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Computer Algorithms and Their Applications

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Algorithm, “a set of rules that precisely defines a sequence of operations”, is the base of programming skills. Computer supported and algorithm based technologies have been developed and widely applied in various domains in recent decades. The cloud computing, big data and other emerging technologies have been recognized by more and more users. The researches on algorithm to improve the performance are becoming increasingly important.

The aim of Vol. 2016, No. E7 of RISTI (Revista Iberica de Sistemas e Tecnologias de Informacao) is to provide original and the latest contributions in computer algorithms and their applications as progressed from the initial scientific contributions, and to introduce emerging computer concepts, algorithms, developments, evidences, and their industry implementations.

We gratefully appreciate the authors for their scholarly contributions, and all the included contents were anonymously reviewed by distinguished experts to maintain academic excellence and integrity. All submitted papers are clearly written in excellent English and contain only original work, which has not been published by or is currently under review for any other journal or conference.

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An Efficient Access Selection Algorithm Based on Improved Genetic Algorithm in Cognitive Networks

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Abstract: As the core technology of cognitive networks, network access selection plays an important role in cognitive networks technology system. In order to improve the performance of access network and enhance the user experience, an efficient access selection algorithm based on iGA is presented. Through the establishment of access selection model, network access selection problem is converted into a constrained optimization problem. Then, an improved genetic algorithm iGA is introduced to solve the optimization problem. To determine the most reasonable initial population, Hamming distance is introduced to quantify the distance between individuals. In addition, heuristic crossover is presented to improve the quality of the population and accelerate the optimal solution searching speed using its local optimization capability. Meanwhile, two important parameters as crossover probability and mutation probability are adjusted adaptively to prevent falling into local optimum solution. At last, real-time and non-real-time services are used for algorithm simulation experiments. Simulation results show that compared with other algorithms, iGA can reduce access blocking rate and packets loss rate, improve access network performance to some extent.

Keywords: cognitive networks, improved genetic algorithm, network access selection, adaptive parameter adjustment.

1. Introduction

As we all know, cognitive networks build on heterogeneous networks such as 3G, 4G, LTE, UMTS and other networks (Akyildiz, F. et al., 2006; Esteban, S. et al., 2014; Konak, A. et al., 2006). The core capability of cognitive networks is that can observe, understand, plan, reasoning and decision-making for the current network environment, by adjusting network parameters and configuration dynamically, thus adapt to change the network environment flexibility, as well as decision-making of the future for the purpose of end to end (Fortuna, C. and Mohorcic, M., 2009). As the core technology in cognitive networks technical system, access selection determines the level of customer service performance. In the traditional heterogeneous network environment, the selection of access network is

mainly based on the level of network signal strength, network had higher signal strength is considered to be the optimal network access network. This decision is very simple and easy to implement, but if the network choose has a lower network bandwidth, or network instability, it cannot give the user a good experience.

To solve the question above, academia proposed a series of access selection methods based on multiple-network attributes such as network bandwidth, network delay, load balance, network stability and so on. Thus, the network access problem can be seen as multi-attribute decision making problem. Researchers proposed a variety of access selection methods for heterogeneous networks based on multi-attribute decision. In this paper (Li, J. et al., 2008), an access selection is proposed based on gray relation analysis and multi-criteria decision, by transforming access selection into multi-criteria decision, the effects of access selection parameters were considered comprehensively and an appropriate access network was supplied for the terminals. This method can make the optimal access selection decision in a relatively short time, but it lacks the ability to learn and adapt to the changes of access network environment, would be difficult to cope with the access selection in a higher complexity heterogeneous network environment. (Chen, Q. et al., 2010) introduced a user-oriented visualized operational scheme at user terminal, it is based on cooperation between different network properties and competitive relationship between the user and service providers to establish a unified network – user game model, by solving the Nash equilibrium price to determine the network optimization pricing mechanism. (Wang, H. et al., 2012) presented an intelligent access selection algorithm based on fuzzy neural network, for this method network bandwidth, delay, load balancing at network side and moving speed at terminal-side are considered as access factors determined the pros and cons for access network. Because of fuzzy neural network has a strong learning ability, can adjust the relevant parameters according to the change for network environment and the user requirements in the process of continuous access, so that the terminal can always maintain the optimal network access.

Compared with traditional heterogeneous network access selection method, multiple access selection factors such as access network, users, services and terminals are considered, the access benefit and effect are substantial increase, while the introduction of machine learning, intelligent optimization algorithm, resulting in the computational complexity increased significantly, access efficiency will declined. In this paper, a new algorithm based on genetic algorithm is proposed, of which the issue is converted into a multiple attribute optimization problem, then genetic algorithm is used to solve the global optimization problem. By keeping the appropriate length of the chromosome and optimizing the fitness function of the population, the convergence rate of the algorithm and reliability of the obtained solution are both improved. In addition, parameter adaptive mechanism is introduced to prevent falling into local optimum solution prematurely. Compared with the traditional genetic algorithm and other multiple decision-making algorithms, the method in this paper has more advantages in access selection efficiency, can improve user experience to a certain degree.

2. Access Selection Model

In cognitive networks, when terminal (cell phone, pad, etc.) within the network coverage area and try to access the network, network access selection mechanism will be triggered.

Access scenario is shown as Figure 1. Assume that the user area is covered by N wireless networks, access selection needs to consider m access factors such as the available bandwidth, blocking rate, delay, received signal strength, service charges and etc. The j^{th} ($j=1,2,3,\dots,M$) evaluation index for the i^{th} ($i=1,2,3,\dots,N$) alternative access network is denoted as a_{ij} , ($1 \leq i \leq N$, $1 \leq j \leq M$).

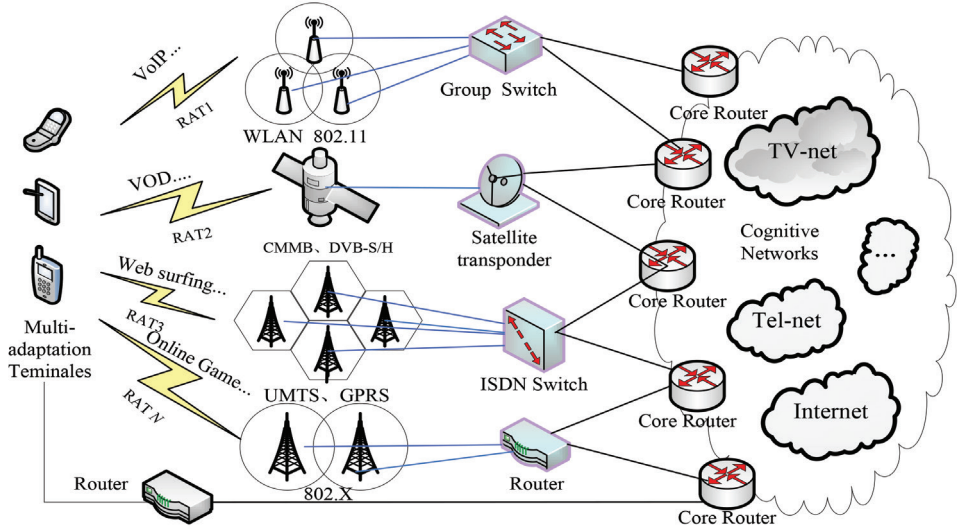


Figure 1 – Access Selection Scenario for Cognitive Networks

For this type of multiple attribute decision-making problem, we need to determine the relative importance of each evaluation index, the importance of evaluation index depends on its weight, the greater the weight, the more important for its corresponding evaluation index. Therefore weights correctly solved have very important significance for multiple attribute decision-making making the right decision. Assume the sample for each network evaluation index is $\{a_{ij} \mid i=1,2,3,\dots,N, j=1,2,3,\dots,M\}$, then the initial judgment matrix A can be constructed as follows

$$A = \begin{vmatrix} a_{11} & a_{12} & a_{13} & \dots & a_{1M} \\ a_{21} & a_{22} & a_{23} & \dots & a_{2M} \\ \dots & \dots & \dots & \dots & \dots \\ a_{N1} & a_{N2} & a_{N3} & \dots & a_{NM} \end{vmatrix} \quad (1)$$

Access selection index is diversity in cognitive networks, it makes the evaluation of indicator variables lack of consistency measure. In order to facilitate the analysis, we need to normalize the raw data. For cost index such as network congestion, latency, service charges and etc use formula (2) to normalize. And for the benefit index such as available bandwidth, received signal strength, length of stay, etc. use formula (3) to normalize.

$$\overline{a_{ij}} = \frac{a_{j\max} - a_{ij}}{a_{j\max} - a_{j\min}} \quad (2)$$

$$\overline{a_{ij}} = \frac{a_{ij} - a_{j\min}}{a_{j\max} - a_{j\min}} \quad (3)$$

The j^{th} index corresponding weight is set to c_j ($j = 1, 2, \dots, M$), $H(i)$ ($1 \leq i \leq N$) is network utility function, can be obtained by calculating the summation of evaluation index weight and index weighted sequence a_{ij} as follows.

$$H(i) = \sum_{j=1}^M c_j a_{ij} \quad (4)$$

By calculating each evaluation index weight distribution $c=(c_1, c_2, \dots, c_M)$, we can get the utility value for all the candidates access network, then the $\max\{H(i)\}$ corresponding network i can be as the preferred access network for terminals. $c=(c_1, c_2, \dots, c_M)$ is a vector, c_j represents each index weights to be met in the interval $[0,1]$. Constraints are shown as formula (5).

$$\begin{cases} 0 \leq c_j \leq 1, j = 1, 2, 3, \dots, M \\ \sum_{j=1}^M c_j^2 = 1 \end{cases} \quad (5)$$

In fact, for different network services, weight distribution scheme is different for the same evaluation index. For example, for streaming media service, available bandwidth occupies a more important role in the distribution of weight, but for a real-time call, network latency is a key consideration factor. Accordingly, for different service, we rewrite formula (4) as follows.

$$H_{(i)}^k = \sum_{j=1}^M c_j^k a_{ij} \quad (6)$$

Where k denotes the service type.

Thus, in order to assess the performance for each alternative access network properly, we need to find the optimal weight distribution evaluation program, and then the network access selection problem is converted into a constrained optimization problem. In this paper, we design a genetic algorithm to solve this constraint optimization problem.

3. Genetic Algorithm Design and Implementation

As an efficient, parallel, global search optimization method, genetic algorithm (GA) has strong robustness and adaptability to solve complex optimization problems that traditional optimization methods are difficult to solve. But there still exist some limitations such as

the search will be slower when close to the global optimal solution, and the individual diversity will soon be reduced, even fall into the local optimal solution. Based on this, this paper proposes an access selection strategy based on improved genetic algorithm (iGA), the algorithm introduces the greedy method into species initialization. In order to improve the optimization speed and prevent the local minimum, the improved algorithm updates the crossover probability and mutation probability adaptively according to the evolution stages and the fitness value of individuals.

3.1. Fitness Function

In this paper, the key of network access selection is to determine the weight for evaluation index c . The more obvious for overall performance gap between each alternative access network, the more easily and quickly to determine the merits of the respective access networks. $c=(c_1, c_2, \dots, c_M)$ mapped the evaluation sequence a_{ij} to network utility value H in each optimization. With continuous optimization of $c=(c_1, c_2, \dots, c_M)$, the distribution of H will be gathered toward certain point, the more closer for the network performance, the group will be more intensive. So these groups can divide H into several categories, which is to divide alternative access network into several categories access network with significant difference of comprehensive performance. Characteristic differences between various types of access network is more obvious, the greater the distance for the group. So we can establish the fitness function $Fitness(c)$ based on spatial distribution of H as follows.

$$Fitness(c) = \frac{1}{m} \sqrt{\sum_{i=1}^m |H(i) - E(H)|^2} \quad (7)$$

$E(H)$ is average value of $H(i)$.

Then, we can estimate the weight of each evaluation index by addressing the maximization problem of fitness function under constraints

$$\begin{cases} C = \arg \max Fitness(c) \\ \sum_{j=1}^M c_j^2 = 1 \end{cases} \quad (8)$$

3.2. Improved Genetic Algorithm to Solve Access Selection Optimization

3.2.1. The basic idea for genetic algorithm to solve the optimization problem

Genetic algorithm is a generation to generation search process based on the fitness degree, mainly constructs by four parts such as encoding mechanism, control parameters, the fitness function and genetic operators (Oreski, S. and Oreski, G. 2014). General genetic algorithm solves the optimization problems as follows.

Sept 1 Generating the initial population. In this paper, Hamming distance between individuals to is used to maintain the diversity of the initial population. In the process of generating the initial population, if the Hamming distance between new individual and individual generated before less than a set value, then re-generate a new individual until a population among all individuals have some differences.

Step 2 Calculating fitness value for each individual. Formula (7) is used to calculating the fitness value of each individual.

Step 3 Selecting operator. Individual has the biggest fitness value will be chosen. Then, calculating the selected probability for each individual according to formulas as follows

$$P(c) = \text{Fitness}(c)e^{-\beta\chi_c} / \sum_{c=1}^{\text{Popsize}} \text{Fitness}(c) \quad (9)$$

β is a tunable parameter in the range of [0,1] that reflected individual fitness and concentration relative importance, for simplicity desirable β can be set to 1; χ (c) denotes the concentration of individual c.

Where

$$\chi(i) = \sum_{j=1}^m s_{i,j} / m \quad (10)$$

And

$$s_{i,j} = \begin{cases} 1, & q_{i,j} \leq \varepsilon \\ 0, & \text{otherwise} \end{cases} \quad (11)$$

$q_{i,j}$ is an index that reflects similarity of individual i and j . j is the individual similarity threshold value, in this paper, ε is set to 0.001.

Step 4 Crossover operator. Selecting the parent and pairing by the crossover probability p_u , and generates new individuals in accordance with the rules of cross algorithm, commonly used methods include single-point cross, cycle cross and etc.

Step 5 Mutation operator. In order to maintain the diversity of the population of individuals to prevent local optimization, we need to follow a mutation probability p_v to determine individual variation randomly, and perform the appropriate mutation. Generally we use reverse mutation operator.

Step 6 Iteration termination conditions. If the predetermined termination condition (the maximum number of iterations) is met, then stop the iteration. Otherwise, go to Step 2, and calculate the fitness value for each individual in the new generation population.

3.2.2. Some changes for genetic algorithm

In a simple genetic algorithm, the parameters of crossover probability p_u , and mutation probability p_v in the evolutionary process is fixed, but the actual research shows that both as a key to the performance of the genetic algorithm. Many scholars studied how to control the adaptive parameters (Ortuño, M. et al., 2013; Pizzuti, C. 2012; Putha, R. et al., 2012; Sun, Z. et al., 2010; Thakur, M. et al., 2014; Thomas, W. et al., 2006). On the basis, we set adjustment mechanism for probability crossover and mutation probability respectively.

A. Adaptive Crossover Probability Adjustment Mechanism

Crossover operator updates the population constantly, value of p_u determines the updated rate for the individual in the population. If the value is too large, the fine pattern of inheritance will be destroyed, and when the value is too small, it will induce the search speed slow, the evolution of the population is difficult. Therefore, in the early evolution, in order to expand the overall scope of the search, to accelerate the speed of updating the population, the value of p_u should be increased. In the later stage of evolution, population overall solution set to stabilize, in order to make the excellent genes structure retention and renewal, p_u should be decreased. Based on the considerations above, we set the adjustment mechanism as follows.

$$p_u(c) = \begin{cases} p_u \max - \frac{1}{2}(p_u \max - p_u \min) \left(\frac{r_{\text{current}}}{R} + \frac{Fitness(c) - Fitness_{\text{ave}}}{Fitness_{\text{max}} - Fitness_{\text{ave}}} \right), & Fitness(c) \geq Fitness_{\text{ave}} \\ p_u \max, & Fitness(c) < Fitness_{\text{ave}} \end{cases} \quad (12)$$

$$p_u \max = \begin{cases} 0.95, & r_{\text{current}} \leq R/4 \\ 0.85, & R/4 < r_{\text{current}} \leq 3R/4 \\ 0.75, & 3R/4 < r_{\text{current}} \leq R \end{cases} \quad (13)$$

$p_u(c)$ denotes the probability individual c cross. In the early evolution a higher probability is given, and in the late we can reduce the probability. R is the maximum number of iterations in the evolutionary process, and r_{current} is current iteration number. The value of $p_u \max$ associated with the number of the iterations, $p_u \min$ is 0.6. $Fitness_{\text{max}}$ is the maximum fitness value for all current individuals, and $Fitness_{\text{ave}}$ is the average fitness value of the current population.

B. Adaptive Mutation Probability Adjustment Mechanism

p_v influences the population mutation, appropriate individual variation can keep the diversity of population, prevent fall into local optimization. However, if the value of p_v is too large, the algorithm is similar to random search, and lost the characteristics of genetic evolution. So we establish mutation probability adjustment formula from two aspects such as the number of evolution generations and individual fitness value.

$$p_v(c) = \begin{cases} p_v \min + \frac{1}{2}(p_v \max - p_v \min) \left(\frac{r_{\text{current}}}{R} + \frac{Fitness(c) - Fitness_{\text{ave}}}{Fitness_{\text{max}} - Fitness_{\text{ave}}} \right), & Fitness(c) \geq Fitness_{\text{ave}} \\ p_v \min, & Fitness(c) < Fitness_{\text{ave}} \end{cases} \quad (14)$$

$$p_v \min = \begin{cases} 0.001, & r_{\text{current}} \leq R/4 \\ 0.002, & R/4 < r_{\text{current}} \leq 3R/4 \\ 0.003, & 3R/4 < r_{\text{current}} \leq R \end{cases} \quad (15)$$

Where $p_v(c)$ denotes mutation probability for individual c , p_v max is 0.05. From formula (12) we know, an individual with smaller fitness value has a smaller mutation possibility. With the increase of the number of iterations, genetic structure of individuals tend to be similar, it is likely to fall into local optimum at this time. To avoid this situation, the probability of individual mutation should be increased, and we can encourage the new individuals generated, so as to maintain the diversity of individuals.

In the early evolution, the possibility of an individual mutate is less, and in the end, increasing the probability of individual variation is conducive to expanding the scope of the search area, escaping from the local optima.

4. Simulation Results and Analysis

4.1. Simulation scenario and settings

OMNET++ and Matlab 7.0 are used to build multi-access networks experiment and analyze the numerical results. On the hexagonal cellular topology, WiMAX, TD-LTE and FDD-LTE are run as three wireless network access points. The enter of mobile terminals obey Poisson distribution, and movement locus meets the random walk model. Transmission time for real-time and non real-time service obeys negative exponential distribution, for real-time service non-real-time service we use VoIP and FTP as examples to simulate and analyze. In order to test and verify the access effect for iGA algorithm proposed in this paper, we use GA, FNN (network selection policy based on fuzzy neural network) and MLB (maximum load balancing) in literature (Wang, H. et al., 2012; Sun, Z. et al., 2010) for comparison.

Parameters	WiMAX	TD-LTE	FDD-LTE
<i>Bandwidth</i>	3.5GHz/10MHz	2.0GHz/10MHz	2.6GHz/10MHz
<i>Frame length</i>	10ms	10ms	10ms
<i>Subcarriers</i>	1024	1024	1024
<i>Transmit power</i>	36dBm	46dBm	46dBm
<i>Noise power</i>	-174dBm/Hz	-170dBm/Hz	-174dBm/Hz
<i>Packet Length</i>	512bit	512bit	512bit
<i>Arrival rate for real time and non real time service</i>	0-0.5 (services/s)	0-0.5 (services/s)	0-0.5 (services/s)
<i>Real-time service rate</i>	64kbs	64 kbs	64 kbs
<i>Non real time service rate</i>	50 kbs	50 kbs kbs	50 kbs

Table 1 – Simulation parameter settings

4.2. Numerical Analysis

4.2.1. Comparison and Analysis of Convergence

Figure.2 shows the relationship between fitness value and the number of evolution for GA and iGA. From the Figure 3 we can see, under the circumstances with the same

number of iterations, the value of optimal solution iGA found is bigger than GA, confirms that iGA has a faster speed to obtain the optimum solution and can avoid falling into local optimum. Meanwhile, iGA begins to converge at around 60 generations, and GA begins to converge at about 90 generations, indicates iGA convergence faster. In actual network access environment, faster convergence means shorter time for access selection operations, the utilization of the access network will be higher.

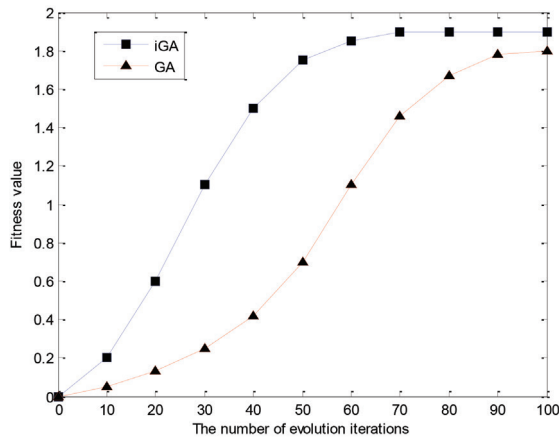


Figure 2 – Relationship between fitness value and the number of evolution iterations

4.2.2. Comparison of Average Access Blocking Rate

Figure.3(a)-(b) show comparison of access blocking rate for RT and NRT services respectively. Obviously, with the increase of the number of new calls, access blocking rate for the four algorithms all increase, but it can be found that compared with the other three algorithms, when the number of new calls more than 35, access blocking rate for iGA is lower, indicating iGA algorithm has better access performance. Especially for real-time services, access the network quickly is essential for users. From Figure 3(a) we know, when the number of arrival new calls is 50, access blocking rate of iGA is only 0.025, compared with MLB and FNN, it falls one and two percentage points respectively, and the gap is widening with the increase of new calls arrival. When the blocking rate increases to a certain extent, users will be difficult to access the network. However, the system uses iGA access selection algorithm can accommodate more users to access, thus improving the overall performance of the access network.

4.2.3. Comparison of Packet Loss Rate

In Figure.4 we can see, the trends of packets loss rate is consistent with the access blocking rate, it indicates that with the increase of the access blocking rate, packet loss rate of the access network is also sharp increase, network performance begins to deteriorate,

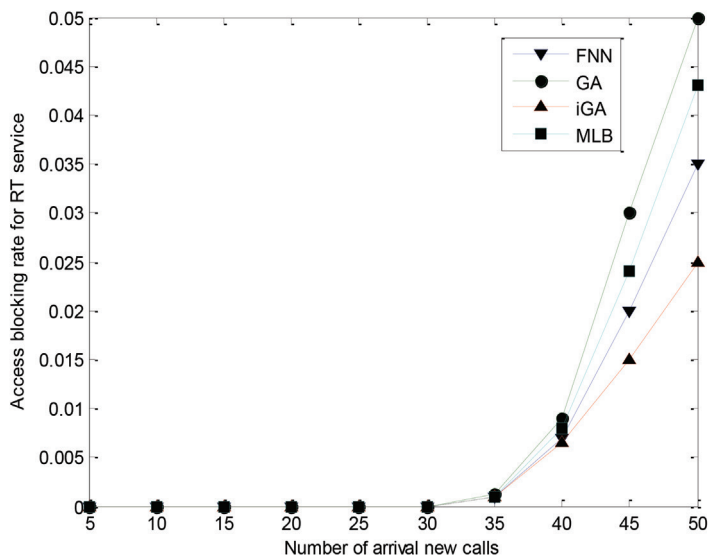


Figure 3(a) – Comparison of access blocking rate for RT services

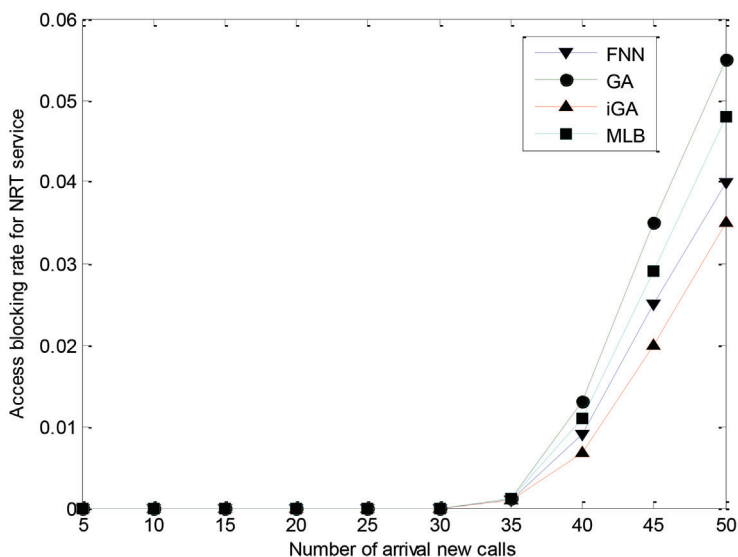


Figure 3(b) – Comparison of access blocking rate for NRT services

resulting in deterioration of the user experience. On the other hand, compared with other algorithms, iGA algorithm in the packets loss rate still has greater advantages, that indicate iGA algorithm can guarantee the performance of the access network better.

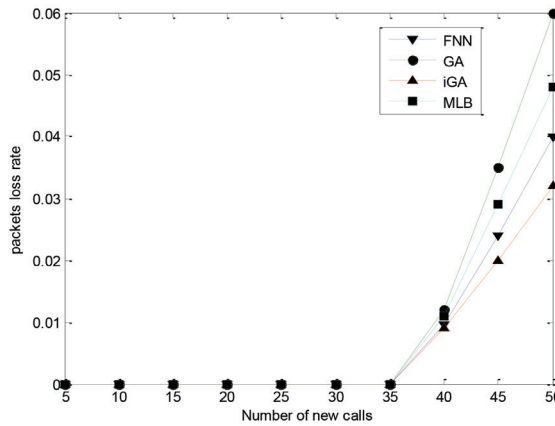


Figure 4 – Comparison of packets loss rate

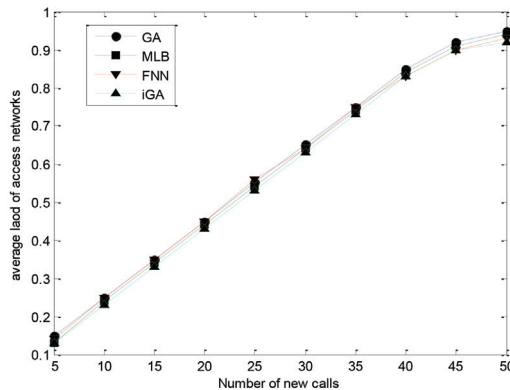


Figure 5 – Comparison of average load of access networks

4.2.4. Comparison of Average Load

Figure.5 shows the average load of access networks. From the Figure we can see, the average access network load is closer for the four algorithms, mainly due to the current network load are considered as a access factor for the four algorithms when new calls select an access network. When the access network to be heavily load, new calls turn to consider an access network with lightly load, it can prevent access network paralyzed due to too many users access the same access network. In other words, these four algorithms are able to change access networks according to the network load and improve the performance of access networks.

5. Conclusions

In this paper, an efficient access selection algorithm based on iGA is proposed to improve the performance of the access networks and user services. Firstly, access selection model is established, and the network access selection problem is converted into a constrained optimization problem. Then, in order to select the optimal solutions, an improved genetic algorithm is proposed. To determine the most reasonable initial population, Hamming distance is introduced to quantify the distance between individuals. In addition, heuristic crossover is introduced to improve the quality of the population and accelerate the optimal solution searching speed using its local optimization capability. Meanwhile, crossover probability and mutation probability as the two important parameters are adjusted adaptively to prevent falling into local optimum solution. At last, simulation results show that iGA has much advantages in access blocking rate and packets loss rate, can guarantee network performance to the greatest extent.

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Fault Diagnosis of Rolling Bearing Based on ELMD and IGK Clustering

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Abstract: A roller bearing fault diagnosis method based on ensemble local mean decomposition (ELMD) and Improve Gustafson-Kessell (IGK) clustering was proposed to deal with fault roller bearings. First, ELMD method was applied to decompose the original signals into numbers of product function (PF) component and a residuals. Then, calculating approximate entropy of the PF component as eigenvectors. Finally, the constructed eigenvectors are put into IGK clustering to recognize different fault types. The analysis results from roller bearing signals with normal, inner race fault, rolling element and out race faults show that the diagnosis method based on ELMD approximate entropy and Improved Gustafson-Kessell can accurately identify roller bearing fault.

Keywords: ELMD; approximate entropy; IGK clustering; fault diagnosis.

1. Introduction

Rolling bearing is one of the important component in the machines, which condition affect the stability, reliability and life of the machines (Ocak, 2007). Therefore, the fault diagnosis in rolling bearing has a great of significance. Due to the nonlinear and non-stationary characteristics of the vibration signal, it is hard to extract the fault information of rolling bearing.

In recent years, many vibration signals processing techniques have been developed to extract fault features of rolling bearing. For example, Yu De-jie et al. applied empirical mode decomposition (EMD) to decompose the vibration signal of rolling bearing and used singular value of intrinsic mode function (IMF) to distinguish the fault features of rolling bearing (Yang Yu, 2005). Can Yan-ping et al. proposed a kind of method, which was based on empirical mode decomposition (EMD) and improved spectral envelope of spectral kurtosis (SK) to distinguish fault diagnosis (Cai, 2011). Feng Fu-zhou et al. put forward a new method based on wavelet transform correlation filter (WTCTF) and permutation entropy to detect early fault of bearing (Feng, 2012). Liu Peng et al. combined multi-scale morphology with singular value decomposition (SVD) to extract the fault feature of bearing (Liu, 2015). Shi Rui-min et al. used the energy signatures of local mean decomposition (LMD) to identify fault type of rolling bearing (Feng, 2015). Xu Kun et al. researches on circuit fault diagnosis

based on artificial intelligence. They prove that the neural network method can greatly improve the diagnostic ability of the circuit fault diagnosis (Xu, 2015).

Due to a lot of noise signal in the rolling bearing fault signal, LMD can cause confusion of frequency distribution. Chen Jun-sheng et al. put forward the ensemble local mean decomposition (ELMD) to restrain the confusion of frequency distribution (Chen, 2011). In ELMD, different white noise was add to the original signal. Then, the noise-added signal was decomposed by LMD. The mean of several PF component was severed the final result.

In this paper, first, the fault signal was decomposed into several PF component through the method of ELMD. Then, the approximate entropy of PF component was calculated, which is dealt with as eigenvectors. Finally, the eigenvectors was accurately identify through improved Gustafson-Kessell (IGK).

2. Principle Analysis

2.1. The fault diagnosis of rolling bearing

The fault signal of rolling bearing was decomposed into a series of PF component, and the part of PF, characterizing the effective features of fault signal, was selected. The PF component contains a lot of data, which cannot be directly used eigenvectors, so the approximate entropy of the PF components was calculated as eigenvectors. Then the eigenvectors is characterized by IGK clustering. Figure 1 is a flowchart of fault diagnosis of rolling bearing.

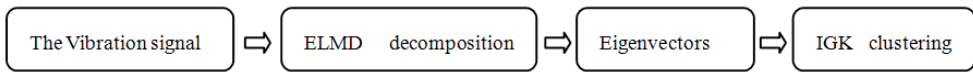


Figure 1 – The Process of rolling bearing fault diagnosis

2.2. Ensemble local mean decomposition

The local mean decomposition is a new time-frequency analysis method. The non-stationary and non-linear signal was decomposed into a plurality of PF component. Each PF component is the product of a pure frequency modulation signal and the envelope signal. In ELMD, different white noise was add to the original signal. Then, the noise-added signal was decomposed by LMD. The signal has continuity at different scales after adding Gaussian white noise, which can be used to reduce the mode mixing.

The ELMD process can be divided into the following steps (Smith, 2005):

1. The ratio α of the amplitude of the original signal and white noise.

$$\alpha = \sigma_n / \sigma_o \quad (1)$$

Where σ_n standard deviation of white noise amplitude is, σ_o is standard deviation of original signal $x(t)$ amplitude.

2. The total numbers of ELMD is M, and when execute the m of LMD,
 $m=1,2,\dots,M$.

① Adding random Gaussian white noise $n_m(t)$ to the original signal

$$x_m(t) = x(t) + \alpha n_m(t) \quad (2)$$

② The $x_m(t)$ was decomposed into k PF component by LMD. $PF_{i,m}$ ($i=1,2,\dots,k$) is the i th component of the m -th LMD.

The $\overline{PF}$ is the mean of PF component of M-th LMD.

$$\overline{PF}_i = \sum_{i=0}^M PF_{i,m} / M \quad (i = 1, 2, \dots, k) \quad (3)$$

The $\overline{PF}_i$ is result of ELMD.

2.3. Improved GK clustering algorithm

The GK (Gustafson kessell) clustering is a kind of fuzzy clustering, which can distinguish and classify faults vibration signal of no clear boundary (Krishnapuram, 1999). The process of GK clustering see the literature.

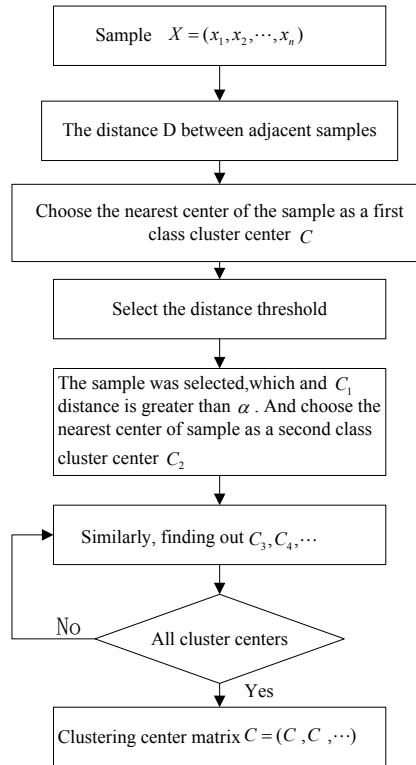


Figure 2 – The process for selecting the initial cluster center by IGK clustering

The IGK (Improved Gustafson kessell) is improved on the basis GK clustering, which improve selection of the initial cluster centers (Zhang, 2009). The specific steps are as follows:

3. Application Example

Used the rolling bearing fault test data of electrical engineering lab in Case Western Reserve University. The motor power used in test is 1.5 KW, the type for bearing used for SKF 6205, bearing's structural parameter is steel ball diameter of 8 mm, number of rolling element is 9, contact angle is 0° .

3.1. ELMD decomposition of signals

Setting the bearing rotating speed to 1750 r/min, failure diameter to 0.1778 mm, sampling frequency to 12 KHz. Each group get 2014 dates, take 40 groups as experimental samples. The test included normal, inner fault, roller fault and outer fault, the signal time domain waveform diagram of four kinds of bearing fault shown as figure 3.

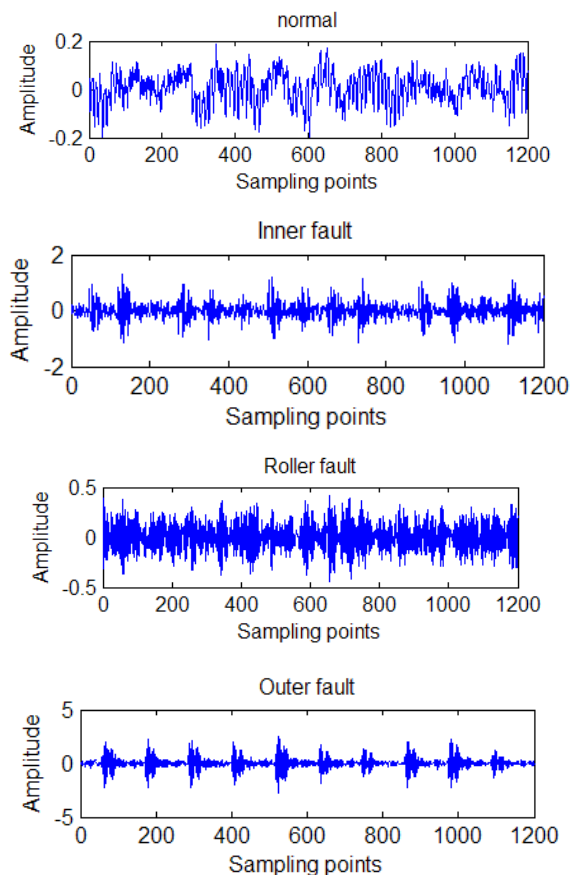


Figure 3 –Vibration signal of four kinds of bearing

Take ELMD decomposition for the vibration signal of bearing's four kinds of status, set the decomposition number to 100 times, set the ratio of white noise and original amplitude to 0.07. Take the rolling element failure for example, the ELMD decomposition results of vibration signal of rolling body as shown in figure 4, get seven PF component and a residual error.

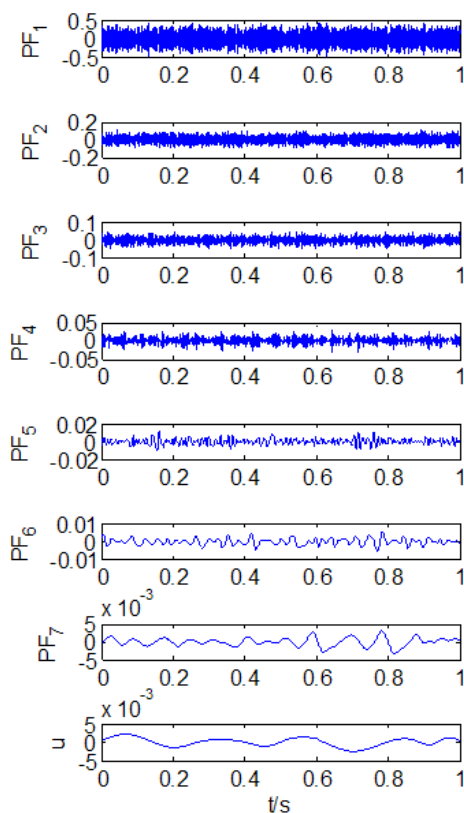


Figure 4 – Ensemble local mean decomposition results of rolling element fault signal

In ELMD decomposition process, due to the influence of noise, number of iterations and steolength, easily to cause excessive decomposition which will making PF false composition. These false compositions can affect the results of ELMD decomposition analysis, so selected PF component which can reflect the characteristics of the original signal effectively. Through calculating the original fault signal and PF component on the relations umber with each other, selected the PF component which contained the original fault vibration signal's valid characteristics.

Take the rolling element failure for example, respectively calculated the relations number between fault vibration signal and the former five PF component, the results are

shown in table 1. In table 1, the relations number between the first three PF component and the original fault vibration signal is greater than 0.1. Stated that the first three PF component contains a large number of original signal characteristics, so selected the first three PF component for analysis.

PF ₁	PF ₂	PF ₃	PF ₄	PF ₅
0.9695	0.2130	0.1147	0.0548	0.002

Table 1 – The cross correlation coefficient of first five PF components and original signal

3.2. Extraction of Approximate Entropy Feature

PF component cannot directly analysis as a feature vector because it often contains large amounts of data. While the approximate entropy can quantity PF component and can effectively reduce the dimension of feature vector. So process the PF component by the approximate entropy to extract the fault characteristic signal more simple and stable.

When calculating the approximate entropy of PF component, the choice of parameters will make a large impact on results. According to the literature, embedding dimension $m=2$, similar tolerance $r=0.3$.

Select the parameters values, calculate the approximate entropy of first three PF component under the four kinds of status, the results are shown as table 2. In the table 2, the approximate entropy of PF component under different status are different, namely that the complexity of different fault condition are different.

Bearing status	PF ₁	PF ₂	PF ₃
normal	0.2900	0.0333	0.0018
inner fault	6.4328	0.3846	0.0271
roller fault	4.2517	0.0865	0.0071
outer fault	8.7186	0.2527	0.0182

Table 2 – The fuzzy entropy of first three PF components of four kinds of bearing

3.3. IGK Clustering Fault Recognition

For the 4 roller bearing fault signals, 40 batches of samples are selected respectively. Upon ELMD process, choose the fuzzy entropy of the first 3 PF components, form a matrix of 160X3, and use IGK clustering to classify and recognize the matrix. With clustering center $c=4$, iteration tolerance $\varepsilon=0.0001$ and weighted index $m=2$, the result is as shown in Fig.5 and Fig.6 is the spatial graph of IGK clustering and Fig.6 is the IGK clustering contour. Fig.5 indicates that the result of same fault signal cluster together, result of different signals are well parted without blurring among themselves.

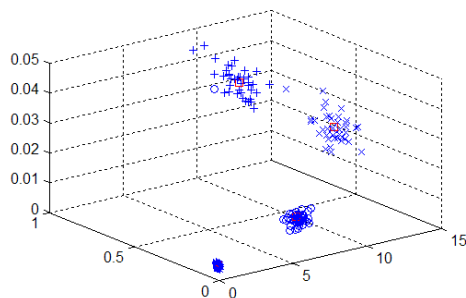


Figure 5 – The spatial graph of IGK clustering

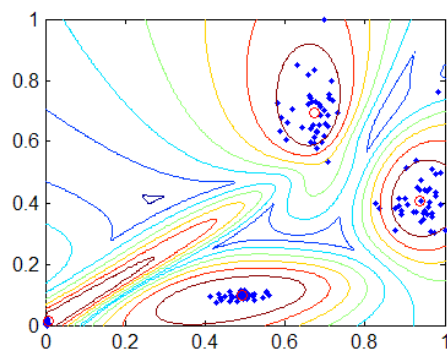


Figure 6 – The IGK clustering contour

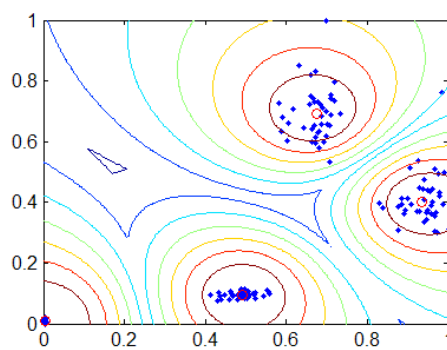


Figure 7 – The FCM clustering contour

Similarly, clustering analysis is conducted on FCM clustering matrix, in order to compare the result of IGK clustering and FCM clustering. The result FCM clustering contour is as shown in Fig.7.

Validation of clustering effect is achieved through clustering validity index. Clustering validity index assesses every approximate entropy to determine the best classification or clustering. Based on the effectiveness of the clustering, when partition coefficient PC of clustering validity index approximates to 1, partition entropy PE approximates to 0, the clustering result is comparatively better. The comparison of GK clustering and FCM clustering effect is shown in Table 3 below. It is indicated that the partition coefficient PC of IGK clustering is 0.9510, greater than that of FCM clustering and approximating to 1. The partition entropy PE of IGK clustering is 0.1402, smaller than that of FCM clustering. This illustrated that IGK clustering is more preferable than FCM clustering.

Clustering validity index	Partition coefficient PC	Partition entropy PE
IGK	0.9510	0.1402
FCM	0.9361	0.1490

Table 3 – The effect comparison of GK clustering and FCM clustering

4. Conclusions

Through the above analysis, the following conclusions:

1. The ensemble local mean decomposition can better reduce mode mixing compare to local mean decomposition, which provide PF components of fault features for IGK clustering.
2. The approximate entropy was indicated complexity of PF component. Then, the result demonstrate that the IGK clustering can distinguish different fault condition of rolling bearing.
3. Through clustering effect of IGK clustering and FCM clustering, it shows that IGK clustering can better identify different fault status.

5. Acknowledgment

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Diagnostic Research on Wireless Sensor Network Fault Based on Multicore Wavelet Relevance Vector

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Abstract: This paper presents a new diagnostic algorithm by applying multicore wavelet relevant vector on the fault diagnosis of a wireless sensor network (WSN) node based on analysis of the node fault category. As for this algorithm, four sorters are used to distinguish normal nodes from the four types of fault nodes, then the simulation test is carried out and the algorithm performance is analyzed in detail.

Keywords: wireless sensor network, multicore wavelet relevance vector, MKRVM Algorithm.

1. Introduction

A wireless sensor network is a self-organizing network with limited energy, limited calculation capacity and limited resources where the WSN nodes are commonly deployed in somewhat uncontrollable or even dangerous situations. Once the nodes are deployed, it is difficult to supplement energy to or repair and maintain the nodes. Any failure or fault of the nodes may lead to a detection error and further make the functions of the nodes inoperative, or even result in paralysis of the whole network. To guarantee the network service quality and prolong its service life, the node fault diagnosis of the wireless sensor network is of particular importance. In recent years, the research on fault diagnosis of a wireless sensor network has become a new topic of broad interest (Aktouf & Parissis, 2012; Wang, Z, 2016).

The relevance vector machine (RVM) is a sparse probabilistic model put forward by Tipping in 2001 as an analogical model to the support the vector machine. Its training process is the RVM under the Bayes framework that can be used for regression estimation and forecasting to obtain the deployment of predicted values. The relevance vector machine currently has successively become the research focus in the field of machine learning as it possesses excellent nonlinear fitting and generalization capabilities as well as the capacity to remedy the regularization parameters to be estimated for SVM. Moreover, it has the disadvantage of RVM not having the estimation result based on probability so that it is successfully used in many fields. The small wavelet analysis, with favorable localized and multi-scale characteristics, has increasingly attracted attention from many fields such as functional approximation, regression analysis and data demising. After the small wavelet

is introduced to the relevance vector machine, the vector machine will attain better generalization capability because functions are given with higher precision.

The research topic of this paper focuses on the diagnosis of a wireless sensor network fault node, for the first time presenting a new diagnostic algorithm by applying multicore wavelet relevant vector to the fault diagnosis of WSN node based on analysis of the node fault category. As for this algorithm, four sorters are used for distinguishing normal nodes from the four types of fault nodes. Then the simulation test is conducted and the algorithm performance is analyzed in detail.

2. Communication model

The development of micro electro-mechanical system and low-power and high-integration digital equipment results in low-overhead, low-power and micro-volume sensor nodes. Such a sensor node is composed of a sensing unit, data processing unit, communication unit and portable power. It can collect data, monitor signals and deliver information.

A wireless sensor network is composed of a large number of low-overhead micro sensor nodes deployed in the monitoring area, and it forms an ad hoc network system via wireless communication. It is aimed to sense, collect and process the information of the monitoring object in the area covered by the network. The structure of the wireless sensor network is shown in Figure 1. A large number of sensor nodes are distributed in the monitoring area to collect and monitor data of an object and the data is processed by collaboration and transmitted to sink nodes. The sink nodes transmit information to the task management nodes via the Internet or communications satellite. Each sensor node in the wireless sensor network combines the functions of node and router of a traditional network. Apart from collection of local information and data processing, it can store, manage and integrate the data forwarded by other nodes and coordinate some special tasks together with other nodes.

The most prominent communications model of a wireless sensor network lifetime is based on multiple source link multiple base stations. The data produced from a source node can be transmitted to a different link of the base station node. The data produced by the source node and intermediate node provides data forwarding business. The data then translates from the edge of the network nodes to the collection of the base station node, and data source node perceives through a jump or jump forward to the base station node. The homologous node can be routed to different base station node through a different data link. The homologous node data has a strong correlation, and different source nodes can cognate data in the process of data fusion. Considering the source data fusion processing that the base station node needs from multiple base station nodes to a tree structure, the root node is connected to the base station through the virtual link, and one of the base station nodes is as a root node which deletes redundant compressed data before sending data to the terminal receiver.

