem of Marxism theoretical education from the social background in the college and university in the present situation and then solve them.

156.5.1 Rich Second Class, and Actively Organize Scientific Practice

The essence of Marxism which students can comprehend is very limited in the short first practice teaching, colleges and universities in the theoretical teaching process should be positive for students to create the Second class with diversified forms and wide-ranging contents in order to combine the political and ideological standards with professional quality education and national and social values goals with objectives of individual students. The new ways of working and communication system realize the dream of interaction of teaching and learning, participatory and collaborative design. Make Marxism Education vivid, and Marxism theory visualized, get rid of the boredom and stereotypes of class. Learn and master the theoretical knowledge through personal practice.

156.5.2 Integrate Multi-Cultural, Grasp the Latest Theoretical Results

With the continuous development of society, Marxist ideology itself is undergoing a process of continuously strengthening and developing. "theoretical system of socialism with Chinese characteristics" in the party's congress makes the proposed outcome of Marxist theory as a unified organic whole and has greatly enriched and developed the Marxist theory. The main ideology of the Marxist ideology determines our building necessarily to be guided by Marxism-Leninism, Mao Zedong Thought, Deng Xiaoping Theory and "Three Represents" important thought and to thoroughly implement the scientific concept of development. Colleges and Universities in the theoretical teaching process should firmly reject the negative social ideology, but also pay attention to the integration of some of non-mainstream ideology, getting its essence, and mastering it, merging the ideology of Marxism with other edge ideology and cross a certain extent, when restricting and guiding the development, rich and maintain their own ideology of Marxism, and promote the harmonious development of diverse ideologies.

156.5.3 Strengthen Supervision on Campus to Promote Healthy Network Communication

Along with the spread of the net-work, geographical limitations of traditional network no longer exists, people exchanges are no longer bound by time and space (Wed 1999). Individuals of different attributes can speak freely on the network. At present, many colleges and universities have applied the school ICT information platform, which is a good practice. Through the network information platform, we can keep abreast of the thinking of students. In the College teaching process, theoretical, ideological and political Teachers can also use this easy way to communicate with the students, thus instilling in the nurture of a correct world outlook and values.

In promoting the status of Marxist theory of history, we must seize the higher education in Marxist theory which is a key step. In the teaching of Marxist theory. Marxist theory must be integrated into the philosophy. Only people see the lag of teaching Marxist from the reality of the status of Marxist theory, can the development of Marxist theory solve the urgent problems faced by and ensure the current status of the mainstream thinking of Marxism theory in China.

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Chapter 157
An Analysis on the Employment Characteristics of Engineering Graduates in China

Cheng Jiang, Xiao-hua Wang and Xiao-jun Zhao

Abstract Based on the national scale of engineering graduate surveys conducted in 2003, 2005, 2007, and 2009 by Peking University, this work provides a statistic comparative analysis and quantitative study on employment results and job search process for the engineering graduates in China, as well as on the development trends with the massification of China higher education. Policy suggestion is raised based on these empirical results.

Keywords Employment characteristics · Engineering · Graduates · China universities

157.1 Introduction

In 1999 the Ministry of Education of China issued "the 21st Century Education Revitalization Action Program", which announced that the net enrollment rate of higher education should reach 15 % of the relevant age group to 2010. Since then the scale of higher education has undergone a historic change in a short period of

C. Jiang (✉)
Graduate School of Education, Peking University, Beijing,
People Republic of China
e-mail: cjiang@gse.pku.edu.cn

X. Wang
China Economics and Management Academy, Central University of Finance and Economics, Beijing, People Republic of China
e-mail: wangxiaohua@cufe.edu.cn

X. Zhao
School of Economics, Peking University, Beijing,
People Republic of China
e-mail: zhaoxiaojun@pku.edu.cn

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five or six years, and the university enrollment expanded by nearly three times. But in recent years these series of increased enrollment has begun to bring far-reaching impacts on China's modernization development and result in some other kinds of social problems (Yue and Ding 2003).