In the process of building the routing, the child radio base station begins to constantly transfer information packages to the surrounding nodes, establishing a communication radius in the expansion of the tree structure. The routing tree structure is shown in Figure

1, where the base station is the root, the data is converting from the source node to the leaves of the tree, and the data from the leaves flows to the root node. After completing the establishment of the tree structure, in the process of the data transfer from source node to others, the source node can adjust the routing link on a small scale, and the original link in the source node goes dormant. Because the wireless sensor network (WSN) is in broadcast mode, all the work nodes can receive information within the scope of the radio, so the new link can be established. Where the data flow is concentrated in the original tree structure, the node can rely on the tree structure to establish multiple pathways and finally arrive at the base station, without the need to refactor all routing processes, as shown in Figure 1.

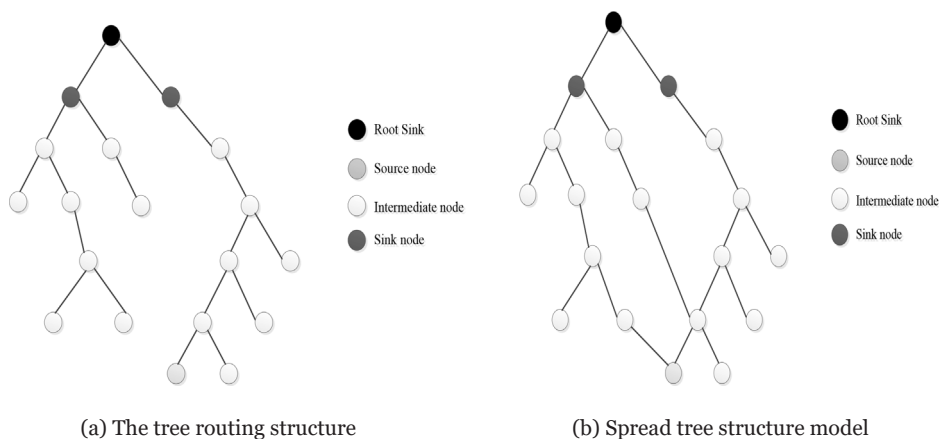


Figure 1 – Wireless sensor network routing model based on multi-station

3. Various considerations

The wireless sensor network is composed of many sensor nodes that are randomly deployed in the detection domain. Generally, there are two conditions if WSN has faults. The first condition is that the user cannot receive data, and the second is that the user receives false detection data. For the first condition, the fault is normally caused by faults of single or multiple node modules such as the power supply unit module and the communication module. However, the second condition tends to be caused by the failure of the sensor of a node (Aydin & Karaköse, 2013). WSN fault commonly results from the fault of relevant nodes that are composed of functional parts. Thus the fault diagnosis of nodes is actually the fault diagnosis of each parts of the nodes.

The WSN node consists of sensor unit module, power supply unit module, processing unit module and communication unit module. A failure in the sensor unit causes failure or fault to the communication with the adjacent nodes. Meanwhile, as the sensor part of the WSN node is limited by low cost, insufficient energy and the ambient environment, its reliability is challenged. This chapter focuses on the research on the sensor part of the node (Khilar, 2007).

The causes leading to common faults of the sensor part are as follows:

1. Shock fault: the random disturbance from power supply and grounding wire, surge, electric spark discharge, burr of D/A exchanger, etc.
2. Bias fault: bias current/voltage, etc.
3. Shortcut fault: bridge circuit corrosion caused by pollution, circuit shortcut, etc.
4. Drift fault: caused by temperature fluctuations;
5. Open circuit fault: signal line cut, chip pin disconnection, etc.
6. Periodic interference: 50Hz power supply disturbance, etc.
7. Nonlinear dead band fault: saturated amplifier, nonlinear element, etc.

The faults that are included in the current experiments are shock fault, bias fault, shortcut fault and drift fault, and they are also the main research objectives in this paper.

Form the signal view, the faults are represented as follows:

1. The shock fault is the random disturbance of the sensor part which leads to impulse wave in the short term;
2. The bias fault causes a fixed deviation between the signal and the original signal;
3. The shortcut fault is the internal shortcut, resulting in the signal being about 0;
4. The drift fault occurs when the signal is deviated from the original signal at a certain speed rate (Chang, 2010).

4. MKRVM Algorithm

A. Relevance vector

Support vector machine is a powerful machine learning method that is widely used for model identification and other fields (Li, 2009). This method is established based on the VC dimensional theory of statistical learning theory and the structure risk minimization principle to seek the best compromise between the model complex and the learning ability as per the limited sample information so as to obtain the highest degree of promotion ability.

Assuming a training sample set $\{x_i, y_i\}_{i=1}^n$, $\{x_i\} \subset R^n$ of n , and x_i stands for the sample input data. If x_i belongs to the first type, $y_i=1$, and if x_i belongs to the second type, $y_i=0$.

1. If there is a classification hyper plane

$$wx + b = 0 \quad (1)$$

If the samples can be classified correctly or the samples of the same class are put at the same side of the classification hyper plane, the sample set will be regarded to be linearly separable, and it can meet the following:

$$\begin{cases} wx_i + b \geq 1 & y_i = 1 \\ wx_i + b \leq -1 & y_i = -1 \end{cases} \quad (2)$$

where w is the weight vector, and b is the bias.

2. The distance between sample point x_i and the classification hyper plane is:

$$\Delta_i = y_i (wx_i + b) = |wx_i + b| \quad (3)$$

Normalize w and b of Eq. (3) and replace w with $\frac{w}{\|w\|}$ and b by $\frac{b}{\|w\|}$, the geometric interval after the normalizing processing is:

$$\delta_i = \frac{wx_i + b}{\|w\|} \quad (4)$$

The distance between a sample set and the classification hyper plane is the geometric distance between the classification hyper plane and the sample point among the set which is nearest to the hyper plane.

$$\delta = \min \delta_i \quad i = 1, 2, \dots, n$$

Optimal separating hyper plane refers to the minimum distance between the training set and the hyper plane being the maximum.

If $|wx_i + b| = 1$, the interval between two types of sample points will be:

$$\zeta = 2\delta_i = 2 \frac{|wx_i + b|}{\|w\|} = \frac{2}{\|w\|} \quad (5)$$

The maximum and minimum of the optimal separating hyper plane will be $\frac{2}{\|w\|}$ and $\frac{\|w\|^2}{2}$ respectively on the condition that Eq. (2) is satisfied.

$$\begin{cases} \min \frac{\|w\|^2}{2} \\ \text{subject to } y_i(wx_i + b) \geq 1, i = 1, 2, \dots, n \end{cases} \quad (6)$$

The problem can be resolved by the saddle point of Lagrange functional:

$$L(w, b, a_i) = \frac{1}{2} \|w\|^2 - \sum_{i=1}^n a_i [(wx + b) y_i - 1] \quad (7)$$

For the saddle point, the following conditions will be met to resolve w_o , b_o and a^o .

$$\begin{cases} \frac{\partial L(w_o, b_o, a^o)}{\partial b} = 0 \\ \frac{\partial L(w_o, b_o, a^o)}{\partial w} = 0 \end{cases} \quad (8)$$

①As for the optimal separating hyper plane, the coefficient a_i will meet the following conditions:

$$\sum_{i=0}^n a_i^0 y_i = 0, \quad a_i^0 \geq 0, \quad i = 1, 2, \dots, n \quad (9)$$

②The optimal separating hyper plane is a linear combination of the training set vector:

$$w_0 = \sum_{i=0}^n a_i^0 y_i x_i = 0, \quad a_i^0 \geq 0, \quad i = 1, 2, \dots, n \quad (10)$$

Only the support vector can have a non-zero coefficient a_i in w_0 expansion and Eq. (11) expresses the support vector expansion. The Lagrangian multiplier and the support vector determine the optimal hyper plane.

According to the conditions of the optimization theory, the optimal hyper plane will satisfy the following equation:

$$a_i^0 [(w_0 x + b_0) y_i - 1] = 0, \quad i = 1, 2, \dots, n \quad (11)$$

When the w_0 expression is inserted into the Lagrange functional expression (8) the following KKT conditions are obtained:

$$\begin{cases} \max W(a) = \sum_{i=1}^n a_i - \frac{1}{2} \sum_{i,j=1}^n a_i a_j y_i y_j (x_i x_j) \\ \text{subject to } \sum_{i=1}^n a_i y_i = 0, \quad a_i \geq 0 \end{cases} \quad (12)$$

Eq. (13) is then calculated with quadratic programming, and the calculated optimal solution is: $a^* = [a_1^*, a_2^*, \dots, a_n^*]^T$, and then the optimal w^* and b^* is obtained as:

$$\begin{cases} w^* = \sum_{i=1}^n a_i^* x_i y_i \\ b^* = -\frac{1}{2} w^* (x_r + x_s) \end{cases} \quad (13)$$

where, x_r and x_s are any pair of support vector in the two types.

Finally, the optimal classification function obtained is:

$$f(x) = \text{sgn} \left[\sum_{i=1}^n a_i^* y_i (x x_i) + b^* \right] \quad (14)$$

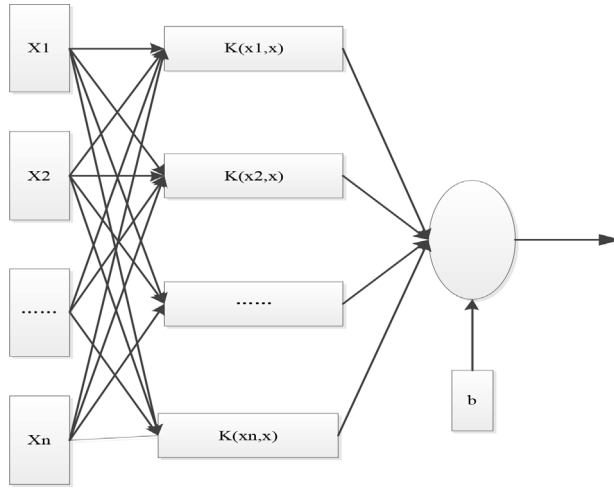


Figure 2 – Support vector structure

If the training set is inseparable, or there is no advance knowledge if it is linearly separable, an optimal hyper plane can be determined to minimize the probability of classification error of the training set, and a slack variable ζ will usually be introduced to correct the optimization objectives and bound terms in Eq. (7), thus obtaining the following formula:

$$\begin{cases} \min \frac{\|w\|^2}{2} + C \sum_{i=1}^n \zeta_i \\ \text{subject to } y_i (wx_i + b) \geq 1 - \zeta_i, \quad \zeta_i > 0, \quad i = 1, 2, \dots, n \end{cases} \quad (15)$$

where C is a penalty factor for a classification error, which is used to adjust the balance between the confidence range and the empirical error. Meanwhile, it can be changed into a dual problem, and the maximized objective function is:

$$\max W(a) = \sum_{i=1}^n a_i - \frac{1}{2} \sum_{i,j=1}^n a_i a_j y_i y_j K(x_i x_j) \quad (16)$$

Constraint conditions are:

$$\begin{cases} \sum_{i=1}^n a_i y_i = 0, & i = 1, 2, \dots, n \\ 0 \leq a_i \leq C \end{cases} \quad (17)$$

where a_i and a_j refer to multipliers and $k(x_i, x_j)$ refers to a kernel function, which can be represented as:

$$k(x_i, x_j) = \phi(x_i) \cdot \phi(x_j) \quad (18)$$

Finally, the optimal classification function is:

$$f(x) = \text{sgn} \left[\sum_{i=1}^n a_i^* y_i K(x_i, x) + b^* \right] \quad (19)$$

The SVM structure is similar to a neural network and the output is a linear combination of the intermediate node with the number of support vectors being N. Each intermediate node has a support vector, as shown in Figure 2.

Although the support vector machine (SVM) is capable of conducting forecast classification well, it fails to obtain the forecast result based on probability. Therefore, the relevance vector machine (RVM) is applied to the diagnosis of wireless sensor nodes.

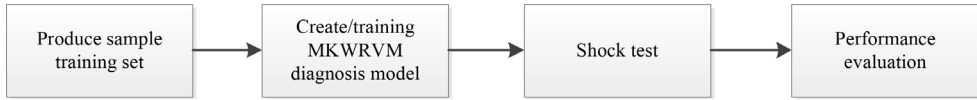


Figure 3 – Relevance vector machine model steps

The training set likelihood function of RVM is defined through applying a generalized linear model as:

$$p(t|w) = \prod_{n=1}^N y(x_n, w)^{t_n} (1 - y(x_n, w))^{1-t_n} \quad (20)$$

where:

$$y(x_n, w) = \delta(w^T \phi(x_n)) = \frac{1}{1 + \exp(-w^T \phi(x_n))} \quad (21)$$

Finally, the decision function of the classifier based on the multi-core RVM can be represented as:

$$f(x) = \text{sign} \left(\sum_{i=1}^n \alpha_i^* y_i \left(\sum_{s=1}^M \mu_s^* k_s(x_k, x_i) \right) + b \right) \quad (22)$$

Wavelet Kernel Function

RVM changes the input space into a high-dimensional space through the kernel function selected in advance and achieves data linearization in the space. $\Psi(x_i)$ is a wavelet generating function to structure the translation invariance wavelet kernel function as in the following:

$$k(x, x') = \prod_{i=1}^L \Psi \left(\frac{x_i - x'_i}{a} \right) \quad (23)$$

where L is the dimension of the input vector and a is the contraction-expansion factor of wavelet kernel function, which are constants needing to be selected optimally. In the fault diagnosis of WSN, Morley wavelet generating function is:

$$\Psi(x) = \cos(1.75x) \exp\left(-\frac{x^2}{2}\right) \quad (24)$$

And the corresponding wavelet kernel function is:

$$k(x, x') = \prod_{i=1}^L \cos\left(1.75 \times \frac{x_i - x'_i}{a}\right) \exp\left(-\frac{\|x_i - x'_i\|^2}{2a^2}\right) \quad (25)$$

5. Simulation experiment and performance analysis

A. Node Fault Model & Simulation

In this paper, 200 nodes are selected, including 80 normal nodes and 120 fault nodes, and the simulation diagnosis is conducted with the method of MKWRVM. Furthermore, the correctness is compared with that of other diagnosis algorithms.

The fault diagnosis of sensor nodes is completed according to the steps shown in Figure 3:

This section of the paper conducts simulation for nodes' sensing components through adopting the Simulink simulation realization method in the references. The results of each output are sampled and the number of nodes which suffer short circuit fault, offset fault, drift fault and impact fault respectively are 30, 30, 30 and 40. Sampling is conducted three times before a fault and seven times after the fault.

As the eigenvalue is not valued in the same order of magnitude and the input variable has a great difference, the normalization processing is required so as to improve the diagnosis effect:

$$x'_i = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}} \quad (26)$$

where: $x_i (i=1,2,\dots,10)$ is a datum of the sample node i before normalization, $x_{\min}$ is the minimum in the sample data, $x_{\max}$ is the maximum in the sample data and x'_i is a datum of the sample node i after normalization.

B. Diagnosis Result Analysis

To study the advantages of the wavelet multi-core relevance vector machine in the aspect of diagnosis, RVM and SVM are used to conduct simulation diagnosis for the wireless sensor nodes under the same conditions and relevant comparison is conducted in this section.

The training of the RVM was conducted under the Bayesian framework, which can produce a decision function with high detection precision and can also improve the real-

time performance of the system. In this paper, RBF is selected as the kernel function of the RVM and the particle swarm optimization algorithm is adopted to determine the width (a) of RBF of RVM. RVM still has high precision.

SVM is a new machine learning method based on a statistical learning theory which adopts the structural risk minimization rule to minimize sample point errors and also minimize structural risks. After improving the generalization of the model, it has higher precision. In the section, RBF is selected as the kernel function of SVM, and adopting the cross validation method, it must find the optimal penalty factor C parameter and the width of the kernel function (σ). Although it has a decision function similar to RVM, it is not capable of achieving probabilistic forecasting, so there is a difference in precision between that of the above-mentioned RVM models.

6. Conclusions

In this paper, the multi-core wavelet relevance vector machine is applied to the node fault diagnosis of a wireless sensor network and a new diagnosis algorithm MKWRVM is proposed. The algorithm distinguishes normal nodes and four types of fault nodes with four classifiers based on the analysis of node fault types and is compared with the support vector machine algorithm and RBF's relevance vector machine algorithm in a combination of simulation experiments. The simulation experiments show that the diagnostic accuracy of the algorithm is higher than that of other algorithms.

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SMEs Credit Evaluation in the E-commerce Supply Chain Financing Model

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Abstract: With the rapid development of the Internet economy, the supply chain financing model under the background of e-commerce plays an increasingly important role in cracking the financing difficulties of small and medium-sized enterprises (SMEs). Whether the credit of SMEs can be evaluated according to the big data resources of e-commerce platforms has become the core issue in the operation of the supply chain financing model. Based on current circumstances and characteristics of e-commerce supply chain financing, this paper focuses on studying credit evaluation for SMEs. The rough set theory is used to construct an evaluation index system and determine the objective weight of each index. The comprehensive weight of each evaluated index is determined by combining with subjective weighting, and finally SMEs credit evaluation is implemented based on the comprehensive weight and the standardized decision-making matrix. Feasibility and effectiveness of the method are confirmed through case test.

Keywords: E-commerce; Supply Chain Financing; Credit Evaluation.

1. Introduction

With the unceasing extension of enterprises, the focus of the enterprise development ideas changes from self-development to supply chain integration development. Since the 1990s, the financing problems based on the perspective of the supply chain have attracted the wide attention from scholars, and supply chain financing plays an increasingly important role in cracking the financing difficulties of SMEs. The current researches are divided into two types: (1) the research based on the traditional perspective—the supply chain financing operational model and strategies were analyzed by J. A. Buzacott (2004) and Nina Yan (2015), and the construction of a supply chain financing system and the effectiveness of each subject in the system were researched by Erik Hofmann (2009), Lili Zhan (2009), and Gema Perez (2012), Rezaei Jafer (2015); (2) the research based on the specific perspective of supply chain financing—the risk early warning, evaluation, and transfer of supply chain financing were analyzed by Zheng Qin (2011) , Lai G Debo. Sycara (2009), and the contractual relationship in supply chain financing was analyzed by Kouvelis P, Zhao W(2012), Lee CH, Rhee BD (2010), Caldentey R,

Haugh MB (2009), Cachon GP (2003) and the cash constraint and funds management of supply chain financing were researched by N. R. Srinivasa Raghavan (2009), Wesley S. Randall (2009), and Hans-Christian Pfohl (2009), and the credit problems in supply chain financing were especially focused by Nina Yan and Baowen Sun (2013) and the supply chain financing loans coordination strategies under the credit constraints were also researched. However, the SMEs credit problems in supply chain financing were focused little in many researches; there were only a few researches concentrating on the financing strategies; the researches concerning about the SMEs credit problems in the supply chain financing model were rarer.

Along with the rapid development of e-commerce platform in recent years, the supply chain financing model based on e-commerce platform, because of its information advantage in reducing the financing risks and reasonably controlling cost, plays an irreplaceable role in cracking the SMEs financing difficulties. How to implement a credit evaluation on the SMEs which are poor in the information transparency and short of credit enhancing mechanism based on e-commerce platform has become the key question in the development of the SMEs. There is the great difference between the SMEs credit evaluation under the background of e-commerce and the traditional supply chain financing model. The traditional supply chain financing mode mainly depends on the credit conditions of core enterprise in supply chain and is based on the business transactions between SEMs and the core enterprise as the basis of credit. While in the supply chain financing business under the background of e-commerce, financial institutions are mainly based on the SEMs' trading information in e-commerce platform to credit so that the SEMs credit evaluation system credit will be a fundamental difference. Based on historical data of supply chain financing under the background of e-commerce, this paper has mined factors that influence enterprise credit using rough set theory, established SEMs credit evaluation index system on this basis and made case analysis. Rough set method from data information system itself has been the objective weight coefficient of various factors, and considered the subjective empowerment of evaluation index that experts gave, enhancing the feasibility of quantitative evaluation, the objective and scientific.

2. Multiple-attribute decision-making and the measure of SMEs credit evaluation standard

2.1. Multiple-attribute decision-making

Multiple-attribute decision-making is also known as multi-objective limited solution decision-making. By studying indexes sequencing and decision-making issues, it first gathers and weighs indexes, and then ranks a set of solutions according to rules, and finally chooses the most reasonable solution. Therefore, multiple-attribute decision-making is widely applicable to all fields and industries, in which the final solution is screened through scientifically weighing and sequencing indexes according to rules, aiming to help enterprises to achieve a benign development.

In this paper, the multiple-attribute decision-making issue was expressed with $C=\{C_1, C_2, \dots, C_n\}$, a mathematical set composed of n attributes (e.g. gross profit rate, and tourists conversion rate).

Decision matrix standardization

Decision matrix is a matrix table expressing the interrelation between relevant factors and decisions, which is often adopted to solve the quantitative analysis and decision issues. The standardized formula for decision matrix is as Equation (1).

$$b_{ij} = \frac{a_j^{\max} - a_{ij}}{a_j^{\max} - a_j^{\min}}. \quad (1)$$

Determining the weight of attributes

Weight is a relative concept with regard to the attributes of an index; the weight of a particular attribute refers to the relative importance of the attribute in the overall evaluation; a weighting system is constituted if each weight corresponding to a group of evaluation attributes system is separated. Weight is extremely important in the decision-making process, which can give a reflection to the position and importance of each condition index in the decision-making process. If a condition index is increasingly important, its corresponding weight is greater. Analyzed from the practical application at ordinary times, there are mainly two methods for determining the weight of related indexes: objective and subjective weighing methods. In this paper, the objective and subjective integrated weighing method based on rough set theory is applied.

Comprehensively sequencing solutions

Alternative solutions are applied to gathering the decision-making information according to certain rules, and these solutions are necessarily prioritized and sequenced. The most common sequencing methods mainly include the method of simple additive weighting, the method of orderly weighted mean, the method of hierarchical additive weighting, the method of LINMAP, the method of additive weighting, and the sequencing method of approximation to ideal solution.

2.2. The selection of evaluation indexes

This paper established the credit evaluation system of SMEs from three aspects, financial indexes, transaction indexes, and customer indexes. In financial indexes, gross profit rate and times interest earned were mainly used in this paper, because the financial data from the small and medium-sized e-commerce enterprises was absent. Then, there were limitations if the analysis was only based on financial index. To better reflect the business results and debt paying ability of SMEs, monthly sales volume, the quantity of monthly orders, consumer evaluation index, the average collection period, and registered fixed number of years were chosen as the transaction indexes of the credit granting system. In customer indexes, enterprise profitability was analyzed in terms of the tourists' conversion rate and collecting rate, and the monthly store views. 10 specific indexes in the three aspects were mutually complemented with each other, which could comprehensively reflect the performance of the small and medium-sized e-commerce enterprises. The selection of the indexes is shown in Fig.1.

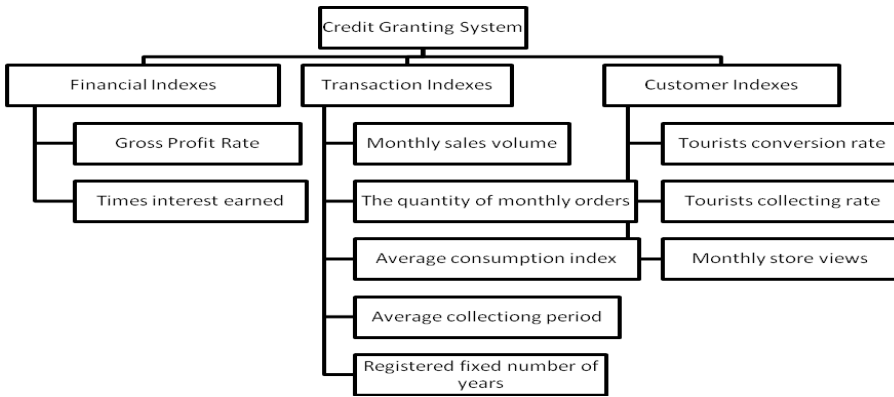


Figure 1 – The selected evaluation indexes and relationships

3. SMEs Credit Evaluation based on rough set theory

3.1. The subjective and objective weight determining method based on rough set theory

Rough set theory is a mathematical tool for solving the inaccurate and incomplete information, which lists the specified indexes into a decision table, and then normalizes and discretizes the miscellaneous indexes in the decision table according to the same rules to generate a simplified decision table, and then classifies the simplified decision table, and finally makes decisions for solutions according to the partition rules. The rough set theory was a theory applicable to data analysis, which was first raised by polish mathematician and professor Pawlak in 1982. In this theory, the original data is analytically induced and summarized according to a known understanding of fixed problems, and the contents hidden in the data are extracted by adopting the method of mathematical statistics to form a certain law helping decision makers reasonably make decisions. The main characteristic of this theory is that it does not need any other information except the original data. This characteristic makes its requirements for data low, but does not affect its objectivity. Therefore, rough set theory better fits decision-making needs.

It was assumed that $S=(U, A, V, F)$ was an information system, in which $U=(1, 2, 3, k, n)$ was the domain of discourse, $A=C \cup D$ and $C \cap D=\varnothing$; $C=(C_1, C_2, \dots, C_n)$ was a set of condition attributes, in which C_i was the attribute of the i th index, D was a set of decision attributes, and C_i and D were the relation of equivalence with U ; $U/C_i=\{X_1, X_2, \dots, X_n\}$ was the undistinguishable partition made by U to the domain of discourse in allusion to condition attribute C_i ; $U/D=\{Y_1, Y_2, \dots, Y_k\}$ was the undistinguishable partition made by U to the domain of discourse in allusion to the set D of decision attributes, and each

equivalence relation corresponded to a partition; $V = \bigcup_{C_i \in A} V_{C_i}$, in which V_c was the range

of attributes C_i ; $f: U \times A \rightarrow V$ was an information function, which gave a value of information to each attribute of each object.

The importance degree of each index attribute was different, so the importance degree was necessarily determined first. In a rough set, some indexes are removed first, and then whether the partition would change after these index attributes were removed was considered; the difference of the partition was greater after an index attribute was removed, indicating the intensity of the index attribute was high, namely, the importance degree was great; if the difference was small, indicating the intensity of the index attribute was very low, namely, the importance degree was small.

$CX = \cup \{Y \in U/C | Y \subseteq X\}$ was the upper approximation of rough set and referred to the set of U elements judged to belong to X according to the knowledge C . $pos_c(D) = \bigcup_{x \in U/D} \underline{C}$,

and also X was the C positive field of D . If $pos_c(D) = \gamma_c(D) = pos_{c-\{C_i\}}(D)$, C_i in C was

unnecessary in D , and otherwise it was necessary. Necessary knowledge index was the main basis of the core enterprises to make decisions. In addition, the dependence of D on C was solved with $\gamma_c(D) = |pos_c(D)|/|U|$, and the law of importance was $\sigma_{CD}(C_i) = \gamma_c(D) - \gamma_{c-C_i}(D)$ and its greater value indicated the greater importance of C_i .

Objective weighting method is as Equation (2).

$$q_i = \frac{\gamma_c(D) - \gamma_{c-i}(D)}{\sum_{i=1}^n [\gamma_c(D) - \gamma_{c-i}(D)]} \quad (2)$$

Comprehensive weight was $\omega_i = \beta \times q_i + (1 - \beta) \times p_i$, in which q_i was objective weight; p_i was subjective weight; β was experience factor, presenting the degree of the decider's preference for objective weight and subjective weight in the decision-making process. Smaller value of β reflected the greater importance attached by the decider to the knowledge and experience of experts; greater value showed the greater importance attached by the decider to the objective weight.

3.2. Selecting samples and determining the weight of indexes

14 SMEs were selected as samples here. First, $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14\}$ was ordered as the studied object, namely, the domain of discourse, the set of the 14 SMEs. C was the condition attribute in each enterprise; C_1 was gross profit rate; C_2 was times interest earned; C_3 was monthly sales volume; C_4 was the quantity of monthly orders; C_5 was consumer evaluation index; C_6 was average collection period; C_7 was the registered fixed number of years; C_8 was tourists' conversion rate; C_9 was tourists' collecting rate; C_{10} was monthly store views; D was decision attribute. In this paper, using the related data of 14 sample enterprises in January 2015 and combined with the rough set theory, the weight of condition attributes was determined. The related data in January 2015 is omitted here. Then, the condition attribute values were normalized, and the decision matrix normalizing formula is as Equation (3).

$$b_{ij} = \frac{a_j^{\max} - a_{ij}}{a_j^{\max} - a_j^{\min}} \quad (3)$$

The normalized enterprise data decision table is as shown in table 1.

SMEs	Condition attribute (C)										Decision attribute (D)
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	
1	0.2	0.14	0.99	0.12	0.53	0.25	0.5	0.94	0.92	0.66	1
2	1	0.43	0.95	1	0.14	00	0.25	0.46	0	1	1
3	0.63	0.39	1	0.88	0.49	0.75	0	1	0.81	0.85	0
4	0.52	0.89	0.39	0.47	0	0.75	0.75	0.55	0.5	0	0
5	0.71	0.58	0.92	0	0.39	0.25	0.5	0.96	0.7	0.61	0
6	0.66	1	0.81	0.92	0.71	1	0.25	0.9	1	0.89	1
7	0.29	0.77	0.96	0.81	0.18	0.25	0	0.48	0.18	0.89	0
8	0.84	0.81	0.46	0.35	0.82	0	0.75	0	0.63	0.17	0
9	0.78	0.52	0.94	0.13	0.45	0.25	0.5	0.07	0.97	0.65	1
10	0.81	0.84	0.52	0.66	1	0.5	0.75	0.27	0.65	0.09	0
11	0.6	0.86	0	0.77	0.88	1	1	0.51	0.67	0.21	1
12	0.32	0.39	0.99	0.91	0.21	0.25	0.25	0.49	0.14	0.84	1
13	0.9	0	0.93	0.26	0.43	0.25	0.5	0.93	0.85	0.62	1
14	0	0.73	0.97	0.86	0.24	0.5	0.25	0.47	0.15	0.8	0

Note: 1—loans were obtained; 0—loans were not obtained

Table 1 – The normalized enterprise data decision (the data in January 2015)

Then, the condition attribute values in table 3 were discretized, and the discretization rules are as shown in table 2.

Partition method (each attribute value was divided into three intervals at average)	The representation method after discretization
The minimum—1/3 breakpoint	1
1/3 breakpoint—2/3 breakpoint	2
2/3 breakpoint—the maximum	3

Table 2 – The discretization rules

The discretized enterprise data decision table is as shown in table 3.

Then, the domain of discourse was indistinguishably partitioned according to decision index and condition index. Next, what condition indexes in C were necessary or unnecessary for D were further defined. Then, the degree of the importance of each attribute index was determined.

Bade on the calculation results, C2 was with the greatest importance, followed by C5, C8 and C3, C4, C7, C9, & C10. Thus, C3, C4, C7, C9, & C10 could be reduced in the decision-making process.

SMEs	Condition attribute (C)										Decision attribute (D)
	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	
1	1	1	3	1	2	3	2	3	3	2	1
2	3	2	3	3	1	3	1	2	1	3	1
3	2	2	3	3	2	1	1	3	3	3	0
4	2	3	1	2	1	1	3	2	2	1	0
5	3	2	3	1	2	3	2	3	3	2	0
6	2	3	3	3	2	1	1	3	3	3	1
7	1	3	3	3	1	3	1	2	1	3	0
8	3	3	2	2	3	3	3	1	2	1	0
9	3	2	3	1	2	3	2	1	3	2	1
10	3	3	2	2	3	2	3	1	2	1	0
11	2	3	1	2	3	1	3	2	2	1	1
12	1	2	3	3	1	3	1	2	1	3	1
13	3	1	3	1	2	3	2	3	3	2	1
14	1	3	3	3	1	2	1	2	1	3	0

Note: 1—loans were obtained; 0—loans were not obtained

Table 3 – The discretized enterprise data decision (the data in January 2015)

At last, the weight of objective C_1 , C_2 , C_5 , C_6 , C_8 were calculated as followed.

$$q_1 = \frac{\frac{2}{14}}{\frac{2}{14} + \frac{3}{14} + \frac{1}{14} + \frac{2}{14} + \frac{1}{14}} = \frac{2}{9}$$

$$q_2 = \frac{3}{9}; \quad q_5 = \frac{1}{9}; \quad q_6 = \frac{2}{9}; \quad q_8 = \frac{1}{9}$$

3.3. Comprehensive evaluation sequencing

According to the above calculation process, we can conclude that in the initially chosen 10 indexes for measuring credits, 5 indexes (i.e. sales volume, the quantity of monthly orders, registered fixed number of years, tourists' conversion rate, tourists' collecting rate and monthly store views) were unnecessary, which could be ignored in the practical credit granting decision. C_1 , C_2 , C_3 , C_6 & C_8 were 5 necessary indexes. According to

the above calculation of attribute weights, the importance of C1, C2, C3, C6 & C8 was expressed as follows: $C2 > C1 = C6 > C5 = C8$.

Under the supply chain financing background of e-commerce enterprises, gross profit rate and times interest earned was still related to the success or failure of credit granting. Higher gross profit rate and times interest earned meant that enterprise possessed higher profitability and could make earnings with the skillful use of loans, not only ensuring the normal business operation, but also reducing the credit granting risks. The SMEs' monthly sales volume and quantity of monthly orders were directly known, but it could not be used as bases for whether credit was granted because the monthly sales volume and the quantity of monthly orders were often affected by the attributes and unit price of products or services except they could only reflect a small part of business results. For example, the enterprises selling large home appliances and the enterprises selling fast-moving consumer products were not comparable in terms of the monthly sales volume and the quantity of monthly orders. Consumer evaluation index, as an index used by e-commerce enterprises for measuring product quality, conformity of online description to real products, satisfaction with logistics, and customer service satisfaction, was also important in the credit granting process. As the credit of physical stores, consumer evaluation index decided whether products were chosen and bought and re-bought by consumers to some extent. The average collection period in the index system represented the time of SMEs to complete an order and also reflected business capital liquidity and utilization rate, but the most importantly could help the lending e-commerce platform know the risk in granting credit and collecting loans—the risk of collecting loans back was higher if the average collection period was higher. E-commerce enterprises' registered year limit was not important, which only meant the endurance of an enterprise, but not the quality of business results in this limited period. For example, many emerging SMEs raised an opportunity and chose proper products so that they often made very good performances plus the appropriate promotion and publicity means. Transaction happens between buyer and seller, in which the customer feedback is very important. For this reason, the tourists' conversion rate embodied the percentage of tourists from viewing products to buying products, and it could be used by the e-commerce platform as a basis for predicting the enterprise profitability in a future period, while the tourists' collecting rate and monthly sore views did not generate actual transactions and thus were not of reference value.

4. Countermeasures and suggestions

Through comprehensively analyzing and sequencing the above indexes, it was known that monthly sales volume, the quantity of monthly orders, and store views were not necessary in credit granting indexes, and therefore, the enterprises with “good sales volume” and “meager profit but high turnover” in a traditional sense were not necessarily suitable for credit granting. The success or failure of credit granting depended mainly on two aspects: (1) enterprise's profit-making status, namely, whether higher profit could be made by enterprise using loans; (2) the credit status of enterprise as well as enterprise owner, namely, whether loans were repaid by enterprise in accordance with the contract after making a profit. Therefore, the credit granting enterprises could be known well from the above two aspects to control the non-performing loan ratio of e-commerce platform.

Based on the characteristics of that financial data have a large number of customers and it is highly dependent on the credit rating, a lot of data that can be easily known in the background such as monthly store views, the quantity of monthly orders, and monthly sales volume, etc, cause low index reference value because they are easy to make virtual transactions and data fraud. The internet-based financial service features big customer data and high dependence on credit rating. A lot of data, such as monthly store views, the quantity of monthly orders, and monthly sales volume that could be accessed directly at the back end, was easy to generate and fabricate through virtual transactions, making the reference value of indexes lower. Therefore, proofs such as corresponding banking daybook were required if this type of indexes was expected to list into the index system. In this paper, credit degree was studied mainly based on the credit status of SMEs, which could only represent the information such as the conformity of products to images, and logistics service and product authenticity, but not the credit status of enterprise owners. However, this data was more important in practice, and also the data source became a difficulty. The mental state and personality characteristics of enterprise owners were judged by introducing an appropriate psychological test system. With this model, the lies and concealment of enterprise owners in all sorts of hypothetical situations were evaluated. The indexes could even be extended to enterprise owners' marital status, water and electricity payment, and court execution targets if the data was shared with the government and related departments later, for the purpose of ensuring the strictness of credit rating and also realizing the public supervision. Moreover, the industry of the main products of enterprises could be evaluated by the e-commerce platform, such as air conditioning, sun protection, and heating with obviously seasonal characteristics. The e-commerce platform, besides collecting enterprise information, must consider whether the industry is powerful in sales in the near future, and then provides supports for the seasonal enterprises before the sales seasons.

In addition, it was seen that the credit granting and measuring method had remained to be reasonable and effective according to the financial indexes of traditional enterprises. The enterprises, under the background of e-commerce, were the same to the traditional enterprises in terms of the examined capabilities such as profitability, solvency, and cash liquidity demanded in the credit granting process, except the difference in transaction flow and operation. But these enterprises could not provide the financial data, thus inspiring the e-commerce platform to reflect the management ability of enterprises in all aspects using the non-financial data generated in the unique transactions of them. In terms of solvency, the focus was on the ratio between the payment in the third party under the condition that products were shipped, but unconfirmed by customers and the payment under the condition that products were ordered by customers, but not shipped by enterprises: the short-term solvency of SMEs was better if the ratio was higher. In terms of operation ability, the focus was on enterprises' average collection period: the operation ability was stronger if the average collection period was shorter and the velocity of turnover was faster. In terms of profitability, the focus was on gross profit rate and times interest earned: the profitability was stronger if the indexes were higher. In terms of development ability, the focus was on the tourists' conversion rate: the possible transaction volume of enterprises in the near future was bigger and the development ability was stronger if the conversion rate was higher. Large amounts of non-financial data were generated according to the enterprises' transactions, from

which the e-commerce platform could also achieve the purpose of selecting appropriate credit granting enterprises. Through the establishment of a reasonable data model and a lot of calculation, loans could be batched, thus greatly reducing the loan-borrowing costs of the e-commerce enterprises, improving the loan-borrowing efficiency, and ultimately implementing the industrialization of loan-borrowing flow step by step with the utilization of the data accumulated by clients over years on the e-commerce platform.

5. Conclusion

There are various channels to solve the problems in the supply chain financing now, but the SMEs under the background of e-commerce are still in a financing dilemma. In this paper, the indexes of the small and medium-sized enterprises were theoretically studied using the multiple-attribute decision-making method, and finally reliable and targeted suggestions were concluded.

Different from traditional enterprises, the enterprises under the background of e-commerce feature fast response and information non-transparency. Thus, the model was forced for e-commerce enterprises to borrow a loan based on the quantity of orders emerges. For this type of enterprises, attention is necessarily paid to the quantity of orders not shipped by enterprises, the period of an entire business flow, and the period of money collecting. Shorter money collecting period and many orders not shipped by enterprises are the basic guarantees for the success of credit granting. For another type of enterprises borrowing a loan based on the credit state, attention is necessarily paid to enterprises' overall gross profit rate and times interest earned, because higher gross profit rate and times interest earned prove that enterprises possess good profitability. The gross profit rate, times interest earned, and other indexes can be solved according to the traditional enterprise financial indexes analysis. In terms of transaction data indexes, the trade data of enterprises on the platform can be reasonably applied, and the factors such as monthly sales volume, the quantity of monthly orders, and registered fixed number of years without a reference value are abandoned. In terms of customer indexes, attention is paid to the data generated in the browsing process of customers with regard to the economic flows in the near future. By classifying the non-financial data according to solvency, operation ability and profitability, a credit granting system exclusive to e-commerce enterprises is customized.

Unclear financing data and small size are the disadvantages of e-commerce enterprises in financing, but their financing difficulties can be effectively solved and also the credit granting from e-commerce platforms to enterprises can be fully automated as long as a reasonable credit granting system is established. The enterprises can apply for a loan online if necessary, and then e-commerce platforms automatically call the useful data from their back end to analyze and instantly issue a loan once they meet the requirements. Thus, manpower is reduced and also the period for examining and verifying loans is shortened, and simultaneously the loan-borrowing flow is industrialized. Ultimately, the platform funds are fully and reasonably utilized.

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Research on the College Music Course Ranking based on the Improved TOPSIS Method

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Abstract: The establishment of the music courses in Colleges and universities is an important part of the quality education. After establishing the music courses, we need to study the ranking of the college music course. There are a lot of colleges in China and many colleges establish the music course. Therefore, this paper studies the college music class ranking. Firstly, we set up the evaluation index of the college music course ranking. In order to enhance the accuracy of the weights and reduce the influence of other factors on the weights, we propose an improved TOPSIS method. In this method, we combine the subjective weight, the objective weight with the feedback weight. Then, we study the college music course ranking for six colleges.

Keywords: improved TOPSIS method, evaluation index, college music course ranking

1. Introduction

Studying the college music course ranking can not only test the achievements of the quality education, but also test the reality of the music course in Colleges and universities. During the research process, we can propose the problems and find out the problems. The discovery of the problems can promote the further improvement for the music teaching level in colleges and universities. Therefore, it is very necessary to study the ranking of the music course in Colleges and universities.

It needs the enough research bases to study the college music course ranking. The research bases of this paper are to evaluate the performance of the college music course. Before evaluating the college music course, we need to establish the appropriate evaluation index. After establishing the evaluation index, we also need to choose the appropriate evaluation method. At present, the main evaluation methods were AHP (Hu and Yi, 2016; Seyyed et al., 2016), Daekook (Kang et al., 2016) and DEA (Borrero et al., 2016). These three methods have their own advantages and disadvantages. At the same time, these three methods integrated during the process of the development. Then, they formed the AHP-TOPSIS (Prakash and Barua, 2015) method and AHP-DEA (Veni et al., 2012) etc. In this paper, we mainly use the TOPSIS method to study the ranking of the college music course. TOPSIS method is a multi-attribute decision making method. The method ranks according to the relative closeness of each evaluation object. Finally, the method obtains

the evaluation results. At present, the method has widely been used in the fields of the supplier evaluation (Francisco et al., 2016; Peter et al., 2016) etc. This paper uses the improved TOPSIS method to study the college music course ranking. We combine the subjective weight, the objective weight with the feedback weight. It enhances the accuracy of the evaluation. Finally, the experiment verifies the accuracy of the method.

2. Establishment of the evaluation index

Before studying the ranking of the college music course, we need to establish the evaluation index. The establishment of the evaluation index should comply with the principles of the scientific nature, the objectivity and the hierarchy etc. According to the present situation of the college music course and other research literature, the evaluation index of the college music course is shown in the following table.

First order index	Second order index	Third order index
The evaluation index of the college music course ranking	Hardware facilities	Teaching site
		Basic musical instruments
		Other conditions
	Teachers strength	Number of Teachers
		Teacher training
		Teacher education and professional title structure
		Teaching funds
		Teaching plan
	Daily teaching	Teaching skills
		communication skills
		Mastery of professional knowledge
		Teaching passion
		Mobilize the enthusiasm of students
	course management	The rationality of curriculum setting
		Daily supervision after class
		Course construction
		Curriculum reform
	Training competition	To participate in Music Competition
		Music Competition Award
		Daily training
	Student self-assessment	Love of music
		Exercise after class
		On the enthusiasm of music learning

Table 1 – The evaluation index of the college music course ranking

3. TOPSIS method

The TOPSIS orders the scheme according to the “positive ideal solution” and the “negative ideal solution”. The basic principle of this method is as follows. According to calculating the optimal solution and the worst solution in the scheme, we compare the distance between the optimal solution and the worst solution for each scheme. Then, we find out the scheme that is the nearest to the optimal solution and is the farthest from the worst solution. Among them, the scheme that is composed of the optimal value of each index is the optimal solution. The scheme that is composed of the worst value of each index is the worst solution. The basic steps of the TOPSIS method are shown as follows.

We assume that the TOPSIS method will evaluate n schemes ($S_1, S_2, \dots, S_n$). Each scheme has m evaluation index ($f_1, f_2, \dots, f_m$).

1. Establishing the matrix according to the original data

$$X = (x_{ij})_{n \times m} \quad (1)$$

2. Standardizing the original matrix and getting the standardized matrix

$$X' = (x'_{ij})_{n \times m} \quad (2)$$

3. Normalizing the index and getting the matrix

$$A = (a_{ij})_{n \times m} \quad (3)$$

Where,

$$a_{ij} = \frac{X'_{ij}}{\sqrt{\sum_{i=1}^n (X'_{ij})^2}} \quad (4)$$

4. Getting the positive ideal solution scheme and the negative ideal solution scheme according to the matrix

The positive ideal solution:

$$A^+ = (a_{i1}^+, a_{i2}^+, \dots, a_{im}^+) \quad (5)$$

$$a_{ij}^+ = \max(a_{ij}) \quad (6)$$

The negative ideal solution:

$$A^- = (a_{i1}^-, a_{i2}^-, \dots, a_{im}^-) \quad (7)$$

$$a_{ij}^- = \min(a_{ij}) \quad (8)$$

5. Calculating the Euclidean distance between each index value and the positive ideal solution, the distance between each index value and the negative ideal solution

$$D_i^+ = \sqrt{\sum_{j=1}^m (a_{ij}^+ - a_{ij})^2} \quad (9)$$

$$D_i^- = \sqrt{\sum_{j=1}^m (a_{ij}^- - a_{ij})^2} \quad (10)$$

6. Calculating the relative approach degree between each evaluation object and the positive ideal scheme

$$C_i^+ = \frac{D_i^-}{D_i^+ + D_i^-} \quad (11)$$

7. According to the value of C_i^+ , ordering the evaluation objects. Because the relative approach degree is in $[0, 1]$, the bigger the value of C_i^+ is, the optimal the scheme is. It shows that the comprehensive benefit is better.

4. Improved TOPSIS method

We assume that the number of the evaluation objects are a . The number of the evaluation indexes of each scheme are b . We make the original data as the basis and establish the original decision matrix.

$$X = (x_{ij})_{a \times b} \quad (12)$$

After establishing the original decision matrix, it needs to standardize and treat the data in order to preventing the lower credibility which is caused by the difference of the index dimension. Therefore, we need to normalize the original decision matrix and get the normalized matrix.

$$Y = (y_{ij})_{a \times b} \quad (13)$$

$$y = \frac{x_{ij}}{\sqrt{\sum_{k=1}^a x_{ik}^2}} \quad (14)$$

Each indicator reflects the standard of a decision-making unit. In general, the importance of each attribute is different. Therefore, it needs to give the different weights for each index. This paper adopts a new comprehensive weight determination method. It combines the subjective weight, the objective weight and the feedback weight. Then, it obtains the index weight. This makes the weight determination process and the results more scientific and comprehensive. It is more conducive for the decision makers in the shortest time to choose a reasonable plan.

The formula of the comprehensive weight is as follows.

$$w_j = \alpha\mu_j + \beta\lambda_j + \gamma v_j \quad (15)$$

Where,

$$\alpha + \beta + \gamma = 1 \quad (16)$$

And,

$$0 < \alpha, \beta, \gamma < 1 \quad (17)$$

In the above formula, μ_j is the subjective weight. λ_j is the objective weight. v_j is the feedback weight. The subjective weight is determined by the AHP analytic hierarchy process. The objective weight makes the weighted squares sum of the distance between each scheme and the ideal point as the basis of the comprehensive evaluation.

$$\min = \sum_{i=1}^a d_i^2 \quad (18)$$

$$d_i^2 = \sum_{j=1}^b (y_{ij}\lambda_j - y_j^*\lambda_j)^2 \quad (19)$$

Where, d_i is the distance between the scheme i and the ideal solution. λ_j is the objective weight of the index j . y_j^* is the ideal solution of the index j .

The feedback weights are obtained according to the effect of the previous schemes. Calculating the nonlinear optimization model,

$$\min = \sum_{i=1}^a d_i^2 \quad (20)$$

Benefit index:

$$y_{ij} = \frac{x_{ij} - \min_{1 \leq j \leq m}(x_{ij})}{\max_{1 \leq j \leq m}(x_{ij}) - \min_{1 \leq j \leq m}(x_{ij})} \quad (21)$$

Cost index:

$$y_{ij} = \frac{\max_{1 \leq j \leq m}(x_{ij}) - x_{ij}}{\max_{1 \leq j \leq m}(x_{ij}) - \min_{1 \leq j \leq m}(x_{ij})} \quad (22)$$

$$S_i^+ = \sqrt{\sum_{j=1}^b (y_{ij}v_j - y_j^+v_j)^2} \quad (23)$$

$$S_i^- = \sqrt{\sum_{j=1}^b (y_{ij}v_j - y_j^-v_j)^2} \quad (24)$$

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad (25)$$

$$d_i^2 = (C_i - U_i)^2 \quad (26)$$

s.t.

$$\sum_{j=1}^b v_j = 1 \quad (27)$$

Where, $v_j > 0, j=1, 2, \dots, a$. a is the number of the scheme. d_i is the difference between the close degree of the solution and the satisfaction degree. v_j is the feedback weight of the index j . y^+j and y^-j are the positive ideal solution and the negative ideal solution of the index j . S^+j is the distance between the scheme j and the positive ideal solution. S^-j is the distance between the scheme j and the negative ideal solution. c_i is the close degree of the i scheme. U_i is the satisfaction degree of the i scheme.

5. Experiment

In this paper, we study the college music course ranking. According to the evaluation of the music course, we can obtain the college music evaluation performances.

These evaluation performances will be as the basis for the college music course ranking. In this paper, we choose six colleges and evaluate the music courses. Then, we get the rankings of these six college music courses. Before the evaluation of the college music courses, we need to obtain the comprehensive weight of the evaluation indexes of the college music course ranking according to the improved TOPSIS method which is proposed in this paper. The comprehensive weight of the evaluation index of the music course in Colleges and universities is shown in the following table.

Second order index	comprehensive weight of Second order index	Third order index	comprehensive weight of third order index
Hardware facilities	0.14	Teaching site	0.37
		Basic musical instruments	0.37
		Other conditions	0.26
Teachers strength	0.17	Number of Teachers	0.23
		Teacher training	0.35
		Teacher education and professional title structure	0.16
		Teaching funds	0.26
		Teaching plan	0.21
Daily teaching	0.31	Teaching skills	0.23
		communication skills	0.19
		Mastery of professional knowledge	0.13
		Teaching passion	0.08
		Mobilize the enthusiasm of students	0.16
		The rationality of curriculum setting	0.36
course management	0.15	Daily supervision after class	0.26
		Course construction	0.19
		Curriculum reform	0.19
Training competition	0.10	To participate in Music Competition	0.34
		Music Competition Award	0.28
		Daily training	0.38
Student self-assessment	0.13	Love of music	0.43
		Exercise after class	0.27
		On the enthusiasm of music learning	0.30

Table 2 – The comprehensive weight of the evaluation index of the college music course

After that, we calculate the relative closeness of each evaluation object according to the third section. The calculation method of the relative closeness degree is shown in the following.

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad (28)$$

The S_1^+ and S_1^- of the first college are $S_1^+ = 0.0871$, $S_1^- = 0.1459$.

The S_2^+ and S_1^- of the second college are $S_2^+ = 0.1344$, $S_2^- = 0.1207$.

We can also obtain the S_i^+ and S_i^- of other four colleges. $S_3^+ = 0.1459$, $S_3^- = 0.0987$, $S_4^+ = 0.0917$, $S_4^- = 0.1004$, $S_5^+ = 0.1571$, $S_5^- = 0.1119$, $S_6^+ = 0.0873$, $S_6^- = 0.1134$.

Then, we can get, $C_1 = 0.626$, $C_2 = 0.4731$, $C_3 = 0.4035$, $C_4 = 0.5226$, $C_5 = 0.4160$, $C_6 = 0.5650$.

Therefore, the ranking of these six colleges are $C_1 > C_6 > C_4 > C_2 > C_5 > C_3$.

6. Conclusion

This paper studies the ranking of the college music course. In order to be able to better grasp the situation of the college music course, we assess the college music course. We rank the college music course according to the evaluation scores. During the evaluation research, the size of the weight has the important influence on the evaluation results. The weight is greatly influenced by the objectivity and subjectivity. This paper puts forward an improved TOPSIS method. The weights of the method are the subjective weight, the objective weight and the feedback weight. The comprehensive weight can avoid that some factors have the great influence during the weight formation process. It can also reduce the influence of the subjectivity and the objectivity. In the experimental part of this paper, we use the improved TOPSIS method to evaluate the music course in 6 universities and get the final ranking. The result is accurate and true.

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A Review of Research Methods on Mobile Technology Adoption

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Abstract: Through literature reviews of mobile technology adoption for the last ten years, the author found the six most commonly-used research methods: empirical research, case study, experimentation, Fuzzy Delphi method, Q methodology, and perceptual mapping. The advantages, disadvantages, and fields of application for each of them underwent individual analysis in the paper.

Keywords: mobile technology adoption; research methods; reviews.

1. Introduction

Along with the trend of smartphone popularization and mobile network bandwidth upgrading, the number of mobile subscribers has mounted up. Mobile technology hence has been more and more favored by enterprises, resulting from increasing studies on mobile technology adoption. Through literature reviews of mobile technology adoption for the last ten years, the author found that research methods on mobile technology adoption were chiefly concentrated on empirical research, case study, experimentation, Fuzzy Delphi method, Q methodology, and perceptual mapping. Among them, empirical research was found to be most frequently-used. The advantages, disadvantages, and fields of application for each of six methods were analyzed one by one in the following sections.

2. Empirical Research

Empirical research is a research method that takes advantage of quantitative analysis technologies to determine interaction modes of and numerical relationships between correlated factors. Documents with empirical studies share similar methods and processes of numerical analysis, but are founded on different theories, which can be classified into two types:

2.1. TAM Theory Based Empirical

Most of the empirical studies concerning mobile technology are based on TAM theories, including Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), and Unified Theory of Acceptance and Use of Technology (UTAUT). These user-oriented theories are good at discussing the users' acceptance of technologies and its influential factors, and can effectively explain intentions and behaviors to use as well.

The characteristics of TRA, TPB, TAM and UTAUT are listed respectively as follows:

- TRA: an individual's intention to perform an action, or behavioral intention, is determined by attitudes toward behaviors and subjective norms.
- TPB: as it is usually the combination of internal factors and external factors that impacts on behavioral intention and actual behavior, this theory hence extends TRA to cover perceived behavioral control.
- TAM: compared to the previous TRA and TPB, TAM holds that the factors of "perceived usefulness" and "perceived ease-of-use" will lead to actual behaviors by exerting influence on attitudes toward usage and intentions to use. The factor of "subjective norm" is excluded from TAM.
- UTAUT: There are four key constructs in UTAUT, namely performance expectancy, effort expectancy, social influence, and facilitating conditions; and four factors to moderate the impact of the four key constructs: gender, age, experience, and voluntariness of use. Empirical research results point out that UTAUT is more effective than any of the previous theory.

In as early as around 2004 and 2005, major researchers conducted empirical research on the basis of TRA. For example, Bauer et al. (2005) studied the factors that motivate consumers to accept mobile technology under the guidance of TRA; Tsang et al. (2004), Standing et al. (2005), and James (2005) employed the theory of TRA to study attitudes of consumers toward mobile technology of advertisements.

Later on, theories of empirical research on mobile technology gradually turned to TPB and TAM. For instance, with the help of TPB and TAM, Yang et al. (2013) studied the models of mobile ads, summarizing influences of technologies and emotions on mobile advertisement acceptance. Liu (2012) used TAM to research into mobile ads acceptance of Japanese consumers and Austrian consumers; the same theory was applied by Bakar and Bidin (2014) to study young Malaysians' acceptance of and purchase intentions to mobile ads of movies; Sultan (2009) also employed TAM to research on what impacted on American users and Pakistan users concerning mobile technology acceptance; on the foundation of TRA, TPB and TAM, Alicia et al. (2015) studied different attitudes toward mobile technology between users having access to mobile Internet and those that were isolated from mobile Internet.

There were still some UTAUT-based empirical studies on mobile technology adoption. To take Wong (2015) as an example, UTAUT was the foundation for his research on key factors that influenced consumers' acceptance on mobile technology.

2.2.IDT-based Empirical Studies

Initiated by Rogers in 1995, the Innovation Diffusion Theory (IDT, for short) divided an individual’s adoption of an innovation into five stages: awareness, interest, evaluation, trial, and adoption. This theory also proposed five main factors that influence adoption of an innovation: relative advantage, compatibility, complexity, trialability, and observability.

Given that mobile technology can be perceived as adoption of an innovation or a new mode, some scholars conducted IDT-based research on intention to respond to mobile technology. There are also viewpoints that TAM and IDT are mutually verified and complementary. Gao et al. (2013) used the combination of IDT and TAM to study what influenced mobile technology acceptance of consumers from different countries (America, China, and western European countries).

The simple and easy-to-implement empirical research methods are suitable for studies on consumers, especially on substantive consumers. However, sample selection and its volumes will greatly impact on empirical results.

3. Experimentation

This approach provides a way to arouse respondents’ mental activities by intentional condition control or situation creation. The costly approach with high requirements on laboratory conditions is rarely put into practice. The studies on influential factors of mobile technology by Varnali et al. (2012) has become the representative example for the method of experimentation.

Stage one: based on previous document achievements, the paper proposed five assumptions, aiming to analyze impact of five factors (approval, incentive, prior experience, content involvement, and perceived medium-fit) on users’ acceptance of mobile technology (Figure 1).

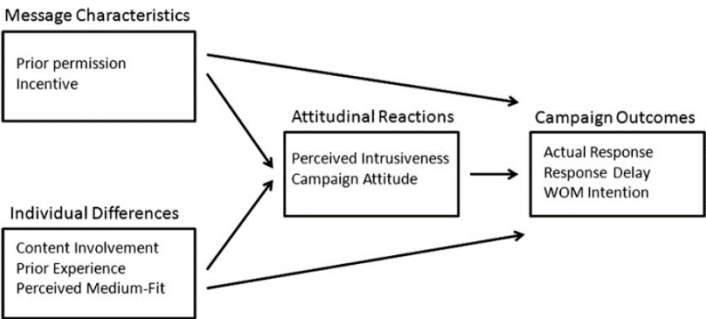


Figure 1 – Research framework in documents by Varnali

Stage two: 262 students were recruited as volunteers by e-mail.

Stage three: a test was conducted three weeks after the recruitment. Specifically, emails were sent stochastically to the 262 respondents inquiring whether the Student

Union could send SMS to them; next, in the name of the Student Union, the tester sent SMS to them asking about the welcomed companies for the next campus job fair; some of the SMS had contents of motivation and commitment, while the rest had none of them; by this way, the tester verified the five factors one by one, and recorded down the respondents' actual response and behavior.

Stage four: the recorded data were analyzed for conclusion (given detailed classification and the large number of figures and tables, the paper will not expound the conclusion here).

As can be seen from the above example, the employment of experimentation can realize a controllable analysis and observation on causal relationships and degrees of mutual influence between certain market phenomena.

As another example, Carvalho, Araujo and Fonseca (2015) developed a mobile game for undergraduate students, and studied how these students accept the mobile game based on experimentation. But this approach has some limitations and costs a lot during implementation.

4. Fuzzy Delphi Method

4.1.Profile

The Fuzzy Delphi method was developed during the late 1940s. It serves as an anonymous summary of randomized experts' forecasts in a number of rounds, and uses statistical analysis and fuzzy computation to convert subjective expertise into quasi-objective data.

4.2.Fuzzy Delphi Based Research

On the basis of Fuzzy Delphi method, Chen (2014) studied mobile ads setup.

First, Chen referred to previous documents for setup of an evaluation index system concerning mobile ads. This system contained 13 attributes: weather, user activities, time, mobile devices, location, promotion, price, brand, background information, preference, interest, search history, and virtual community.

Then, the Fuzzy Delphi communication structure was used to collect expertise, where experts were invited to evaluate the significance of each commodity index and service index in the system. A total of 61 valid questionnaires was obtained, the results being shown in Table 1.

Thresholds for goods and services were set as 75 and 70, respectively, and acted as the criteria of significant attributes. Accordingly, five crucial attributes of goods were: brand (79.97), price (78.38), promotion (76.82), preference (76.65) and interest (76.56); five crucial attributes of services were: price (74.77), brand (71.80), promotion (71.54), preference (71.46) and time (70.31).

4.3.Reviews of the Fuzzy Delphi Method

This method aims at acquiring expert consensus on a particular objective to be forecasted. Nevertheless, it has some disadvantages:

Attribute	Min. Value	Sk	Max. value	Attribute	Min. Value	Sk	Max. value
<i>Weather</i>	60.57	65.49	79.25	<i>Weather</i>	58.02	62.82	75.26
<i>User activities</i>	64.82	70.11	81.03	<i>User activities</i>	60.64	65.99	77.26
<i>Time</i>	62.85	69.24	80.34	<i>Time</i>	63.67	70.31(5)	80.77
<i>Mobile device</i>	65.74	70.92	81.98	<i>Mobile device</i>	63.34	68.37	79.89
<i>Location</i>	63.93	70.41	82.49	<i>Location</i>	60.92	68.58	79.38
<i>Promotion</i>	70.97	76.82(3)	87.59	<i>Promotion</i>	64.26	71.54(3)	82.92
<i>Price</i>	72.77	78.38(2)	88.57	<i>Price</i>	67.70	74.77(1)	84.07
<i>Brand</i>	72.62	79.97(1)	88.74	<i>Brand</i>	64.11	71.80(2)	81.59
<i>Background information</i>	63.93	70.69	81.28	<i>Background information</i>	59.20	66.60	77.00
<i>Preference</i>	68.36	76.65(4)	86.61	<i>Preference</i>	64.26	71.46(4)	81.28
<i>Interest</i>	69.43	76.56(5)	85.70	<i>Interest</i>	61.77	70.26(6)	80.70
<i>Search history</i>	62.79	67.69	79.23	<i>Search history</i>	57.79	63.36	74.87
<i>Virtual community</i>	64.11	68.71	80.85	<i>Virtual community</i>	60.08	65.77	77.49

Fuzzy Delphi survey results for goods

Fuzzy Delphi survey results for services

Table 1 – Evaluation on significance of each commodity index and service index

1. Vague inputs and lack of communication among experts may lead to different perceptions and wrong responses.
2. Too many rounds may render the approach costly and time-consuming, and result in low response rates.
3. Some expert comments may be deducted subjectively.
4. The basis of Fuzzy Delphi communication structure lay in experts' revising their earlier answers in light of the replies of other members of their panel until an agreement was reached. However, the fact was ignored that the alleged agreement was limited to an acceptable fuzzy range that tended to misguide expert (Lin and Ren, 2009).

5. Q Methodology

5.1. Introduction to Q Methodology

Developed by William Stephenson in 1935, Q methodology was deemed as a breakthrough of research methods such that it is on a par with Factor Analysis. With people as the analytic unit, this approach stresses the value of subjectivity and individuality in social sciences. Valuable data was obtained by means of personal survey, where the persons were classified into an uncertain number of homogeneous subcategories. (Dong et al., 2008).

5.2. Practical Examples

With Q methodology, two South Korean scholars, Kim and Lee (2015), refined audiences of mobile ads. Here is the list of the research processes.

5.2.1. Produce Q Concourse

By mentioning concourse, one is referring to the set of viewpoints and attitudes on the research theme. The research theme in this study is mobile ads, and three approaches were used for production of Q concourse.

1. Interview with 31 users of different genders, ages, professions, education levels, residential areas, and mobile device types.
2. Survey on well-known social networks and online blogs.
3. Review of previous documents.

In this way, a total of 363 statements was collected.

5.2.2. Develop Q Samples

1. Deduct repetitive statements.
2. Classify valid statements (into 19 types).
3. Re-classify these statements into positive one, neutral one, and negative one. As a result, they were streamlined to be 40 statements.

Through classification and streamline, the obtained 40 statements became the Q samples of broad representativeness.

5.2.3. Choose Respondents (or P Samples)

Given that the large number of respondents may spark statistical problems, the principle of small samples by Stevenson was conformed to in choosing respondents. What's more, stochastic rules should be replaced with broadness and inclusiveness. On the basis of demographic statistics characteristics, and with the help of objective sampling, judgmental sampling, and snowball sampling, this research finally selected out 43 valid respondents.

5.2.4. Q Ordering or Q Classification

The respondents were required to classify sample sentences into nine types, ranging from “least agreed” (-4) and “neutral” (0) to “most agreed” (+4). It was demanded to take on normal distribution, where the number of sample sentences for the nine types was 3, 4, 4, 5, 5, 5, 4, 4 and 3, respectively.

5.2.5. Q Factor Analysis

Data analysis would be conducted upon the completion of Q classification. There were three continuous steps: step 1. Calculate relative coefficients of Q ordering; step 2. Analyze factors of correlated matrices; step 3. Compute scores of and differences between factor statements. Except for some missing values, there were a total of 36 samples left for Q analysis, which were divided into four types.

5.2.6. Quantitative Verification

With the intention to identify real-life consumer segmentation according to the above types of attributes, and to the advantage of follow-up market strategy formulation, the author conducted survey on 317 intelligent mobile users.

5.2.7. Explanation

According to the aforementioned analysis and survey, the author detailed the four types, and analyzed ads preference of different types of users (Table 2)

Consumer Segmentation	Preferred Ads		Not Preferred Ads
<i>I. The Business Partner</i>	Cross media(n-screen)ads Mobile web banner ads	<---->	Social Network (SNS) ads (IV type)
<i>II. The Skilled Enthusiast</i>	In-apps ads QR or AR ads LBS or map ads Mobile web banner ads	<---->	Streaming media ads E-book ads Coupon ads(III type)
<i>III. The New Experience Seeker</i>	Coupon ads Streaming media ads E-book ads	<---->	Mobile web banner ads LBS or map ads In-apps ads(I or II type)
<i>IV. The Close Buddy</i>	Social network(SNS) ads Coupon ads LBS or map ads Cross media(n-screen) ads	<---->	QR or AR ads(II type)

Table 2 – Ads preference of different types of users

Q methodology is poorly informed and rooted in China. Some foreign criticisms hold that Q methodology does not fit well with sectional studies, and that compulsory statement selection may affect every next selection of respondents.

6. Perceptual Mapping

Early studies presented data by descriptive statistical analysis and crosstabs. However, with rapid development of computer graphic technology, a series of novel and intuitional perceptual mappings have gained more and more attention from modern professional market analysts. With the help of this approach that can unveil consumers’ perception and preference on a range of products or brands, companies are able to understand customer demands, locate products or brands, comprehend positions of their rivals, and find out market vacancy as well.

By fetching and analyzing information of 416 of the Fortune 500 enterprises from their websites, Scharl (2005) summarized the frequency of mobile business access in different areas and industries. He expressed them visually in the form of perceptual mapping, which was shown in Figure 2.

In this figure, the square and the circle represent industry and mobile business, respectively. The vertical dimension reflects industries’ attitudes toward mobile business. It can be seen that electronics and info technology involve wireless network and its service frequently, and the rest companies give priority to mobile telephones and SMS. This phenomena mirrors the wide acceptance of SMS and mobile telephones.

Heinonen and Strandvik (2006) used perceptual mapping to demonstrate Finnish consumers’ response to mobile marketing; and Tripathi (2008) displayed the present influence of mobile marketing on Indian markets in perceptual mapping.

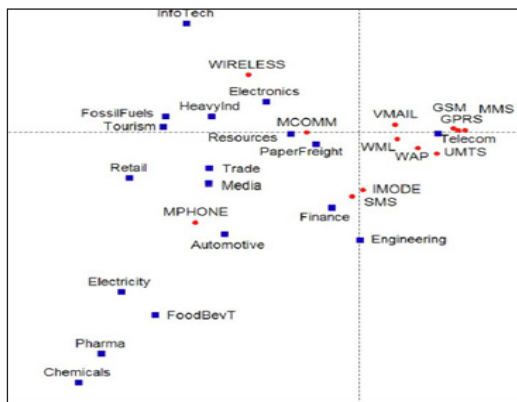


Figure 2 – The frequency of mobile business access in different areas and industries

7. Case Study

As the method of case study is relatively simple, the paper lists several examples in the paper. Ghezzi et al. (2009) researched on 229 companies of mobile services by means of semi-structural high profile interviews, covering 60 mobile marketing companies, 63 mobile companies, and 106 supply chain enterprises. A series of important classified variables were recognized in the research; similarly, three Finland scholars (Karjaluoto et al., 2004) divided mobile marketing companies into mobile advertisement agencies and mobile marketing technology providers for separate in-depth interviews, aiming to explore the position and role of mobile marketing media in integrated marketing.

8. Conclusions

Mobile technology has thoroughly entered global households. Meanwhile, the inevitably continuous research into mobile technology adoption will provide soils for innovative research methods. It remains to be a personal question on which research method is optimal.

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Path Construction for Group Companies Accounting Information Transferring Based on XBRL and Cloud Computing Technology

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Abstract: This paper pointed out the advantage of accounting information transmission in group companies and designed the specific path of accounting information disclosure based on XBRL and cloud computing technology through analyzing the requirements of accounting information demander and the differences in accounting information disclosure for traditional accounting and accounting in information technology environment. Finally, the paper forecasted the future development of XBRL technology in the field of accounting.

Keywords: XBRL technology; cloud computing; group company accounting; accounting information disclosure

1. Introduction

In April 1998, the United States CPA Hoffman (Hoffman) etc. raised the language philosophy of XBRL (Extensible Business reporting language) after studying the XML technology which was used to electric financial reports. In July 1997, under the sponsorship of the American Institute of Certified Public Accountants (AICPA), a working group was set up on XBRL naming the financial reporting framework standard to be created based on XML as Extensible Business Reporting Language. In April 2000, the XBRL Committee held its first press conference, officially introduced the XBRL. In July 2000, XBRL's development began to obtain preliminary results. XBRL Committee released the first XBRL Financial Reporting Standards: XBRL v1.0 specification and XBRL taxonomy. The XBRL Taxonomy is created according to American generally accepted accounting principles in manufacturing and commercial filed. In November 2008, the meeting of China accounting information board and XBRL China Regional Organization meeting was held in Beijing. XBRL is an open international standard which is not restricted to specific operating platform. Via XBRL, commercial and financial report data can be timely, accurately, efficiently and economically stored, processed and communicated (Bergeron B, 2003). It is a standard method of enterprise financial report preparation, publication, data exchange, financial statements and information analysis. XML is a self-describing, extensible, standardized data exchange method, allowing financial information automatically conversion and reliably extraction between

all forms of software and technologies, including the Internet. Based on XML, XBRL is successfully improved to promote enterprise financial information communication and exchange through redefinition of financial data and process.

In 2002, China Securities Regulatory Commission organized Shanghai Stock Exchange and Shenzhen Stock Exchange to investigate on the XBRL standard, and formulated the “information electronic disclosure specification of Listed Companies”. Shanghai Stock Exchange began to promote and apply periodic reports submitting system based on XBRL for the company’s annual report of listed companies since 2003. The Shenzhen Stock Exchange officially launched the periodic reports system of listed companies based on XBRL since January 2005. In February 2006, Information Center of China Securities Regulatory Commission and Information Center of the China Insurance Regulatory Commission, Credit Information System Bureau of the People’s Bank of China, Chinese Academy of Sciences and the Shanghai Stock Exchange initiated the establishment of XBRL China Regional Organization for promotion. Meanwhile, under the guidance and support of the Ministry of Finance, the preparations for the “XBRL China organization” are started. In December 2007, XBRL International Organization announced that XBRL China Organization was formally established. In October 2008, China joined the XBRL International Organization in the name of China Accounting Standards Committee becoming a member of the provisional national region. In May 2010, XBRL International Organization announced that XBRL China Regional Organizations were approved to become official members of the Regional Organization. In November 2009, Ministry of Finance sought the views of “architecture specification of Chinese XBRL Taxonomy”, “Basic Technical Specifications of China XBRL Taxonomy” and “metadata standard of finance and accounting information resource core elements. In January 2010 “XBRL annual Financial Report Disclosure template” was published to seek the views. China National XBRL classification standards were developed by the Ministry of Finance and the XBRL industry pioneers. The standards were released in October 2010 and formally implemented since January 2011 (Li Xiaochang, 2011).

Traditional financial report is nonstructural document, such as PDF, Doc, HTML format, even is the print version in paper medium. It is difficult to both query and data analysis. It is unable to obtain the information quickly required for users. The accounting and financial reporting based on XBRL language is a kind of Internet financial report. It is a financial report form with the advantages of high efficiency, reliability, low cost (Xue Linsheng, 2008).

2. Literature Review

Since Hoffman proposed the development of XBRL as a starting point in 1998, many scholars began to investigate XBRL all over the world. Some of them were related to the disclosure of financial information. In technical point of view, it was necessary to create XBRL. Because companies’ financial information format was not consistent, there were too many internet pages, so many search results gives by intelligent search engine, there were too many inherent defects in HTML and so on aspects, it was difficult to get required financial information via the Internet search function. However, XBRL could achieve the goal of automatic financial information search. Therefore, XBRL was inevitability from technical point of view (Deb receny R., & Gray L, 2008). From all points of view in complete chain of financial reporting including management party, stock exchange, tax authorities, analysts, investors, creditors, and reports creators XBRL had great

advantages. Experimental methods were also carried out to study the advantages of XBR mainly focused on the impact of decision making based on the financial report of XBRL format for nonprofessional users. It was found that XBRL technology can help persons to make decisions by improving the transparency of enterprises' financial reporting information (Hodge F D. Kennedy J J, & Maines L A, 2004).The characteristics and application fields of XBRL were investigated, and problems faced in China were also analyzed to get a solution (Liu Yongze, Hu Renyu, & Yi Ming, 2007). At current stage, the application of XBRL and cloud computing technology in the financial reporting level of listed companies is not enough; it should be extended to the entire financial reporting information chain and enterprise financial information system.

3 XBRL and Cloud Computing Technology

3.1. XBRL (Extensible Business Reporting Language)

XBRL is a data description language. It can make variety of business information data extraction and exchange reliable and smooth between different software, platform, and technology. It is the most recent technology used in unstructured information processing, especially in financial information processing which is developed based on XML (Extensible markup language). From technical point of view, XBRL is mainly constituted by the XBRL specification, XBRL Taxonomy and XBRL instance document. The detail XBRL is showed in Figure 1. The XBRL specification mainly gives the definition of various special terms on financial information and guides the user how to write a XBRL documents to meet the requirements of standard. The specification is released by XBRL Steering Committee. XBRL creates different labels for each item in the business report and all labels are collectively referred to as the classification criteria. Classification criteria are the key to generate an instance of the document which must conform to the provisions of the technical specifications. The instance document is a collection of data elements, which are named according to the classification criteria as the carrier of enterprise financial information (Han Shucheng, & Zhao Zhanguang, 2010).

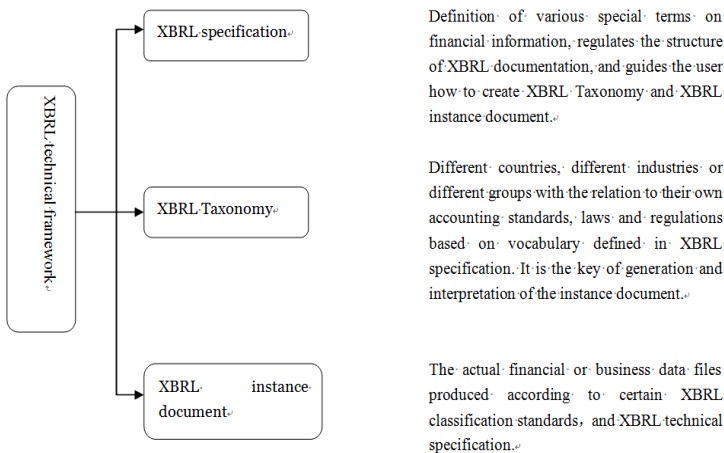


Figure 1 – XBRL technical framework

XBRL inherits the advantages of XML language. Compared with previous paper or pure electronic browse report, it has a lot of advantages. It can be operated cross platform such as different operating systems, databases and application software with only one time input with permanent benefit; It can greatly reduce the multiple input errors, saving time and cost, improve the enterprise financial report preparation efficiency and information disclosure quality; It can easily track data, meet the financial reporting supply chain different user's individual needs, strengthen users' online data analysis, improve the decisions availability of information users; It can strengthen the efficiency of financial information supervision, improve the transparency of information and provide the conditions for continuous auditing.

The impact of a new technology is always along with the resistance. Currently there is no unified XBRL classification standard in China, so the users do not know whether the information is audited by the auditor or not; Although the operational risk of the input is reduced, while the network security is very important; XBRL implementation cost is high including cost for purchasing a large number of office computers, equipping with a high performance web server, setting of the large database management system and developing of suitable XBRL instance document converter.

3.2. Cloud Computing Technology

Information communication technology developed quickly in recent years (Jezreel Mejia, & Mirna Muñoz, 2016). An efficient information technology should be able to achieve synergies effect of the management ability and competition advantage of the enterprise. Network resources can be rationally allocated at any time to optimize the best resource integration or collaboration to realize the functions enterprises' required. No matter how far the distance, are able to effectively manage all business processes (Maria Manuela Cruz-Cunha, & MAS Ivaro Rocha, 2013). Cloud computing technology is such an efficient information technology.

Cloud computing is a shared computing resource pool based on network and configuration. It is convenient for access as required. It is the latest development technology of distributed computing, parallel processing and grid computing. It has been widely used as low cost, high sharing of information processing.

XBRL instance document can be stored in the corresponding accounting data resource pool with the application of cloud computing technology using XBRL classification standard of China. The user of the accounting report can extract the corresponding accounting data from the cloud platform resource pool with application of the XBRL technology. The data resources in the accounting information resource pool are highly shared. For network accounting, online accounting report can be achieved through the technology of XBRL. Enterprise financial data is stored in the cloud platform dynamic data resource pool, when the user querying a company's financial report, the system will package financial data with XBRL specification and then transfer the financial report to the client through the Internet in the form of super text. The client can check and trace the source of the information through a web browser or other browser (Fan Zhenrong, 2013).

From the enterprises' perspective, XBRL can be applied to both internal financial reporting and external financial reporting. To internal aspect, internal management

persons can get more detailed financial reporting information in order to manage the enterprises more effectively, promote the efficiency of decision making, improve enterprises' internal management mechanism and provide accounting information with higher quality. To external aspect, the external financial reporting can be created via the cloud computing technology, so as to shorten the report generation time and enhance the timeliness of the information.

From the regulatory perspective, XBRL can solve the problem of effectively utilization of large amounts of unstructured financial data. Its application promoted the strict implementation of accounting standards, improved the efficiency of the regulatory agencies and prevented information errors during the course of transmission. The application of XBRL and cloud computing technology improves the transparency of accounting information and promotes the improvement of the quality of accounting information. At the same time, it realizes information sharing between different regulatory systems and different regulatory.

From the perspective of the investors, the implementation of XBRL and cloud computing technology can reduce the cost to get the information and enhance the information acquisition, transmission and processing speed, create all kinds of information needed accurately and timely, so that it is useful for investors to make investment decisions more scientific and reasonable.

4. Construction Transferring Path of XBRL and Cloud Computing Technology in Group Company Accounting Information Aspect

Group company ERP information chain based on XBRL and Cloud Computing Technology is created based on the core of accounting items. It can be created based on XBRL database with business handling according to its requirements. The financial reports can be provided according to different size, different industry of enterprises to meet the needs of different information producers and users.

4.1. Accounting Information Transferring Advantage of Group Company based on XBRL and Cloud Computing Technology

Under China's current economic environment, enterprises are proposed to rapid develop to meet the specific needs of XBRL. At the same time the cost can be reduced as much as possible. The solution of cloud computing technology based on the network of information technology is more likely to be accepted by more and more enterprises. Accounting information transferring in Group Company based on XBRL and cloud computing technology has the following advantages:

From a technical point of view, the enterprises are no longer necessary to equip with professional technical personnel with IT skill, but also can get the latest technology to meet the demand for enterprise information management; from the investment perspective, the enterprises can pay as required only without complete the investment in order to avoid taking up too much of the working capital with timely access to the latest hardware platform and the optimal solution.

From maintenance and management point of view, special maintenance and management personnel are not required as well as additional fee for the maintenance and management personnel because the enterprises take the measurements of hiring to manage the business (Han Shucheng & Zhao Zhanguang, 2010).

4.2. Transferring Path of XBRL and Cloud Computing Technology in Group Company Accounting Information Aspect

The transferring path of XBRL and cloud computing technology in Group Company accounting information aspect can be divided into 4 different sections. They are as following.

- Enterprises will record real-time business and store the original data in the database server.
- Various formats of database files should be transferred into XML files in programming and so on measures. Standard XBRL instance document can be created with XBRL via XBRL instance document creator developed by software developers based on classification criteria and guidelines defined by the Committee. XBRL Taxonomy, the guidelines and instance generator is distributed in the SaaS cloud computing center.
- XBRL instance document can be transferred to network server provided by SaaS supplier via Internet. Professional auditors appointed by XBRL Committee will check the authenticity of the document.
- The request is sent out to web server via the client, and then the server can send the XBRL instance document to the client according to the display style (CSS or XSLT) of XBRL documents customized by the user. The user can analyze and compare the content displayed in the client. Finally, the personalized needs of information supplied can be achieved. The purchasing and maintenance of background database and instance generator and training for IT professionals belongs to professional SaaS provider. Therefore, the enterprises can focus on their core competencies. Only if client software and internet access is available, the accounting information can be accessed. The IT cost can be reduced.

5. Conclusion

The core value of XBRL is to improve the quality of enterprises' financial information. The major aim of construction of XBRL accounting information transferring path under cloud computing technology is to ensure that the accounting information require can get the accounting information timely, dynamically. Additionally, the users of financial statements can trace the sources of enterprise information. On the one hand, group company can save the cost of accounting information disclosure, on the other hand, XBRL can provide the technical support to the application of enterprises' accounting report which can realize the data interaction between financial system and other management system, realize information resource integration, analysis and determine the business operations and the weak areas rapidly and accurately, support management decision more efficiently. Actively investigating XBRL and cloud computing technology

in the business level of the accounting information transferring path can make the user of business accounting reports understand the demand of accounting information and rest assured on it, improve the market competitiveness of enterprises more positively.

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Research on the relationship between corporate philanthropy and corporate value from the financing constraints perspective via computer software

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Abstract: With the development of the computer technology, more and more people focus on corporate philanthropy. The information of corporate philanthropy may be considered as an important factor to make financial decisions. The listed companies need to pay attention to the relationship between corporate philanthropy and corporate value. However, the relationship between corporate philanthropy and corporate value has not formed a unified understanding. We use the economic software to test the assumption in order to find some conclusions. First, corporate philanthropy can alleviate financing constraints. Second, with the increasing of the degree of financing constraints, the corporate value is decreasing. Third, corporate philanthropy has played a positive role in increasing the corporate value.

Keywords: Corporate philanthropy, Financing constraints, Corporate value, Computer software.

1. Introduction

As the development of the computer technology, it is more convenient for scholars to explore the problems of the corporate philanthropy. The information technology can be applied to dealing with social problems. Computer technology can be used to solve the problem of economy and management (Crespo & Santos, 2015). Philanthropy report shows the total amount of corporate donations was 48.575 billion RMB in 2011, it accounted for 57.5 % of the total annual contributions in China. We can see that corporate has played an important role in philanthropy. Corporate Philanthropy is a sponsored investment. It will serve the community in the short term. What's more, it is beneficial for corporate development in the long term. The relationship between corporate social responsibility and corporate value is an important topic. In fact, as companies are recognizing the importance of social responsibility, they are more likely to invest on corporate philanthropy. The reasons why the relationship between corporate philanthropy and corporate value is inconsistent has many aspects (Wood &

Jones, 1995). The route analysis is beneficial for us to explore the relationship between corporate philanthropy and corporate value.

Corporate philanthropy can bring the economic benefits in the long term based on the theory of profit maximization. The information disclosure of corporate philanthropy can increase the corporate reputation (Wang & Pan, 2011). As the reputation is increasing, the impression of company is increasing. Companies may obtain subsidies from government through the implementation of charity based on the resource exchange theory. Corporate philanthropy can enhance the evaluation of government. Companies establish a good relationship with the local government via corporate philanthropy. It is also conducive to accumulate political capital. This motivation is more apparent in private enterprises. Based on above analyses, this paper explores the intrinsic link between corporate philanthropy and corporate value.

This paper uses the economic software to analyze the relationship between corporate philanthropy and corporate value. The significance of this study lies in below: First, it is beneficial for verifying the relationship between corporate philanthropy and corporate value. Second, it is beneficial for clarifying the relationship between corporate philanthropy and corporate financing behavior. Third, it is beneficial for government to engage the relevant policies which encourage the listed companies to take part in philanthropy.

2. The empirical analysis

2.1. Hypothesis

Corporate philanthropy is a special manifestation of corporate social responsibility (Erusalimsky, 2006). Corporate philanthropy shows a higher level of demand. People may pay attention to corporate philanthropy. The relationship between corporate philanthropy and corporate value is a popular topic. However, the research conclusion is not unified in this area. The empirical result of the relationship between corporate social responsibility and corporate value is not uniform (Scholtens, 2008). In this paper, we clarify the relationship between corporate philanthropy and corporate value from two angles. First, the problem is analyzed on the stakeholder perspective. Corporate philanthropy can promote the establishment of the positive relationship between the company and the stakeholders (Lee, Choi, Moon & Babin, 2014). Corporate philanthropy can enhance consumer perception of products and increase the sales of the product (Campbell, Gulas & Gruca, 1999). Corporate philanthropy can improve the brand reputation in the market and play an important role in the long-term development strategy (Gardberg & Fombrun, 2006). The company's position in the market can be reflected by the ability of corporate philanthropy. Second, the problem is analyzed on the political connections perspective. The private enterprises hope to improve their profits by giving response when the government calls for charity (Li & Zhang, 2007). When the major government officer is changed, managers may adjust their production plans to coordinate with government activities (Julio & Yook, 2012). Public visibility plays a positive role in promoting the philanthropy (Wang & Qian, 2011). In summary, we can propose the hypothesis 1 as following:

H1: there is a positive relationship between corporate philanthropy and corporate value

The impact of corporate philanthropy on financing constraints is an important evidence for decision-making in the listed companies. We can analyze the relationship between

corporate philanthropy and corporate financing from two aspects. First, based on the resource exchange theory, it is beneficial for companies to gain a good impression in order to financing from the government. Corporate philanthropy can reduce the burden on the government. The government may give some potential preference in the same competitive conditions. Corporate can obtain government resources and good impression by completing the task of the government (Huseynov & Klamm, 2012). Corporate philanthropy has become one of the methods to establish a good political connection. Second, corporate philanthropy can improve the corporate social image and alleviate the financing constraints based on reputation mechanism. On the one hand, if the companies take part in philanthropy, the banks may deem the companies' the default rate is much lower. Therefore, they are willing to lend to such companies. On the other hand, the overall economic strength can be reflected in corporate philanthropy. The banks may consider that the cash flow of these companies is relatively abundant. Therefore, they are willing to lend to such companies. Corporate philanthropy can enhance the companies' reputation (Fombrun & Shanley, 1990). Corporate philanthropy can be reflected by the amount of charitable donations (Brammer & Millington, 2005). As the charitable donation is increasing, the company is more likely to establish a good corporate image. The enhancing of the reputation can promote the companies' debt financing (Godfrey, 2005). Therefore, based on the above analysis we can propose the hypothesis 2 as following:

H2: corporate philanthropy can alleviate financing constraints

Companies need to pay a higher cost for the external financing due to the reason of the information asymmetry (Myers & Majlufn, 1984). The companies have to give up some investment projects. The corporate value will be reduced at the same time. The agency problem will affect the financing constraints to some extent (Luo, Li & Zhang, 2015). Companies who have political connections face up to weak financing constraints (Song, Ai & Li, 2015). The financing constraints are weak in the state-owned enterprises (Guariglia & Liu, 2014). There is a significant correlation between political connections and corporate value in wind energy manufacturing companies (Zhang, Li, Zhou & Zhou, 2014). On the one hand, there are conflicting objectives based on principal-agent theory. Therefore, managers often prefer to obtain shareholders' support when the companies face up to the financing difficulties. If the shareholders only consider their own interests, it is difficult for the manager to gain internal financing. What's more, the corporate value will be reduced due to the missing of the investment opportunities. On the other hand, compared with large state-owned enterprises, private companies are more easily to face up to financial difficulties. Political connections are beneficial for enhancing the corporate value to some extent. Therefore, based on the above analysis we can propose the hypothesis 3 as following:

H3: corporate financing constraints has a negative effect on corporate value

2.2. Research design

1. Data

The data in this paper is mainly from GTA database. We select the A-share of the listed companies from 2008 to 2012 as samples. We remove parts of the sample based on the

following principles: First, the financial and insurance companies are excluded in this paper. Second, the incomplete data of the listed companies is removed in the paper. Third, ST and * ST listed companies are excluded in this paper. In addition, there are two principles when we collect the data. First, the data of corporate philanthropy is from the notes of financial statements. Second, the data is supplied by cniif website.

2. The definition of the variables

We use the SA index (Hadlock & Pierce, 2010) to measure the financing constraints. We choose Tobin's Q to measure the corporate value. The main variables are corporate philanthropy (charity), financing constraints (SA) and corporate value (Q) in this paper. The main control variables are from many aspects, including increase rate of main business revenue, currency ratio, ROA, asset-liability ratio, firm size and the listed age. The introduction of the variables is shown in Table 1.

Name	Code	Description
Increase rate of main business revenue	Growth	(Operating income in the current year - Operating income in the previous year)/ Operating income in the previous year
Currency ratio	Cash	(Currency+Marketable Securities)/Current Liability
Return on assets	ROA	Net Income /Average Total Assets
Asset-liability ratio	Lev	Total debt/ Total Assets
Firm size	Size	The natural logarithm of total assets
The listed age	Age	The age of the listed companies
Financing Constraints	SA	$SA = 0.043(size^2) - (0.04age) - (0.737size)$
Corporate Value	Q	Tobin's Q
Corporate Philanthropy	Charity	From the notes of the financial statements
Year	Year	If it is the current year, we fill in "1", otherwise fill in "0".

Table 1 – The description of variables

2.3. Research model

According to the model made by Wang and Pan (2011), we design the model 1 as following:

$$Q = c + \beta_1 charity + \beta_2 growth + \beta_3 Cash + \beta_4 Lev + \beta_5 ROA + \beta_6 Age + \beta_7 Size + \mu \quad (1)$$

Model 1 is used to study the relationship between corporate philanthropy and corporate value. We use the current corporate philanthropy and the lagged corporate philanthropy as explanatory variables to analyze the problem. In addition, we use the model 2 to examine the relationship between corporate philanthropy and financing constraints.

$$SA = c + \beta_1 charity + \beta_2 growth + \beta_3 Cash + \beta_4 Lev + \beta_5 ROA + \mu \quad (2)$$

Model 2 is used to examine the impact of corporate philanthropy on financing constraints. As the financing constraints are calculated by firm size and age, so we exclude these two variables as control variables to improve the accurate rate. If the cash flow is not sufficient, the company may face up to the financial trouble rapidly. Mode 3 is designed to examine the relationship between financing constraints and corporate value. The data is analyzed by SPSS and Eviews software.

$$Q = c + \beta_1 SA + \beta_2 growth + \beta_3 Cash + \beta_4 Lev + \beta_5 ROA + \mu \quad (3)$$

2.4. The empirical results

1. Descriptive Statistics

As shown in Table 2, the average of Tobin's Q is 1.664. It indicates that the overall market value of the sample enterprises is higher than its replacement cost. If the enterprises issue fewer shares and buy more investment goods, the investment spending will increase. The standard deviation of the corporate value is 1.772. The gap of the enterprises between the maximum and minimum is very great.

	Minimum	Maximum	Mean	Standard deviation
<i>Q</i>	0.097	29.433	1.664	1.772
<i>Cash</i>	-0.200	67.344	0.558	1.626
<i>Lev</i>	0.007	12.127	0.549	0.335
<i>Growth</i>	-25.369	930.917	1.709	24.669
<i>ROA</i>	-3.529	2.637	0.032	0.108
<i>Size</i>	17.049	28.405	22.053	1.343
<i>SA</i>	-5.587	-2.053	-3.682	0.255
<i>Age</i>	0.000	69.000	15.149	5.495
<i>Charity</i>	5.011	20.253	12.676	2.207

Table 2 – Descriptive Statistics

We can find that the corporate value is different in different enterprises. The average of Cash is 0.558 and the standard deviation is 1.626. It indicates that the capital structure does not vary greatly. There still existing some differences among companies. The average of firm size is 22.053. The average of asset-liability ratio is 0.549. The average of ROA is 3.2%. It shows that the overall financial circumstance is good in the listed companies. According to the standard deviation of financial index, we find that the capital structure and the profitability are relatively stable. The average of the operating income growth is 1.709. And it indicates that the operating income of the companies is increasing in general. The standard deviation of age is very large, and it shows that the historical basis of the listed companies is uneven. The average of charity is 12.676, the gap of corporate philanthropy between the minimum and the maximum is very big. We can see that the overall size of corporate philanthropy is relatively big.

2. The regression analysis

1. The impact of corporate philanthropy on corporate value

Model1a (Current impact)				Model1b(Lagged impact)			
Variable	Coefficient	T-stat	P- value	Variable	Coefficient	T-stat	P- value
Constant	11.906	34.421	0.000	Constant	13.908	30.647	0.000
Charity	0.076	7.372	0.000	Charity-1	0.062	4.602	0.000
Cash	0.116	10.479	0.000	Cash	0.130	9.802	0.000
Lev	1.120	16.814	0.000	Lev	1.306	16.287	0.000
Growth	-0.002	-1.256	0.209	Growth	-0.002	-1.473	0.141
ROA	6.031	23.090	0.000	ROA	7.165	18.003	0.000
Size	-0.579	-32.805	0.000	Size	-0.650	-28.782	0.000
Age	-0.004	-1.084	0.278	Age	-0.005	-0.972	0.331
Year	Control	Adj-R2	0.415	Year	Control	Adj-R2	0.417
F-statistic	208.826	P-value	0.000	F-statistic	181.027	P-value	0.000

Table 3 – The regression results of model 1

We analyze the relationship between corporate philanthropy and corporate value to test hypotheses 1. The results are shown in Table 3. As shown in model 1a, the goodness-of-fit in the model is 41.5 %. We find that the model is well fitted. The coefficient of corporate philanthropy is 0.076. There is a positive correlation between corporate philanthropy and the corporate value at the 1% significance level. Corporate philanthropy has a positive effect on the corporate value. In addition, there is a positive relationship between currency ratio and corporate value. Asset-liability ratio has a positive effect on corporate value. There is a positive correlation between ROA and corporate value. We find that both internal capital structure and profitability can affect corporate value. We use the lag period of corporate philanthropy as the independent variable to make model 1b. As the results of model 1b show, the coefficient of the corporate philanthropy is 0.062. It indicates that the implementation of corporate philanthropy can affect the corporate value in the following year. In summary, there is a positive relationship between corporate philanthropy and corporate value. The assumption 1 is correct.