Firstly, it is undeniable that the increased enrollment happened in such a short period, and so more and more people have the right to equal access to higher education quickly. But most experts consider the university expansion as short-term economic means to stimulate domestic demand and ease the pressure on employment. In addition, some research point out that more young people go to college would cause a serious shortage of skilled workers (Educating the engineer of 2020; The engineer of 2020).

The number of graduates increases every year, which causes a direct difficulty of college students' employment, and increases the pressure on postgraduate entrance examination. The problem of qualifications devaluation has been the hot topic in some literature, but the employment situation and characteristics of engineering graduates have not been studied quantitatively. In this work, we will use the large sample of engineering graduates in China colleges to reveal some more profound social phenomena and relationship between the major and individual factors (Blaug et al. 1969).

157.2 Methodology

157.2.1 Data

This study is based on four national surveys of graduate conducted in 2003, 2005, 2007, and 2009. These data sets are organized by the Institute of Economics of Education at Peking University. The following analysis will adopt the subsample of the total four surveys, only including the engineering major graduates. As is shown in the Table 157.1, 70 % of graduates are male, and "985 or 211 Project" universities account for less proportion relative to the other colleges or universities.

Table 157.1 Sampe description

	2003	2005	2007	2009
Total sample	18,723	21,220	16,388	21,753
Engineering major	6,180	5,520	3,579	6,960
Male (%)	72.4	75.5	70.9	74.1
Female (%)	25.8	24.5	29.1	25.9
East area (school number)	16	14	17	21
Center area (school number)	8	9	9	5
West area (school number)	21	11	2	3
"985 project" universities (number)	4	5	3	3
"211 project" universities (number)	8	4	1	6
Other colleges or universities (number)	32	25	24	20

157.2.2 Methodology and Software

Here we will firstly use the statistic comparative analysis with the sample, then the classical logistic model to find the determinants of employment characteristics for the engineering students in China universities. During the process of analysis, we will use the soft of EXCEL and Solutions Statistical Package for the Social Sciences (SPSS) 17.0 alternately.

157.3 Results

157.3.1 Employments Rate

From the large sample data of engineering graduates, we find from 2003 to 2009, the largest proportion of the graduates still could search their jobs before they leave campus, although in 2007 this proportion drops dramatically. We should remember in August 2007 the US loan credit broke out. The American stock market has fallen constantly (Zhang et al. 2011). As the worlds' economies are becoming more connected, it has dragged global stock and industry market down over half a year. From our sample, it still has an effect on graduates' employment in 2009.

We could also find in the first decade of this century, one-fifth of the engineering graduates could not find satisfactory jobs when they finish their course study. Another significant change is the percentage of free-lance graduates. In 2003 and 2005, only 3.1 % or less of graduates would choose self-employment or flexible employment, but in 2007 this number has increased by nearly four times (Table 157.2).

157.3.2 Starting Salary of the Engineering Graduates

The growth trend of starting salary of the engineering graduates is very clear, although the Finance Crisis in 2007 has a very short and negative effect on the

Table 157.2 Emploment situation of engineering graduates (%)

	2003	2005	2007	2009
(1) Find a job	52.4	62.4	49.1	45.8
(2) Looking for a job	22.6	11.4	23.4	22.7
(3) Free-lance	3.1	2.9	11.7	8.5
(4) Go abroad	15.8[a]	1.5	1.4	2.3
(5) Further study		16.2	9.4	17.7
(6) Voluntary unemployment	4	3.9	4.1	1.8
(7) Others	2.1	1.8	1	1.1

[a] In 2003, (4) and (5) are counted together

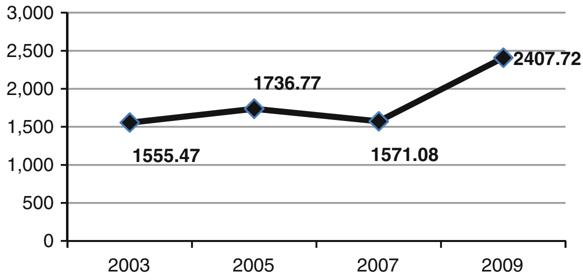

Fig. 157.1 The trend of starting salary of engineering graduates (yuan)

starting salary. In 2009, the starting salary of engineering has exceeded 2,000 Yuan. From 2003 to 2009, the average salary per month of engineering graduates has grown almost 1,000 Yuan, at a rate of 8 % every year (Fig. 157.1).