2. The impact of corporate philanthropy on financing constraints

We use the absolute value of SA as the dependent variable to analyze the relationship between corporate philanthropy and financing constraints. When the absolute value of SA index is large, the financing constraints will be serious. The results of model 2 are shown in table 4. As the results of model 2a show, the adjusted R^2 is 0.073, and the model has passed the F-test. It shows that the model fits well and overall demonstrates a significant linear relationship. The

Model2a (Current impact)				Model2b(Lagged impact)			
Variable	Coefficient	T-stat	P- value	Variable	Coefficient	T-stat	P-value
Constant	3.837	128.142	0.000	Constant	3.964	122.621	0.000
Charity	-0.016	-7.979	0.000	Charity-1	-0.017	-7.495	0.000
Cash	-0.003	-1.239	0.215	Cash	-0.003	-1.070	0.285
Lev	-0.038	-2.509	0.012	Lev	-0.038	-2.318	0.021
Growth	0.000	0.769	0.442	ROA	0.250	3.095	0.002
ROA	0.117	1.940	0.053				
Year	Control	Adj-R ²	0.073	Year	Control	Adj-R ²	0.058
F-statistic	29.224	P-value	0.000	F-statistic	22.963	P-value	0.000

Table 4 – The regression results of model 2

coefficient of corporate philanthropy in model 2a is -0.016, indicating that the implementation of corporate philanthropy has a negative effect on financing constraints. Corporate philanthropy is conducive to alleviate the problems of cash-flow shortage in the short term. We use the model 2b to test the relationship between corporate philanthropy and the lagged value of financing constraints. It also indicates that corporate philanthropy can ease financing constraints in the next period. In summary, the assumption 2 is correct.

3. The impact of financing constraints on corporate value

Model 3a				
Variable	Coefficient	Standard deviation	T-stat	P- value
Constant	3.686	0.333	11.081	0.000
SA	-0.881	0.090	-9.810	0.000
Cash	0.175	0.014	12.521	0.000
Lev	0.854	0.072	11.921	0.000
Growth	0.001	0.001	0.833	0.405
ROA	1.745	0.218	8.009	0.000
The dummy variable of year	Control		Adj-R ²	0.141
F-statistic		100.934	P-value	0.000

Table 5 – The regression results of model 3

The financing constraints can make the company fall into the difficulty of cash-flow shortage in the short term. Therefore, the financing constraints can affect corporate value rapidly. We use the Tobin's Q as the dependent variable and the financing constraints as the independent variable to explore the relationship between financing constraints and corporate value.

As shown in Table 5, the adjusted R^2 of the model is 0.141 and the model has passed the F-test. It indicates that the overall equation shows a significant linear relationship. The coefficient of financing constraints is -0.881. It indicates that there is a negative relationship between financing constraints and corporate value. As the financing constraints are increasing, the corporate value is decreasing. In summary, the assumption 3 is correct.

3. Conclusions

Based on the above theoretical and empirical analysis, this paper draws the following conclusions:

1. Corporate philanthropy can enhance the corporate value. Corporate philanthropy has a positive effect on corporate value. It indicates that the implementation of corporate philanthropy is beneficial for enhancing corporate value. Corporate philanthropy can create corporate value to some extent. Corporate philanthropy is beneficial for the development of the company in the long term. The implementation of corporate philanthropy is not only good for the society but also is good for the companies themselves. What's more, our results are beneficial for the government to formulate policies and encourage corporate philanthropy.
2. Corporate Philanthropy can ease the financing constraints problems in the company. As the efforts of corporate philanthropy are increasing, the times of they face up to financial trouble will decrease to some extent. It also verifies the reason that some enterprises face up to the trouble of bankruptcy and still want to take part in philanthropy. Corporate philanthropy can improve the ability to obtain the loan and ease the problem of the cash-flow shortage.
3. The corporate value is reduced by the problem of financing constraints. The more serious problem of financing constraints, the lower corporate value will be. As the financing constraints are decreasing, the corporate has sufficient cash flow and less likely to be bankruptcy. The Reducing of the financing constraints can enable companies to have more money to invest on the project, and improve corporate value ultimately.

Based on the above analysis, this paper presents the following recommendations:

1. The relevant department can encourage corporate to take part in philanthropy. On the one hand, enterprises can enhance the corporate image by philanthropy. The corporate image can generate prestige value and lead to the corporate value increasing. On the other hand, the government may change their attitude according to the consequence of the corporate philanthropy.
2. Corporate need to improve the internal control structure. A good internal governance structure can reduce the extent of asymmetric information. The bank can recognize the internal situation of the enterprises. Therefore, it is more easily for a company which owns good quality of internal control to obtain the loan from the bank.

3. The company needs to accelerate the rate of capital cycle. We find that there is a negative relationship between financing constraints and corporate value. If the companies face up to the lower financing constraints, the companies can make full use of the cash flow in the essential investment projects. The companies can use the capital more effectively by capital cycle.

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A Multi Index Measurement Model of PE Class Teaching Levels Based on Fuzzy System Theory

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Abstract: In order to address existing problems in PE class teaching processes during the implementation of essential-qualities-oriented education in high schools, the paper researched on multi-index measurement methods and a corresponding model of PE class teaching levels in high schools as well. By analyzing influential factors of PE class teaching levels in high schools, the paper established an adaptive measurement index system for the teaching levels. With a classified analysis, both the qualitative and quantitative measurement indexes of fuzziness in terms of PE class teaching levels underwent effective normalized treatment. Based on the fuzziness of measurement indexes, the paper built a multi-index fuzzy measurement model of the PE class teaching levels in high schools. On the foundation of a consideration of different index weights, the comprehensive fuzzy correlation degree of PE teaching level measurement was obtained, thus realizing effective measurement of PE class teaching levels. Relative case verification proved the effectiveness of the proposed methods and the model in the paper.

Keywords: fuzzy system theory, multi index measurement model, PE class teaching

1. Introduction

Physical education is an important link in carrying out high school education, and plays critical roles in facilitating high school education especially at the key point where traditional education is transforming into essential-qualities-oriented education (Fan, 2014; Fan, 2013; Lu and Zhao, 2016; Zhang, 2016). PE class teaching acts as the core component of physical education. PE class teaching levels are overriding measurement criteria of physical education capacity (Zhang, 2015; Shao, 2014; Shen, 2013). Currently, domestic scholars have conducted a series of research, attaining corresponding research achievements in such aspects as assessment index systems, assessment approaches, and assessment models in terms of PE class teaching (Zhao, 2010; Jiao, 2010; Wang, 2006; Zheng, 2005). However, present studies remain to be restricted to a certain degree by factors like immature assessment index systems, poor treatment of qualitative indexes and quantitative indexes, insufficient consideration of fuzzy information, incapability of precise quantitative analysis, etc. Given the above conditions, the paper established

an adaptive measurement index system for PE class teaching levels in high schools on the basis of analyzing existing research achievements. On the foundation of fuzzy system theory, the paper also introduced a multi-index fuzzy measurement model of PE class teaching levels in high schools (Kaveh, 2013; Wu, 2014; Radko, 2015; Rao, 2016; LI, 2013).

2. The measurement index system and the multi-index fuzzy measurement model

2.1. Influential factor analysis

Traditional PE class teaching weighs the teaching link more, but overlooks neither the learning link nor the output results between teaching and learning. Therefore, in light of traditional PE class teaching, the teaching link merely reflects the initiative influence of teachers on PE class education, but considers students or output results in an inadequate manner. Thus, to the authors' understanding, the teaching link, the learning link, and the output results between teaching and learning are supposed to be used to measure the PE class teaching levels comprehensively.

2.2. Selecting principles of measurement indexes

Several fundamental principles should be followed in selecting measurement indexes of PE class teaching levels, aiming at ensuring the accuracy and reliability of the measurement analysis.

The pertinence principle: measurement indexes are required to be chosen from the teaching link, the learning link, and the output results between teaching and learning.

The scientific principle: measurement indexes should be selected scientifically and rationally, containing certain logical levels and relationships.

The objective principle: selection of measurement indexes is supposed to base on objective and real conditions so that the analysis results of the indexes can reflect essential issues.

The analyzable principle: the selected measurement indexes are supposed to help measure analysis results effectively and to represent analysis results in a right and reliable way.

2.3. The measurement index system

On the basis of the aforementioned analysis, the paper established an adaptive measurement index system for PE class teaching levels in high schools, whose structures and contents are shown in Table 1.

2.4. Normalized treatment of measurement indexes

Measurement indexes of PE class teaching levels can be divided into qualitative indexes and quantitative indexes, either of which may be positive, negative or moderate. To endow unified measurement criteria to the measurement indexes of different types, it is necessary to exercise normalized treatment over them.

The magnitude of qualitative indexes is described by fuzzy membership. The more the qualitative indexes approach the ideal maximal fuzzy value, the more the magnitude

The system level	The measurement level	The index level
the measurement index system for PE class teaching levels S	The teaching link S ₁	Lesson preparation S ₁₁
		Course contents S ₁₂
		Course means S ₁₃
		Course highlights S ₁₄
		Course methods S ₁₅
		Attitudes and appearances S ₁₆
	The learning link S ₂	Professional qualities S ₁₇
		Classroom disciplines S ₂₁
		Learning initiatives S ₂₂
		Participation S ₂₃
		Training effects S ₂₄
		Assessment criteria S ₂₅
	The output link S ₃	Physical fitness S ₃₁
		Thinking quality S ₃₂
		Creativity and divergent thinking S ₃₃
		Passing rate S ₃₄
		Teaching satisfaction S ₃₅
		Skill mastery S ₃₆

Table 1 – The measurement index system for PE class teaching levels in high schools

approaches 1; by contrast, the more the qualitative indexes approach the ideal minimal fuzzy value, the more the magnitude approaches 0.

There are three forms in treating qualitative indexes. Assuming the magnitude of Index i is v_i , and the threshold interval is $[va\ i, vb\ i]$. If the qualitative index is positive, the normalized magnitude r_i is expressed as:

$$r_i = (v_i - v_i^a) / (v_i^b - v_i^a) \quad (1)$$

If the qualitative index is negative, the normalized magnitude r_i is expressed as:

$$r_i = (v_i^b - v_i) / (v_i^b - v_i^a) \quad (2)$$

If the qualitative index is moderate, the normalized magnitude r_i is expressed as:

$$r_i = \left| \frac{v_i^b + v_i^a}{2} - v_i \right| / \left(v_i^b - \frac{v_i^b + v_i^a}{2} \right) \quad (3)$$

2.5. Fuzzy measurement grades

The centesimal system is applied to grading PE class teaching levels. On the premise of having consulted relative scholars and experts, the paper classifies the PE class teaching levels into such five fuzzy grades as excellent, favorable, average, barely passed, and failed. The fuzzy magnitudes that are corresponded to each of the five fuzzy grades are shown in Table 2 as follows.

Fuzzy grades	Codes	Magnitudes
Excellent	A	90-100
Favorable	B	80-90
Average	C	70-80
Barely passed	D	60-70
Failed	E	0-60

Table 2 – Fuzzy measurement grades

2.6. Fuzzy measurement analysis

Assuming that the magnitude of the fuzzy measurement grade j in terms of PE class teaching levels is $u_j = [ua_j, ub_j]$, the measurement analysis objective P 's fuzzy distance d_{ij} between the measurement analysis index i and the fuzzy measurement grade j is:

$$d_{ij} = \sqrt[Q]{\left(\left| r_i - \frac{u_j^a}{100} \right|^Q + \left| r_i - \frac{u_j^b}{100} \right|^Q \right) / 2} \quad (4)$$

In particular, when $Q=1$, the expression (4) becomes:

$$d_{ij} = \left(\left| r_i - \frac{u_j^a}{100} \right| + \left| r_i - \frac{u_j^b}{100} \right| \right) / 2 \quad (5)$$

And when $Q=1$, the fuzzy distance is expressed as:

$$d_{ij} = \sqrt{\left(\left| r_i - \frac{u_j^a}{100} \right|^2 + \left| r_i - \frac{u_j^b}{100} \right|^2 \right) / 2} \quad (6)$$

Then, the fuzzy correlation degree k_{ij} is given as

$$k_{ij} = 1 - d_{ij} \quad (7)$$

2.7. Model formation

Thus, the fuzzy correlation degree matrix K is obtained as:

$$\mathbf{K} = \begin{bmatrix} k_{11} & \cdots & k_{1j} & \cdots & k_{1n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ k_{1j} & \cdots & k_{ij} & \cdots & k_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ k_{m1} & \cdots & k_{mj} & \cdots & k_{mn} \end{bmatrix} \quad (8)$$

Given that there may be different weights among the measurement indexes of PE class teaching levels, the weight sequence W can be expressed as:

$$\mathbf{W} = [w_1, \cdots, w_i, \cdots, w_m] \quad (9)$$

Thus, the comprehensive fuzzy correlation degree sequence H between the measurement analysis objective and the fuzzy measurement grades is expressed as:

$$\begin{aligned} \mathbf{H} &= (h_1, \cdots, h_j, \cdots, h_n) = \mathbf{W} \otimes \mathbf{K} \\ &= [w_1, \cdots, w_i, \cdots, w_m] \otimes \begin{bmatrix} k_{11} & \cdots & k_{1j} & \cdots & k_{1n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ k_{1j} & \cdots & k_{ij} & \cdots & k_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ k_{m1} & \cdots & k_{mj} & \cdots & k_{mn} \end{bmatrix} \end{aligned} \quad (10)$$

In case of multi levels in fuzzy measurement analysis of PE class teaching levels, the comprehensive fuzzy correlation degree can be obtained through a repeated execution of equation (8) – equation (10).

The value of comprehensive fuzzy correlation degree can be referred to in identifying the fuzzy measurement grade of the measurement analysis objective. The relative principle is:

$$h_o = \max(h_1, \dots, h_j, \dots, h_n) = h_t \quad (11)$$

which shows that the fuzzy measurement grade of the measurement analysis objective is Grade t.

Overall, the specific implementation steps for the multi-index measurement model of PE class teaching levels based on fuzzy system theory are as follows:

1. First, based on the discussed content in Section 2.1, analyze the influential factors of PE class teaching levels in high schools;
2. Next, based on the discussed content in Section 2.2 and Section 2.3, establish a measurement index system;
3. based on the discussed content in Section 2.4 and on the measurement index system as well, conduct normalized treatment on measurement indexes of different types;
4. Consult experts, and classify fuzzy grades of PE class teaching levels in high schools on the basis of the discussed content in Section 2.5;
5. based on the discussed content in Section 2.6, analysis the fuzzy measurement of PE class teaching levels in high schools;

The measurement level	weight	The index level	magnitude	weight
The teaching link	0.4	Lesson preparation s_{11}	0.95	0.10
		Course contents s_{12}	0.90	0.15
		Course means s_{13}	0.85	0.15
		Course highlights s_{14}	0.90	0.20
		Course methods s_{15}	0.80	0.20
		Attitudes and appearances s_{16}	0.80	0.05
		Professional qualities s_{17}	0.90	0.15
The learning link	0.3	Classroom disciplines s_{21}	0.90	0.15
		Learning initiatives s_{22}	0.95	0.25
		Participation s_{23}	0.90	0.25
		Training effects s_{24}	0.80	0.25
		Assessment criteria s_{25}	0.80	0.10
The output link S_3	0.3	Physical fitness s_{31}	0.85	0.15
		Thinking quality s_{32}	0.80	0.15
		Creativity and divergent thinking s_{33}	0.70	0.15
		Passing rate s_{34}	0.90	0.20
		Teaching satisfaction s_{35}	0.80	0.15
		Skill mastery s_{36}	0.70	0.20

Table 3 – The measurement analysis data

6. Finally, based on the discussed content in Section 2.7, obtain the comprehensive fuzzy correlation degree, which is then applied to obtain the fuzzy measurement grades of the measurement analysis objectives.

3. Case verification

The proposed model and methods in the paper are discussed with an annual performance assessment of PE class teaching levels in a certain high school as an example. The fuzzy measurement grades that are given in Section 2.5, together with survey analysis and expert advice, are used to obtain the measurement analysis data (Table 3) of the measurement analysis objective. On the basis of the discussed contents in the paper, the fuzzy correlation degree can be obtained between the measurement analysis objective and the fuzzy measurement grades. Corresponding results are shown in Table 4.

Measurement indexes	Measurement grades				
	A	B	C	D	E
Lesson preparation S_{11}	0.95	0.90	0.80	0.70	0.35
Course contents S_{12}	0.95	0.95	0.85	0.75	0.40
Course means S_{13}	0.90	0.95	0.90	0.80	0.45
Course highlights S_{14}	0.95	0.95	0.85	0.75	0.40
Course methods S_{15}	0.85	0.95	0.95	0.85	0.50
Attitudes and appearances S_{16}	0.85	0.95	0.95	0.85	0.50
Professional qualities S_{17}	0.95	0.95	0.85	0.75	0.40
Classroom disciplines S_{21}	0.95	0.95	0.85	0.75	0.40
Learning initiatives S_{22}	0.95	0.90	0.80	0.70	0.35
Participation S_{23}	0.95	0.95	0.85	0.75	0.40
Training effects S_{24}	0.85	0.95	0.95	0.85	0.50
Assessment criteria S_{25}	0.85	0.95	0.95	0.85	0.50
Physical fitness S_{31}	0.90	0.95	0.90	0.80	0.45
Thinking quality S_{32}	0.85	0.95	0.95	0.85	0.50
Creativity and divergent thinking S_{33}	0.75	0.85	0.95	0.95	0.60
Passing rate S_{34}	0.95	0.95	0.85	0.75	0.40
Teaching satisfaction S_{35}	0.85	0.95	0.95	0.85	0.50
Skill mastery S_{36}	0.75	0.85	0.95	0.95	0.60

Table 4 – The fuzzy correlation degree

Thus, it can be obtained that the comprehensive fuzzy correlation sequence is $H=(0.8943, 0.9338, 0.8895, 0.8000, 0.4500)$. According to the values of the fuzzy correlation degree, the fuzzy correlation degree reaches the maximal value between the measurement analysis objective and Grade B. This demonstrates that the grade of the objective's PE class teaching level is favorable.

4. Conclusion

The paper provides the fundamental principles of selecting measurement indexes of PE class teaching levels in high schools. Under such principles, the paper establishes the measurement index system of PE class teaching levels in high schools, and also provides a multi-index measurement model of PE class teaching levels based on fuzzy system theory. Through a normalized treatment of both qualitative indexes and quantitative indexes, the paper sets up the fuzzy distance and fuzzy correlation degree between the measurement analysis objectives and the measurement grades, realizing a multi-index fuzzy measurement of PE class teaching levels in high schools. A specific case has been used to verify and analyze the proposed model and methods in the paper, whose results prove the feasibility of the model.

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Research on the Innovative Approach for Teaching Russian Based on the Computer Network Platform

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Abstract: This paper analyzes the significance of the computer to the Russian teaching, and to investigate secondary vocational teachers and students, found that although they pay attention to network for Russian learning and the relationship between Russian teaching, but Russian technical secondary school teaching compared with other types of Russian teaching, is not to make full use of network resources, more can't give full play to their potential. And according to the results of the survey analysis led to the secondary vocational school of Russian network curriculum resources development and application of lagging reasons.

Keywords: innovative approach, teaching Russian, computer network platform

1. Introduction

With the development of Sino-Russian trade and the enormous demand from the exchange between China and Russia together with the holding of a series of activities, like “Year of China in Russia” and “Year of Russia in China”, the need of Russian talents has progressively increased and the Russian major has once again embraced a good prospect under this situation (Chlopak, 2003). Meanwhile, it also evokes the thinking of all academies on the standards of Russian talents. Obviously, if the standards of Russian talents cultivated in the secondary educational schools are consistent with those from other colleges, then they will be lack of competitiveness while seeking for a job. Therefore, it's imperative to develop special Russian major (Gulenkin, Korennoy & Karaulov, 2011). Since it is professional education, it should highlight the occupational contents. So we have to make the students acquire necessary professional knowledge and skills while learning the Russian. Then how do they obtain the knowledge required with limited conditions? Here the development and application of the Russian curriculum resources are of vital importance and the internet serves as the optimal way to acquire these resources (Marks and Cronje, 2008). “In recent years, the rapid development of the Russian internet and various websites offer a favorable condition for us to collect and sort up all kinds of Russian resources (Alexei, Kirill & Maxim, 2010).” The development and application of the Russian network curriculum resources at school then owns a congenital advantage. As a professional Russian teacher, he should develop excellent curriculum resources through the internet and improve the comprehensive application ability of his students. In addition, he has to cultivate the versatile talent conforming to

the requirements of the times and make the students of Russian major become more suitable for the demand of the society (Nicholas and Toporski, 2008).

2. The Research on the Status Quo of the Development and Application of Russian Curriculum Resources at School under the Internet Context

2.1. Research Object

We randomly choose two classes every grade from 1 to 3 in Manzhouli secondary vocational and technical school and Jiutai secondary vocational Russian school in Changchun (Cary, 1977). There are 6 classes are concluded in the survey, altogether 180 students. And 40 teachers of the Russian major in the above two schools also have accepted the research (Khenner and Semakin, 2014).

2.2. Survey Content

The survey looks into the teachers' knowledge and usage upon the network resources, including online target, time and usage skills, etc.; their knowledge and application of Russian curriculum network resources, including skills for making courseware, use of courseware, acquiring online resources and the application of online resources; their awareness on "curriculum standard" and curriculum reform as well as the actions taken (Liu, 2016; Shraiberg, 1996).

2.3. Form of Survey

1. Questionnaire. In order to make the questionnaire subjectively reflect the real situation, we have compiled the questionnaire for the status quo of the development and application of the Russian network resources at school for the teachers and students, respectively according to the real conditions of the two schools (Voiskounsky, 2008). 2. Individual interview (Meskill and Anthony, 2008). According to the structure of the questionnaire, we have drawn up a unified and specific interview outline and carried out interview on several cases so as to further discuss the questions in it (Bulatov and Shur, 2013).

2.4. Survey Result

Totally, we get back 215 valid questionnaires in which 176 are from the students with the recovery rate of 97.7% and 39 are from the teachers with the rate of 97.5% (Abrosimov, Zelenogorsky & Kryukov, 1999). Then we use spss to make statistical analysis on the results and obtain the reliability coefficient of the entire questionnaire which is 0.745. The data sequence shows a normal distribution which explains the situation it reflects is rather reliable, seen as Table 1.

1. Overall, most of the teachers believe that the impact of the network on the education is rather big, in particular, many of them give the answer "not now, but it will be great in the future" (Khenner and Semakin, 2014). Hence, it can be seen that the teachers have realized that the Internet will bring changes to the education (Shraiberg, 1996). However, we also have to see that there are few teachers who have a deep understanding of the Internet and the number become less while concerning the one uses it. The teachers don't have plenty of

Problem	Result
Teachers think that the Internet's influence on education	(A) Had a great influence on education 3.1 (B) Have more influence on education 48.5 (C) Little influence on education 42.5 (D) Has no effect on education 3
Teachers' understanding of the network	(A) Understand better 18.2 (B) General understanding 15.2 (C) poor 9 (D) Don't understand 57.6
Have you participated in training associated with Internet use	(A) Yes 90.2 (B) No 9.8
Do you have personal email	(A) Yes 96.4 (B) No 3.6
Do you often use E-mail to send email	(A) always 17.2 (B) often 34.4 (C) Once in a while 45.5 (D) never 2.8
Have you ever communicate with students by email	(A) always 8.7 (B) often 15.2 (C) Once in a while 72 (D) never 3.2
Do you often go online	(A) In the home 70.2 (B) The school 15.2 (C) Internet cafes 4.6 (D) My friend's house or other 19.5
The conditions of the school you have to use network teaching	(A) Yes 90.5 (B) No 9.5
Your online time on an average day	(A) 10-30 min 20.3 (B) 30-60 min 50.6 (C) 60-120 min 18.6 (D) 120 min 10.7
Through the network to understand what do you like best	(A) Current news 30.6 (B) Professional knowledge 50.6 (C) Encyclopedia of knowledge 18.4 (D) other 10.7
The purpose of the network is varied, you often through the Internet	(A) Searching for information 23.6 (B) To send and receive mail 76.4
You visit the BBS associated with Russian	(A) always 30.5 (B) often 31.3 (C) Once in a while 27.8 (D) never 10.7
You have a personal home page or personal BBS	(A) Yes 36.6 (B) No 19.7
Do you think of the network to the Russian teaching	(A) always 23.6 (B) often 28.4 (C) Once in a while 36.9 (D) never 10.9
Have you ever know that students use the network resources	(A) Yes 50.2 (B) No 49.8

You used the network classroom teaching	(A) always 45.9 (B) often 12.3 (C) Once in a while 11.6 (D) never 10.9
Do you think the role of Russian education of the network in the future	(A) Understand better 30.6 (B) General understanding 21.9 (C) poor 10.6 (D) Don't understand 8.5
Teachers' understanding of curriculum resources	(A) Understand better 12.3 (B) General understanding 6.9 (C) poor 36.9 (D) Don't understand 21.4

Table 1 – Russian network curriculum resources development and application of investigation—teachers

time online and the younger ones surpass the elderly on online time. But with work being the main purpose of surfing the Internet, most of the teachers are to obtain some teaching information and some young teachers often or sometimes download some new network tools and software (Meskill and Anthony, 2008).

2. The young teachers outperform the middle-aged ones in making courseware, but most of them disagree to use the multimedia courseware on the class. Many of them think that making the courseware will spend too much time and part of them believe that the application of such courseware will distract the attention of the students (Redkina, 2007). So they will use the application courseware to show their teaching when it comes to public courses; on the other hand, most of teachers agree to search or use online materials and resources to enrich the students' knowledge while preparing the course; when being asked for the acquiring method of Russian Internet resources, in their opinion, having several strong searching engine is a must. As for searching Russian information, the prior promotion is this (Diekert and Volkov & Voronkov, 2007).

We have sent down 180 questionnaires in the two secondary occupational school among the students and got back all of them. The recovery rate is 100% in which 4 are invalid, so the effective recovery rate is 97.7%, as shown in Table 2.

3. From the survey results, we can find that the undergraduates are very early to contact the Internet among which 48.6% of the vocational students begin to contact network when they are in primary school. All of the vocational students have learnt the knowledge of the computer in which 98.2% of them can operate it independently (Dietze, 1987). Moreover, part of the students consciously make use of the Internet channel to acquire the Russian knowledge.

The students generally reflect that the teacher rarely use the courseware during the Russian class, not to mention self-searching the Russian knowledge. Additionally, the current Russian book seems to be difficult for them, neither can they learn some practical things, so they hope the teacher can teach some targeted and practical knowledge that can be used immediately. Besides, they hope to add 1 or 2 quarter of information technology which enables them to search Russian technology online and watch the Russian movies.

Problem	Result
Teachers think that the Internet's influence on education	(A) Had a great influence on education 23.3 (B) Have more influence on education 1.2 (C) Little influence on education 20.4 (D) Has no effect on education 30.6
Teachers' understanding of the network	(A) Understand better 36.9 (B) General understanding 25.2 (C) poor 10.4 (D) Don't understand 14.3
Have you participated in training associated with Internet use	(A) Yes 44.1 (B) No 45.9
Do you have personal email	(A) Yes 36.6 (B) No 66.4
Do you often use E-mail to send email	(A) always 10.2 (B) often 3.2 (C) Once in a while 25.6 (D) never 40.3
Have you ever communicate with students by email	(A) always 10.2 (B) often 12.3 (C) Once in a while 65.3 (D) never 5.4
Do you often go online	(A) In the home 10.2 (B) The school 3.6 (C) Internet cafes 25.1 (D) My friend's house or other 10.4
The conditions of the school you have to use network teaching	(A) Yes 16.5 (B) No 20.5
Your online time on an average day	(A) 10-30 min 20.3 (B) 30-60 min 2.6 (C) 60-120 min 50.3 (D) 120 min 21.7
Through the network to understand what do you like best	(A) Current news 12.6 (B) Professional knowledge 18.6 (C) Encyclopedia of knowledge 60.8 (D) other 5.7
The purpose of the network is varied, you often through the Internet	(A) Searching for information 36.5 (B) To send and receive mail 64.5
You visit the BBS associated with Russian	(A) always 14.2 (B) often 47.8 (C) Once in a while 46.2 (D) never 1.2
You have a personal home page or personal BBS	(A) Yes 23.3 (B) No 76.7
Do you think of the network to the Russian teaching	(A) always 12.9 (B) often 52.6 (C) Once in a while 3.3 (D) never 30.9
Have you ever know that students use the network resources	(A) Yes 41.2 (B) No 58.8
You used the network classroom teaching	(A) always 14.2 (B) often 26.5 (C) Once in a while 47.5 (D) never 1.6

Problem	Result
Do you think the role of Russian education of the network in the future	(A) Understand better 25.6 (B) General understanding 36.3 (C) poor 22.2 (D) Don't understand 10.2
Teachers' understanding of curriculum resources	(A) Understand better 23.6 (B) General understanding 36.6 (C) poor 10.4 (D) Don't understand 25.8

Table 2 – Russian network curriculum resources development and application of investigation—students

They also denote that most of teachers of the information technology don't agree them to surf the Internet. Some students even reflect that the information technology is always considered to be the subsidiary course and it's always been "stricken" by other lessons. Many students hope the teacher to use multimedia courseware in the Russian class while there are also a few who hope the teacher to tell them some concentrated websites concerning the learning resources of Russian (Diekert, Volkov & Voronkov, 2007).

3. Results Analysis

From the survey on the teachers and students in the secondary occupational school, although the Internet has gained some attention from them for its benefit in Russian learning and teaching, the Russian teaching in the secondary occupational school hasn't yet fully made use of the network resources, nor sufficiently released its potential by comparing with other types of Russian teaching. What has caused the stagnation on the development and application of the Russian network curriculum courseware resources in the secondary occupational school? The author analyzes the reasons from the following points.

3.1. Seeing from the Level of the School

1. Lack of material resources. Although the country has paid attention to the occupational education in recent years and made certain investment, entirely speaking, the secondary occupational school still lacks of teaching equipment with imperfect or obsolete facilities. In my school, for example, it only has two function classrooms, one multimedia classroom and one speech training classroom. It's often the case that the function classroom sometimes can't meet the demand and sometimes being left abandoned. Besides, it is also short of computers that six or seven teachers share one computer (Meskill and Anthony, 2008). People often say "one can't make bricks without straw", actually, neither can the one make bricks without soil. If the hardware facility lags behind, how can we develop and use the network courseware resources?
2. Short of Teachers. Allowing for the general enrollment of the secondary occupational schools and the lack of teachers, so teachers only have to overwork

for a long time. According to relevant survey, the classes per week of 62.5% of the teachers in the secondary occupational schools have reached 20 to 30 which is 4 to 6 classes every day. The long-time overwork makes the teacher feel rather tired and they merely have energy or time to working on the development and application of the coursework resources plus the pressure from the society and the family. Even though they are strong in will, they lack of strength. As a massive and systematic project, the development of courseware resources requires the specialized R&D of the teacher, perfect hardware facilities and equipment and also large amount of investment, which leads to the situation that though the school wants to do it, they are short of money.

3.2 Seeing from the Level of the Teacher

1. (1) Weak consciousness in developing network course resources. For a long time, the professional teachers of the Russian major in the secondary occupational school completely execute the directive curriculum plan and they have no need to develop or create the courseware. Besides, they rarely contact the concept of course resources during the pre-job training and on-the-job training, not to mention the network course resources. Therefore, they lack of the awareness of developing and applying the Russian network course resources.
2. Lack of professional accomplishment and ability in course development. Many teachers in the secondary occupational school grow up from normal education and most of them haven't gone through the training for professional teachers, neither have they experienced the test of social practice. Hence, without the guidance of educational teaching theories, the development and application of will enter the erroneous zone and without social practice, you will be lost in the cast sea of the network resources.
3. Wrong viewpoint toward the students. Concept of student refers to the basic viewpoint of the educators toward the students. It dominates the education behavior and decides the working attitude and pattern of the educators. The students in the secondary occupational school have left the public the impression of low learning enthusiasm and less-positive learning motivation. They don't have clear learning target with low efficiency and are easily been attempted or interrupted. A lot of teachers also treat their students as so and some even think that some students are too stupid to learn. Some teachers consider that the students can merely understand the knowledge in the book. Even though the network resources are plentiful, they are all in vain (Redkina, 2007). And also another group of teachers want to adopt the network technological teaching method and show the students the resources collected, but meanwhile they also afraid of their being easily disrupted by the external world for their weak self-control. Finally, they give up the idea. Some teachers strongly oppose to the idea that the students can surf the Internet to search the Russian knowledge in the class and they deem that being online is only for games or chatting, which gives the students the chance to be away from the learning and also makes it hard to monitoring the class. In fact, these are the wrong concept upon the students. Under its impact, some young teachers have neither energy nor enthusiasm to study the teaching method and develop new course resources. Not to mention the research on the development and application of the Russian network coursework resources.

4. Insufficient application of information technology. The information technology consists of the hardware and software of the computer, network and communication technology, development tool for application software, etc. With its popularization, the hardware of teaching has been greatly improved and every school is equipped with multimedia classrooms. With the “hardware” of multimedia classroom, we also need the “software”, namely, the courseware to fully play its role. However, during the survey, the author finds that some experienced teachers don’t frequently use the multimedia classroom. There are two reasons for it: one, part of the teachers do not familiar with the operation of the multimedia equipment; two, some of them can’t make the courseware or can only make defective ones which only contain the exhibition of simple words and images so that it can’t attract the students. Actually, the development and application of the network resources is closely related to the application of information technology. In practical teaching, some network resources can directly be used as the courseware, and some of them may need to be processed before being shown to the students. The practice has proved that the insufficient application of the information technology will hinder the development and application of the network courseware resources.

4. Development and Application of Russian Online Curriculum Resources

4.1 The Characteristics of the Network Oral Communication Resources Complies with That of the Oral Communication Teaching

The online resources for oral communication mainly consists of writing materials and network visual and audio resources. The first one provides topics, knowledge and strategy for oral communication while the later one is a new-type resource. Its main characteristics is that it can integrate kinds of media through hyperlink, that is, the integration of video, cartoon and audio. It can visualize the living scene and enable the students to experience the communication by role playing. The network audio and visual media can mobilize many sensory stimulation to exchange information. Besides, it can allow the real-time communication of many parties via the hyperlink. In the process of real oral communication, the basically necessary conditions are the following: the two communicating parties, it should be the interpersonal communication at least between two people; communication intention, the communication can’t come into shape without the expansion on the same topic; communication environment, all communications are made in specialized context which contains many connotations; the type of communicative language, namely, the language used should be mutually understood by the communication parties.

The oral communication teaching includes the training on “listening”, “speaking”, interaction between “listening” and “speaking” and conformation of talks and behaviors, namely, the training of capability of oral communication. It puts emphasis on the interactions between listening and speaking and the practical features of interpersonal communication. As the network visual and audio technology becomes increasingly mature, the features of the network oral communication resources and the Internet multimedia technology offer suitable ground for the implementation of the teaching of the Russian oral communication.

4.2. The Application Principles of Online Oral Communication Resources in the Oral Communication Teaching

1. Selecting the Topic that Students Are Interested in.

First of all, the teacher should choose a topic that can grasp the students' interests. He should guide them to pay attention to current affairs and get them observe the society from their own perspective as well as feel the melody of the age. Besides, it's his duty to improve their cultural virtues and make them speak out their voices. Confronting with complex information, the teacher should guide the students to identify things scientifically and objectively with their own ideas and cultivate their innovative minds.

2. Setting up Context for Oral Communication

We ought to set up the context for oral communication and create the language environment. The virtuality of the Internet can simulate the scene of communication and heighten the atmosphere. In this link, the simulation function of the online audio and visual resources are of vital importance.

3. Fully Using Various Kinds of Resources on the Internet

During the spoken language teaching, the students fully utilize various resources on the Internet. They can communicate on a topic chosen from the Internet and enrich their contents with materials acquired on the Internet. The online audio and visual resources offer great help to the oral communication teaching. Both of the teacher and the students can adopt kinds of forms to conduct simulated trainings of oral communication. At the same time, the knowledge and experience of oral communication online will provide the teaching with strong support.

4. Timely Evaluation and Summary

After the online oral communication course, we can make use of the online audio and visual resources, like the video of online oral communication practice, to compare with the training and find the shortcomings.

5. Conclusion

The information technology consists of the hardware and software of the computer, network and communication technology, development tool for application software, etc. With its popularization, the hardware of teaching has been greatly improved and every school is equipped with multimedia classrooms. With the "hardware" of multimedia classroom, we also need the "software", namely, the courseware to fully play its role. However, during the survey, the author finds that some experienced teachers don't frequently use the multimedia classroom. There are two reasons for it: one, part of the teachers do not familiar with the operation of the multimedia equipment; two, some of them can't make the courseware or can only make defective ones which only contains the exhibition of simple words and images so that it can't attract the students. Actually, the development and application of the network resources is closely related to the application of information technology. In practical teaching, some network resources can directly be used as the courseware, and some of them may need to be processed before being shown to the students. The practice has proved that the insufficient application of

the information technology will hinder the development and application of the network courseware resources.

This paper hopes to grasp the attention of the Russian major on the development and application of network resources establish the consciousness of development and application of online Russian curriculum resources. Furthermore, it also expects to offer certain guidance and reference to the development and utilization of the Russian curriculum resources under the network context. It's worth further discussions about how to make use of the network resources and technologies in teaching Russian at school. As a professional Russian worker in the 21th century, we ought to continuously refresh out minds and follow the stream as well as actively learn advanced technologies. Additionally, we should improve our working approach and bravely make innovation and challenge new things so as to push the professional Russian education in China forward endlessly.

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Evaluation of optimal educational model related to folk music in China with fuzzy preference relations

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Abstract: Folk music as an aspect of culture diversity and soft power in a country has been attracted much attention. In order to inherit folk music to the next generation, different educational models are generated. Then, for different purpose, an appropriate educational model should be selected. Therefore, compared to other direct assessments, fuzzy preference relation is introduced in this paper to objectively express the preference of experts. Then, consistency and consensus measure, and aggregation process are also defined in this paper to generate the final an optimal educational model. Finally, the proposed method is applied in a real case to demonstrate its applicability.

Keywords: fuzzy preference relations, optimal educational model, folk music

1. Introduction

Now, music cultural diversity has become a mainstream trend in the existing social music culture development. Folk music is an important aspect of culture diversity. To inherit folk music is a good way to develop and improve culture diversity. More importantly, folk music as a kind of soft power in a country has attracted much attention all over the world (Kons et al., 2016). In China, folk music has a long history and cultural product of thousands of years. Thus, how to inherit and develop folk music is a big challenge that our country should face. For this purpose, education is a basic way to complete it. The educational value of folk music is defined as the positive and beneficial impact of folk music as an objective educational resource of society on individuals and society. The literature review of folk music especially the education of folk music will be demonstrated in the Section 2. In the modern society, Hereinto, there are many educational model of folk music in the existing education field. For example, on-line learning, face-to-face learning, telephone learning, class learning and so on has been applied in different district for different purpose. On-line learning is more flexible but lacks of good atmosphere. Face-to-face learning can provide better atmosphere but efficiency is poor. So, to evaluate different educational model to select an optimal educational model is a key task in the development of education of folk music. Because this evaluation is handled by considering several attributes and inviting several experts, it can be considered as a multiple attribute group decision making problem (Liao et al., 2016; Zhu and Xu, 2014).

To the best of our knowledge, the multiple attribute group decision making methods can be divided into two categories: direct assessments and preference relations (Li and Chen, 2016; Kim and Ahn, 1999). Here, it is easier for experts to provide preference relations (Kim et al., 1999). The commonly used valued preference relations are multiplicative preference relations and fuzzy preference relations (Sun and Ma, 2015; Wu and Chiclana, 2014). So, fuzzy preference relations as a basic and popular way are introduced in this paper to express the preference of experts. Taking the experts' characteristics with regard to knowledge, skills, experience and personality into account, they can choose their favourable preference relations to represent preferences. In fuzzy preference relations, two aspects need to be handled: consistency and consensus measure, and aggregation process. Consistency is associated with transitivity property. Consensus can guarantee the effectiveness of group decision making. The purpose of aggregation process is to aggregate preference relations of experts and further to generate the optimal educational model in this paper.

The rest of the paper is organized as follows: Section 2 reviews the literatures related to folk music and its education in China. Section 3 shows the proposed method including the construction of preference relation matrix, the definition of consistency measure and consensus measure and the aggregation process. Section 4 uses the proposed method to select an optimal educational model. Section 5 concludes this paper.

2. The existing studies of folk music education in China

Folk music is generated from the folk, spreads in the folk and reflects the history, society, labor, local conditions and customs and daily life of a nation. In China, folk music can be used in a broad and a narrow sense. From the perspective of broad sense, Chinese folk music includes Han nationality and other minority nationalities. On the other hand, from the perspective of narrow sense, Chinese folk music only includes Han nationality. The value of folk music is huge, which is considered to be related to a kind of soft power in a country and a typical representative of culture in a country.

In China, many researchers have devoted into studying folk music especially the education of folk music. Zhang (2015) rethought the influence and spread of folk music in minority nationalities. Zhu (2013) studied the development of folk music based on the perspective of soft power of culture. Yang emphasized the importance of education in folk music. Xie (2011) pointed out the education of folk music in the age of Internet. Internationally, many researchers also have discussed the value of music especially the education of music. Hietanen et al. (2016) focused on connecting student teachers' formal and autonomous learning to solidify their music education paths. Rauduvaite and Lasauskiene (2015) discussed opportunities of music education improvement integrating popular music and using innovative methods of personal meaning and emotional limitation in the context of theories of pedagogical thought. Semradova and Hubackova focused on characteristic of education, including distance education and comparison of the extent of teacher responsibility, which provides us a new way to think the education of folk music.

In brief, the education of folk music is important in a country. Thus, how to select an optimal educational model is a problem need to be solved as mentioned in Introduction.

3. The proposed method with fuzzy preference relation

As mentioned in Introduction, the group decision making method is proposed with fuzzy preference relations in this section. Details are demonstrated below.

3.1. the model of the group decision making

In a group decision making problem, several experts e_t ($t=1, 2, \dots, q$) are first invited to provide their preference using fuzzy preference relations for all the assessments a_{ij} ($i=1, 2, \dots, m; j=1, 2, \dots, n$) to construct several decision matrixes $D_j^t = [a_{ij}]_{m \times m}$. For each alternative A_i ($i=1, 2, \dots, m$), any expert is required to express his/her preference on each attribute C_j ($j=1, 2, \dots, n$) which is constructed by the specific problem. Then, all experts specify the attribute weights of the n attributes denoted as $w=(w_1, w_2, \dots, w_n)^T$ with $0 \leq w_j \leq 1$ ($j=1, 2, \dots, n$) and $\sum_{i=1}^n w_j = 1$ (Xu, 2014)

Therefore, $q \times n$ decision matrixes can be generated as follows:

$$D_{j(m \times m)}^t = \begin{matrix} & C_j & A_1 & A_2 & \cdots & A_m \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} & \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mm} \end{pmatrix} \end{matrix} \quad (1)$$

3.2. fuzzy preference relation

Definition 1 (Herrera-Viedma and Porcel, 2009). Given a set of alternatives $X=\{x_1, x_2, \dots, x_m\}$, a MPR matrix on X is defined as $A \subset X \times X$, $A=(a_{ij})_{m \times m}$, where a_{ij} denotes the ratio of the preference intensity of alternative x_i to that of x_j , which means x_i is a_{ij} times as good as x_j . As suggested by Saaty (1980), the scale 1-9 is used to measure a_{ij} , where $a_{ij} = 1$ indicates indifference between x_i and x_j , $a_{ij}=9$ indicates x_i is absolutely preferred to x_j , and $a_{ij} \in \{1/8, \dots, 1/2, 2, \dots, 8\}$ indicates the intermediate preference intensity between x_i and x_j . A multiplicative reciprocal A satisfies $a_{ij} \cdot a_{ji} = 1$, $\forall i, j \in \{1, \dots, m\}$.

Similar to Definition 1, the concept of fuzzy preference relation should be defined in the following.

Definition 2. A fuzzy preference relation R on a set $X = \{x_1, x_2, \dots, x_m\}$ is a fuzzy set on the product set $X \times X$, i.e., it is characterized by a membership function $u_R: X \times X \rightarrow [0, 1]$.

From the Definition 1, it can be deduced that a fuzzy preference relation R on X can be conveniently expressed by an $m \times m$ matrix $R=(r_{ij})_{m \times m}$, where $r_{ij} = u_R(x_i, x_j)$ ($i, j=1, 2, \dots, m$) is interpreted as the preference degree or intensity of the alternative x_i over x_j . When $r_{ij} = 0.5$, it indicates indifference between x_i and x_j ($x_i \sim x_j$); When $r_{ij} > 0.5$, it indicates that x_i is preferred to x_j ($x_i \succ x_j$). In general, $R = (r_{ij})_{m \times m}$ satisfies the additive reciprocity property, namely, $r_{ij} + r_{ji} = 1$ for all $i, j = 1, 2, \dots, m$. Without loss of generality, in this paper, R is assumed to be additive reciprocal.

Then, in a group decision making, consistency is one of the important factors (Herrera-Viedma et al., 2007). In this paper, the concept of additive consistency is defined below.

Definition 3. The fuzzy preference relation $R = (r_{ij})_{m \times m}$ is additively consistent, if it satisfies

$$r_{ij} = r_{ik} + r_{kj} - 0.5 \quad (2)$$

for all $i, j, k = 1, 2, \dots, m$ with $i < k < j$ and $r_{ij} + r_{ji} = 1$.

According to the Eq. (1), Herrera-Viedma classified three cases which are denoted by

1. $r_{ij}^{k,1} = r_{ik} + r_{kj} - 0.5$ by $r_{ij} = r_{ik} + r_{kj} - 0.5$;
2. $r_{ij}^{k,2} = r_{kj} - r_{ki} + 0.5$ by $r_{kj} = r_{ki} + r_{ij} - 0.5$;
3. $r_{ij}^{k,3} = r_{ik} - r_{jk} + 0.5$ by $r_{ik} = r_{ij} + r_{jk} - 0.5$.

Thus, the three deviations can be deduced from the mentioned three cases.

$$1. \quad \varepsilon r_{ij}^{k,1} = \frac{\sum_{k=1, k \neq i, j}^n |r_{ij}^{k,1} - r_{ij}|}{n-2};$$

$$2. \quad \varepsilon r_{ij}^{k,2} = \frac{\sum_{k=1, k \neq i, j}^n |r_{ij}^{k,2} - r_{ij}|}{n-2};$$

$$3. \quad \varepsilon r_{ij}^{k,3} = \frac{\sum_{k=1, k \neq i, j}^n |r_{ij}^{k,3} - r_{ij}|}{n-2}.$$

Then, using the deviations the consistency level related to the fuzzy preference relation r_{ij} ($i < j$) can be defined in the following:

$$CL_{r_{ij}} = 1 - \varepsilon_{r_{ij}} \quad (3)$$

where $\varepsilon_{r_{ij}} = \frac{2}{3} \cdot \frac{\varepsilon r_{ij}^{k,1} + \varepsilon r_{ij}^{k,2} + \varepsilon r_{ij}^{k,3}}{3}$ such that $\varepsilon_{r_{ij}} \in [0,1]$.

The lower the $CL_{r_{ij}}$ is, the more inconsistent the fuzzy preference value r_{ij} is. When there is no inconsistency at all, $CL_{r_{ij}} = 1$,

Based on the Eq. (3), the consistency level of a fuzzy preference relation $R = (r_{ij})_{m \times m}$ can be proposed as follows:

$$CL_R = \frac{\sum_{i,j=1, i \neq j}^n CL_{r_{ij}}}{n(n-1)} \quad (4)$$

Here, $CL_R \in [0,1]$.

3.3.group consensus reaching process

Consistency is a critical issue in decision making with preference relations because the lack of consistency in preference relations may lead to unreasonable results. In general, the consistency of a preference relation is identified by transitivity properties among preference judgments. There are different types of transitivity properties including the weak transitivity, the max-min transitivity, the max-max transitivity, the restricted max-min transitivity, the restricted max-max transitivity and the multiplicative transitivity.

When a fuzzy preference relation $R=(r_{ij})_{m \times m}$ is complete, one can easily obtain that the fuzzy preference relation $\tilde{R} = (\tilde{r}_{ij})_{m \times m}$ is additively consistent, where

$$\tilde{r}_{ij} = \sum_{k=1}^n \frac{r_{ik} + r_{kj}}{n} - 0.5, i, j = 1, 2, \dots, n. \quad (5)$$

Definition 4. Let $R = (r_{ij})_{m \times m}$ be a fuzzy preference relation, and $\tilde{R} = (\tilde{r}_{ij})_{m \times m}$ be the associated additively consistent fuzzy preference relation. The additive consistency index (ACI) of R is defined as follows:

$$ACI(R) = 1 - \frac{2}{n(n-1)} \sum_{i,j=1, i < j}^n d(r_{ij}, \tilde{r}_{ij}) \quad (6)$$

Here, $d(r_{ij}, \tilde{r}_{ij}) = |r_{ij} - \tilde{r}_{ij}|, i, j = 1, 2, \dots, n$.

Consensus is defined as general or widespread agreement of the experts. In order to reach group consensus, the first thing we should do is to measure the closeness among the expert's opinions. As full and unanimous consensus is often unreachable, an alternative approach is to use softer consensus measure.

Definition 5. Let $R^t = (r_{ij}^t)_{m \times m}$ be a fuzzy preference relation provided by the expert $e_t(t=1, 2, \dots, q)$, and $R^* = (r_{ij}^*)_{m \times m}$ be the associated collective fuzzy preference relation. The group consensus index (GCI) of R^t is defined as follows:

$$GCI(R^t) = 1 - \frac{2}{n(n-1)} \sum_{i,j=1, i < j}^n d(r_{ij}^t, r_{ij}^*) \quad (7)$$

Given a critical value denoted by ϕ . It can be used to measure the consensus in a group decision making. That is, if $GCI(R^t) > \phi$, the group consensus can be considered to be reached. In this paper, average opinion of experts can be regarded as the value of ϕ .

$$\varphi = \sum_t^q w_t GCI(R^t), \quad (8)$$

where w_t denotes the weight of the expert t .

3.4. The process of the decision making method

In this sub-section, the process based on group consensus measure and consistency measure is demonstrated in the following.

Step 1. Form a MAGDA problem. A manager selects the experts, identifies attributes and their types (benefit and cost), and lists alternatives to form a MAGDM problem.

Step 2. Prepare for the group consensus in order to solve the MAGDA problem. The manager identifies MAXCYCLE, the maximal number of times of GAD to avoid the delayed convergence of collective solution, sets CYCLE = 0, a cycle counter; decides relative weights of experts.

Step 3. Collect experts' FPRs. All experts independently give their FPRs on all attributes of all alternatives.

Step 4. Decide whether the group consensus is reached. It is determined whether the group consensus is reached using Eqs. (7)–(8). If so, go to Step 8. Otherwise, go to Step 5.

Step 5. Organize the GAD and collect the renewed FPRs of experts. If CYCLE > MAXCYCLE then go to Step 8. Otherwise, all experts renew their FPRs. Furthermore, CYCLE = CYCLE + 1 is set by the manager, and the GAD is organized by the manager to help the experts to renew their FPRs. After that, go to Step 6.

Step 6. Form the aggregated group FPRs on each alternative. Calculate the aggregated group FPRs on each alternative.

Step 7. Generate a ranking order of alternatives.

Step 8. Finish the procedure. The manager checks whether CYCLE > MAXCYCLE holds. If so, a conclusion of no group consensus based solution for the MAGDA problem can be drawn. Otherwise, the optimum alternative or the ranking order of alternatives can be selected as a group consensus based solution to the MAGDA problem reaching the predefined group consensus.

4. Illustrative example

Folk music as a culture can guarantee the stability of society in our country. It is widely accepted that music can connect everyone all over the world beyond the geographical limitations. Hereinto, the education of folk music is critical to develop folk music. Thus, we should propose a scientific method to select an optimal educational model of folk music for different purposes.

Using the proposed method in Section 3, three experts are invited firstly to provide their preference to three alternative educational models including telephone, Internet and

class denoted by A_1, A_2 and A_3 . In addition, three attributes are specified by the experts including quality, cost, benefits denoted by C_1, C_2 , and C_3 .

The experts provide fuzzy preference relations of each alternative on each attribute, respectively. Therefore, 9 decision matrixes can be constructed. Here, the attribute weight can be determined as $w = (0.3, 0.4, 0.3)^T$ by the experts. Because of the limitation of content, we select three decision matrixes in the following to demonstrate the preference of the experts.

C_1	A_1	A_2	A_3
A_1	0.5	0.4345	0.4835
A_2	0.5655	0.5	0.6736
A_3	0.5155	0.3264	0.5

Table 1 – Decision matrix with fuzzy preference relation provided by expert e1 related to attribute C_1

C_1	A_1	A_2	A_3
A_1	0.5	0.3575	0.5038
A_2	0.6425	0.5	0.6886
A_3	0.4962	0.3114	0.5

Table 2 – Decision matrix with fuzzy preference relation provided by expert e2 related to attribute C_2

C_1	A_1	A_2	A_3
A_1	0.5	0.4749	0.4673
A_2	0.5251	0.5	0.4987
A_3	0.5327	0.5013	0.5

Table 3 – Decision matrix with fuzzy preference relation provided by expert e2 related to attribute C_3

Then, based on the Tables 1-3 and omitted 6 Tables, fuzzy preference relations on each attribute related to each alternative can be aggregated into collective fuzzy preference relations between pairs of alternatives in the Table 4.

C_1	A_1	A_2	A_3
A_1	0.5	0.4178	0.4867
A_2	0.5822	0.5	0.5951
A_3	0.5133	0.4049	0.5

Table 4 – Collective decision matrix with fuzzy preference relation

Finally, the ranking order is demonstrated as $A_2 \succ A_3 \succ A_1$ which indicates that A_2 is the optimum educational model in Table 5.

C_1	<i>Ranking-order</i>
A_1	3
A_2	1
A_3	2

Table 5 – The ranking order of alternatives

5. Conclusion

Folk music as an aspect of culture diversity and soft power in a country has been attracted much attention. In China, folk music has a long history and cultural product of thousands of years. Thus, how to inherit and develop folk music is a big challenge that our country should face. In order to inherit folk music to the next generation, different educational models are generated. Then, for different purpose, an appropriate educational model should be selected. Therefore, compared to other direct assessments, fuzzy preference relation is introduced in this paper to objectively express the preference of experts. In fuzzy preference relations, two aspects need to be handled: consistency and consensus measure, and aggregation process. Consistency is associated with transitivity property. Consensus can guarantee the effectiveness of group decision making. The purpose of aggregation process is to aggregate preference relations of experts and further to generate the optimal educational model in this paper.

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Research on the College Student Ideological Education under the Network Public Opinion Environment based on the Computer Platform

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Abstract: With the rapid development of the science and technology, the network public opinion has gradually developed into the leading position of the public opinion. The network public opinion spreads into every corner of the society by its own way and affects all aspects of the social life. College students are easy to accept new things and easy to get the new ideas from the network public opinion. Then, they express their own opinions. Therefore, the network public opinion will exert a subtle influence on the ideological education of the college students. In this paper, we propose an improved TOPSIS method to study the ideological education of the college students based on the computer platform under the network public opinion environment. Firstly, we establish the evaluation index. Then, we use the improved TOPSIS method to evaluate. Finally, the model and method of this paper are illustrated by experiments.

Keywords: computer Platform, network public opinion environment, evaluation index.

1. Introduction

The network public opinion opens the new position for the ideological and political work in Colleges and enriched the content of the ideological and political work (Ding and Wang, 2013). However, the new situation of the campus network public opinion also changes the traditional education idea and the cognitive way. It brings the impact and challenge for the ideological and political work model. The Internet public opinion has both positive and negative aspects to the ideological education of the college students (Li et al., 2010). With the development of the computer technology, the information transmission speed is very fast. The high speed flow of the information also brings the great adjustment to the traditional ideological education work of the college students. How to make a reasonable use of the computer platform to improve the ideological education of the college students is a problem that many teachers seriously think about. Therefore, the impact of the network public opinion on the ideological education of the college students causes the attention of the educators in Colleges and universities (Li, 2011; Yin, 2016).

For the single attribute decision problem, the alternative schemes that are ordered had a complete order (Lan et al., 2015). However, when the scheme is more than one, due to

each attribute had the related relationships or the conflicts, the alternative schemes are not ordered totally (Baykasoğlu et al., 2016). Therefore, the multiple attribute decision making problems are more complicated than the single attribute decision problem (Sun et al., 2015). The essential difference between the multiple attribute decision and the other classic decision methods is that it needed the preference of the decision maker as the decision basis (Qin et al., 2016). According to the classification method for the decision problem of the foreign literature, the traditional TOPSIS method is a multi-attribute decision making method which is commonly used. The method evaluated the alternative scheme that the decision variable is discrete and has the limited number of the alternative schemes. Then, it orders them and selects the optimum scheme. The TOPSIS method has been applied in many fields, such as the risk assessment (Taylan et al., 2015) (Daekook Kang), the website evaluation (2016) et al. (Lan), and the educational evaluation (2015), Yao Zeng) etc.

In this paper, in order to evaluate and study better the ideological education of the college students computer platform evaluation based on network public opinion, firstly, we establish the corresponding evaluation system. Then, we propose an improved TOPSS method. Finally, we use the method to study the ideological education evaluation of the college students under the network public opinion.

2. Establishment of the evaluation index

The ideological education evaluation of the college students under the network public opinion is to evaluate the influence on the ideological education of the college students. According to the evaluation, we can find the possibility of the network public opinion to the ideological education evaluation of the college students. Then, we take the relevant measures to deal with these possible. In order to study better the ideological education evaluation of the college students under the network public opinion, we need to establish a complete evaluation system. The evaluation system must be objective, scientific and reasonable. We establish the evaluation indicators of the ideological education of the college students based on the computer platform under the network public opinion. It is showed in table 1.

3. TOPSIS method

TOPSIS method is a multi-attribute decision making method based on the geometry. The method evaluates each scheme from n attributes. The basic principle of the TOPSIS method is to use the distance between the positive ideal solution and the negative ideal solution in the multi objective decision problem to order the evaluation object. The indexes of the positive ideal solution reach the optimal. It can be understudied a virtual optimal solution. The negative ideal solution is opposite completely. TOPSIS method is a very effective method in multi objective decision analysis. The steps of the method are shown as follows.

The first step is to establish the initial judgment matrix.

We set the scheme set is $p=\{p_1, p_2, \dots, p_m\}$. The evaluation index set of each scheme is $r=\{r_1, r_2, \dots, r_m\}$. The evaluation index r_{ij} is the j evaluation index of i scheme. The initial scheme is as follows:

First order index	Second order index	Third order index
Evaluation index of the ideological education of the college students on the computer platform under the network public opinion environment	Social influence	Effect of group effect
		Effect of polymer diffusion
		Polarization effect
		The influence of opinion leaders
	Personal influence	The influence of negative public opinion attention degree on college students' ideology
		The influence of negative public opinion trust degree on college students' ideology
		The influence of positive public opinion attention degree on college students' ideology
		The influence of positive public opinion trust degree on college students' ideology
		The influence of public opinion on the ideology of college students
	Influence of ideological education	Equality consciousness
		Tolerance consciousness
		Active consciousness
		Dialogue consciousness
	Influence of ideological education content	Security concept education
		The education of socialist core values
		legal education
		Psychological education
		Competence education
	Influence of ideological education method	Supervision difficulty
		Traditional teaching environment
		The complexity of the environment of ideological education

Table 1 – Evaluation index of the ideological education of the college students on the computer platform under the network public opinion environment

$$P = (r_{ij})_{m \times n} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

(1)

The second step is to standard the decision matrix. For the income index,

$$b_{ij} = \frac{r_{ij} - \min_j(r_{ij})}{\max_j(r_{ij}) - \min_j(r_{ij})} \quad (2)$$

For the consumption index,

$$b_{ij} = \frac{\min_j(r_{ij}) - r_{ij}}{\max_j(r_{ij}) - \min_j(r_{ij})} \quad (3)$$

The third step is to weight the normalized decision matrix.

$$R = (r_{ij})_{m \times n} = \begin{bmatrix} w_1 b_{11} & w_2 b_{12} & \cdots & w_n b_{1n} \\ w_1 b_{21} & w_2 b_{22} & \cdots & w_n b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ w_1 b_{m1} & w_2 b_{m2} & \cdots & w_n b_{mn} \end{bmatrix} \quad (4)$$

The fourth step is to calculate the positive ideal solution and the negative ideal solution.

$$R^+ = \{(\max_n w_n b_{mn} | m \in J_1), (\min_n w_n b_{mn} | m \in J_2)\} \quad (5)$$

$$R^- = \{(\min_n w_n b_{mn} | m \in J_1), (\max_n w_n b_{mn} | m \in J_2)\} \quad (6)$$

Where, R^+ is the positive ideal solution and R^- is the negative ideal solution. The distance between the evaluation object and the ideal solution is,

$$D_i^+ = \sqrt{\sum_{j=1}^n (r_{ij} - r_j^+)^2} \quad (7)$$

$$D_i^- = \sqrt{\sum_{j=1}^n (r_{ij} - r_j^-)^2} \quad (8)$$

In the formula, $D^+ i$ is the distance between the positive ideal solution and the evaluation object. $D^- i$ is the distance between the negative ideal solution and the evaluation object. $r^+ i$ is the element that is corresponding to $D^+ i$. $r^- i$ is the element that is corresponding to $D^- i$.

The fifth step is to calculate the closeness degree.

$$C_i^+ = \frac{D_i^-}{D_i^+ + D_i^-} \quad (9)$$

Where, $i=1, 2, \dots, m$.

4. The improved TOPSIS method

In this paper, in order to better study the ideological education of the college students on the computer platform under the network public opinion environment, we put forward an improved TOPSIS method. The specific process of the method is as follows.

We set the evaluation object set is $\{A_j\}$. The evaluation set is $\{X_j\}$. x_{ij} is the initial value for the j index of the i object. The matrix $\{X, ij\}$ is the proximity matrix of x_{ij} . The weight is w_j .

$$b_{ij} = \sqrt{\prod_{k=1}^n a_{ik} a_{kj}} \quad (10)$$

The subjective weight is,

$$w_j^1 = \frac{c_j}{\sum_{k=1}^n c_k} = \frac{\sqrt{\prod_{k=1}^n b_{jk}}}{\sum_{s=1}^n \sqrt{\prod_{k=1}^n b_{jk}}} \quad (11)$$

Determining the proportion of the subjective weight and the objective weight coefficient is α_1 . The adjustment coefficient is α_2 . The combined weight is,

$$w = (\alpha_1 + \alpha_2) \frac{\sqrt{\prod_{k=1}^n \sqrt{\prod_{t=1}^n a_{jt} a_{tk}}}}{\sum_{s=1}^n \sqrt{\prod_{k=1}^n \sqrt{\prod_{t=1}^n a_{jts} a_{stk}}}} + (1 - (\alpha_1 + \alpha_2)) \cdot w_j \quad (12)$$

We set the determination matrix is $B' = (b'_{ij})_{m \times n}$. The normalized matrix is $B = (b_{ij})_{m \times n}$. The index weight vector is $w = (w_1, w_2, \dots, w_n)^T$. After the weighted processing, we get the index membership degree matrix

$$R = (r_{ij})_{m \times n} = (w_j b_{ij})_{m \times n} \quad (13)$$

The positive ideal point and the negative ideal point are respectively,

$$r^+ = (r_1^+, r_2^+, \dots, r_n^+), r_j^+ = \max_i r_{ij} \quad (14)$$

$$r^- = (r_1^-, r_2^-, \dots, r_n^-), r_j^- = \min_i r_{ij} \quad (15)$$

We define the distance between the evaluation object and the positive ideal solution.

$$d_j^+ = [\sum_{i=1}^m (w_i |r_{ij} - r_j^+|)^p]^{\frac{1}{p}} \quad (16)$$

We define the distance between the evaluation object and the negative ideal solution.

$$d_j^- = [\sum_{i=1}^m (w_i |r_{ij} - r_j^-|)^p]^{\frac{1}{p}} \quad (17)$$

We define the relative closeness degree between the j evaluation object and the negative ideal solution is,

$$C_j = \frac{(r_j - r^-)^T (r^+ - r^-)}{\|r^+ - r^-\|^2} = 1 - \frac{r^- r_j^+}{\|r^-\|^2} \quad (18)$$

Where, $r_j = (r_{1j}, r_{2j}, \dots, r_{nj})^T$.

The relative closeness degree between the j evaluation object and the negative ideal solution is the relative distance between the feature vector r_j of the j target and the negative ideal point r^- . The relative standard is the square $\|r^+ - r^-\|^2$ of the Euclidean distance between the ideal point and the negative ideal point. $(r_j - r^-)^T (r^+ - r^-)$ is the closeness degree between the feature vector r_j of the j target and the negative ideal point r^- . By analysis, $0 \leq C_j \leq 1$. If $r_j = r^+$, $C_j = 1$. If $r_j = r^-$, $C_j = 0$. If C_j is bigger, it shows that the evaluated object j is more close to the ideal point while it is farther away from the negative ideal point.

5. Experiment

In order to be able to study the ideological education of the college students on computer platform under the network public opinion, we select 6 universities and evaluate them separately. They record as A, B, C, D, E, F . In this paper, we use the improved TOPSIS method to study the ideological education of the university study based on the computer platform under the network public opinion. Firstly, we calculate the weight of each index. The specific data are shown in the following table.

The second index	The weight of the second index	The third index	The weight of the third index
Social influence	0.29	Effect of group effect	0.25
		Effect of polymer diffusion	0.25
		Polarization effect	0.25
		The influence of opinion leaders	0.25
Personal influence	0.23	The influence of negative public opinion attention degree on college students' ideology	0.22
		The influence of negative public opinion trust degree on college students' ideology	0.22
		The influence of positive public opinion attention degree on college students' ideology	0.15
		The influence of positive public opinion trust degree on college students' ideology	0.15
		The influence of public opinion on the ideology of college students	0.26
Influence of ideological education	0.16	Equality consciousness	0.25
		Tolerance consciousness	0.25
		Active consciousness	0.25
		Dialogue consciousness	0.25
Influence of ideological education content	0.16	Security concept education	0.14
		The education of socialist core values	0.34
		legal education	0.25
		Psychological education	0.16
		Competence Education	0.11
Influence of ideological education method	0.16	Supervision difficulty	0.26
		Traditional teaching environment	0.31
		The complexity of the environment of Ideological Education	0.43

Table 2 – Evaluation index weight of college students' ideological education based on computer platform under the network public opinion

Then, we calculate the relative closeness degree according to the formula (). The calculation results are shown in the following table.

colleges	C_j	order
A	0.6435	3
B	0.7268	1
C	0.6536	2
D	0.5270	4
E	0.3418	6
F	0.4621	5

Table 3 – The calculation results

The ranking order of each university is B>C>A>D>F>E.

6. Conclusion

The college students have the higher acceptance of the new things. At the same time, the Internet time of colleges is longer. Therefore, college students are vulnerable to the influence of Internet public opinion. Internet public opinion will have a great influence on the ideological education of the college students. It also raises concerns for many educators. In this paper, we study the ideological education of the college learning based on the computer platform under the network public opinion. In this paper, we do the following work. Firstly, we establish the ideological education evaluation index of the college learning based on the computer platform under the network public opinion. Secondly, we introduce the TOPSIS method. Thirdly, we propose the improved TOPSIS method. Fourthly, we apply this method to study the ideological education of the college learning based on the computer platform under the network public opinion. The experimental results prove the correctness of the evaluation system.

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Research on PCA Evaluation Model of the Agricultural Circular Economy Development in Heilongjiang Based on Data Mining Province

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Abstract: The healthy development of agricultural circular economy is crucial for the agricultural modernization in our country. At the moment, the evaluation of agricultural circular economy is too general. Therefore, to solve this problem, this article selects the key factors in the development of agricultural circular economy. Based on the data from the Statistical Yearbook of Heilongjiang Province from 2004 to 2014, this paper carries out data mining and adopts the SAS 9.3.1 statistical analysis software and establishes PCA model to conduct evaluation of the development of agricultural circular economy in Heilongjiang Province. Finally, the factors affecting the development of agricultural recycling economy in a large number of data are found through the algorithm. This results show that: economic development, reducing resource investment and natural resources and environment security index are the influencing factors of agricultural circular economy development, which needs to be addressed primarily. This paper suggest to formulate differential agricultural circular economy development strategies aiming at the score of evaluation index of agricultural circular economy development in Heilongjiang Province.

Keywords: data mining; agricultural circular economy; PCA model; evaluation, Heilongjiang Province

1. Introduction

The proposal of ‘developing the circular economy energetically’ appeared in the Party’s Third Plenary Session of the 16th Central Committee, Agriculture as the basic industry of the national economy and the weak industry has becoming the inevitable trend for agricultural development in the future.

Heilongjiang Province as big agricultural province in China, According to the data from Statistical Bureau in Heilongjiang Province, by the end of 2015, the cultivated land in Heilongjiang Province reaches 11.7652 million hectares, making it an important strategic reserve base of commodity grain in China. And the grain yield reaches 63.24 million tons and occupying the ‘No.1 province of grain yield’ for five consecutive years. However, because of the extensive management mode of traditional agriculture for many years and

the one-sided pursuit of grain yield and economic benefit, Heilongjiang Province ignores the coordinated development among economy, society and nature, which leads to the great burden on agro ecological environment and directly influences the continuous increase of farmers' income. What's worse, it also exerts a strong impact on the sustainable development of agricultural economy in Heilongjiang Province. Therefore, to achieve the coordinated development in Heilongjiang Province, take efficient and cyclic utilization of resources as core, 'reduction, recycling and reclamation' as principle and 'low consumption, low emission and high efficiency' as basic characteristics, the value of data resources must be deeply carried out mining to improve the sustainable development of recycling industry decision-making credibility in the era of big data.

2. Method Selection of Evaluation Model

With the development of agricultural circular economy, carrying out evaluation research with the use of data mining technology has become a hot spot in the field of research. The researches carried by domestic scholars about agricultural circular economy are: Han Long et al. (2013) holds that the evaluation of agricultural circular economy falls in to two major categories: the first is the comprehensive evaluation conducted on countries and regions from macro level; the second is the evaluation conducted on industrial parks and enterprises or specific industry model and farm from micro level. The article mainly focuses on the comprehensive evaluation conducted on provinces. Therefore, Qin Zhong et al. (2010) adopts DEA method to calculate the development of agricultural circular economy in Guangdong Province. Li Jia (2015) applies rough set method to carry out dynamic evaluation of the development of agricultural circular economy in Guangdong Province. Li Yating et al. (2009) uses fuzzy analysis method to conduct comprehensive evaluation of the development of agricultural circular economy in Beijing. Zhao Bo (2012) conducts the evaluation of the development of agricultural circular economy in Chongqing adopting AHP, weight given by evaluation index and standardized method. Jia Shijing (2015) uses fuzzy comprehensive evaluation method to carry out evaluation of the development of agricultural circular economy in China. There exists correlation among indexes in the evaluation index system of the agricultural circular economy in Heilongjiang Province. And the indexes we select are relatively more, which adds the amount of calculation and the complexity of problem for analysis. Therefore, we need to screen and simplify the evaluation system, finding major influencing factors. What's more, An Haiyan (2009) has already applied it in the evaluation of the agricultural circular economy in the typical counties of Heilongjiang Province and gained promising results. Therefore, this paper adopts principal component analysis to carry out evaluation of the agricultural circular economy in Heilongjiang Province. PCA is a kind of multivariate statistical analysis method that has been applied widely. This method considers the relationship among indexes, applies descending dimension method and finds out several comprehensive factors from numerous variable indexes, making it reflect the information of original variable as far as possible (Wang W.M., Liu X.L., 2011). And the factors selected are not related to each other, contributing to the comprehensiveness, comparability and objectivity of the evaluation result. The adoption of this method on the comprehensive evaluation of agricultural circular economy not only simplifies the calculation, but avoids subjectivity and arbitrariness, making the analysis result more accurate, reasonable and objective (Zhan J.G, Liu E.P., Liu H.Q., 2014).

Both cater to the large sample to be analyzed. Once the problems and errors have been identified, the possible improvements or solutions to the problems identified are proposed (Saltiveri, Toni Granollers; Fransi, Eduard Cristóbal and Salla, Yolanda Montegut, 2013).

3. Building of Development Evaluation Model of Agricultural Circular Economy

3.1. Setting of Evaluation Index System

According to the Twelfth Five-year Plan of Environmental Protection in Heilongjiang Province, we must follow the concept of agricultural circular economy and take provincial agricultural production and the actual situation of ecological environment as basis. Thus, it is an inevitable requirement that the evaluation of agricultural circular economy must give consideration to three aspects of indexes, which is society, economy and ecological benefit so as to reflect the complexity of agricultural system comprehensively and accurately. Therefore, this paper establishes the comprehensive evaluation index system of agricultural circular economy in Heilongjiang Province containing 4 first grade indexes, which are economy and social development, resource reduction input, resources circulation utilization and natural resources and environment security and 22 second indexes and specific content as follows:

Classification index	Second index		Interpretation of index
Index of economic development A_1	B_1	Net income per capita of farmer	Total income per capita of farmer-cost spending per capita of farmer, unit: Yuan/person ⁻¹
	B_2	Agricultural GDP per unit are	Total output value of agriculture/total planting area of crop, unit: 10,000 Yuan/ hm^2
	B_3	Agricultural mechanization level	Reflecting the use of agricultural machinery per planting area of crop, can be expressed in total power of agricultural machinery/ planting area of crop, unit: W/ hm^2
	B_4	Unit area grain yield	Total grain yield/total planting area of crop, unit: Kg/ hm^2
	B_5	Urbanization level	Urban population/total population, unit: %
	B_6	Engel coefficient of rural area	Showing the proportion of food expenditure in personal income, in important index to evaluate the overall living standards of rural residents and the social development in rural area unit: %
	B_7	Agricultural technical research and development level	The proportion of agricultural technical research and development level in the total value of agriculture production, namely=agriculture technical R&D expenditure/agriculture GDP ratio, unit: %
	B_8	Agricultural output ratio per capita	Reflecting the agriculture output value that can be created by each of the agricultural population, can be expressed in agriculture output value/agricultural population, unit: Yuan/person

Resource reduction input A_2	B_9	Application intensity of chemical fertilizer	Amount of chemical fertilizer applied/planting area of crop, unit: Kg/hm ²
	B_{10}	Agricultural electricity consumption	Total agricultural electricity consumption; unit: 100 million KWH
	B_{11}	Usage amount of pesticide	Total usage amount of pesticide/planting area of crop, unit: Kg/hm ²
	B_{12}	Application intensity of agricultural diesel oil	Total usage amount of agricultural diesel oil/planting area of crop, unit: Kg/hm ²
	B_{13}	Agricultural water consumption coefficient	Reflecting whether the utilization of water resources is reasonable or not, namely total agricultural water consumption/planting area of crop, unit: 10 thousand m ³ /hm ²
	B_{14}	Application intensity of agricultural film	Usage amount of plastic film/planting area of crop, unit: Kg/hm ²
Resource circulation utilization A_3	B_{15}	Effective irrigation coefficient	Effective irrigation area//planting area of crop, unit: %
	B_{16}	Multiple cropping index	Total planting area of crop/cultivated land area, unit: %
	B_{17}	Effective utilization coefficient of chemical fertilizer	Agricultural output value/usage amount of chemical fertilizer, unit: Yuan/kg
Natural resources and environment security A_4	B_{18}	Forest coverage rate	Forest land with canopy density over 0.2/total land area, unit: %
	B_{19}	Water resource quantity per capita	Reflecting the water resources quantity per capita in China, namely total water resources quantity/total population, unit: thousand m ³ /person
	B_{20}	Cultivated land per capita	Total population/total cultivated land, unit: hectare/ person
	B_{21}	Planting area proportion of green food	Planting area of green food (including organic food)/ area of cultivated land area, unit: %
	B_{22}	Erosion area of comprehensive control	Unit: 10 thousand hectare

Table 1 – Evaluation index system of Heilongjiang agricultural circular economy development

3.2. Data Source

Due to the implementation of the Plan of Ecological Province Construction started in 2003 in Heilongjiang Province and that it takes some time to reveal the effect of the execution and implementation of policy, thus the data source in this research comes from the Statistical Yearbook of Heilongjiang Province (2004-2014) China Rural Statistical Yearbook (2004-2014).

3.3. Dimensionless Method of Index

In the evaluation index system of Heilongjiang agricultural circular economy development, because of the negative effect index existing in part of the original data, thus we apply fuzzy membership function to conduct dimensionless processing on the original data of application intensity of chemical fertilizer, usage amount of pesticide, agricultural electricity consumption, agricultural water consumption coefficient, application intensity of agricultural diesel oil and application intensity of agricultural film in the category of ‘resource reduction input index’. The formula is as follows:

1. Positive index using semi-trapezoidal membership function:

$$M(N) = \frac{N_i - N_{in}}{N_{im} - N_{in}}$$

In this formula: $M(N_i)$ is the value of membership degree of the actual numerical value of the i th index; N_i the actual numerical value of the i th index; N_{im} is the maximum value (upper limit value) of this index, N_{in} is the minimum value (lower limit value) of this index. Due to the rule of $N_i \notin N_{im}$ and $N_{in} = 0$, the above-mentioned formula can be simplified as $M(N_i) = N_i / N_{im}$.

2. Reverse index using semi-trapezoidal membership function:

$$M(N_i) = \frac{N_{im} - N_i}{N_{im} - N_{in}}$$

After the standardization of index, it receives no influence from dimension and indexes can be compared with each other. That the bigger the quantized value of index indicates the actual value of this index is closer to the most advanced value.

3.4. Calculation Result and Analysis

This paper applies SAS 9.3.1 statistical analysis software to conduct PCA on the development of agricultural circular economy in Heilongjiang Province and obtains variance decomposition principal component extracting analysis table (Table 2). The eigenvalue of previous three principal components is more than 1 and the accumulating contribution rate reaches 90.82%, which means that the majority of original variable information can be interpreted by these three factors.

Principal component	Eigenvalue	Variance contribution rate/%	Accumulating contribution rate/%
F1	14.9754	0.7131	0.7131
F2	2.1543	0.1026	0.8157
F3	1.9419	0.0925	0.9082

Table 2 – Factors of eigenvalue, contribution rate and accumulation contribution rate

In the initial factor loading matrix, the numerical value of common factor in most of the variables is usually average, which is difficult to explain the significance of each common factor and inconvenient to conduct analysis and explanation of practical problem. Out of this consideration, this paper conducts linear combination of initial common factor, namely factor rotation hoping to find the common factor with more evident practical significance. After orthogonal rotation (the common factors after orthogonal rotation still maintain the independent nature), great change occurs to loading matrix, like Table 3.

We can judge from the loading numerical value of factor that the information content of the first principal component F1 is relatively high in terms of net income per capita of farmer, agricultural mechanization level, unit area grain yield, urbanization level and agricultural output ratio per capita and thus can be interpreted as the factor of overall level of agricultural circular economy development; the loading of the second principal component F2 is relatively big in terms of application intensity of agricultural diesel oil, agricultural water consumption coefficient, application intensity of agricultural film and thus can be seen as characterization factor of resource reduction input aspect of agricultural circular economy in Heilongjiang Province; the loading of the third principal component F3 is relatively big in terms of erosion area of comprehensive control, planting area proportion of green food and reflection degree of other aspects is relatively small and thus can be used as the factor of natural resources and environment security aspect.

Index	F1	F2	F3
N1	0.2559	-0.0382	-0.0561
N2	-0.2522	0.0649	-0.0626
N3	0.2564	-0.0288	-0.0033
N4	0.2438	-0.0095	-0.1040
N5	0.2510	-0.1020	0.0326
N6	-0.1077	0.4786	-0.0665
N7	0	0	0
N8	0.2555	-0.0151	-0.0837
N9	0.2250	0.1470	0.3000
N10	0.2539	-0.0809	-0.0501
N11	0.2080	0.0933	0.3917
N12	0.1830	0.2840	0.3646
N13	0.2205	0.3205	-0.0401
N14	0.1799	0.4234	0.1298
N15	0.2537	0.0933	0.0426
N16	-0.1806	-0.1558	0.3197
N17	0.2460	-0.022	-0.1740
N18	0.2105	-0.2402	-0.0392
N19	0.2375	-0.2450	-0.0772
N20	0.1574	-0.0530	-0.3974
N21	0.2179	-0.2807	0.0849
N22	-0.0510	-0.3480	0.5150

Table 3 – Factor loading matrix after rotation

Table 4 is the coefficient information of principal component expressed in original variable and we can get the expression of three principal components. It should be noted that it is the expression of principal component expressed in original variable that is given by SAS statistical system software here. And the principal component factor we get is that after standardization. Therefore, to get the relationship between original variable, we need to times the square root of principal component factor variance, namely:

$$F1 = (0.2559N_1 - 0.2522N_2 + 0.2564N_3 + 0.2438N_4 + 0.2510N_5 - 0.1077N_6 + 0.2555N_8 + 0.2250N_9 + 0.2539N_{10} + 0.2080N_{11} + 0.1830N_{12} + 0.2205N_{13} + 0.1799N_{14} + 0.2537N_{15} - 0.1806N_{16} + 0.2460N_{17} + 0.2105N_{18} + 0.2375N_{19} + 0.1574N_{20} + 0.2179N_{21} - 0.0510N_{22}) \times \sqrt{14.9754}$$

$$\text{In a similar way, } F2 = f2 \times \sqrt{2.1543} \quad F3 = f3 \times \sqrt{1.9419}$$

Until now, we can establish the econometric model of agricultural circular economy evaluation in Heilongjiang Province, which is:

$$F = (3.8698f1 + 1.4678f2 + 1.3935f3) / 0.9082$$

Index	F1	F2	F3
N1	0.2559	-0.0382	-0.0561
N2	-0.2522	0.0649	-0.0626
N3	0.2564	-0.0288	-0.0033
N4	0.2438	-0.0095	-0.1040
N5	0.2510	-0.1020	0.0326
N6	-0.1077	0.4786	-0.0665
N7	0	0	0
N8	0.2555	-0.0151	-0.0837
N9	0.2249	0.1474	0.3004
N10	0.2539	-0.0809	-0.0501
N11	0.2080	0.0933	0.3917
N12	0.1830	0.2840	0.3646
N13	0.2205	0.3205	-0.0401
N14	0.1799	0.4234	0.1298
N15	0.2537	0.0933	0.0426
N16	-0.1806	-0.1558	0.3197
N17	0.2461	-0.0218	-0.1740
N18	0.2105	-0.2402	-0.0392
N19	0.2375	-0.2450	-0.0772
N20	0.1574	-0.0530	-0.3974
N21	0.2179	-0.2807	0.0849
N22	-0.0512	-0.3483	0.5149

Table 4 – Principal component score matrix

4. Conclusions

4.1. In Table 4 principal component score matrix, the first principal component F1 mainly embodies the net income per capita of farmer, agricultural mechanization level, unit area grain yield, urbanization level and agricultural output ratio per capita of economic development category. These five indexes get high score and can be treated as the priority of economic and social development in the future.

4.2. In Table 4 principal component score matrix, the second principal component F2 mainly embodies the agricultural diesel oil, agricultural water consumption coefficient, application intensity of agricultural film of resource reduction input. These three indexes get high score. However, the reduction index is negative index, so we need to control the promotion of absolute value number of these three indexes in the future development.

4.3. In Table 4 principal component score matrix, the third principal component F3 mainly embodies the erosion area of comprehensive control and planting area proportion of green food in the natural resources and environment security index.

5. Suggestion

5.1. Heilongjiang Province should establish the agricultural circular economy development planning and agricultural circular economy evaluation index system according to the actual situation within the province as soon as possible. (1) In the aspect of economic and social development, we need to bring agricultural circular economy into the 13th Five-year Plan of agricultural development of Heilongjiang Province, support leading enterprises of agricultural circular economy, encourage the innovation of agricultural circular economy and popularize advanced and applicative scientific and technological achievements. (2) In the aspect of resources reduction and natural resources and environment security, we need to increase the investment of environmental protection funds, control and reduce the pollution of agricultural non-point source, build ecological community, advocate green lifestyle and green production mode and keep carrying forward the construction of agricultural ecological cycle functional zone. (3) In accordance with 18th CPC National Congress, President Xi Jinping puts forward the concept of ecological civilization; take it as the spirit of the policy of guiding to the development of agricultural circular economy in Heilongjiang.

5.2. Based on the scores of each index, sorting operation, as the basis of adjusting agricultural circular economy development strategy in Heilongjiang Province, makes the pertinence of agricultural circular economy development strategy. For example, we should focus on the index of net income per capita of farmer, agricultural mechanization level, unit area grain yield, urbanization level and agricultural output ratio per capita in economic development category, to strengthen the ecological integration of agriculture industry and achieve the recycling of resources, thus the level of agricultural recycling economy in Heilongjiang province can be improved; the index of application intensity of agricultural diesel oil, agricultural water consumption coefficient, application intensity of agricultural film in resources reduction input, The system of emission reduction targets linked with the government and officials achievements and the green GDP accounting system can be implemented; comprehensive control and planting area

proportion of green food in the natural resources and environment security category and other factors that exert relatively big influence, the level of environmental protection can be improved through modifying the local environmental protection regulations and instituting Promotion regulations on the development of agricultural recycling economy in Heilongjiang province, corresponding with industry and department function and formulating agricultural circular economy development strategy and system differentially.

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Engine Dynamic Characteristics Research Based on Experiment and Computer Numerical Simulation

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Abstract: Due to the development of the high-speed, light-weight, and high-power engine, engine's dynamic characteristics are widely concerned. Especially, the dynamic characteristics of the complex combination structures with joint surfaces are the study hotspot. In the study, a novel study method of the dynamic characteristics of combination structures was presented. Firstly, the engine was divided into many substructures according to the dynamic substructure method. Secondly, virtual elements were introduced to simulate the joint surface's dynamic characteristics and the stiffness and damping characteristics of the virtual elements were identified. Thirdly, all the substructures were assembled according to the substructures modal synthesis method and dynamic characteristics of the engine were solved by computer numerical simulation. Finally, experimentally measured dynamic characteristics of the actual engine were compared with the simulation results. The dynamic characteristics of the actual engine were consistent with the simulation results, indicating that the novel method was efficient and correct.

Keywords: dynamic characteristics, modal synthesis, virtual element, joint surface, computer numerical simulation

1. Introduction

With the development of the computer simulation technology and testing technology, the dynamic characteristics of mechanical system is getting more and more attention (Xu and Tan, 2016). Especially for high-speed, high-precision, and complex mechanical system, dynamic characteristics significantly affect its working performance and product quality. Large-scale complex mechanical structures, such as engine systems and vehicle transmission systems, are composed of a number of components assembled together according to a certain functional requirement and the connection part among the components is known as the “joint surface” (Liao et al., 2004; Zhao et al., 2016). A variety of contact forms exist on the joint surface of these mechanical structures, such as elastic contact, plastic contact, coupled thermal-elasticity contact, and the contact

between the oil film and mechanical parts (Tian et al., 2013). When the structure vibrates, damped vibrations having multiple degrees of freedom occur between joint surfaces and energy accumulation and consumption occurs at the joint surface, thus leading to the complex elasticity and damping characteristics of the joint surface (Wang et al., 2011). The characteristics of joint surface significantly affect the dynamic performance of the mechanical structures by reducing integral stiffness and increasing damping of the mechanical structure, which results in the decrease in natural frequencies and the complex vibration modes. Therefore, the contact problems of joint surface should be considered in the analysis of the dynamic characteristics of complex mechanical structures (Huang and Jin, 2012). It is necessary to further study the dynamic characteristics of composite structures, especially large and complex composite structures.

The remainder of this paper is organized as follows. In Section 2, the study progresses on dynamic characteristics of the combination structures are summarized and a novel method is proposed to simulate the dynamic characteristics of engine combination structures. In Section 3, the fundamental theory of the new method is introduced. Section 4 describes the application of this new method in the engine combination structures and presents the comparison of numerical simulation results with the experimental ones. Conclusions are summarized in Section 5.

2. Study Progresses on Dynamic Characteristics of Composite Structures

Several study methods of the dynamic characteristics of single or simple mechanical structures, such as experimental modal analysis, finite element analysis method, and boundary element method, are widely used. Engine modeling has achieved significant results. The group in Madison University established finite element model for each diesel engine part and performed the engine simulation. Yuehui Liu made a modal test of diesel engine body and finite element method (FEM) calculation (Sun, 2012). At present, the FEM has been applied to study dynamic characteristics of some structures successfully. However, the finite element analysis cannot provide precise calculation results for the complex assembled structures. Machine tools are composed of many substructures connected together by joints such as bolts, rivets, glue, and welds. Among these joints, the bolted joint is mainly employed in the fixed connection of parts for the convenience of repair and replacement. Characteristics of the joints determine the dynamic behaviors of machine tools and most vibration energy loss occurs at the joint between two joint surfaces. The contact problems of joint surface had been extensively studied since the 1960s, and the studies on the dynamic characteristics of joint surface had obtained great achievements (Li, 2002; Jalali, 2016; Mao et al., 2010; Mehrpouya et al., 2016; Bachmayer and Whitcomb, 2003; Jia et al., 2013), especially in the dynamics of bolt joint surfaces. Zhao presented a non-linear virtual material method based on surface contact stress to describe the bolted joint for accurate dynamic performance analysis of the bolted assembly and used the fractal geometry theory to describe the surface topography (Zhao et al., 2016). Hassan Jalali presented an identification approach in which the dynamic characteristic equation of linear interface parameters was adopted and the approach was applicable to both analytic and numerical problems (Jalali, 2016).

The scope of previous studies on joint surface was limited to two relatively simple mechanical members. However, the dynamic characteristics of large, complex composite structures were seldom reported at home and abroad. In the studies on large complex mechanical structures such as engine structures, complex model requires the longer computation time and allows the higher computation precision. In order to reduce the computational scale and guarantee the calculation accuracy, a novel method was presented to simulate the dynamic characteristics of engine combination structures in this paper. We comprehensively utilized the joint surface dynamic characteristics simulation method, experimental modal analysis method, and substructure modal synthesis method to deeply study the dynamic characteristics of large complex combination structures.

3. Methodology

This method includes several main steps. The first step is to divide the engine into many substructures according to the dynamic substructure method, namely, the substructure modal synthesis method. The second step is to introduce virtual elements to simulate the dynamic characteristics of the joint surface of two substructures and identify the stiffness and damping characteristics of the virtual elements by the combined identification method of the theoretical modeling and dynamic experimental method (experimental modal analysis method). The third step is to assemble all the substructures in accordance with substructures modal synthesis and get dynamic characteristics of the engine by numerical simulation of the whole structure dynamic model (Cui and Yang, 2008). Finally, an experiment is conducted to measure the similarity between dynamic characteristics of the actual engine and the simulation results.

3.1. Experimental Modal Analysis of Engine Combination Structure

In order to carry out experimental modal analysis, the pulse hammer excitation method was adopted under the condition of free suspension state to individually hang engine block, crankshaft, cylinder head and their combination structures with elastic rope (Yasuda et al., 1997). The modal test system is shown in Fig. 1.

In order to obtain modal parameters precisely, the multi-position exciting technology was used and the excitation frequency of the test system was set as 1000 Hz (Fu et al., 2000). Because single point measure method is prone to omit some modes, the multi-position measure method is chosen for each structure to avoid mode omission. Through the test, the natural frequencies and vibration modes (eigenvalues and eigenvectors) of engine block, crankshaft, cylinder head, and their combination structures can be obtained.

3.2. Sub-Structure Modal Synthesis Method

Substructure modal synthesis method is also called dynamic substructure method and mainly used in the dynamic characteristics analysis of complex combination structures, such as engine combination structures. In the dynamic analysis and design of some large complex structures, degree of freedom can reach ten thousand and even hundred thousand, thus leading to the unimaginable computation load. Therefore, degree of freedom should be reduced effectively. The dynamic substructure method, namely, the

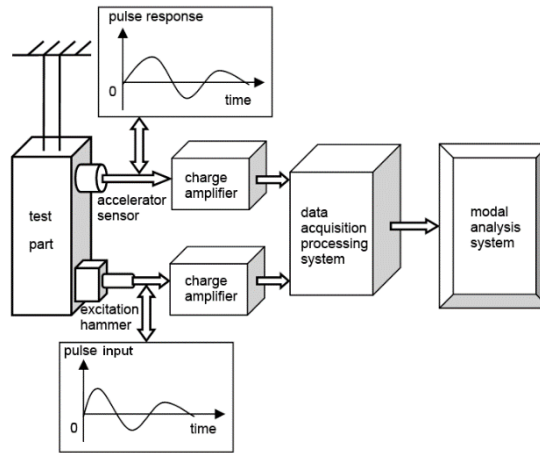


Figure 1 – Diagram of the modal test system

substructures modal synthesis method, can decrease the calculation load caused by the large degree of freedom. The method is described as follows:

Generally, in the substructure modal synthesis method, the vibration system's kinematics equation is converted into modal coordinate space equation and the higher modes of the substructures are removed. Therefore, it is required to convert the original system's physical coordinate into modal coordinate for all modal synthesis methods. Detailed steps are introduced as follows (Zhao et al., 2016; Cui and Yang, 2008).

Substructure kinematics equation can be established by dividing the whole structure into several substructures. Then, each one's kinematics equation can be established according to any model or method. Supposing that the r -th kinematics equation of substructures is expressed as:

$$m_r \ddot{x}_r + k_r x_r = f_r \quad (1)$$

where m_r , k_r and f_r are the mass matrix, stiffness matrix, and exciting force vector based on generalized coordinate x_r .

Then, the substructure kinematics equation is converted into the modal coordinate equation. Supposing that the right-hand side of Eq. (1) is zero, its eigenvalues are solved. The main modes of substructures are calculated and the other modes, such as rigid body modes and constrained modes, are determined. These modes constitutes modal matrix φ_r . Modal matrix φ_r consists of substructures' lower order modes under simple conditions. The first coordinate conversion of Eq. (1) can be implemented by taking φ_r as transformation matrix.

$$x_r = \varphi_r p_r \quad (2)$$

Substructures kinematics equation can be expressed with the other equation containing modal coordinate p_r :

$$\bar{m}_r \ddot{p}_r + \bar{k}_r p_r = \bar{f}_r \quad (3)$$

where $\bar{m}_r$, $\bar{k}_r$ and $\bar{f}_r$ are the mass matrix, stiffness matrix, and exciting force array based on modal coordinate p_r . In addition, they are defined as follows:

$$\bar{m}_r = \varphi_r^T m_r \varphi_r, \bar{k}_r = \varphi_r^T k_r \varphi_r, \bar{f}_r = \varphi_r^T f_r \quad (4)$$

The non-connected kinematics equation of the whole structure can be obtained if all the substructures' kinematics equations with modal coordinate are combined together.

$$\begin{Bmatrix} \bar{m}_1 & & & & & \\ & \bar{m}_2 & & & & \\ & & \ddots & & & \\ & & & \ddots & & \\ & & & & \bar{m}_n & \\ & & & & & 0 \end{Bmatrix} \begin{Bmatrix} \ddot{p}_1 \\ \ddot{p}_2 \\ \vdots \\ \ddot{p}_n \end{Bmatrix} + \begin{Bmatrix} \bar{k}_1 & & & & & \\ & \bar{k}_2 & & & & \\ & & \ddots & & & \\ & & & \ddots & & \\ & & & & \bar{k}_n & \\ & & & & & 0 \end{Bmatrix} \begin{Bmatrix} p_1 \\ p_2 \\ \vdots \\ p_n \end{Bmatrix} = \begin{Bmatrix} \bar{f}_1 \\ \bar{f}_2 \\ \vdots \\ \bar{f}_n \end{Bmatrix}.$$

It can be simplified as follows:

$$\bar{M} \ddot{p} + \bar{K} p = \bar{F} \quad (5)$$

where both $\bar{M}$ and $\bar{K}$ are block diagonal matrices.