157.3.3 Distribution of Working Place

With the acceleration of urbanization process in China, large numbers of rural residents flocked to the cities. The employment of Engineering students' is also no exception (Chen et al. 2006, Liu 2009). From our data, we could see more and more engineering graduates are working in the cities, to 83.9 % in 2009, while only 3.2 and 1.2 % goes to the villages and towns or other rural areas. This result perhaps is closely related with the major characteristics, because in cities the industry is certainly more developed than in the rural area (Table 157.3).

157.3.4 Satisfaction of Engineering Graduates' Employment

Satisfaction degree of employment is a composite indicator to measure the employment outcomes. Overall, with the advance of industrialization, the engineering students' employment satisfaction is becoming higher and higher. Only 7.9 % feels unsatisfied with the employment results, which significantly less than other major, especially the Liberal arts college students. Furthermore, if we carefully examine this issue, we find the engineering graduates in the East Area are more satisfied with their jobs than their peers in the Middle or West Area (Table 157.4).

Table 157.3 Woking distribution of engineering graduates (%)

	2003	2005	2007	2009
Large and medium-sized cities	82.0	78.8	76.9	83.9
County towns	14.3	15.3	15.1	11.7
Villages and towns	3.0	4.1	5.3	3.2
Rural area	0.7	1.8	2.7	1.2

Table 157.4 Satisfaction degree of engineering graduates (%)

	2003	2005	2007	2009
Very satisfied	5.4	4.3	12.6	14.0
Satisfied	38.8	35.2	37.4	41.4
Medium satisfied	47.6	49.5	41.8	36.8
Not satisfied	6.6	9.0	6.7	6.3
Extremely not satisfied	1.6	1.9	1.4	1.6

157.3.5 Determinants of Employments and Satisfactory

To screening the determinants of employment results and satisfactory degree, we use the classical logistics model and regression method. Here the dependent variables is from the question "whether you have found your job when you leave the campus?" and "whether you feel satisfied with your first job?"Both are Binary variables. The independent variables have rich contents, including the gender, Ethnic, academic achievement rankings, internship experience, level of the school, father's educational level, family income levels, family residence, father's occupation.

For the employment results, internship experience and father's occupation are the most significant determinants. For the job satisfactory, gender, level of school and family income level play a very important role. We come to a conclusion that family background, working experience and income are the code terminates of employments for the engineering graduates in China.

157.4 Discussion

We found that with the accelerated process of industrialization and urbanization in China, the engineering students' employment environment is getting better, and the wage level and satisfaction degree could confirm this argument. Of course, what we must be wary of is that the Financial Crisis, and such kind of great changes will have profound impacts on the employment outcomes of engineering students (Su 2007; Shen et al. 2007; Daudt and Salgado 2005).

157.5 Conclusion

In this study, we adopt the large sample data of engineering graduates in China and statistic methods to analyze the employment characteristics and trends.

With the rapid expansion of university enrollment in China, employment of college students are becoming more prominent. But the quantitative research on the employment of domestic engineering students is few. This research gives us a basic and comprehensive description on the employment results for the engineering graduates in China. Firstly, the engineering students' employment results are closely related with the macroeconomic environments, such as the process of industrialization, urbanization or globalization. Secondly, judging from the micro-level, the individual's ability and family background also have a significant impact on employment outcomes. For the considerations of job satisfaction, gender and the wealth of the family play an important role (Poser 1998; Andrea 2006).

Generally speaking, the engineering students' employment is affected synthetically by the macro environment, family background and personal factors (Sun and Ran 2010; Wang 2012; Wu and Cao 2011).

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