When the second coordinate conversion is completed, the kinematics equation of the whole connected structure expressed with generalized modal coordinate can be obtained according to the constraint conditions of the substructures' joint surfaces. Because the integration of the substructures is implemented in the collection p consisting of substructure modal coordinate p_r , the constraint conditions should be expressed with the collection p . Obviously, the collection p is related to modal matrix φ and the constraint condition expression varies with φ .

The balance conditions of joint surface force have been satisfied in modal coordinate system and only the displacement compatible condition should be considered. Supposing that the displacement of joint surface point's compatible equation in physical coordinate is:

$$HX = 0 \quad (6)$$

where H represents the constraint matrix; X represents the displacement vector. According to Eq. (2), we get the compatible equation expressed with the coordinate p

$$H\phi p = 0 \text{ or } Bp = 0 \quad (7)$$

Combining Eq. (5) with Eq. (7), the kinematics equation of the whole structure assembled with all the substructures is obtained. The number of the degrees of freedom of the whole structure is smaller than the sum of that of all the substructures because of the mutual constraints among the substructures. If the collection p is divided into dependent coordinate p_d and independent $p_i=q$, the matrix B is treated in the same way. Then Eq. (7) can be rewritten as:

$$\begin{aligned} (B_d \ B_i) \begin{Bmatrix} p_d \\ q \end{Bmatrix} &= 0 \\ B_d p_d &= -B_i q \\ p_d &= -B_d^{-1} B_i q \\ \begin{Bmatrix} p_d \\ q \end{Bmatrix} &= \begin{pmatrix} -B_d^{-1} B_i \\ I \end{pmatrix} q \\ \text{or } p &= Sq \end{aligned} \quad (8)$$

where S is transformation matrix of the second coordinate conversion. After the coordinate conversion of Eq. (5) according to Eq. (8), the kinematics equation of the connected whole structure expressed by generalized coordinate q is obtained as

$$M\ddot{q} + Kq = F \quad (9)$$

where

$$M = S^T \overline{M} S, \ K = S^T \overline{K} S, \ F = S^T \overline{F} \quad (10)$$

After solving the Eq. (9), the natural frequencies of the whole structure are obtained and the main modals, frequency responses, and kinematics status expressed by generalized coordinate q , are also obtained.

Finally, after the coordinate conversion of Eqs. (8) and Eq.(2) to physical coordinate, the main modes of each substructures and each kinematics status expressed by physics coordinate are obtained.

3.3.Simulation of Dynamic Characteristics of Joint Surface With Virtual Elements

The dynamic characteristics of the joint surfaces should be considered in the establishment of the dynamics model of complex assembled structures (Zhao et al., 2016; Yasuda et al., 1997). Moreover, in the application of the modal synthesis theory,

the dynamic characteristics of joint surfaces should be identified or simulated according to the dynamic substructure method (Bachmayer and Whitcomb, 2003).

A simulation method of dynamic characteristics of the joint surface with the concept of virtual elements was applied in engine combination structures. The method is described as follows:

Supposing that there are two substructures: l and y . Mass matrix and stiffness matrix of substructures l are M_l and K_l , respectively. Mass matrix and stiffness matrix of substructures y are M_y and K_y , respectively. Virtual elements are introduced to simulate the connection characteristics between two substructures. This virtual element could be defined by two characteristics: elasticity and damping. The schematic diagram of the simulation of the dynamic characteristics of joint surface by using virtual elements is shown in Fig. 2.

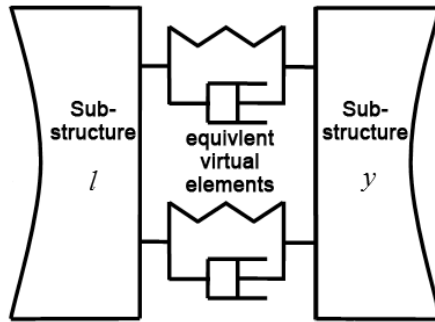


Figure 2 – Schematic diagram of the simulation of the dynamic characteristics of joint surface by using virtual elements

Virtual elements are adopted to simulate the features of joint surfaces between engine block and cylinder head, the outer surface of crankshaft, and the inner surface of sliding bearing.

3.4. Parameter Identification Method of Virtual Elements of Joint Surface of Combination Structures

To study the dynamic characteristics of the joint surface, the stiffness and damping characteristics of the virtual elements should be identified according to the combination identification method of theoretical modeling and dynamic experimental method described in Subsection 3.1. Specific identification process is introduced as follows:

The equations of a free vibration system can be written as

$$M\ddot{x} + C\dot{x} + Kx = 0 \quad (11)$$

where M , C , and K are respectively the mass matrix, damping matrix and stiffness matrix of the system and can be obtained by analysis methods. The characteristic equation of the system is

$$(\lambda_i^2 M + \lambda_i C + K)\varphi_i = 0 \quad (12)$$

Considering stiffness and damping of the joint surface, we get

$$[\lambda_i^2 M + \lambda_i (C + C^J) + K + K^J]\varphi_i = 0 \quad (13)$$

where C is zero because structural damping is generally ignored and C^J and K^J are unknown stiffness and damping parameters of the joint surface and should be identified. By dynamic experiment and modal parameter identification, eigenvalues λ_i and eigenvectors φ_i of the system can be obtained. After substituting each eigenvalue and eigenvector into Eq. (13), linear equations with unknown joint surface parameters can be obtained as

$$AZ = B \quad (14)$$

where Z is a vector of unknown parameters of joint surface; A and B are known coefficient matrix and constant matrix involving the system mass, stiffness, damping and the measured frequency response function. Therefore, the parameter identification problem of the joint surface is converted into the solution problem of linear equations. Multiplying A^T on both sides of Eq. (14) gives

$$A^T AZ = A^T B \quad (15)$$

Thus, the least squares solution of Z is obtained as:

$$Z = (A^T A)^{-1} A^T B \quad (16)$$

where Z is the parameter of joint surface obtained by solving Eq. (16).

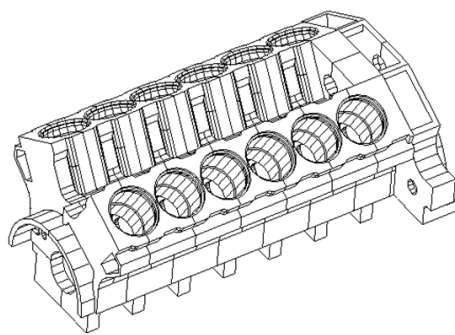
4. Result Analysis And Discussion

The application of the novel study method of dynamic characteristics in the engine is described below.

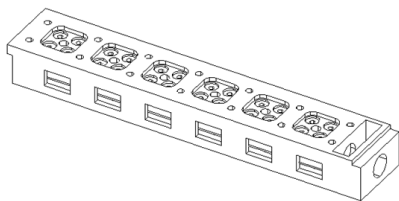
4.1. Model Establishment of Engine Block+Cylinder-Head+Crankshaft

In the dynamic analysis and design of some large complex structures such as engine block, cylinder-head, crankshaft and their combination structures, degree of freedom

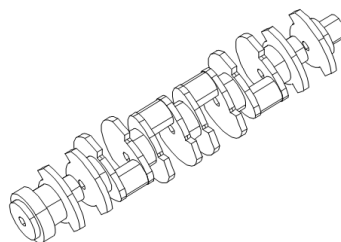
may reach hundreds of thousands and even one million, thus leading to the unimaginable computation load. Therefore, the degree of freedom should be reduced effectively. The method of dynamic substructure described in Subsection 3.2, namely, substructures modal synthesis method, can decrease the computation load. In the method, the whole structure is firstly divided into a lot of substructures or components and then each structure is subjected to finite element analysis based on the comparison of modal tests to obtain dynamic characteristics of every substructure. The engine substructures include engine block, cylinder head, and crankshaft. The solid model of these substructures are shown in Fig. 3. On the basis of the reliable finite element models of each substructure, the finite element model of the whole structure is obtained.



(a) Solid model of engine block



(b) Solid model of cylinder-head



(c) Solid model of crankshaft

Figure 3 – Solid model of engine substructures

Because an engine is a structure assembled with different parts, there are all kinds of joint surfaces in the engine, such as the surface between block and cylinder head, the outer surface of crankshaft, and the inner surface of sliding bearing, thus leading to the difficulty in model establishment. Considering that dynamic characteristics of the joint surface of the engine combination structure cannot be carried out theoretically

or experimentally, virtual elements were introduced and the stiffness and damping characteristics of virtual elements of the joint surface were identified through the combination method of theoretical modeling and dynamic experiment. The specific identification process was described in Subsection 3.4.

After obtaining the dynamic characteristics of substructures such as engine block, cylinder head, and crankshaft, all the substructures were assembled together according to the mutual coupling conditions among the substructures and the dynamic model of engine was obtained according to the substructure modal synthesis method. With the stiffness and damping parameters of the joint surface identified above as the boundary conditions, the dynamic characteristics of the engine combination structures can be obtained by numerical simulation of the engine dynamic model. The three-dimensional solid model of engine combination structure composed of engine block, crankshaft, and cylinder head was established (Fig. 4).

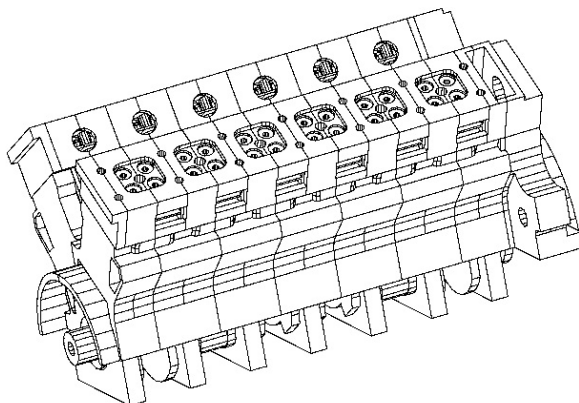


Figure 4 – Solid model of engine combination structure

4.2. Finite Element Modal Analysis and Comparison

The engine combination structure's solid model was meshed by the tetrahedron four-node elements. Then the finite element model of the combination structure is obtained, as shown in Fig. 4. By substituting the identified stiffness and damping parameters of joint surface among engine block, crankshaft, and cylinder head into the dynamic model of the whole structure, the dynamic characteristics of the engine structures can be obtained by numerical simulation.

When solving modals with the finite element analysis, Lanczos method, an efficient solving method of engineering eigenvalue, is adopted (Luo and Hu, 2015; Cai and Liang, 2014). At last, the natural frequency comparison of numerical simulation results of the engine combination structures and the experimental results are listed in Table 1.

mode order	experimental result	simulation result	errors (%)
1	220.35	235.19	6.73
2	365.19	362.15	-0.83
3	408.17	401.46	-1.64
4	458.03	429.92	-6.14
5	541.48	531.62	-1.82
6	574.26	603.11	5.02

Table 1 – Comparison of numerical simulation results with the experimental one (unit: Hz)

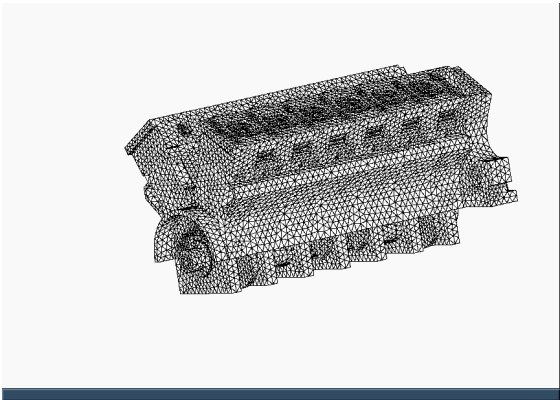


Figure 5 – Finite element model of the engine combination structure

In Table 1, the relative errors between numerical simulation results of natural frequency for the combination structures and the experimental ones are less than 7%, which satisfies engineering requirements. At the same time, the study found that testing and simulation vibration modes are also in good agreement. The comparison results proved that the results were consistent with actual situations.

5. Conclusions

In this paper, a novel method was proposed to simulate the dynamic characteristics of engine combination structures. We comprehensive utilized the joint surface dynamic characteristics simulation method, experimental modal analysis method, and substructure modal synthesis method to explore the dynamic characteristics of large complex combination structures. By comparing the dynamic characteristics results obtained from the novel method and the experimental ones, we found that the relative errors between the simulation results and the experimental results were less than 7%, which satisfied engineering requirements. The comparison results proved that the results were consistent with actual situations. The main conclusions are drawn as follows:

It is feasible to simulate the engine combination structures according to the substructure modal synthesis method. This method can also be applied to other large complex composite structures. The method extracts the lower-order modes and removes the higher-order modes of the substructures, thereby reducing solution time and improving computational efficiency.

The dynamic characteristics of joint surface can be effectively simulated with virtual elements. The simulation is also called the establishment of the equivalent dynamic model of joint surface. The equivalent dynamic model of joint surface facilitates the analysis and study of dynamic characteristics, dynamic tests and parameter identification.

The parameter identification method of joint surface by the combination of theoretical and experimental methods can also be feasible. The combination of the equivalent dynamic model of joint surface and dynamic test yields the effective and comprehensive identification method in engineering applications.

The novel method proposed in this paper is suitable for dynamic characteristics study of engine combination structures and can be used for other kinds of machinery combination structures. The method provides a solid foundation for improving the dynamic performance of the whole machine.

Acknowledgment

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Minimal Spanning Tree Analysis of Topological Structures: the Case of Hang Seng Index

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Abstract: To explore the nature of Hong Kong stock market's dynamic characteristics during financial crisis, 31 stocks are collected from the components of HSI. Based on minimal spanning tree (MST) algorithm, the dynamics of Hong Kong stock market during 2008 financial crisis are analyzed from micro-macro analysis perspective. Empirical results show that MST length, network diameter, characteristic path length dropped steeply at the beginning of the crisis, and then such parameters fluctuated slightly and rose to initial level finally. Cluster coefficient and average degree increased gradually and reached maximal value at the initial phase, afterwards these values at this level fluctuated and went up to a higher level at the end of financial crisis. This implies that Hong Kong stock market networks became more compact and few great hub nodes with large degree presented.

Keywords: Complex network, financial crisis, stock market, minimal spanning tree

1. Introduction

Correlation between stock market plays a central role in investment theory and risk management, and also one of the key elements for the optimization problem (Chi et al. 2010; Sensoy & Benjamin 2014). Thus, a correlation based network could be very useful in analyzing the interactions between financial markets and building optimal investment strategy (Chen et al. 2015).

The analysis of topological properties of stock market network has led to new insights (Anton et al. 2014). Recently, analyses based on network models have been proposed for studying the correlations among global stock markets, including the works of (Caraianni 2012; Nobil et al. 2014; Sensoy & Benjamin 2014.) The usual approach involves a procedure of constructing the financial complex networks by using the stock index as nodes and the correlation coefficients of stock index return sequence as weighted edges based on the vast amounts of financial data. Some researchers analyzed the correlation between the financial pattern of the international stock market and the market by

considering the topology structure properties of the network (Han & Wang 2014). For example, Nobi et al. (2014) analyzed the changes of the correlations between the Korean stock index and the global stock index as well as the network topology attributes by employing Jaccard similarity measurement and the stock index data from 2000 to 2012. Their study showed that the average correlation of Korean stock index decreased while that of the global stock index increased and there is no significant correlation between the Korean stock index and the global stock index. By establishing the directed and weighted network, Yang et al. (2014) analyzed the correlations among 26 global stock index under the background of subprime mortgage crisis and European debt crisis. Their research results showed that the stock index influences on China, United States and Japan were always significant during the crises. And in the early period of crises, the stock markets of developed countries led the global stock market trend while in the late, the influences of developed countries declined and the emerging countries played the role of leader in the stock markets on behalf of developed countries. Sensoy & Benjamin (2014) studied the correlations and stabilities of Asia-Pacific stock markets by using the dynamical spanning tree methods to analyze the stock index weekly return data between 1992 and 2013 from 11 Asia-Pacific countries including Japan, India, Hongkong, China Mainland, Taiwan, Thailand, Malaysia, Indonesia, Philippe, Australia, Korea and Singapore. They though Hongkong played the core role in the Asia-Pacific stock markets and had significant correlations with the other 10 stock markets during the financial crisis.

Summarizing from the above literatures, we found that these traditional parameter analysis methods are born with the defect of inconsistent results due to the parameter and index diversity. Also, the methods usually need some assumptions that may not be fully satisfied by empirical data (Štefan et al. 2012). Combined with the explanation and analysis capability of complex network on stock market behaviors (Zhu 2016), this study analyzes the correlations and the structure evolution characteristics of Hong Kong stock market during 2008 financial crisis in order to correct the above mentioned defects based on minimal spanning tree.

The paper is structured as follows. Section 2 presents the dataset collection and process procedure. Section 3 describes how to construct stock networks. In Section 4, we describe how to detect and match communities in the networks. The analysis of topology dynamic structure is then offered in Section 4 and Section 5. Finally, some findings are summarized and some thoughts are presented to future researches.

2. Data Collection and preprocessing

To explore topological properties of stock market network under the background of the financial crisis, stock dataset was collected through Yahoo Financial Channels (<http://finance.yahoo.com/>). All the constituent stocks selected by this research are from 55 Hang Seng Index constituent stocks from 10 December 2012. After deleting 19 stocks with incomplete information, thirty-one stocks are ultimately picked out as research objects which are having transaction information of relevant year and can be broadly representative of the market.

The study makes an investigation with the data from 23 September 2008 to 23 March 2009 which is regarded as interim period of financial crisis, and during this period there are a total of 130 trading days corresponding to 130 shares information. Accordingly,

the study selects two periods containing 130 trading days before or after the interim period as the early/late period of financial crisis for comparative study. Based on the boundaries between the total outbreak and the end of the financial crisis, time can be divided into three periods (each periods included 130 trading days), namely, March 25, 2008 to September 22, 2008, September 23, 2008 to March 23, 2009 and March 24, 2009 to September 21, 2009.

In order to expand the study sample and to weaken the influence of noise on the statistical results, we have taken the form of moving window to investigate the data. The window size and interval will affect the length and the number of time windows. So referring to literature (Liu & Tse. 2012; Sensoy & Benjamin. 2014), the window size is set to 130 days, which means each study period includes stock information of 130 trading days. Meanwhile, the window is moved backward 10 days to construct a new data sample. In this way, 28 group samples are obtained eventually. In addition, all the time is covered from March 25, 2008 to September 21, 2009 including a total of 390 trading days.

3. Constructing stock networks

In the stock market, investors' focus is on the stock yield which is chosen as a variable to study the correlativity between each two stocks yield. Here, the stock yield is defined as:

$$P_t = \frac{S_t - S_{t-1}}{S_{t-1}}$$

Here, S_t and S_{t-1} respectively represent the price at time t and $t-1$.

$$P_i(t, T) = \begin{pmatrix} P_{i(t)} \\ P_{i(t-1)} \\ \dots \\ P_{i(t-T+1)} \\ P_{i(t-T)} \end{pmatrix}$$

Here, i represents the identification serial number of stock, T indicates the selected time range. If the total amount of stocks in the research is N , then we can put the correlation coefficient between two shares yield in an matrix. Among them, the matrix elements r_{ij} represents the yield correlation coefficients between stock i and stock j .

To facilitate the subsequent calculations, we normalize the column vector of stock yield as follows:

$$X_i = \begin{pmatrix} (P_{i(t)} - \mu_i) / \sigma_i \\ (P_{i(t-1)} - \mu_i) / \sigma_i \\ \dots \\ (P_{i(t-T+1)} - \mu_i) / \sigma_i \\ (P_{i(t-T)} - \mu_i) / \sigma_i \end{pmatrix}$$

Among them, μ_i and σ_i were expectation and standard deviation of variable group X_i . Thus, according to the correlation coefficient formula, we get:

$$r_{ij} = \sum_{k=t}^{t-T} \frac{X_{it} X_{jt}}{|X_{it}| |X_{jt}|}$$

To constructing undirected and weighted networks, distances between stock indices should be measured. According to Eq (4), for the correlation coefficient r_{ij} of the given stock index i and j , the distance d_{ij} between i and j is calculated by:

$$d_{ij} = \sqrt{2(1 - r_{ij})}$$

If the correlation coefficient between the two stocks is greater than or equal to a predetermined threshold, then we can assume that there exist similarities between the two stocks' ups and downs. Accordingly, if r_{ij} is greater than or equal to a predetermined threshold, then the graph constructed between i and j is adjacent. Typically, if the threshold is too large or too small, it cannot effectively extract the important information from the network (Štefan et al. 2012). Therefore, this article will determine the final threshold based on the probability distribution of the correlation coefficient between each two stocks. By examining the distribution of the correlation coefficient, the threshold is set as 0.7, which means only when correlation coefficient is greater than or equal to 0.7, the edge between two nodes of stocks will exist.

Based on the distance matrix, we build the stock market network and get the corresponding minimal spanning tree in order to simplify the relationship between stock yields for further research. As has been shown in numerous studies (Mantegna 1999; Tabak et al. 2010), the vertices of MSTs often form clusters that can broadly correspond to an industry classification taxonomy. Further on, it was possible to identify known events by observing specific topological properties of an MST (Bonanno et al. 2001). Thus, an MST is perhaps a rather drastic approach for improving our understanding of the behaviors and structures of stock market network from a more macro point of view. Here, the construction of a Minimal Spanning tree during period I (from March 25, 2008 to September 22, 2008) is as follows: First, input the distance matrix and draw the corresponding network diagram; Then, using graph min span tree function in MATLAB software to build the network and draw the corresponding minimal spanning tree.

4. Macro-analysis on topology structure of stock market network

4.1. Minimal spanning tree length changes with time

As can be seen from Figure 1, the minimal spanning tree length drops dramatically to a lower level in early periods, then maintain stable at this level in the medium period with slight increase, and afterwards rose steeply to the initial level with some fluctuations. Thus, the 2008 financial crisis made stock prices volatility of the Hong Kong stock market more synchronizing. This can explain, to some extent, that each stock yield volatility can more profoundly affect other stocks. The reason may be that stock market uncertainty is exacerbated by the financial crisis, and therefore, synergies between the stock price rise. The rise of synergy means that the stock market network becomes more vulnerable, because price fluctuations at this time of any a stock is likely to lead many other stocks change to this direction, thereby causing the overall stock market movement.

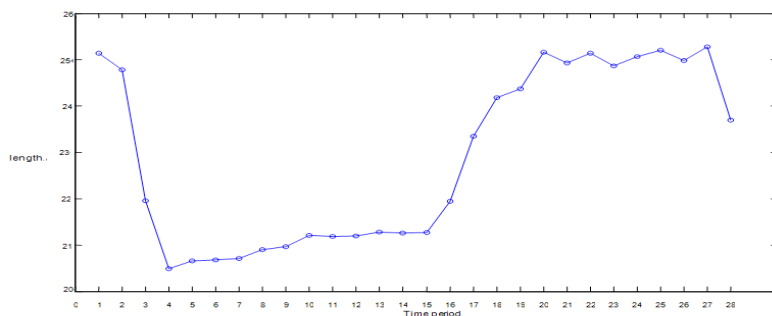


Figure 1 – Description of Minimal spanning tree`s length changes with time

4.2. Minimal spanning tree diameter and characteristic path length changes with time

As can be seen from Figure 2, the minimal spanning tree diameter (a blue line) falls down to a lower level at the beginning, then increases gradually to approach to the early level, and finally after some fluctuations, the length returns to the initial level again. Compared to the minimal spanning tree diameter, characteristic path length (green line) can show the tightness between objects represented by network node from the maximum view on the average level. Specifically, with other indicators being the same, the shorter the path length is, the higher the overall tightness of the network nodes will be and vice versa. From Figure 2, path length decreases to very low levels in the early period, then rises slowly at mid period and at last increases rapidly and exceeds the initial level. Thus, the Minimal Spanning tree diameter and characteristic path length changes show that the financial crisis broke out in the interim, which means during the most severe crisis situation, the association between stock becomes maximum. It further indicates that in the financial crisis the direction of stock changes shows more consistency.

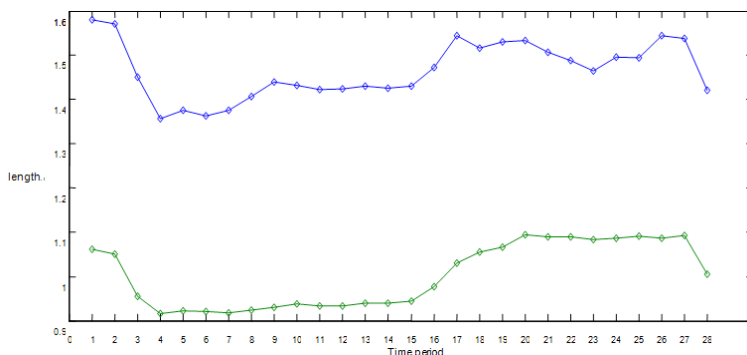


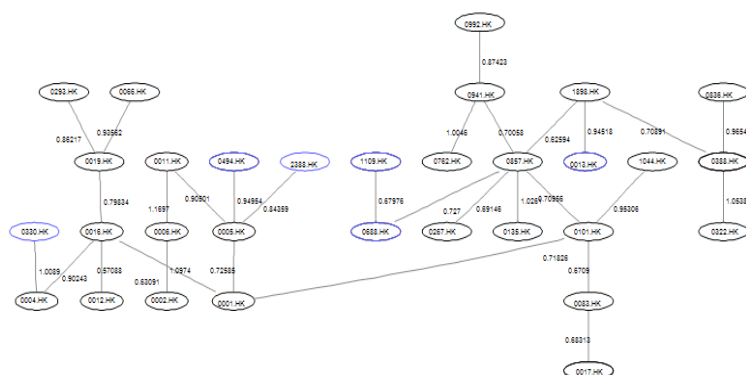
Figure 2 – Analysis on MST`s diameter and characteristic path length

4.3. Minimal spanning tree topology changes with time

Figures 3, Figures 4, Figures 5 represent the minimal spanning tree topology based on stock market network of the initial, mid and final period in financial crisis respectively. Wherein the different types of stocks are shown by different colors. Specifically, red, green, yellow and blue represent the Finance Sub-index, Utilities Sub-index, Properties Sub-index and Commerce & Industry Sub-index respectively.

From the minimal spanning tree topology change of view, in midterm of the financial crisis, the number of stocks having larger influence basin decreases, but among which, the influence of individual stocks has increased. This change would return to the initial level in the latter part of the financial crisis.

From the perspective of spanning tree topology changes of different stocks, real estate stocks are directly connected with other property stocks in the early and later financial crisis. While in the middle of the financial crisis, the closeness among them has declined. The internal relations among financial stocks change dramatically during financial crisis. However, due to the short of financial stock samples, this kind of change has little value for reference. For Utilities Sub-index stocks, the internal relations is consistent during the financial crisis, for example, Power Assets Holdings Limited and CLP Holdings are directly connected in both periods, while the connection between China Resources Power and these two stocks are relatively loose. For Commerce & Industry Sub-index stocks, in the early and late of financial crisis, there is a sub network which has a large number of nodes and includes only Commerce & Industry stocks. While in the medium of financial crisis, there are two such networks, but the size of the network nodes is reduced. In other words, in the financial crisis, Commerce & Industry Sub-index stocks show further classified aggregation.



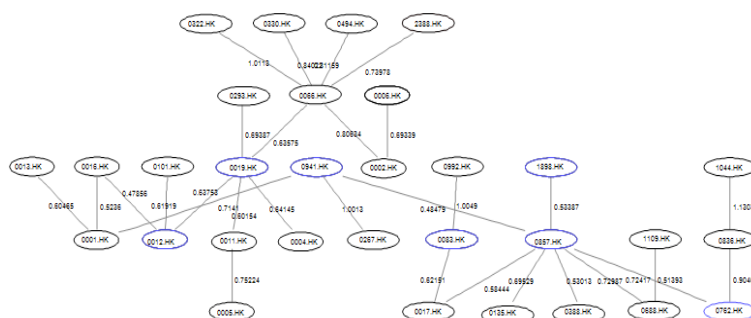


Figure 4 – Minimal spanning tree in the medium period of financial crisis

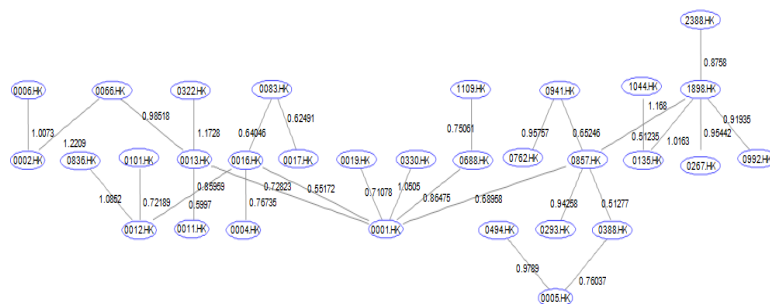


Figure 5 – Minimal spanning tree in the later period of financial crisis

5. Micro-analysis on topology structure of stock market network

5.1. Central node of the stock market network changes with time

From the view of the number of central nodes in each period of the financial crisis, at medium-term the number of central node triples the level at early times, while the number of central node falls down to a considerable level. The rapid increase of central nodes shows that the financial crisis makes the number of stocks with greater impact increase. The corresponding time of interim period in financial crisis is September 23, 2008 to March 23, 2009, which is a period after Lehman Brothers bankruptcy and Merrill Lynch being acquired, and during which the increase of the central node in stock market network shows that upheaval of large financial institutions would exert a more profound impact on the structure of stock market.

From the perspective of the stock industry categories represented by central nodes in each period during financial crisis, Properties stocks always have big influence on each period. In mid-crisis, the impact range of Commerce & Industry stocks surges and exceeds the scope of Properties stocks; Meanwhile, financial stocks appears in the central node first. In the later period of the crisis, the scope of Commerce & Industry stocks and Finance stocks has declined, but compared to the initial, the scope still expanded.

Overall, combining the proportion of stocks in the sample, we can see that Properties stocks in Hong Kong stock market is of great importance, while the influence of Utilities stocks are relatively small.

Some individual stocks, like Cheung Kong, Henderson Land, Sun Hung Kai Properties and China Petro, have large range of influence on the various periods of financial crisis. Among them, Cheung Kong, Henderson Land and Sun Hung Kai Properties have been in the stock market for a long time with their main business being related to real estate. This shows that even under the impact of the financial crisis, Properties stocks with old brand in Hong Kong can still maintain their position in the stock market. Stocks whose impact range is expanding in the mid-crisis and still remaining in the post-crisis are New World Development, China Coal Energy and stocks of the Hong Kong Stock Exchange.

5.2. Stocks influenced most by the financial crisis

We adopt the standard deviation of importance ranking to investigate the stocks which are mostly influenced by the financial crisis. After calculation, top ten stocks with largest standard deviation are selected. The stocks most strongly influenced by the financial crisis, besides HSBC Holdings Plc belonging to Finance stocks and Hang Lung Properties belonging to Properties stocks, are all Commerce & Industry stocks. It indicates that 2008 financial crisis had a significant impact on the status of Commerce & Industry stocks. The reason why the ranking of the Corporation dropped and rose dramatically has something to do with the fact that it is the only railway company providing equestrian-related transport services during the Beijing Olympics. And influential rankings of HSBC Holdings fell and went up largely because of the negative impacts on the banking system from the 2008 financial crisis.

6. Conclusions

The nature of the stock market and dynamic characteristics was investigated during financial crisis from micro-macro analysis perspective.

From the macro-level view of the overall stock market volatility, the financial crises led to the increase of stock fluctuation cooperatively and the enlargement of influence between inter-industry stocks. Aggregation of the same industry stocks indicate that financial crisis can trigger the potential impact mechanism in same industry of stock market network, which can further affect the entire market network topology. The reason may be that there exist similarities among the degree and mechanism among the same industries, resulting in the high consistency of stock price fluctuations.

From the micro-level view of the influence of stock changes, Utilities stocks and Commerce & Industry stocks account for relatively large in influential stocks in the early, mid and late of financial crisis. Meanwhile, it is the Commerce & Industry stocks that is affected most by financial crisis.

In addition, after a comprehensive analysis and research of network parameters change map, this paper has two findings. First, the period of most dramatic changes in Hong Kong stock market is earlier than the most severe period in the financial crisis, which indicates that the stock market is sensitive to the crisis. This finding has also great

significance for the financial institutions to assess and forecast the upcoming crisis. Second, at the late of financial crisis, network structure in medium period with the trends of concentrating gradually became decentralized. This shows, on one hand, that the stock market itself, to some extent, has the ability to adjust to the financial crisis; On the other hand, it also indicates that a highly decentralized network in face of financial markets crisis will become relatively fragile.

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Factors Affecting the New Sales Channel of Agricultural products in China Based on the Development of Computer and Internet Technology

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Abstract: Due to the fast development of computer and internet technology, a new sales channel of agricultural has emerged, and has been playing a more and more significant role in China. Data was collected by means of questionnaire inquiry and analyzed by SPSS21.0 and AMOS21.0, a SEM was constructed to analyze the factors which are affecting the sales channel based on the computer and internet technology. Through empirical study, it finds that consumption, internet trading platform, online payment, logistics are the important factors that affect the development of agricultural products sales in the new channel.

Keywords: Agricultural products, Internet platform, Online payment

1. Introduction

As China is a big country in producing and consuming agricultural products, these products have a significant bearing on Chinese residents' life. Enjoying rapid development, the computer and internet plays a more and more crucial role in agricultural products, which takes a new sales channel for them, especially the wireless networks and smart phone are gaining popularity. The computer and internet technology can not only reduce the circulation of and increase sales channel for agricultural products, but also reduce transaction costs, promote sound development of relevant market information service function and increase the farmers' income. The agricultural products in China have always been sold in the traditional market, in which the relevant infrastructure and application are not standardized enough. In addition, restricted by regional differences as well as agricultural products' own features, the new sales channel of agricultural products in China is still facing a number of challenges. This paper studies the factors affecting the development of the new sales channel of the agricultural products in China and finds out the key links and influence factors, which have both theoretical and

practical significance to the development of the new sales channel of the agricultural products under the fast development of computer and internet technology.

2. Literature Review

Taking CNKI as the database, it finds a total of 439 papers through the retrieval of agricultural products e-commerce by the end of 2015. The earliest research on agricultural products e-commerce appeared in 2001. It was only less than 10 papers every year until 2008. From 2009, the number increased year by year. It is on the peak in 2015 with the number of 160. The number, however, is still not much enough.

After analyzing these materials, it found that foreign scholars mainly focus on such factors as supply chain and transaction mode to study the agricultural products e-commerce. Mueller (2000) has researched the agricultural products e-commerce from the supply chain. Ruiz et al. (2010) have believed that the network-based management system of data processing, storage and transmission can facilitate the query and tracking of agricultural products logistics. Hsu et al. (2011) have put forward that cold chain logistics featuring “multi-temperature joint distribution” cold chain can ensure the freshness and quality of agricultural products, thus reducing transportation cost and products loss of the agricultural products e-commerce. Banker et al. (2007), by studying online coffee auctions in India, have given the procurement models in the agricultural supply chain. Wen (2007) has proposed a knowledge-based intelligent electronic commerce system for selling agricultural products. China’s scholars have researched agricultural products e-commerce mainly from the consumer purchase intentions, laws, foreign experience and the influence factors. Guo Haixia (2010), from the perspective of legal protection, has initiated the the legal system to safeguard farmers’ economic rights, educational rights and complete network, thus further guaranteeing the sound development of agricultural products e-commerce. Zhang Shengjun, et al. (2011) have proposed that China have to focus on the development of new rural infrastructure, agricultural products business information services, agricultural products e-commerce transactions and personnel training, all of which can lay a solid foundation for the development of agricultural products e-commerce. Ge Jun, et al. (2013) by learning from developed countries, have believed that China has to strengthen the infrastructure construction, establish the agricultural products standardization system, enhance personnel training and introduce the third party trading model. Kang Jun, et al. (2009) have researched the security applications, payment methods, sharing mechanisms and legal protection. Besides, Ali Institute has been releasing White Paper on the Ali Agricultural Products E-commerce annually, which has lasted from 2012 to 2015.

The existing research results are worth referencing, but there are still some deficiencies. For instance, they don’t draw full analysis to the factors affecting the development of agricultural products e-commerce, in which the supply sources, consumers and other relevant factors should be considered seriously. In addition, they also lack the empirical research and quantitative analysis. With the purpose of promoting the development of agricultural products e-commerce in China, the thesis, by structure model, uses SPSS21.0 and AMOS 21.0 for quantitative analysis, and finds out the important factors influencing the development of agricultural products e-commerce.

3. Theoretical Model and Research Hypothesis

3.1. Theoretical model

Basing on supply chain theory and ecosystem theory, it builds a theoretical model, as shown in Fig. 1. There are not only such supply chain links as suppliers, trading platform and consumers, but also the ecological system elements like payment, logistics and environment.

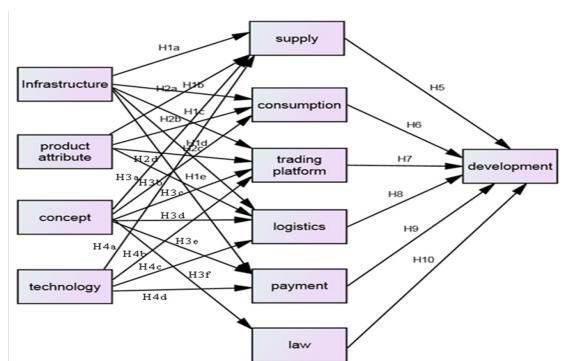


Figure 1 – Theoretical model for the development of the agricultural products e-commerce

3.2. Indirect influential factors

Infrastructure, product attribute, concepts and technology not only have largely impacts on agricultural products supply chain and commercial ecosystem, but also affect the development of agricultural product e-commerce directly. Based on the aforesaid analysis, here are the hypotheses below:

H1a: the infrastructure has a positive influence on supply

H1b: the infrastructure has a positive influence on consumption

H1c: the infrastructure has a positive influence on the trading platform

H1d: the infrastructure has a positive influence on logistics

H1e: the infrastructure has a positive influence on payment

H2a: the product attribute has a positive influence on supply

H2b: the product attribute has a positive influence on consumption

H2c: the product attribute has a positive influence on the trading platform

H2d: the product attribute has a positive influence on logistics

H3a: the concept has a positive influence on supply

H3b: the concept has a positive influence on consumption

H3c: the concept has a positive influence on the trading platform

H3d: the concept has a positive influence on logistics

H3e: the concept has a positive influence on payment

H3f: the concept has a positive influence on law

H4a: the technology has a positive influence on supply

H4b: the technology has a positive influence on the trading platform

H4c: the technology has a positive influence on logistics

H4d: the technology has a positive influence on payment

3.3. Direct influence factors

The supplier, consumer, and trading platform all serve as the core links in both supply chain theory and ecosystem theory. As e-commerce is accompanied by various security risks and credit crisis, suppliers and consumers pay close attention to the relevant legal systems and guarantees, for they think that a sound legal system in agricultural products supply chain and trading links can raise the frequency of transactions and consumers' purchase intentions. Based on the aforesaid analysis, here are the hypotheses below:

H5: the supply has a positive influence on the development of the agricultural products e-commerce

H6: the consumption has a positive influence on the development of the agricultural products e-commerce

H7: the trading platform has a positive influence on the development of the agricultural products e-commerce

H8: the logistics has a positive influence on the development of the agricultural products e-commerce

H9: the payment has a positive influence on the development of the agricultural products e-commerce

H10: the law has a positive influence on the development of the agricultural products e-commerce

4. Research Method and Model Building

4.1. Research method

The questionnaire is designed according to the scale resulting from the literature analysis, experts' opinions and research hypotheses. In order to increase the reliability of the data, it uses face-to-face research method to obtain research data. Before the large sample research, it has conducted a small sample test based on the questionnaire. First, it chose 67 samples, including farmers, trading platform staff, consumers and logistics practitioners. Second, SPSS21.0 and AMOS21.0 were used to analyze the data and the reliability and validity tests were conducted based on the data. Finally, the structural

equation model of the growth level of the county and township e-commerce is constructed in combination with the verification results.

4.2. Model building

According to the theoretical model above, revision is made in combination with the small sample test results. The observational variables, error variables and SEM are shown in Fig. 2.

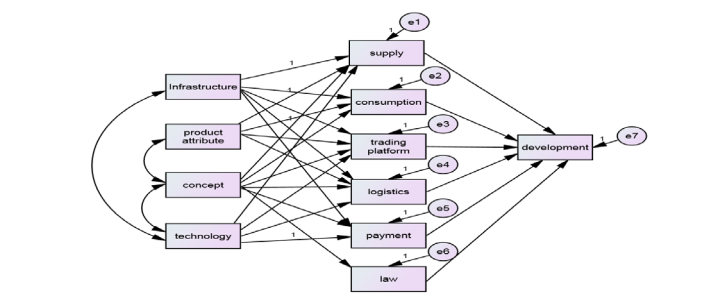


Figure 2 – Structural equation model for the development of the agricultural products e-commerce

5. Data Analysis

5.1. Data collection

Through giving out and retrieving paper questionnaires on site, it took farmers, agricultural products suppliers, logistics practitioners, the third party payment practitioners and consumers as the research object, and totally 292 valid samples were obtained finally. Mueller (1997), as there were more than 200 samples, structural equation model analysis can be used.

5.2. Validity and reliability test

The Cronbach's α coefficient is used for the validity test. As a result, the overall Cronbach's α coefficient is $0.852 > 0.700$, and the Cronbach's α of all observed variables is more than 0.700 , which indicates that the measuring tool has good validity; the overall KMO is $0.824 > 0.700$, and KMO of all observed variables is more than 0.700 ; the Sig value of statistics in Bartlett sphericity test is less than 0.01 , which indicates significant correlation among the variables and it is appropriate to conduct a factor analysis. The factor is extracted by use of the principal components analysis and selected by means of the maximum variable orthogonal method. The resultant load of observed variables on their attached factors is more than 0.500 ; the composite reliability (CR) of all variables is more than 0.700 ; the average variance extraction (AVE) satisfies the minimum requirement of being more than 0.500 , which demonstrates good convergent validity and discriminate validity. Based on the analysis above, the measuring tool designed is considered to have passed the validity and reliability test.

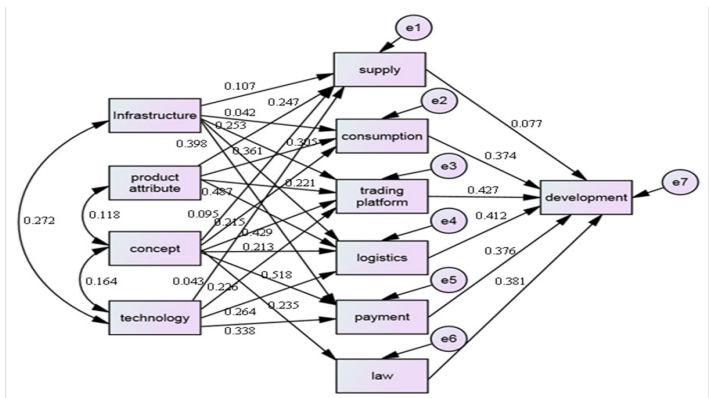


Figure 3 – Development model of the the agricultural products e-commerce via the standardized estimated value

5.3. Good-of-fit analysis

When adapting the measurement data and the structural equation model, it uses the absolute fit statistics, which mainly includes the chi-square value, GFI, CFI and RMR. Tab. 1 shows that the model fits well as a whole, which means that the structural equation model fits the actual research data.

Statistics	Chi-square value	GFI	CFI	RMR
Index value	p=0.253	0.915	0.962	0.018
Standard	p>0.05	>0.90	>0.90	<0.05
Good-of-fit analysis	Reasonable	Reasonable	Reasonable	Reasonable

Table 1 – Good-of-fit test result

5.4. Hypothesis testing

The path relationship among all factors is seen in Fig. 3. In combination with Tab. 2, the research hypotheses are verified according to the test standard. According to the test results, the paper accepts such assumptions as H1c, H1d, H1e, H2a, H2b, H2d, H3b, H3c, H3e, H3f, H4b, H4c, H4d, H6, H7, H8, H9 and H10; it rejects such assumptions as H1a,H1b,H2c,H3a,H3d,H4a and H5.

6. Conclusions and Discussions

Through the research, it found that the consumption, trading platform, logistics and payment are important factors that affect the development of the agricultural products e-commerce in China. Due to the security and credit risks in the e-commerce itself, the legal protection is of great significance to the development of the agricultural products

Research hypothesis	Estimate	C.R.	P	Result
H1a: infrastructure→supply	0.107	2.030	0.053	Rejected
H1b: infrastructure→consumption	0.042	2.364	0.147	Rejected
H1c: infrastructure→trading platform	0.253	4.661	0.007	Accepted
H1d: infrastructure→logistics	0.361	5.663	***	Accepted
H1e: infrastructure→payment	0.398	2.579	***	Accepted
H2a: product attribute→supply	0.247	2.657	0.013	Accepted
H2b: product attribute→consumption	0.305	3.447	***	Accepted
H2c: product attribute→trading platform	0.221	5.642	0.157	Rejected
H2d: product attribute→logistics	0.487	4.273	***	Accepted
H3a: concept→supply	0.095	2.612	0.044	Rejected
H3b: concept→consumption	0.215	3.427	0.028	Accepted
H3c: concept→trading platform	0.429	4.463	***	Accepted
H3d: concept→logistics	0.213	1.998	0.574	Rejected
H3e: concept→payment	0.518	3.227	***	Accepted
H3f: concept→law	0.235	2.153	0.046	Accepted
H4a: technology→supply	0.043	2.441	0.213	Rejected
H4b: technology→trading platform	0.226	3.427	0.026	Accepted
H4c: technology→logistics	0.264	2.334	0.007	Accepted
H4d: technology→payment	0.338	3.112	0.027	Accepted
H5: supply→development	0.077	2.148	0.034	Rejected
H6: consumption→development	0.374	2.449	***	Accepted
H7: trading platform→development	0.427	2.996	0.042	Accepted
H8: logistics→development	0.412	3.217	0.027	Accepted
H9: payment→development	0.376	2.652	0.018	Accepted
H10: law→development	0.381	3.224	0.009	Accepted

Notes: *** means that $P < 0.001$. If $p > 0.001$, then the value of p will be shown.

Table 2 – Research hypothesis testing result

e-commerce. While supply is less important due to excessive outputs and supplies of agricultural products as well as asymmetric information in China. In promoting the development of agricultural products e-commerce, it needs to focus on meeting and expanding consumers' demand. In addition, it should base on the trading platform and lay more emphasis on improving the logistics and payment as well as relevant legal system.

The attributes of agricultural products determine that not all agricultural products are suitable for e-commerce transactions, especially some fresh agricultural products whose loss is higher in the logistics process. When sales by e-commerce channel, it needs to pay more attention to products supply and logistics. The unsound infrastructure, especially

the logistics and payment related infrastructure has become an important short board restricting the development of agricultural products e-commerce. Consumption concept and the concept of the new trading mode and the payment mode by agricultural products suppliers are all important factors affecting the development of the agricultural products e-commerce. Besides, many consumers have not yet accepted the purchase and consumption of agricultural products through e-commerce channels, instead, they still remain buy these products through regular trading channels.

The trading platform, payment and law have also been troubled by the concept, which is mainly caused by the factors like region, population, economy and culture in China. In developing the agricultural products e-commerce, it should start from attributes of the agricultural products, take the impact of the concept into full account and attach highly importance to the significant factors affecting the development of the agricultural products development.

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Industrial economy performance evaluation method based on the hybrid PCA/DEA model

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Abstract: The increment of industry economy is of great importance in national economy, and it is a crucial element for society development. In this paper, we discuss how to evaluate industrial economy performance using hybrid PCA/DEA model. As PCA can effectively describe the variance structure of a matrix of data with linear integrations of variables, and then represent data by a few of principal components, in this work, we introduce the PCA model to promote the discrimination of DEA. The proposed industrial economy performance evaluation method is made up of three steps. In step 1, the PCA model is used to extract the features of a number of indicators in the evaluation index system, and then reserve indicators with higher weight. In step 2, DEA model is exploited to deal with the comprehensive evaluation task through fully using input and output indicators. In step 3, unreasonable index is able to be adjusted and improved via analyzing the evaluation results of input and output. To test the effectiveness, we collect experimental dataset from the Statistical yearbook of China's high tech industry. Experimental results show that our proposed method can effectively evaluate performance of the industry economy.

Keywords: Industrial economy, Principal component analysis, Data envelopment analysis, Decision making unit.

1. Introduction

As is well known that national economy cannot develop well without supports of different industries. As the foundation element of the increasing of a country, the increasing of industry economy is of great importance in national economy. However, the research of economic increasing usually demonstrates on the variance of the gross, and ignores the fluctuation of the industrial structure. On the other hand, existing studies have not deeply studied the relationship between various industries.

Economic development refers to a process of the gross, and the variance of industries is related to the variance of the gross. It can be seen that the gross of industrial economic benefit is increasing with time goes by, however, the quality indexes are not high, and the increasing of economy requires the increasing of input. Furthermore, the industrial economy is divided as three layers. Various industries may affect each other, that means there are strong correlations between different industries. From the above, we can see that studying on industrial economy performance greatly benefit the whole economic

system, and then optimize its internal structure. In this paper, we take the high-tech industry as an example to study on this problem, because the 21st century is the era of knowledge economy. It has great significance for high-tech industry development. Furthermore, it can also boost the technical systems theory and discover if it has a great impact between the technical system and the high-tech industry.

The main innovation of this paper lies in that we introduce hybrid principal component analysis/data envelopment analysis (PCA/DEA) model to solve the proposed Industrial economy performance evaluation problem. Chen et al. utilized the PCA/DEA model to evaluate and analyze the relative efficiency of the iron ore logistics of each port in that area. This work is made up of two main steps: 1) PCA is exploited to achieve six synthetic indicators, which contain four input indicators and two output indicators, from fifty original indicators, 2) DEA algorithm is exploited with the particular synthetic indicators (Chen et al., 2016). Poldaru et al. use the PCA/DEA model to evaluate the quality of life scores in Estonian counties. This work uses the PCA-DEA model to calculate and forecast QOL scores and rankings of Estonian counties (Poldaru and Roots, 2014). Fu et al. integrated PCA and DEA model together to boost the efficiency of decision-making units with higher accuracy. Experimental results demonstrate that using PCA and DEA together, the performance of energy projects can be estimate more accurately than utilizing DEA model only (Fu, OuJia, 2013). The hybrid PCA/DEA model has also been used in other fields, such as Input-Output Efficiency estimation (Peng and Wang, 2013), R\&D Efficiency of Large and Medium-sized Industrial Enterprises (Xu, 2013), Evaluating the performance of human capital management (Tavakoli and Shirouyehzad, 2013), and Recognition of human actions (Gómez-Conde et al., 2011).

The rest of this paper is organized as follows. The next section describes the hybrid PCA/DEA model. Section 3 discusses how to evaluate the industrial economy performance using the hybrid PCA/DEA model. In section 4, experiments are provided test the effectiveness of the proposed method. In the end, we conclude the whole paper and point out the future works.

2. The hybrid PCA/DEA model

Data envelopment analysis is belonged to a non-parametric linear programming method which can compare performance of various decision making units based on multiple inputs and outputs. The DEA model aim to obtain the most efficient DMUs, and the PCA refers to a data reduction method of multivariate data. Furthermore, PCA is able to describe the variance structure of a matrix of data utilizing linear integrations of variables, and then represent the data by a few of principal components. Particularly, in this work, the PCA model is utilized to boost the discrimination of DEA.

Suppose that there are n units with q output which is represented as Y and r inputs which are denoted as X . Then, the efficiency of decision making unit DMU_a is defined as follows.

$$\min_{U,V} VX^a - v^a \quad (1)$$

$$\text{s.t. } 1) VX - UY - v \geq \quad (2)$$

$$2) UY^a = 1, U \geq 0, V \geq 0 \quad (3)$$

Where U, V denotes the vectors of decision making unit weight, and the symbol v^a is a scalar, X^a, Y^a , represent the input and output column vectors of the decision making unit DMU .

Suppose that the random vector $X = (X_1, X_2, \dots, X_N)$ has the correlation matrix M with eigenvalues $\lambda_1 \geq \lambda_2 \geq \lambda_3 \geq \dots \geq \lambda_N \geq 0$ and the normalized eigenvectors $l_1, l_2, \dots, l_N$. Exploiting the linear combinations, the transpose operator is defined as follows.

$$X_{PCi} = \sum_{j=1}^N l_{ji} X_j, i \in \{1, 2, \dots, N\} \quad (4)$$

$$Var(X_{PCi}) = X_{PCi} M l_i, i \in \{1, 2, \dots, N\} \quad (5)$$

$$Cor(X_{PCi}, X_{PCk}) = X_{PCi} M l_k, i, k \in \{1, 2, \dots, N\}, i \neq k \quad (6)$$

where PCs denote the uncorrelated linear combinations which are sorted by the variances by the descending order. The hybrid PCA/DEA model is described as follows.

$$\min_{U_{PC}, V_{PC}} V_{PC} X_{PC}^a - v^a \quad (7)$$

$$\text{s.t. 1) } V_{PC} X_{PC} - U_{PC} Y_{PC} - v^a \quad (8)$$

$$2) U_{PC} Y_{PC}^a = 1 \quad (9)$$

$$3) U_{PC} \geq 0, V_{PC} \geq 0 \quad (10)$$

Based on the above analysis, we utilize the PCA technique to input information and output information respectively.

3. Evaluating industrial economy performance using the hybrid PCA/DEA model

The PCA/DEA model can fully integrate the advantages of PCA method in feature extraction and DEA method in the comprehensive evaluation and performance

improvement (ILLESCAS, 2015). Firstly, we use the PCA model to extract the features of a number of indicators in the evaluation index system, and then reserve indicators with higher weight. Secondly, DEA model is used to solve the comprehensive evaluation task by fully take advantage of input and output indicators. Furthermore, unreasonable index can be adjusted and improved by analyzing the evaluation results of input and output.

Suppose that the original data matrix of the index system is defined as follows.

$$X = (x_{ij}), i \in \{1, 2, \dots, n\}, j \in \{1, 2, \dots, p\} \quad (11)$$

The hybrid PCA/DEA model is implemented as the following steps:

1. Normalizing the original data

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{\sqrt{\text{var}(x_j)}} \quad (12)$$

$$\text{where } \bar{x}_j = \sum_{i=1}^n \frac{x_{ij}}{n} \text{ and } \text{var}(x_j) = \frac{1}{n-1} \cdot \sum_{i=1}^n (x_{ij} - \bar{x}_j)^2$$

2. Calculate the correlation matrix $R(r_{ij})_{p \times p}$, and r_{ij} is defined as follows.

$$r_{ij} = \frac{S_{ij}}{\sqrt{S_{ii} \circ S_{jj}}} \quad (13)$$

$$S_{ij} = \frac{1}{n-1} \cdot \sum_{k=1}^n (z_{ki} - \bar{z}_i) \cdot (z_{kj} - \bar{z}_j) \quad (14)$$

$$\text{where } \bar{z}_i = \sum_{k=1}^n \frac{z_{ki}}{n} \text{ and } \bar{z}_j = \sum_{k=1}^n \frac{z_{kj}}{n} \text{ are satisfied.}$$

3. Let $|R - \lambda| = 0$, and compute the characteristic value, feature vector, and cumulative contribution rate of correlation matrix.
4. Determine the main components according to the cumulative contribution rate.
5. After analyzing the principal components, reserve several important indicators as input and output indicators for the DEA model.
6. Input the indicators we choose to the DEA model, and then obtain the optimal solution.
7. Obtain the industrial economy performance evaluation results.

To evaluate the values of DEA and PCA, spatial coordinate of the PCA/DEA model is given in Fig. 1, in which the two-dimensional coordinate screen is established for the horizontal and vertical axes, and the range of the coordinate axes should be selected according to the DEA and PCA values. Particularly, the horizontal axis is divided into high area and low area, similarly, the longitudinal axis is divided into high area and low area as well.

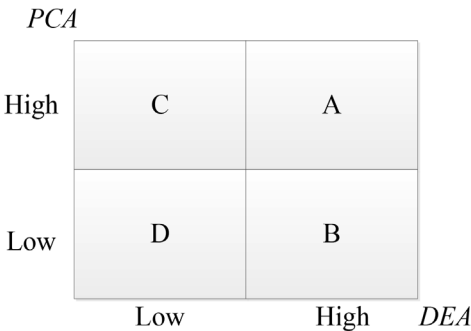


Figure 1 – Spatial coordinate of the PCA/DEA model

4. Experiment

In this paper, we take the high technology industry as an example to test the performance of the proposed method. The experimental data are collected from “Statistical yearbook of China’s high tech industry)”. The industries used in this experiment is listed in Table.1

ID	Industry name
I1	Chemical manufacturing
I2	Manufacture of Chinese traditional medicine
I3	Manufacture of biological and biochemical products
I4	Aircraft manufacturing and repair
I5	Spacecraft manufacturing
I6	Communication equipment manufacturing
I7	Radar and ancillary equipment manufacturing
I8	Radio and television equipment manufacturing
I9	Electronic device manufacturing
I10	Electronic components manufacturing
I11	Home audio-visual equipment manufacturing
I12	Other electronic equipment manufacturing
I13	Electronic computer manufacturing
I14	Electronic computer peripheral equipment manufacturing

ID	Industry name
I15	Office equipment manufacturing
I16	Medical equipment and equipment manufacturing
I17	Instrument and meter manufacturing

Table 1 – Illustration of the industries in this experiment.

The data structure of the input and output for industries of Table. 1 is shown in Table 2.

Categories	Element name
Input elements	Total investment in fixed assets
	New fixed assets
	R&D personnel input
Output elements	Main business income
	Gross profit
	Profit and tax
	Number of invention patents

Table 2 – Data structure of the input and output elements

As is shown in Table. 1, the samples are collected from 17 industries ($\{I_1, I_2, \dots, I_{17}\}$), and SPSS is used to carry out principal component analysis, and m principal components are exploited to establish the industrial economy performance evaluation model.

$$F_n = \sum_{i=1}^q a_{in} X_i \quad (15)$$

where $a_{in} = \frac{p_{in}}{\sqrt{\lambda_n}}$, $n \in \{1, 2, \dots, m\}$ is satisfied, and a_{in} is the score coefficient of the i^{th}

indicator in the n^{th} principal component evaluation model, p_{in} is the load value of the i^{th} indicator in the n^{th} principal component, and λ_n is the eigenvalue of the n^{th} principal component.

Based on the definition of Eq.15, the performance evaluation model based on m principal components is defined as follows.

$$F = \sum_{k=1}^m \left(\frac{\lambda_k}{\sum_{k=1}^m \lambda_k} \right) \cdot F_k \quad (16)$$

Utilizing the proposed Industrial economy performance evaluation method, the evaluation results by DEA and PCA are given in Fig. 2

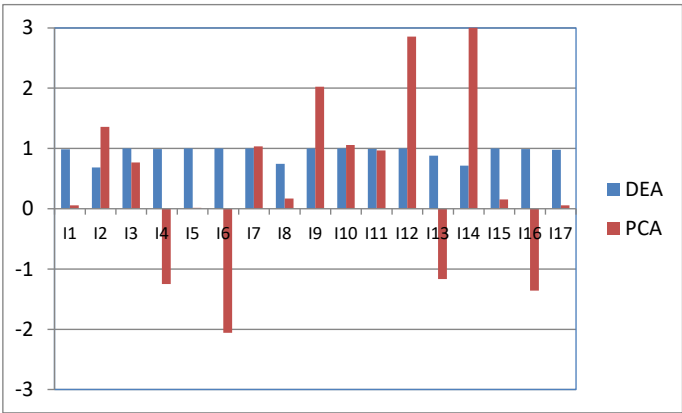


Figure 2 – Industrial economy performance evaluation results for DEA and PCA model.

Afterwards, we show the space distribution of various industries in the spatial coordinate, and the distribution is given in Fig. 3.

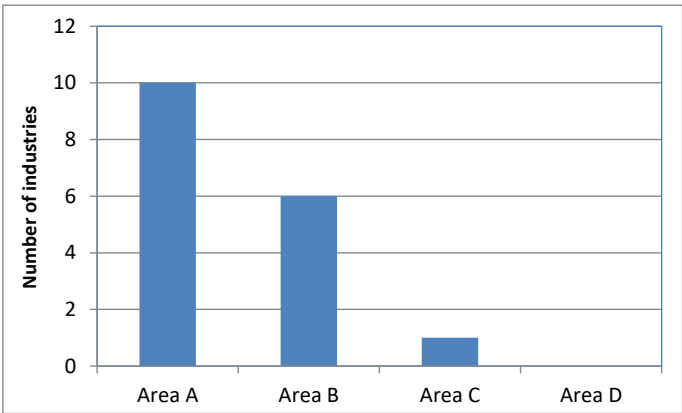


Figure 3 – Space distribution of various industries in the spatial coordinate

From Fig. 3, it can be observed that most industries are distributed in Area A or Area B. The industry which is located in area A develops with high quality, and has higher input/output ratio. Industries which located in both Area A and Area B have some disadvantages, such as low effectiveness or low input/output ratio.

5. Conclusion

This paper aims to evaluate industrial economy performance with high accuracy. The proposed industrial economy performance evaluation method is established by three steps. (1) The PCA model is used to extract the features of a number of indicators in the evaluation index system, and then reserve indicators with higher weight. (2) DEA model is used to complete the comprehensive evaluation task through fully using input and

output indicators. (3) Unreasonable index are adjusted and improved through analyzing the evaluation results of input and output. Finally, experimental results demonstrate the effectiveness of the proposed method.

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Research on the Extension Model for Subdivision of Postsecondary Students' Comprehensive Ability

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Abstract: The paper undertook research on the assessment of postsecondary students' comprehensive ability, and produced an extension theory based extension model for subdivision of the integral competence of students educated in universities. First, a discussion was conducted on index selection principle of comprehensive ability evaluation concerning college students. Under the guidance of the principle, the paper chose indices and established a corresponding multifaceted, multi-factor, multi-dimensional index system that can subdivide and assess the comprehensive ability of postsecondary students. Then, the paper analyzed key technical links for implementing the noted extension model, which included determination of multilevel evaluation index set, index unitary scale processing, index weight acquirement, extension level classification, classical domain construction, computation of extension distance and extension superiority, and realization of the model and its algorithm. Finally, in combination with case study, the paper verified both the assessment index system and the extension model. The verification result proves the viability and operability of the proposed method and model.

Keywords: index system, extension model, Postsecondary students' comprehensive ability

1. Introduction

College education propels social development. Cultivation of college students is required to be reformed and improved from various angles, positions, and levels, such as deepening higher education, innovating college education modes, improving postsecondary education strategies, and diversifying college education means (Zhang et al., 2009; Li, 2011; Zhang et al., 2008). The comprehensive ability of third-level students directly reflects the quality of higher education. How to effectively enhance and assess the integral competence of college students has increasingly drawn the attention of the society and universities and colleges as well, and has become the key direction and focus of studies on higher education and of construction and reform of educational engineering (Yang, 2013; Zhu et al., 2011; Zheng, 2012).

In order to effectively intensify postsecondary students' comprehensive ability, it is a must to gain in-depth recognition of its essence, so that targeted measures can be taken to improve modes and levels of higher education (Liu and Liu, 2007; Jiang et al., 2011). Assessment

on postsecondary students' comprehensive ability is an efficacious approach to deeply understanding and promoting the integral competence of students educated in universities.

Therefore, it has constantly been one of the key projects of higher education circles to develop a scientific, rational, and adaptive index system to evaluate postsecondary students' comprehensive ability (Liu et al., 2011; Jin et al., 2012; Zhang, 2008; Shi and Han, 2011; Wu and Li, 2016). The author referred to relative research achievements, analyzed current status of college student cultivation and their comprehensive ability, and consulted relative experts and scholars. On these bases, an assessment of postsecondary students' comprehensive ability was conducted in the paper based on extension theory (Wang et al., 2014; Liu and Zou, 2012; Cigoli and Metere, 2016).

Specifically, an index system and an extension model were established to subdivide and assess postsecondary students' comprehensive ability, whose feasibility was verified by case study. The result in the paper provides auxiliary and effective support for improving college students' comprehensive ability.

2. An index system of subdividing and assessing postsecondary students' comprehensive ability

2.1. Index selection principle

When subdividing and assessing postsecondary students' comprehensive ability, one should take into account all the links and corresponding factors of college student cultivation. As the assessment is a complex, multifaceted system decision and analysis engineering, assessment index selection is necessary to comply with certain principles such that the index system can be established scientifically and rationally.

1. Scientific principle

The selection of evaluation indices should be scientific thought based, scientific, and reasonable. The determinate evaluation indices are supposed to reflect evaluation contents and their essence and inherent laws clearly and precisely.

2. Comprehensive principle

The decided evaluation indices should be able to reflect the characteristics and connotations of college students' integral competence comprehensively and accurately. They should act as the basis for multi-angle, multi-dimensional analysis of college students' comprehensive ability in addition to the capability of guaranteeing uniform analysis results.

3. Representative principle

The evaluation indices should reflect prominent factors that impact on evaluation contents. It is suggested to choose representative indices on the one hand, and attenuate less influential indices on the other hand. What's more, the evaluation indices should be independent from each other, so that redundant information can be reduced or even eliminated.

4. Oriented principle

Given that the establishment of the evaluation index system aims to better serve for the improvement of third-level students' comprehensive ability, the evaluation indices

should act as a good orientation in effectively guiding and promoting the improvement of college students' comprehensive ability.

5. Objective principle

The evaluation indices should be selected on the basis of facts. They should be able to practically reflect the existing conditions of all the links in the course of evaluating college students' comprehensive ability, so that the evaluation results can be reliable and objective.

6. Both comprehensively and personally

Due to the implementation of essential-quality-oriented education, the comprehensive ability of college students is reflected in various aspects, including the development of both collective competence and individual capacities. Therefore, the evaluation indices should effectively integrate common requirements of all-round development with demands on personalized progress.

7. Both quantitatively and qualitatively

Some of the evaluation objectives can be accurately described and quantitatively analyzed, while the rest can only undergo qualitative analysis due to failure of precise description. Given that, the evaluation indices should be both quantitatively and qualitatively, so that the evaluation objectives are effectively represented.

8. Comparable principle

The selection of evaluation indices should be scientific, objective, reasonable, and precise. It should guarantee easy access to evaluation magnitudes, and contribute to qualitative and quantitative analysis. The decided evaluation indices are supposed to assure operable, effective evaluation, and efficaciously distinguish evaluation results that are hence trustable.

2.2. The establishment of the index system of subdividing and assessing postsecondary students' comprehensive ability

Based on the above index selection principle, by consulting relative experts, four assessment criteria were determined during establishment of the index system, namely learning ability, research practice ability, ideological and political quality, and cultural and physical quality. Table 1 is the structure and contents of the index system.

3. The extension model of subdividing postsecondary students' comprehensive ability

3.1. The extension set of tier one indices (namely the four assessment criteria)

Tier one indices contained learning ability X_1 , research practice ability X_2 , ideological and political quality X_3 , and cultural and physical quality X_4 . Thus the extension set of tier one indices X was expressed as:

$$X = \{x_1, x_2, x_3, x_4\} \quad (1)$$

System level	Criterion level	Index level
the index system of subdividing and assessing postsecondary students' comprehensive ability X	learning ability X_1	GPA X_{11}
		Learning attitude X_{12}
		Learning method X_{13}
		Professional skill X_{14}
	research practice ability X_2	Ability for scientific and technological activities X_{21}
		Ability for social practice X_{22}
		Ability for scientific and technological innovation X_{23}
		The times for the student to participate in projects or win a prize for papers or patents X_{24}
		The ability of achievement transformation and engineering application X_{25}
	ideological and political quality X_3	Political consciousness X_{31}
		Ideological level X_{32}
		Moral level X_{33}
	cultural and physical quality X_4	Physical quality X_{41}
		Cultural quality X_{42}
		Mental quality X_{43}
		Linguistic ability X_{44}
		Individual cultivation X_{45}

Table 1 – The index system of subdividing and assessing postsecondary students' comprehensive ability

3.2. The extension set of tier two indices

Tier two indices served as a detailed description of tier one evaluation indices. According to the structure and content of the proposed index system in the paper, the extension set of tier two indices was built up based on the four assessment criteria, which was shown as follows:

$$\begin{cases} X_1 = (x_{11}, x_{12}, x_{13}, x_{14}) \\ X_2 = (x_{21}, x_{22}, x_{23}, x_{24}, x_{25}) \\ X_3 = (x_{31}, x_{32}, x_{33}) \\ X_4 = (x_{41}, x_{42}, x_{43}, x_{44}, x_{45}) \end{cases} \quad (2)$$

3.3. The vector of the assessment indices

According to the tier two indices of the extension set, with a comprehensive reference to expert advice, statistics and data analysis, and investigation and survey, the paper determined the respective quantitative and qualitative magnitudes of all the evaluation indices from the evaluation objectives. If the magnitude of the j th tier-two index under the t th criteria was given as $X_t(X_k)$, the vector of the t th criteria was expressed as:

$$V_t = (v_t(x_1), v_t(x_2), \dots, v_t(x_{n_t})) \quad (3)$$

Where n_t denoted the number of evaluation indices under the t th criteria.

In particular, if there were m evaluation objectives, the vector matrix of the evaluation indices under the corresponding criteria V_t was defined as:

$$\mathbf{V}_t = \begin{bmatrix} v_{1t}(x_1) & v_{1t}(x_2) & \cdots & v_{1t}(x_{n_t}) \\ v_{2t}(x_1) & v_{2t}(x_2) & \cdots & v_{2t}(x_{n_t}) \\ \vdots & \vdots & \cdots & \vdots \\ v_{mt}(x_1) & v_{mt}(x_2) & \cdots & v_{mt}(x_{n_t}) \end{bmatrix}_{m \times n_t} \quad (4)$$

3.4. Extension rank classification

Extension rank is the extension level of the evaluation targets. The rougher the extension rank is, the larger the evaluation granularity is, which brings difficulty to distinguish differences among evaluation targets. The finer the extension rank is, the smaller the evaluation granularity is, and the harder it is to distinguish the rank belongingness of evaluation targets. After overall consideration, the paper endowed the evaluation targets with five extension ranks, namely excellent Ra_1 , favorable Ra_2 , intermediate Ra_3 , passed Ra_4 , and poor Ra_5 . The extension rank set Ra was expressed as:

$$Ra = \{Ra_1, Ra_2, Ra_3, Ra_4, Ra_5\} \quad (5)$$

3.5. Calculation of the weight of the subdivided evaluation indices

AHP method was used to compute the weight of the subdivided evaluation indices in the paper. The evaluation targets were pairwise assessed with the ratio scale in the range of 1-9, and the comparison matrix A was obtained as:

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{ne} & \cdots & a_{nn} \end{bmatrix} = [a_{ij}]_{n \times n} \quad (6)$$

where a_{ij} denoted the significance of index i to index j , $1/9 \leq a_{ij} = 1/a_{ji} \leq 9$, $a_{ii} = a_{jj} = 1$.

The maximum characteristic root $\lambda_{\max}$ of the comparison matrix A was expressed as:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n \left(\frac{(\mathbf{A} \times \mathbf{W})_i}{w_i} \right) \quad (7)$$

where w_i denoted the weight of the index i , and

$$w_i = \left(\prod_{j=1}^n a_{ij} \right)^{1/n} / \sum_{i=1}^n \left(\prod_{j=1}^n a_{ij} \right)^{1/n} \quad (8)$$

By referring to the table, the average random consistency index RI was obtained. Consistency check was conducted on A , namely

$$CR = \frac{\lambda_{\max} - n}{RI * (n - 1)} \quad (9)$$

If $CR < 0.1$, A had a satisfactory consistency. If not, A should be revised until $CR < 0.1$.

3.6. Uniform scale processing

Quantitative evaluation targets could be described by fuzzy membership degree or by the ratio scale in the range of 0-1; while qualitative evaluation targets should undergo uniform scale processing.

If the magnitude of index j was $v(x_j)$, its interval was expressed as $[v_{\min}(x_j), v_{\max}(x_j)]$. If index j was positive, the uniformly scaled magnitude $r(x_j)$ was given as:

$$r(x_j) = \begin{cases} 0, & v(x_j) < v_{\min}(x_j) \\ \frac{v(x_j) - v_{\min}(x_j)}{v_{\max}(x_j) - v_{\min}(x_j)}, & v(x_j) \in [v_{\min}(x_j), v_{\max}(x_j)] \\ 1, & v(x_j) > v_{\max}(x_j) \end{cases} \quad (10)$$

If index j was negative, the uniformly scaled magnitude $r(x_j)$ was given as:

$$r(x_j) = \begin{cases} 1, & v(x_j) < v_{\min}(x_j) \\ \frac{v_{\max}(x_j) - v(x_j)}{v_{\max}(x_j) - v_{\min}(x_j)}, & v(x_j) \in [v_{\min}(x_j), v_{\max}(x_j)] \\ 0, & v(x_j) > v_{\max}(x_j) \end{cases} \quad (11)$$

3.7. Classical domain and controlled fields

As all the evaluation targets had a uniform ratio scale in the range of 0-1, in combination with the contents of extension rank, the classical domain U_k of the extension rank k was established, where $k=1, 2, 3, 4, 5$.

$$\begin{cases} u_1 = [u_1^{\min}, u_1^{\max}] = [0.90, 1.00] \\ u_2 = [u_2^{\min}, u_2^{\max}] = [0.80, 0.90] \\ u_3 = [u_3^{\min}, u_3^{\max}] = [0.70, 0.80] \\ u_4 = [u_4^{\min}, u_4^{\max}] = [0.60, 0.70] \\ u_5 = [u_5^{\min}, u_5^{\max}] = [0, 0.60] \end{cases} \quad (12)$$

The controlled field u_o could be expressed as:

$$u_o = [\min(u_k), \max(u_k)] = [0, 1.00] \quad (13)$$

3.8 calculation of extension distance and extension superiority

If the magnitude of an evaluation target in correspondence to index j was expressed as $r(x_j)$, according to the noted uniform scale processing, $0 \leq r(x_j) \leq 1$, the extension distance ρ_{jk} of the evaluation target between index j and extension rank k was described as:

$$\rho_{jk} = \left| r(x_j) - \frac{u_k^{\min} + u_k^{\max}}{2} \right| - \frac{u_k^{\max} - u_k^{\min}}{2} \quad (14)$$

Then, the correlation coefficient k_{jk} of the evaluation target between index j and extension rank k was described as:

$$K_{jk} = \begin{cases} \frac{-\rho_{jk}}{|u_k|}, & r(x_j) \in u_k \\ \frac{\rho_{jk}}{\rho_{jo} - \rho_{jk}}, & r(x_j) \notin u_k \end{cases} \quad (15)$$

Thus, the extension superiority φ_k between the evaluation target and the extension rank k was expressed as:

$$\varphi_k = \sum_{j=1}^n (w_j * K_{jk}) \quad (16)$$

3.9. Comprehensive ordering and model achievement

There were a two-stage structure for the index system of subdividing and assessing postsecondary students' comprehensive ability. Equation (16) was firstly used to conduct extension superiority treatment on the extension set of tier-two evaluation indices, so that parameters of the tier one indices in the corresponding extension set was obtained. In the same manner, Equation (16) was employed to conduct extension superiority treatment on the extension set of tier-one evaluation indices, thus the overall extension superiority was acquired. According to the overall extension superiority, the extension rank of an evaluation target was obtained.

4. Case study

For the case study, the paper assessed the comprehensive ability of graduates from a certain university. Specifically, the statistics of any one graduate from the university was analyzed; and the leaders, teachers, and counselors in the department that the graduate belonged to were consulted; then, the final evaluation data was obtained. Meanwhile, AHP method was used to calculate the weight of different evaluation targets, as shown in Table 2.

Criteria level	weight	Index level	weight	magnitude
X_1	0.301	X_{11}	0.418	4.25
		X_{12}	0.143	0.90
		X_{13}	0.143	0.80
		X_{14}	0.296	0.75
X_2	0.256	X_{21}	0.167	0.70
		X_{22}	0.222	0.85
		X_{23}	0.278	0.90
		X_{24}	0.111	6
		X_{25}	0.222	0.80
X_3	0.232	X_{31}	0.40	0.85
		X_{32}	0.30	0.90
		X_{33}	0.30	0.95
X_4	0.211	X_{41}	0.20	0.60
		X_{42}	0.20	0.65
		X_{43}	0.20	0.80
		X_{44}	0.20	0.80
		X_{45}	0.20	0.80

Table 2 – Index magnitude and its weight

Index level	Extension rank				
	Ra_1	Ra_2	Ra_3	Ra_4	Ra_5
X_{11}	0.05	-0.05	0.05	0.15	0.25
X_{12}	0	0	0.10	0.20	0.30
X_{13}	0.10	0	0	0.10	0.20
X_{14}	0.15	0.05	-0.05	0.05	0.15
X_{21}	0.20	0.10	0	0	0.10
X_{22}	0.05	-0.05	0.05	0.15	0.25
X_{23}	0	0	0.10	0.20	0.30
X_{24}	0.10	0	0	0.10	0.20
X_{25}	0.10	0	0	0.10	0.20
X_{31}	0.05	-0.05	0.05	0.15	0.25
X_{32}	0	0	0.10	0.20	0.30
X_{33}	0	0.05	0.15	0.25	0.35
X_{41}	0.30	0.20	0.10	0	0
X_{42}	0.25	0.15	0.05	-0.05	0.05
X_{43}	0.10	0	0	0.10	0.20
X_{44}	0.10	0	0	0.10	0.20
X_{45}	0.10	0	0	0.10	0.20

Table 3 – Extension distance

Index magnitudes underwent uniform scale processing. With corresponding formulas, the extension distance and extension superiority of the evaluation target were obtained, as shown in Table 3 and Table 4, respectively.

Criteria level	Extension rank				
	Ra_1	Ra_2	Ra_3	Ra_4	Ra_5
X_1	-0.263	0.160	-0.028	-0.401	-0.551
X_2	-0.233	0.069	-0.195	-0.407	-0.556
X_4	-0.1	0.05	-0.475	-0.65	-0.738
X_4	-0.369	-0.127	-0.065	-0.183	-0.325
Overall extension superiority	-0.240	0.051	-0.182	-0.415	-0.548

Table 3 –Extension superiority

The overall extension superiority meant that the comprehensive ability of the targeted graduate was Ra_2 .

5. Conclusion and prospect

A discussion is conducted on index selection principle of comprehensive ability evaluation concerning college students. Under the guidance of the principle, the paper chooses indices and establishes a corresponding index system that can subdivide and assess the comprehensive ability of postsecondary students. Based on extension theory, the paper builds up an extension model for subdivision of the integral competence of students educated in universities. By constructing classical the classical domain and the controlled field of evaluation indices in the extension model, the paper establishes a corresponding model to calculate the extension distance and extension superiority. According to the obtained overall extension superiority, the paper acquires the extension rank, thus realizing effective evaluation on the comprehensive ability of postsecondary students.

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The Selection of Self-employment of Home-going Peasant-workers Based on Big Data Analysis

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Abstract: Based on the big data analysis, this paper, through using the quantile regression method and combining the non-agricultural employment form of self-employment, carries out an analysis of home-going peasant-workers' decision making about self-employment and different levels of non-agricultural income from the aspects of human capital and so forth. Here are the research conclusions: among the non-agricultural income group, the income of the self-employed is obviously higher than the wage earners; factors like human capital and family characteristics have significantly influenced the probability of choosing self-employment, and non-agricultural training will help workers get access to wage employment; the self-employment choice has different influence on the non-agricultural income at different quantiles, and its impact on the middle and high-income groups is particularly significant; non-agricultural training has a significantly positive impact on all the quantiles of non-agricultural income; and education also has a significant impact on all the quantiles and such an impact shows an increasing trend.

Keywords: big data; home-going peasant-workers; self-employment; human capital; quantile regression

1. Introduction

Since the reform and opening up three decades ago, peasant-workers have followed a trend of "going out" to find jobs, which is also accompanied by a return migration of "staying behind". Many factors have contributed to the current two-way flow of peasant-workers, like the low income growth of peasant-workers, the macro-industrial restructuring, the increase of employment opportunities in the middle and western areas, as well as the integration of the labor market. Meanwhile, the limitations of the household registration, the guidance of the government policies, the fluctuations in the economic cycle, the individual family factors (such as the education of the children and the support for the elderly) will also have an essential impact on peasant-workers' decision of returning home. Home-going peasant-workers who are possessed with funds, techniques and management ability expect to obtain non-agricultural income in addition to land revenue. They have not only obtained local wage income, but also carried out self-employment activities to seek for their own development. In the process of urbanization, home-going peasant-workers' self-employment is of great significance to solving the problem of farmers' local employment, improving their

non-agricultural income, enhancing the vitality of rural economy and promoting the coordinated development between the rural and urban areas. To clarify the mechanism of human capital for the self-employment and non-agricultural income of home-going peasant-workers in China, it is helpful for the government to develop entrepreneurship support policies.

We are interested in digging out what factors have affected home-returning peasant-workers' self-employment decision and furthermore, what factors have affected their non-agricultural income, what impact self-employment decision can exert on their non-agricultural income. This paper uses the multi-provincial rural household survey data in China to analyze the above issues so as to provide some enlightenment for guiding peasant-workers' self-management behavior and improving their non-agricultural income.

This paper consists of five parts: the first part is introduction; the second part is literature review; the third part contains data sources, models and methods; the fourth part is result analysis and discussion; and the final part is conclusion and policy suggestions.

2. Literature Review

According to Schults's point of view (1961), human capital has a direct impact on people's income. Scholars have pointed out that human capital and social capital will influence rural peasant-workers' self-employment choice and non-agricultural income. Luan Jiang and Li Qiang (2011) held that the return rate of education to China's peasant-workers' non-agricultural income was 3.9%, whereas Wei Zhong (2004) asserted that the return rate of education to non-agricultural employees' wage was relatively low, or even negative. The significance of training to farmers' non-agricultural income is widely recognized. Ning Guangjie (2012a) found out that the income of farmers who had received training was 8.4% higher than those who hadn't.

The research about self-employment decision making has been fruitful home and abroad. In terms of education, Borjas (1989) believed that people who had received more education can more easily find a paid job and therefore were less likely to choose self-employment. However, Yueh (2009) had the opposite conclusion. Domestically, Yang Qijing and Wang Yufeng (2010) held that returnees' education level had a significant impact on their entrepreneurial decision. To be specific, if the education level increased by one unit, the probability of self-employed entrepreneurship would increase by 21.6%. Besides, in terms of working experience, the accumulation of working experience can help accumulate the capital, promote the management ability and technical expertise, and finally lead to a higher probability of self-employment. On the other hand, working experience is related with age. An older person is more likely to avoid risks, and is therefore less likely to choose self-employment (Bernhardt, I, 1994). Some scholars have analyzed self-employment decision making from the aspect of gender (Liu and Wang, 2013). Among the peasant-workers, male workers are more likely to choose self-employment than females. In addition, some hold that entrepreneurial spirit has a pivotal impact on self-employment income. Zhu Honggen (2012) pointed out that entrepreneurial spirit can remarkably promote the start-up companies' performance through analyzing the survey data of home-going peasant-workers' entrepreneurship in Jiangxi province.

While examining the rate of return of education, gender and training to non-agricultural income, most literature involves the OLS regression analysis but gets a result of average rate of return, which fails to reflect the differences that education, training, etc. affect the non-agricultural income. In comparison, quantile regression can describe the distribution features of influential factors in a more comprehensive, robust and accurate manner, and is therefore widely developed and applied in many disciplines.

The above research results have provided this paper with a basic framework. For example, the influential factors of home-going peasant-workers' non-agricultural income and self-employment decision making include educational background, experience, gender and so forth, and they have laid the basis for the quantitative analysis in this paper. This paper, however, differs from the present literature from the following aspects: first, this paper bases on the micro data of many provinces in China, targets at the special group of home-going peasant-workers and carries out the analysis of self-employment decision making; second, it combines different levels of non-agricultural income and estimates the return of human capital, self-employment and training to non-agricultural income.

3. Data Sources, Models and Methods

3.1. Model and Method

3.1.1. Model of self-employment choice

Probit model is established to testify the influential factors of home-going peasant-workers' self-employment choice. Here is the equation:

$$\begin{aligned} \Pr(\text{self} = 1) = & \alpha + \beta_1 \text{gender} + \beta_2 \text{marital} + \beta_3 \text{child} + \beta_4 \text{age} + \beta_5 \text{exp} \\ & + \beta_6 \text{training} + \beta_7 \text{eduyr} + \beta_8 \text{ability} + \varepsilon \end{aligned} \quad (1)$$

In this equation, self is the explained variable, 1 means choosing self-employment and 0 means the opposite; α is the constant and β_i stands for the coefficient vectors of all the explained variables; gender represents the gender dummy variable, 1 means male and 0 means female; marital stands for the marital dummy variable, 1 means married (including the first marriage and remarriage) and 0 means unmarried (including cohabitation, divorce, widowhood and singlehood); child represents the number of children. When children are young, the greater number of children requires parents to spend more time to take care of them and therefore prompts parents to choose the freer self-employment form to obtain non-agricultural income instead of entering the enterprise to gain the wage income; when children have grown up, they can help their parents to carry out self-employment activities. age represents the age, and as peasant-workers grow older, they will possess more knowledge and fortune, which are vital to self-employment; exp stands for the time that peasant-workers work outside the hometown, and the longer they work outside, the more experience they will obtain, and the more likely they will choose self-employment; training refers to the dummy variable of non-agricultural training that peasant-workers have received, 1 means that peasant-workers have received training while 0 means the opposite. After peasant-workers have received non-agricultural training, they will on one hand obtain richer knowledge, which will stimulate them to choose self-employment; but on the other hand, they will

more easily enter the enterprise and gain wage income. $enuyr$ stands for the years of education of peasant-workers, and it is measured by the time that they have received education; meanwhile, this paper also chooses a psychological characteristic variable ability, which represents the entrepreneurial spirit. In the questionnaire, when it comes to the question of “if there is any difficulty that can never be overcome”, 1 means “totally not” and 0 means the opposite. ε refers to the error.

3.1.2 Quantile regression model of non-agricultural income

The extended Mincer equation (1986) is used to examine the influential factors of home-going peasant-workers' non-agricultural income, and a model is established as follows:

$$\ln y = \alpha + \beta_1 self + \beta_2 gender + \beta_3 marital + \beta_4 age + \beta_5 exp + \beta_6 exp^2 + \beta_7 training + \beta_8 eduyr + \beta_9 ability + \varepsilon \quad (2)$$

In this model, y refers to the non-agricultural income of sample individuals, whose unit is Yuan per hour; $self$ represents the binary dummy variable (1 means self-employment while 0 means the opposite).

The further step is to find out the rates of return of human capital and self-employment to income at different levels of non-agricultural income. According to the quantile regression method put forward by Koenker and Bassett (1978), for $F(y) = prob(Y \leq y)$, the regression equation can be defined as:

$$q_\tau = \inf\{y: F(y) \geq \tau\} (0 < \tau < 1) \quad (3)$$

τ in Equation 3 represents the quantile, commonly taken as 0.1, 0.2, ..., 0.9; q_τ is the τ -th quantile value of the continuous random variable y . Then a quantile regression estimate is made to Equation 2, we can get

$$q_\tau(\ln y | X) = X\beta_\tau + \alpha_\tau \quad (4)$$

y in Equation 4 is the non-agricultural income per hour, X is the vector consisted of explanatory variables, α_τ is the estimate value of the quantiles' intercept, β_τ is the coefficient vector value of the explanatory variable at the quantile of τ , whose estimator $\hat{\beta}_\tau$ can be defined by the following minimum problem

$$\min_{\beta_\tau, \alpha_\tau} \sum_{\ln y \geq X'\beta_\tau} \tau |\ln y - X'\beta_\tau - \alpha_\tau| + \sum_{\ln y < X'\beta_\tau} (1 - \tau) |\ln y - X'\beta_\tau - \alpha_\tau| \quad (5)$$

In the estimation Formula 5, under the condition that the sum of weighted residuals' absolute values be minimum, the parameter vectors β and α are namely the parameter estimates of the quantile regression.

3.2. Data sources and descriptive statistics

Data used in this paper origins from a rural household survey in 2008 of China Household Income Project (CHIP). This project's individual samples amount to 31791, covering 9 provinces of Hebei, Jiangsu, Zhejiang, Anhui, Henan, Hubei, Guangdong, Chongqing and Sichuan and containing the information of individual characteristics, education, training and employment and so forth.

Due to the research needs, this study firstly limits the sample ages between 16 and 60. According to the answer to the question "Have you ever worked or done business outside your hometown?" we can tell whether the individual is a home-going peasant-worker or not. Furthermore, according to the answer to the question "What's your current or previous non-agricultural employment form? Self-employed or working for others?" we can tell if the individual has ever made a self-employment decision. After eliminating the samples of doing a part-time job, the two employment forms, self-employment and wage employment, constitute the research object of home-going peasant-workers' non-agricultural income in this paper. On this basis, after deleting the samples whose information is missing, we can get a total number of 6423 samples of home-going peasant-workers' non-agricultural income, among whom the self-employed are 583, accounting for 9.08%; the wage-earners are 5840, accounting for 90.92%.

As can be seen from Table 1, the average weekly working time for the self-employed is 52.07 hours, shorter than the total samples and the wage employment, and they are thus

variable	all the samples (non-agricultural employment)		self-employment		wage employment	
	mean	standard deviation	mean	standard deviation	mean	standard deviation
average monthly income (yuan)	1431.2	1013.12	1910.97	2557.8	1387.29	706.73
weekly working time (hour)	55.59	15.01	52.07	20.4	55.91	14.38
hourly income (yuan)	7.61	8.396	11.8	15.4	7.22	7.31
logarithm of hourly income	1.79	0.66	2.078	0.84	1.77	0.63
gender	0.64	0.48	0.73	0.45	0.63	0.48
marital status	0.62	0.49	0.88	0.33	0.59	0.49
age	30.21	10.21	36.36	9.77	29.65	10.06
experience	6.44	6.19	10.32	7.37	6.68	5.88
years of education	8.57	2.23	8.29	2.13	8.598	2.24
entrepreneurial spirit	0.12	0.32	0.24	0.43	0.11	0.31
training	0.34	0.47	0.29	0.46	0.34	0.47
number of children	1.46	0.84	1.74	0.82	1.54	0.76
sample size	6423		583		5840	

Table 1 – Descriptive Statistics (Mean and Standard Deviation)

more flexible in time arrangement; in terms of marriage, the average marriage rate of the self-employed is 84%, far exceeding the overall samples of 62%; in terms of age, the average age of the self-employed is 6.71 years longer than the wage-earners; in terms of working experience (time as peasant-workers), the self-employed have an average term of 10.32 years whereas the wage-earners only have 6.68 years, and more experienced peasant-workers are more inclined to choose self-employment; the average years of schooling of the self-employed are shorter than the total samples and wage employment; meanwhile, the self-employed have received less training but maintained a higher level of entrepreneurial spirit.

As can be observed from the kernel density distribution of average hourly income (see Figure 1), the income distribution of self-employment samples is obviously leaning toward the left of all samples and wage samples. This is due to the fact that the average income of the self-employed is higher than the two other samples. The average hourly income of self-employment is 11.8 Yuan, whereas that of wage employment is only 7.22 Yuan. Meanwhile, the non-agricultural income distribution of the male samples is also located on the left of the female samples.

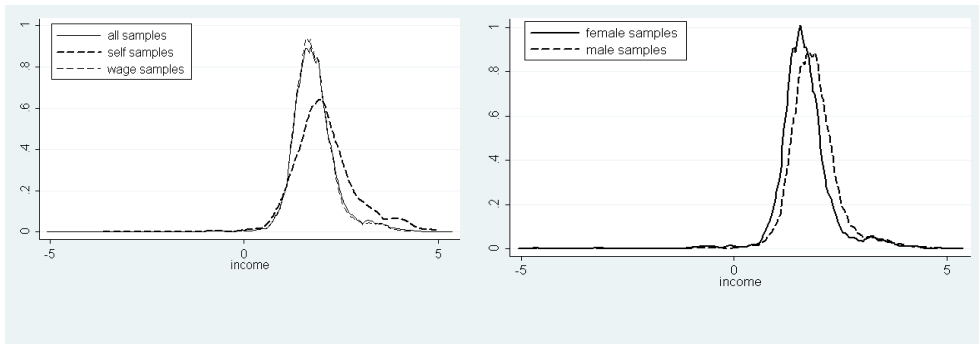


Figure 1 – Kernel Density Distribution of Average Hourly Income (Logarithm)

4. Result Analysis and Discussion

Table 2 gives the analysis result of self-employment's influential factors. It can be noted from the four models that the older the home-going peasant-worker is, the more likely he will choose self-employment, and the result is statistically significant; besides, the more experience the worker has obtained, the more likely he will choose self-employment; moreover, there are significant gender differences, and the probability of self-employment by the males is 1.5% higher than the females; the impact of the children's number has verified the previous analysis, that is once a child is added, the probability of self-employment will increase by 1.7%; the impact of marital status on self-employment probability is also significant, and the probability of self-employment by the married is 4.5% higher than the unmarried. The impact of training is significantly negative, which indicates that peasant-workers who have received training are more easily recruited into the factory and gain wage income; entrepreneurial spirit can increase the probability of self-employment by

3.3%, and it is statistically significant; Model 1 estimates the impact of years of education on self-employment and the result is negative and insignificant. To examine the impact of different levels of education on self-employment, Model 2, Model 3 and Model 4 are established, and it is learned that the impact of primary middle school and below on the probability of self-employment is positive whereas that of high school and university is negative. This is perhaps due to the fact that peasant-workers with a higher educational degree are more easily employed by an enterprise while those with poor educational background fail to gain the wage income and therefore choose self-employment.

Explanatory variables	Model 1		Model 2	Model 3	Model 4
	estimate coefficient	average marginal utility			
age	0.006* (1.72)	0.0009* (1.82)	0.007**(2.13)	0.0068**(1.98)	0.0067*(1.95)
experience	0.02*** (5.25)	0.0027*** (5.17)	0.0196*** (5.13)	0.0199*** (5.20)	0.0198*** (5.19)
gender	0.115 ** (2.19)	0.015** (2.21)	0.105** (2.01)	0.11** (2.12)	0.109** (2.09)
number of children	0.1225*** (3.82)	0.0169*** (3.80)	0.1233*** (3.84)	0.1238** (3.86)	0.1236*** (3.85)
marital status	0.344*** (4.63)	0.045*** (5.00)	0.337*** (4.53)	0.34*** (4.59)	0.34*** (4.59)
training	-0.11** (-2.06)	-0.01 (-1.47)	-0.119** (-2.25)	-0.116** (-2.19)	-0.118** (-2.22)
years of education	-0.0114 (-1.16)	-0.0017 (-1.25)			
primary middle school and below			0.0038 (0.07)		
high school				-0.0631 (-1.01)	
university					-0.1387 (-0.80)
entrepreneurial spirit	0.209*** (3.12)	0.0328*** (2.82)	0.206*** (3.07)	0.209*** (3.13)	0.206*** (3.08)
constant	-2.057*** (-15.50)		-2.22*** (-21.42)	-2.18*** (-23.21)	-2.16*** (-22.97)
Adjusted R ²	0.0878		0.0878	0.0871	0.0876

(Dependent Variable: = 1 if self-employed; = 0 otherwise)

otes: a. z statistics in parentheses; b. * significant at 10%; ** significant at 5%; *** significant at 1%;

Source: CHIP data, authors' calculation.

Table 2 – Probit Estimate of Self-employment Decision

Second, from the aspect of human capital, the working experience as peasant-workers has a greater impact on high-income and low-income groups than the middle-income group.

After a further investigation, it is learned that experience's impact on income is firstly positive but later negative, displaying a shape of inverted U and reflecting that experience has more influence on the income groups at two ends, but with the increase of experience the decline rate also grows faster. Training has a significantly positive and similar impact on all the quantiles of non-agricultural income, which fully demonstrates that training is of great significance to improving home-going peasant-workers' non-agricultural income; education has a significant impact on all the quantiles and its impact shows an increasing trend, which means that education has a Matthew effect on non-agricultural income, and OLS estimate has evidently underestimated education's role in promoting middle and high-income groups. It is worth noting that "difficulties can be overcome" (entrepreneurial spirit) has an insignificant impact on non-agricultural income, which is consistent with the conclusion of Ning Guangjie (2012b). One possible explanation is that the working environment and

management environment where peasant-workers obtain non-agricultural income are not complex, therefore individuals' psychological features cannot exert a significant impact on their income. Other human capital variables, like gender, have all exerted a significantly positive impact on non-agricultural income.

Variables	OLS	$\tau=0.10$	$\tau=0.25$	$\tau=0.50$	$\tau=0.75$	$\tau=0.90$
<i>self</i>	0.279*** (9.80)	0.003 (0.07)	0.12*** (3.13)	0.21*** (5.64)	0.41*** (8.82)	0.74*** (9.50)
<i>age</i>	-0.002 (-1.63)	-0.0045*** (-3.65)	-0.003*** (-2.69)	-0.0016* (-1.81)	-0.0027** (-2.38)	0.0032 (1.12)
<i>exp</i>	0.0216*** (5.84)	0.031*** (6.06)	0.017*** (4.06)	0.022*** (6.71)	0.0189*** (5.11)	0.027*** (4.40)
<i>exp²</i>	-0.0006*** (-4.14)	-0.0013*** (-4.92)	-0.0006*** (-2.75)	-0.0006*** (-3.90)	-0.0004*** (-2.57)	-0.0008*** (-3.52)
<i>gender</i>	0.175*** (10.11)	0.167*** (8.92)	0.18*** (11.68)	0.17*** (13.13)	0.18*** (10.09)	0.175*** (5.02)
<i>marital</i>	0.056** (2.50)	0.093*** (3.67)	0.084*** (3.90)	0.039** (2.14)	0.06*** (2.67)	-0.019 (-0.40)
<i>training</i>	0.0965*** (5.45)	0.07*** (3.28)	0.0995*** (5.61)	0.104*** (7.48)	0.09*** (5.45)	0.09** (2.53)
<i>eduyr</i>	0.022*** (6.45)	0.017*** (3.63)	0.018*** (5.19)	0.025*** (8.21)	0.027*** (8.26)	0.032*** (5.08)
<i>ability</i>	-0.018 (-0.66)	-0.051 (-1.50)	-0.043* (-1.80)	-0.0074 (-0.33)	0.0064 (0.25)	-0.0067 (-0.11)
<i>Constant</i>	1.38*** (30.27)	0.959*** (18.84)	1.148*** (27.14)	1.314*** (34.59)	1.606*** (35.17)	1.745*** (21.81)
<i>R²</i>	0.0624	0.0349	0.0398	0.0537	0.0578	0.0607

Notes: a. t statistics in parentheses; b. * significant at 10%; ** significant at 5%; *** significant at 1%;

Table 3 – Quantile Regression Estimates for Non-agricultural Income

As can be seen from the quantile regression trend (Figure 2), with the change of quantiles, self-employment and years of education have an increasingly greater impact on non-agricultural income, which reflects a significant promoting role of self-employment and education; the working experience as peasant-worker approximates the shape of “W” and its square approximates the shape of “M”, reflecting that experience has great influence on income groups at the two ends and such influence is firstly positive and later negative, which is consistent with the previous analysis in this paper; training’s impact on all the quantiles approximates a horizontal line, which shows that training has similar influence on all levels of income groups.

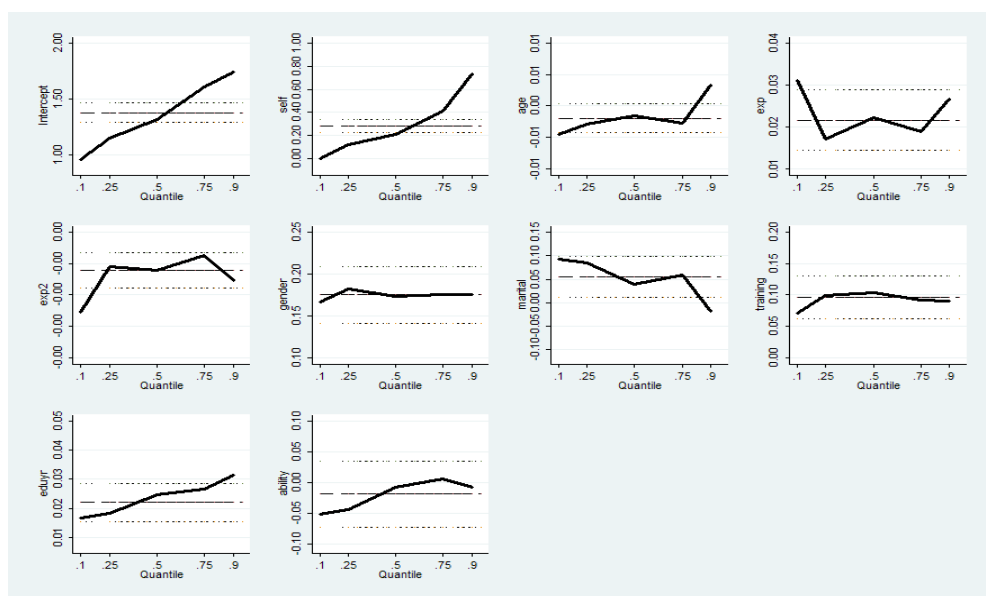


Figure 2 – Curves of Coefficients of Variables

5. Conclusion and Policy Suggestions

This paper bases on the multi-provincial rural household survey data of China and carries out an analysis of home-returning peasant-workers’ non-agricultural income. It combines self-employment, the particular non-agricultural employment form, to analyze self-employment decision making and study different levels of non-agricultural income from the aspects of human capital and so on. Research shows that among the non-agricultural income group, the self-employed has an obviously higher income than the wage-earners, and the former has an hourly income of 11.8 Yuan whereas the latter only has 7.22 Yuan; the analysis of self-employment decision-making shows that working experience as peasant-workers, age, gender, family feature and psychological characteristic of overcoming difficulties have remarkably increased the probability of choosing self-employment, and the non-agricultural training that has been received can

help the workers to obtain wage employment; the analysis of different levels of non-agricultural income has demonstrated that the self-employment choice has different influence on non-agricultural income at different quantiles, and the top 10% income group can get a return as high as 0.74 through choosing self-employment, and OLS has underestimated the impact of self-employment on middle and high-income groups. The impact of peasant-workers experience on non-agricultural income is firstly positive but later negative, and non-agricultural training has a significantly positive impact on all the quantiles of non-agricultural income. Education has a significant impact on all the quantiles and such impact shows an increasing trend, which means that education has a Matthew effect on non-agricultural income. Besides, there are gender differences in self-employment decision making and non-agricultural income.

The above analysis and conclusion have some policy implications. Thus, this paper holds that on the one hand, the government should improve the entrepreneurial environment of home-going peasant-workers, readily encourage the home-going peasant-workers, especially those who have obtained profound working experience and received higher education to be engaged in self-employment activities, and promote the entrepreneurial training and other forms of non-agricultural training. On the other hand, the government should attach great importance to the gender differences of non-agricultural employment, strengthen the public services construction in villages and towns, and emancipate laborers, especially the female laborers from family labor so as the enhance the vitality of the rural labor market.

Acknowledgement

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Pickup and Distribution Center Estimation Model of Fresh Agricultural Products Based on Computer Simulation

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Abstract: This paper focuses on the discussion of domestic Taobao village fresh agricultural products in domestic distribution model and the practical problems, proposes to reduce the distribution costs in the process of distribution and the difficulty of distribution in remote areas, according to a regional population demand intensity and geographical factors such as will be required to distribution of the total geographical division into several small regions, in a number of small regional category settings from mentioning, the use of computer simulation is simulated by means of construction and implementation of the distribution of fixed area partition method and model.

Keywords: agricultural product distribution model; computer simulation; estimation model; distribution area

1. Introduction

Along with the gradual rise of electronic commerce information and logistics technology, more and more small and medium enterprises gradually contact a mode which is based on Taobao, its fundamental platform, to sell fresh agricultural products. B2C fresh Taobao electricity, as an emerging thing in the field of electronic commerce, it is still in the stage of exploration. According to its current situation, B2C fresh Taobao electricity in their production, there are still some problems in production, supply and marketing. Combined with Taobao and the examples of fresh agricultural products in the Taobao to analyze the merits and demerits of operating model in fresh agricultural products, which can put forward some suggestions to optimize and improve. This paper is going to focus on the fresh agricultural products operating model of domestic electric business Taobao village, sum up the defects of electric business operating model of fresh agricultural products in Taobao village in our country, and to explore the future trend of operating mode of fresh agricultural product in Taobao village in our country, do a research in order to promote China's Taobao village of fresh agricultural products operating model of integration development, to improve operation of the overall market competitiveness of e-commerce enterprise at the same time, and reduce the cost of logistics, and can improving its operating model, making it quickly meet the market demand.

In China, related research starts late, assumptions to this question are mostly a single hypothesis. Miss Miu has carried on a comprehensive research on cold-chain distribution routing problem, which is based on the data using the improved genetic algorithm and Matlab to solve the model and obtain the global optimal solution. She made the planning optimization of distribution route be operational and made optimization route be visual (Miu, 2010). Mr Pan et.al put forward a concept called fresh food delivery timeliness and fairness and established fresh food fair distribution vehicle routing model, and with the aid of ant colony algorithm, he concluded that the optimal path based on the principle of fair distribution (Pan et.al, 2013). A foreign scholar, called K.G Govindan, and his teammate studied double location routing problem with time window for supply chain network (SCN) of perishable foods, and established a multi-objective optimization model which aim is the lowest cost and minimization of environmental impact, the innovative use of combination of multi-objective particle swarm optimization algorithm (MOPSO) and adaptive multi-objective variable neighborhood search (AMOVNS) hybrid algorithm to provide a more effective solution for the model (Govindan et.al, 2014). Later scholars study the optimization scheme from a more realistic looking, Jiafu Tang put forward a question based on the partial delivery of the vehicle routing problem (SDVRP), which follow the delivery capacity of the vehicle loads and the distribution of goods to choose the optimal path, combined the SDVRP with weighted path optimization problem (WVRP) to be SDWVRP, setting up a model considering loading capacity and delivery time, aiming at lowest cost, using the ant colony algorithm to solve the problem (Tang et.al. 2013). Researchers like Cachon, standing at the height of strategy, aiming at the characteristics of target customers, proposed a dynamic pricing model about the reference price to study the dynamic pricing problem of the product (Cachon and Swinney, 2009). Scholars like Qian classify the product line in the market; formulate pricing mechanism according to different categories of products (Qian and Dan, 2013). Scholars such as Parlaktürk aim at the big customers, mining the value of product diversity to these customers (Parlaktürk, 2012). But a scholar named Dan, in Stackelberg game manufacturers being the countermeasures, studies the inventory coordination problems between traditional and electronic channels, establishes double channel model to coordinate, achieve coordination contract parameters which meet the balance (Dan and Xu, 2013). Yong qiang shi think two pricing contract and wholesale price contract can achieve channel coordination, but quantity discount contract cannot achieve coordination (Shi et.al, 2014). Lu and others think that a strategy that exists to coordinate this supply chain with delivery time uncertainty, which can make the whole supply chain to maximize performance, and the strategy can effectively compensate for the limitations of information sharing (Lu and Zhu, 2008). Jimenez-martin, a focuses on the safeguard selection within the risk analysis and management in information systems (IS) under a fuzzy perspective (Jimenez-martin et.al, 2015). A major contribution of this assessment is that, given a set of characteristics that are intrinsic to composition-based software development and to end users, a set of relevant functions and heuristics to detect general problems of functional suitability and usability are proposed (Hernandez et.al, 2016).

2. Fresh Electricity Suppliers and Operational Model Analysis

Electronic commerce of fresh agricultural products, that is, by using the Internet will be fresh vegetables, fruits, or meat and other derivative products for online sales model.

This is a modern network of the transaction model, different from the traditional trading pattern, is the fresh agricultural product electronic commerce not only needs the support of the network, but also needs the support of the third party logistics system. Through the self-built logistics system or customers online selection of goods for distribution by means of delegation, there is time and space in the middle. Taking a customer to complete an online transaction specific process as an example, we must first through online selection of goods and the order - businesses according to the customer demand for partial shipments picking and packing - the goods through the self-built logistics system or the third party logistics system of distribution and eventually reach the hands of customers. In this process because we are conveying a shorter shelf life and need to maintain a high degree of freshness of fresh products, so taking into account the special nature of the goods, the speed and technology in the transmission is the biggest test of the whole operation mode. Therefore, fresh electricity suppliers need to have a high standard in terms of transportation cost control and logistics technology.

2.1. Platform Business Model

With two companies we know for examples, the one is Alibaba, the other is SF. We usually contact is Taobao, Tmall that kind of Internet trading platform. A large platform has a number of shops and a healthy competition. The front end of the platform is what we usually see the online shopping transaction interface, and the support of the back-end platform is used before we said the rookie logistics system. In early 2014, the Alibaba trading platform has reached hundreds of billions of sales market, the technology has become increasingly mature and derived from more transactions, such as the unsold goods for sale, not only allows users to buy their favorite goods ahead of time, but also to give the seller sufficient preparation time, so that the whole business model is more penetrating. Another SF is C2B in the form of high-end commercial value platform direct supply mode, the high priced products as their own sales positioning to reduce the risk of the loss of the logistics transportation cost of a single goods order. Optimization of SF is a stand-alone operation mode, gradually formed a fast logistics based on the fresh electricity suppliers convergence platform.

2.2. “The Field to the Dining Table Directly” Model

This model can analogy to the B2C, is the whole operation process of independent swept, including online trading, procurement, warehousing, distribution, marketing, and post sales processing. We take Jingdong as an example, Jingdong now do just stay online trading platform, the development of Jingdong in the later period is to achieve “The field to the dining table directly” mode of operation, but want to do this, for the distribution system of fresh agricultural products and the need for high cost and high-end technical support of cold chain logistics system still need to constantly strive to explore.

2.3. Localization +O2O Mode

The essence of this model is to carry out the localization of the operation mode, through the combination of B2B, B2C form; the latter will join the O2O model to integrate a set of patterns. At present, some large supermarkets in our country have this form, combined with the characteristics of fresh agricultural products, not only in our country and even

abroad, such as WAL-MART and other large supermarkets are also tested, localized operations are the main features of this model.

3. Pickup Center Estimation Model of Fresh Agricultural Products Distribution

3.1. Partition Method and Model Hypothesis of Distribution Fixed Area

To reduce the enterprise in the distribution process of distribution cost and the difficulty of distribution in remote areas, according to a regional population demand intensity and geographical factors such as will be required to distribution of the total geographical division into several small regions, in a number of small regional category set from mentioning, the user simply according to their own area to the designated locations to receive the goods can be.

A lot of methods can be used in the classification of fixed distribution areas, such as cluster analysis, rectangle partition method (KARP), pole line partition method, sector partition method, genetic algorithm and so on. Here we use a more simple and convenient method of clustering analysis.

Cluster analysis, also called group analysis and point group analysis, is a kind of multivariate statistical method. Cluster analysis method can also be used (1) direct clustering method (2) the shortest distance clustering method (3) the distance clustering method, the overall level of the basic idea is the existence of differences between samples or Index of similarity sex, according to a plurality of observations batch of samples, and can find some similar levels of tolerance between the sample or index statistics to distinguish between these types of statistics as a basis. Some similar level of large samples or indicators of aggregation for a class, some of the other between the degrees of similarity between the larger samples or indicators for another class, until all the samples or indicators aggregated. Here we use the shortest distance clustering method to implement the model calculation.

The (X_i, Y_i) for the coordinate position i of users, then we assume that:

1. Each fixed area only to set up a point from mentioning;
2. A number of requirements of users are independent of the fixed area;
3. The user's demand and its geographical location known;
4. The ideal state of the natural environment in which the transport range is located, and does not have the effect of force majeure;
5. Distribution in some areas in the needs of the user can only divide the region since some goods in.

In the use of the shortest distance clustering method, we first need to remember this calculation method is to find the smallest two adjacent demands between the distance and to merge as a demand point, in the continuous integration has been the remaining two points for the last remaining the distance between two points of regional division. For example, we have a total of n points on the user; we need to calculate the distance between two points of the n points. In these distances in the select a minimum value of two users to merge, then we will rest $(n-1)$ points, in which continue to find two home

from minimum to and, by analogy, division of the region according to the calculation of the above conditions can be in only the last two points.

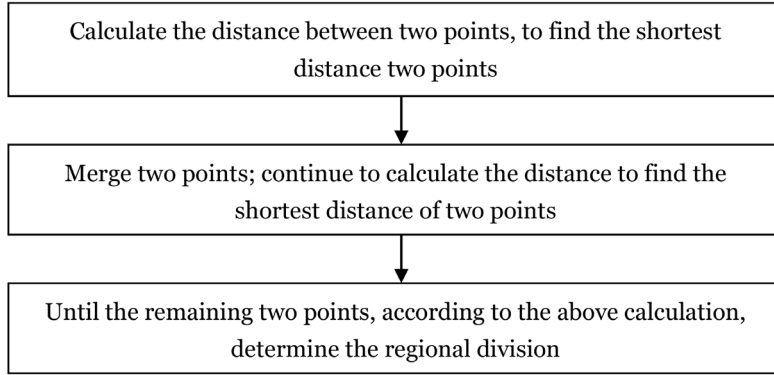


Figure 1 – By adopting the method of short distance clustering application steps

Range absolute value is expressed as:

$$D(X_i, Y_i) = \sum_{i=1}^N |X_i - Y_i| \quad (1)$$

3.2. Construction Division Points

Fixed area since the reminding setting can not only save part of the extra shipping costs, the benefits of cold chain system is also obvious. Such as the distribution of fresh agricultural products, in order to ensure that the goods freshness, we need to products will be placed in the refrigerator or other electronic devices. In fixed since reminded we can add insurance device until the customer to receive goods, can ensure the commodity of freshness and separate distribution is reduced due to the lack of security equipment caused by the goods damaged by corrosion rate.

Ignoring the effect of geographical conditions and weather factors, we select the gravity method in some areas set points. We assume that each region only a self-reminding and since reminding O and demand point I between the number of goods transported are not negative, mathematical model, center of gravity method to determine:

Min

$$Z = \sum_{o=1}^B \sum_{i=1}^N D_{oi} C_{oi} \quad (2)$$

$$D_{oi} = \sqrt{(X_i - X_o)^2 + (Y_i - Y_o)^2} \quad (3)$$

Order partial derivative =0, then

$$X_O' = \left(\sum_{o=1}^B \sum_{i=1}^N D_{oi} C_{oi} X_i / D_{oi} \right) / \left(\sum_{o=1}^B \sum_{i=1}^N D_{oi} C_{oi} / D_{oi} \right) \quad (4)$$

$$Y_O' = \left(\sum_{o=1}^B \sum_{i=1}^N D_{oi} C_{oi} Y_i / D_{oi} \right) / \left(\sum_{o=1}^B \sum_{i=1}^N D_{oi} C_{oi} / D_{oi} \right) \quad (5)$$

D_{oi} = the distance between pickup center o and demand point i

W_{oi} = the number of delivery goods between pickup center o and demand point i

C_{oi} = the unit cost of delivery goods between pickup center o and demand point i

the geographical coordinates of pickup center o (X_o , Y_o)

The geographical coordinates of the demand point i (X_i , Y_i)

B= the number of pickup centers

By using EXCEL, we can calculate the simple solution process, calculate the most reasonable setting location, the distribution process can be explained with a simple diagram:

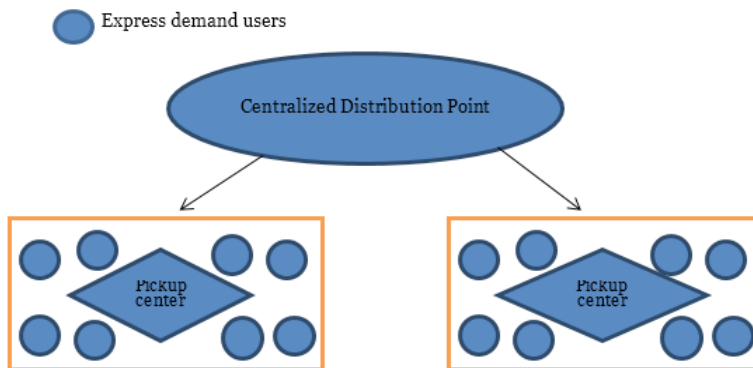


Figure 2 – Schematic Diagram of a Fixed Area From Mentioning Delivery

3.3. Calculation of Weight and Consistency Check

We need to test the consistency of the data in order to avoid the logical contradiction when the numerical value of the rectangular data is in accordance with the logical standard. It can be seen that the consistency of the test is essential. Based on the analytic hierarchy process and the comparison of the 22 factors, we first calculate the judgment matrix of each layer, then calculate the geometric mean and the weight. We can automatically calculate the value of the project by using the EXCEL table:

Target Z	Natural environment	Economic environment	Industry environment	Traffic Environment	Infrast- -ructure	Cost
Natural environment	3	0.6	1/3	1	1.5	3/8
Economic environment	15	3	1	9	15	1.5
Industry environment	27	9	3	21	27	6
Traffic environment	9	1	3/7	3	9	0.6
Infrast- -ructure	6	3/5	1/3	1	3	3/7
Cost	24	6	1.5	15	21	3
Geometric mean	0.979149	5.710962	13.281957	2.532363	1.291995	9.258762
Weight H	0.088866	0.5183100	1.2054360	0.229830	0.117258	0.840300

Table 1 – Target Layer Judgment Matrix

The matrix of the target layer Z is:

$$\begin{bmatrix} 3 & 0.6 & 1/3 & 1 & 1.5 & 3/8 \\ 15 & 3 & 1 & 9 & 15 & 1.5 \\ 27 & 9 & 3 & 21 & 27 & 6 \\ 9 & 1 & 3/7 & 3 & 9 & 0.6 \\ 6 & 3/5 & 1/3 & 1 & 3 & 3/7 \\ 24 & 6 & 1.5 & 15 & 21 & 3 \end{bmatrix}$$

Weight H matrix is:

$$\begin{bmatrix} 0.088866 \\ 0.518310 \\ 1.205436 \\ 0.229830 \\ 0.117258 \\ 0.840300 \end{bmatrix}$$

In summary, ZH is:

$$\begin{bmatrix} 3 & 0.6 & 1/3 & 1 & 1.5 & 3/8 \\ 15 & 3 & 1 & 9 & 15 & 1.5 \\ 27 & 9 & 3 & 21 & 27 & 6 \\ 9 & 1 & 3/7 & 3 & 9 & 0.6 \\ 6 & 3/5 & 1/3 & 1 & 3 & 3/7 \\ 24 & 6 & 1.5 & 15 & 21 & 3 \end{bmatrix} \begin{bmatrix} 0.088866 \\ 0.518310 \\ 1.205436 \\ 0.229830 \\ 0.117258 \\ 0.840300 \end{bmatrix}$$

$$\text{Consistency index} = \frac{\left[\sum_{i=1}^6 (ZH)_i / NH_i \right] - N}{N - 1} \quad (6)$$

According to the average random consistency index, we can find 1.26,

The random consistent ratio can be calculated to be about $0.036 < 0.1$,

So the matrix Z of the target layer is consistent, the numerical calculation is correct, and the evaluation is reasonable.

Then, according to the above method, we can calculate and judge the consistency of each index by EXCEL.

3.4. Conclusion Analysis

In a certain region set from mentioning not only can make fresh agricultural products distribution enterprises to reduce transportation costs, also due to the particularity of fresh agricultural products preservation, to provide users with more high-quality product quality. I from the audience's point of view, consumers in receipt of product logistics information can according to their own time to self-reminding pickup, cannot afford to worry about original goods alone when the quota no sign and so on. And in point of mentioning set a series of digital preservation, and other special equipment, there is no need to worry about commodity hand after the product deterioration and other issues caused due to weather or time. II from the perspective of fresh agricultural products distribution company of the special storage demand of fresh agricultural products need to use special equipment, if from mentioning the settings in the fixed area, dedicated electronic fresh keeping device can recycling, inversely proportional to the transit of goods quantity and the cost, namely demand delivery quantity of goods more, fixed units into the lower. In addition, the use of professional equipment to maintain fresh agricultural products and enhances customer interest, and help the latter to expand into a stable source. Go deep into the audience to understand the latest market demand, the future direction of fresh agricultural operations have a great reference value, even if the market changes, but also to mobilize resources. However, because the model is under the assumption of the absolute ideal, when we apply to the actual problem, we still need to continue to explore and research.

4. The Optimization and Improving Suggestions

No matter what the final operating trading system is, all of us should take providing customers with high quality products as the operating guidelines. If we directly develop trading platform, then slowly accumulate customer, which may be more dangerous and the upfront costs are high. We still need to improve and optimize business models set up under the background of fresh agricultural products Online Taobao. We can start from the following aspects, and constantly develop fresh agricultural products market.

4.1. The Brand Needs Solid Skeleton

With many people getting success in the business, a lot of people will copy their operating model, but the result is not satisfactory. Because not all successful models can be applied directly to the enterprise. Before realizing real problem, the imitation of successful man began to collect all kinds of operational scheme. One of the plan explicitly pointed out that we can not only just follow the personal brand of those successful men, but also need to increase the international competitiveness. We need to use the advantage of foreign markets, promote brand to overseas, be the international standard industry pioneer, make the enterprises bigger and stronger through a different approach. Establishing a strong brand concept is associated with grasping the quality. Only standardized quality of the goods can attract more consumers.

We firstly choose the qualified fresh agricultural products supplier from the vast market, then introduce them to the consumer from stores or network gradually. Take fresh outbreaks of electricity blank period and set up standards for related product quality as soon as possible, or the request of the rough machining and the packing and shipping. From the fresh, safe, guaranteed agricultural products promotion, customers can let the standard products directly into the kitchen of the masses. When this standardization system is formulated, the evaluation standard is to be the judge standard of local people and the brand truly entered the audience's heart. Only solid skeleton and escort has the connotation of the brand in the information age of the science and technology.

4.2. To Explore More Changes of Profound Circulation Pattern

Actually a localization of fresh agricultural products is difficult to complete proprietary, we still need to cooperate with suppliers who can provide high quality source, in most cases we select high quality supplier of goods in the market. We eventually want to realize the goal is to build a complete set of measuring product standards, and to establish a scientific process, put standardized brand concept into consumer cognition. Accomplishing these goals still needs continuous efforts, and one of the biggest obstacles is the lack of good faith. But on the other hand, we also can take the gap as the breakthrough point to create more opportunities.

On today's network, there are too many virtual products, many of them are content to content or people to people, we were not able to complete them together. Just think, if we put the people and things together in some way, the effect can be better? In particular, we make a story or the understanding or the spirit of producers on the goods be expressed, the most direct approach is through the packing of the products. When

consumers get the product, they not only can experience the high-quality product, also can realize the story behind the farmers, processing workers or distribution personnel. Let the consumer have a deep understanding of opportunity when they consume at the same time, through the establishment of physical connection with people, which is a more humanized characteristic in the process of operation. Product promotion is more deeply rooted in the hearts of the people.

4.3. Make the Standard Open and Brand Promoted

If we want to fresh agricultural products to be perfect, we need to check source without scrutiny. Market for agricultural products is the independent third party in the producers and consumers naturally, is the two best roles to set up and maintain the two. After establishing a set of standard processes system, the remaining enterprise will be in accordance with the requirements for such standard. Imagine, when the standard is specific, they perform the same kind of benchmark in the industry and then they have the absolute leading ability, have relatively large control rights for the future industry operation. Along with the Internet, we will gradually make fresh agricultural products to be a standard shape, to complete great breakthrough. Today's society we need our true ability, with high-quality product quality capturing the heart of customers, the brand continuously upgrading, the optimization of resources will become another important motivation of fresh electrical business operations.

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Research on the Comprehensive Evaluation Model of the Physical Education based on the Grey Clustering Analysis Method

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Abstract: Comprehensive evaluation of physical education in colleges and universities is to analyze teaching ability and quality and teachers' quality in a comprehensive manner, which can effectively reflect P.E. teaching level in colleges and universities, so it is of great significance. This paper first establishes a comprehensive evaluation index system of physical education by analyzing comprehensive evaluation indexes. Then, a grey clustering analysis method is used to determine the gray categories for comprehensive analysis of physical education, and whitenization weight function is constructed correspondingly. Finally, upon a standardized processing of evaluation indexes, initial data is obtained to establish a comprehensive evaluation model of the physical education based on the grey clustering analysis method, completing an effective analysis of teaching level. The results of case analysis indicate that the presented model is feasible and effective.

Keywords: grey clustering analysis method, comprehensive evaluation index system, physical education

1. Introduction

As an important part of higher education, physical education serves as a significant means of enhancing overall quality and ability of higher education personnel in an all-round way, and it is of great significance in higher education. (LI, 2014; Yang, 2007) How to fully and efficiently carry out physical education in higher education is a major research topic. To this end, it is imperative to make a comprehensive evaluation on physical education in colleges and universities in an overall and effective manner, and to analyze relevant factors. On that basis, targeted implementation strategy is presented. (Ma, 2014; LI, 2006) Currently, a series of studies have been conducted concerning physical education evaluation in colleges and universities, and better theoretical results and effect of engineering application have been achieved in such respects as analysis of factors influencing the development and development strategy for physical education (Zhen, 2010; Sun, 2013; Zhou, 2014), research on evaluation index system of physical education (Wu, 2013; Yu, 2014; He, 2013) and research on evaluation model of physical education (Sun, 2006; Su, 2011). Nonetheless, comprehensive evaluation index system

and evaluation model remain to be further studied. For this reason, this paper will analyze and draw on the existing research results to present an improved comprehensive evaluation index system of physical education. Meanwhile, in view of the fuzziness of evaluation information, this paper presents a comprehensive evaluation model of the physical education based on the grey clustering analysis method (Chia, 2009; Ker-Tah, 2011; Liu, 2012; Alexi, 2016) from the grey system theory (Fátima et al., 2014; Muhammad, 2015; Vikas, 2015).

2. Comprehensive evaluation index system of physical education

2.1. Selecting principles of comprehensive evaluation indicators

1. Principle of scientific rationality
Scientific law and nature of evaluation target can be presented by selecting evaluation indicators from the principle of scientific rationality, hereby accurately and clearly expressing content and status of evaluation.
2. Principle of objective authenticity
Factors in the evaluation process are presented exactly based on objective facts, so as to ensure the authenticity and integrity of evaluation content.
3. Principle of overall integrity
Selecting indicators from a single angle leads to evaluation deviation inevitably. Therefore, indicators shall be selected from an overall perspective to ensure integrity and comprehensiveness.
4. Principle of comparative analysis
Selection of indicators shall contribute to the effective analysis of qualitative and quantitative evaluation, thus making evaluation analyzable.

2.2. Comprehensive evaluation index system

This paper has conducted a survey and made a statistical analysis of many colleges and universities through questionnaire. In accordance with the above-mentioned selecting principles of evaluation indexes, comprehensive evaluation index system is divided into four parts, including basic professional ability, teaching management and control ability, manifestation of teaching results and ability cultivation of students, by soliciting opinions and suggestions from experts in the field, as shown in Table 1.

3. Comprehensive evaluation model of the physical education based on the grey clustering analysis

3.1. Gray category of comprehensive evaluation of physical education

To effectively and accurately make a comprehensive evaluation on teaching level in physical education, there is a need to reasonably classify the gray category of comprehensive evaluation of physical education, which is classified into terrible(l_1), worse(l_2), poor(l_3), average(l_4), medium(l_5), better(l_6), excellent(l_7) in this paper.

The whitenization weight function for the gray category k of evaluation index j can be expressed by the following four equations. The first equation is $f_j^k(x) = f_j^k[u_1, t_1, t_2, u_2]$:

System	Part	Evaluation index
Comprehensive evaluation index system $\bar{X}$	Basic professional ability X_1	Academic level x_{11}
		Technical capacity x_{12}
		Classroom effect x_{13}
		Teaching planning x_{14}
	X_2 Teaching management and control ability X_2	Teaching means x_{21}
		Teaching organization x_{22}
		Educational reform ability x_{23}
		Teaching management x_{24}
	X_3 Manifestation of teaching results	Teaching method x_{25}
		Scientific research results x_{31}
		Teaching research results x_{32}
		Qualified rate of talents x_{33}
	X_4 Ability cultivation of students X_4	Social satisfaction x_{34}
		Physical quality x_{41}
		Professional knowledge and skills x_{42}
		Innovation and development ability x_{43}
		Practical and adaptive ability x_{44}
		Capacity for independent scientific research x_{45}

Table 1 – Comprehensive evaluation index system X_i

$$f_j^k(x) = f_j^k[u_1, t_1, t_2, u_2] = \begin{cases} 0 & x \notin [u_1, u_2] \\ \frac{x - u_1}{t_1 - u_1} & x \in [u_1, t_1] \\ 1 & x \in [t_1, t_2] \\ \frac{u_2 - x}{u_2 - t_2} & x \notin [t_2, u_2] \end{cases} \quad (1)$$

The second equation is $f_j^k(x) = f_j^k[u_1, t_1, -, -]$:

$$f_j^k(x) = f_j^k[u_1, t_1, -, -] = \begin{cases} 0 & x \leq u_1 \\ \frac{x - u_1}{t_1 - u_1} & x \in [u_1, t_1] \\ 1 & x \geq t_1 \end{cases} \quad (2)$$

The third equation is $f_j^k(x) = f_j^k[u_1, t_1, -, u_2]$:

$$f_j^k(x) = f_j^k[u_1, t_1, -, u_2] = \begin{cases} \frac{x - u_1}{t_1 - u_1} & x \in [u_1, t_1] \\ 0 & x \notin [u_1, u_2] \\ \frac{u_2 - x}{u_2 - t_2} & x \in [t_2, u_2] \end{cases} \quad (3)$$

The forth equation is $f_j^k(x) = f_j^k[-, -, t_2, u_2]$:

$$f_j^k(x) = f_j^k[-, -, t_2, u_2] = \begin{cases} 0 & x \notin [0, u_2] \\ \frac{u_2 - x}{u_2 - t_2} & x \in [t_2, u_2] \\ 1 & x \in [0, t_2] \end{cases} \quad (4)$$

3.2. Data processing of grey clustering analysis

Data of various indexes needs normalization processing before making grey clustering analysis to unify the metric in the process of analysis. If evaluation index j is an effective index, the value r_j upon normalization will be given by the following equation:

$$r_j = \frac{x_j - \min_{1 \leq j \leq n}(x_j)}{\max_{1 \leq j \leq n}(x_j) - \min_{1 \leq j \leq n}(x_j)} \quad (5)$$

In particular, if the membership degree of evaluation index i can be worked out directly, it can use the above formulation directly for analysis.

3.3. Establishment of comprehensive evaluation model

Whitenization weight function can be constructed based on the above-mentioned gray categories of comprehensive evaluation of physical education, and the overall structure diagram is shown in Figure 1.

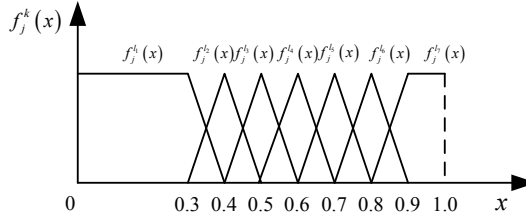


Figure 1 – Structure of whitenization weight function

Therefore, a whitenization weight function for gray category can be expressed as follows:

$$\begin{cases} f_j^{l_1}(x) = f_j^k[-,-,0.3,0.4] \\ f_j^{l_2}(x) = f_j^k[0.3,0.4,-,0.5] \\ f_j^{l_3}(x) = f_j^k[0.4,0.5,-,0.6] \\ f_j^{l_4}(x) = f_j^k[0.5,0.6,-,0.7] \\ f_j^{l_5}(x) = f_j^k[0.6,0.7,-,0.8] \\ f_j^{l_6}(x) = f_j^k[0.7,0.8,-,0.9] \\ f_j^{l_7}(x) = f_j^k[0.8,0.9,-,-] \end{cases} \quad (6)$$

Given $f_j^k(r_j)$ is the whitenization weight function value of evaluation target in respect of evaluation index j and gray category k , clustering analysis matrix F can be expressed as follows:

$$\mathbf{F} = \begin{bmatrix} f_1^1 & \cdots & f_1^1 & \cdots & f_1^m \\ \vdots & \cdots & \vdots & \cdots & \vdots \\ f_j^1 & \cdots & f_j^1 & \cdots & f_j^m \\ \vdots & \cdots & \vdots & \cdots & \vdots \\ f_n^1 & \cdots & f_n^1 & \cdots & f_n^m \end{bmatrix}_{n \times m} \quad (7)$$

where n represents the number of evaluation index and m represents the number of gray category.

If weight sequence of evaluation index $\mathbf{w}=(w_i, \cdots, w_j, \cdots, w_n)$ is obtained, clustering coefficient sequence λ can be given by the following equation:

$$\begin{aligned} \ddot{\mathbf{e}} &= (\lambda_i, \cdots, \lambda_i, \cdots, \lambda_m) = \mathbf{w} \otimes \mathbf{F} \\ &= (w_i, \cdots, w_j, \cdots, w_n) \otimes \begin{bmatrix} f_1^1 & \cdots & f_1^1 & \cdots & f_1^m \\ \vdots & \cdots & \vdots & \cdots & \vdots \\ f_j^1 & \cdots & f_j^1 & \cdots & f_j^m \\ \vdots & \cdots & \vdots & \cdots & \vdots \\ f_n^1 & \cdots & f_n^1 & \cdots & f_n^m \end{bmatrix}_{n \times m} \end{aligned} \quad (8)$$

Gray category with the maximum clustering coefficient is the category of evaluation target. That is to say, in case of the following equation:

$$\lambda_o = \max_{1 \leq i \leq m} \lambda = \max_{1 \leq i \leq m} (\lambda_i, \cdots, \lambda_i, \cdots, \lambda_m) = \lambda_s \quad (9)$$

the gray category of evaluation target will be s .

3.4.Steps for model execution

In line with the above demonstration, comprehensive evaluation model of physical education based on the grey clustering analysis method can be implemented in accordance with the following steps:

Step 1: Determine comprehensive evaluation indicators for physical education based on selecting principles;

Step 2: Solicit suggestions from experts to effectively classify gray category for comprehensive evaluation of physical education;

Step 3: Acquire the data for comprehensive evaluation of physical education based on the results of survey and statistical analysis;

Step 4: Process various evaluation indexes with the use of data processing model discussed in the paper;

Step 5: Construct whitenization weight function of evaluation target concerning gray category, and establish calculation model for gray clustering coefficient.

Step 6: Calculate the gray clustering coefficient between evaluation target and gray categories, and the gray category of evaluation target is decided by gray clustering coefficient.

4 Case study

It is imperative to carry out effective check on teachers, in order to improve implementation capability of education and enhance teaching level in colleges and universities, ensure teaching quality and stimulate work impetus of teachers. Comprehensive evaluation of teachers and teaching is an important part of performance management in colleges and universities, providing a basis for objective and accurate evaluation of teachers. Take performance evaluation of physical education in a physical education institute as an instance, this paper further explains the presented model. On the basis of expert score and statistical analysis of data, the paper gets comprehensive evaluation data of physical education of an evaluation target through study and information gathering (as shown in Table 2).

Part	Weight	Evaluation index	Weight	Value
Basic professional ability X_1	0.20	Academic level x_{11}	0.20	0.85
		Technical capacity x_{12}	0.20	0.95
		Classroom effect x_{13}	0.30	0.80
		Teaching planning x_{14}	0.30	0.80
Teaching management and control ability X_2	0.30	Teaching means x_{21}	0.15	0.75
		Teaching organization x_{22}	0.15	0.85
		Educational reform ability x_{23}	0.20	0.90
		Teaching management x_{24}	0.20	0.95
		Teaching method x_{25}	0.30	0.80
Manifestation of teaching results X_3	0.20	Scientific research results x_{31}	0.20	0.60
		Teaching research results x_{32}	0.20	0.60
		Qualified rate of talents x_{33}	0.30	0.95
		Social satisfaction x_{34}	0.30	0.85
Ability cultivation of students X_4	0.30	Physical quality x_{41}	0.20	0.85
		Professional knowledge and skills x_{42}	0.30	0.90
		Innovation and development ability x_{43}	0.20	0.80
		Practical and adaptive ability x_{44}	0.20	0.85
		Capacity for independent scientific research x_{45}	0.10	0.60

Table 2 – Comprehensive evaluation data of physical education

Based on gray categories for comprehensive evaluation of physical education, the whitenization weight function is employed to work out the clustering analysis matrixes of indexes between the evaluation target and gray categories.

$$\mathbf{F}_{X_1} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0.500 & 0.500 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.000 \\ 0 & 0 & 0 & 0 & 0 & 1.000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1.000 & 0 \end{bmatrix}$$

$$\mathbf{F}_{X_2} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0.500 & 0.500 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.500 & 0.500 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.000 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.000 \\ 0 & 0 & 0 & 0 & 0 & 1.000 & 0 \end{bmatrix}$$

$$\mathbf{F}_{X_3} = \begin{bmatrix} 0 & 0 & 0 & 1.000 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1.000 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.000 \\ 0 & 0 & 0 & 0 & 0 & 0.500 & 0.500 \end{bmatrix}$$

$$\mathbf{F}_{X_4} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0.500 & 0.500 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1.000 \\ 0 & 0 & 0 & 0 & 0 & 1.000 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.500 & 0.500 \\ 0 & 0 & 0 & 1.000 & 0 & 1.000 & 0 \end{bmatrix}$$

Based on the weight of various indexes in Table 1, calculation model for gray clustering coefficient is used to work out the clustering analysis matrix of part between the evaluation target and gray categories.

$$\mathbf{F}_X = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0.700 & 0.300 \\ 0 & 0 & 0 & 0 & 0.075 & 0.450 & 0.475 \\ 0 & 0 & 0 & 0.100 & 0 & 0.150 & 0.450 \\ 0 & 0 & 0 & 0.400 & 0 & 0.400 & 0.500 \end{bmatrix}$$

In consideration of the weight of different elements, we can infer the clustering coefficient sequence $\lambda=(0,0,0,0.110,0.023,0.425,0.443)$ between the evaluation target and gray categories for comprehensive evaluation of physical education. That is to say,

$\lambda_o = \max_{1 \leq i \leq m} \lambda = 0.443 = \lambda_7$ indicates that the target has obtained excellent result in the performance evaluation.

5. Conclusions

This paper studies the selection of evaluation index and establishment of evaluation system in the process of comprehensive evaluation of physical education. A comprehensive evaluation model of the physical education is established based on the grey clustering analysis method. Effective evaluation for level of physical education is accomplished through the establishment of gray categories, evaluation data processing and whitenization weight function of various indexes. The case study demonstrates that the presented model is effective and feasible, which serves as a new method and means for intelligent evaluation of physical education in colleges and universities, so it is of great value in engineering application.

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The Applied Study of Psychological Tests and Brain-computer Interfaces on Selection of Antarctic Explorers

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Abstract: As a typical representative of the extreme environment, Antarctic is cold, confine, isolated and single stimulated. Few people can adapt well in Antarctic. What kind of features previous explorers have to adapt to the extreme environment? In this study, we took the Chinese explorers from team 21-32 as our objects and analyzed the data of personality traits, personality types and mental health, so that we summed up the 16PF, MBTI, SCL-90, SAS and SDS as selection indices. The conclusions are: The explorers exhibited higher gregariousness, conscientiousness in 16PF; Most of the explorers' personality type is STJ; Most of the people are mental health. The application of automatic processes trainings will improve the accuracy and effectiveness of selection. With the development of VR and BCIs in extreme environment, it will provide instructions of selection indicators for the selection and training of Antarctic teams.

Keywords: Personality type, ICE, Psychological selection, Automatic processes training, Brain-computer interface.

1. Introduction

Antarctica is the coldest and toughest place on the earth where there are special geographical location, harsh and extreme natural environment. The isolated confine environment brings a series of physiological and psychological problems to people who work and live in Antarctica for a long time. The most frequently encountered problems include physical problems, emotional problems, human resource problems and task problems. Specifically, first of all, polar researchers found that Antarctic expedition personnel will appear a series of adverse symptoms, such as sleep problems, anxiety, headache, feeling lonely, depressed, and so on because of the great changes in the living environment. These symptoms are referred to as “winter syndrome” (Yan, 2009). Secondly, the work in the Antarctic is hard, boring and repetitive, which has a higher requirement on the team members' professional skills and psychological quality. Thirdly, it's easily to generate interpersonal conflict because of the lack of privacy in artificial station. In addition, due to the special location and environment, the risk and the cost of rescue are both quite high if accident happens, which bring a huge loss of labor and material resources.

As early as the age of heroes, people have found the importance of mental health in the selection. Some explorers had mental disorders during the expedition, such as visual hallucination, auditory hallucination and etc. Some others suffered from mental illness after returning home. The appearance of mental disease mainly related to the extremely isolated and closed environment of Antarctic. In order to guarantee the expedition, we need to select out those who probably have a history of mental disease, psychiatric symptoms, or other traits that can easily lead to mental disorders.

Personality trait is also an important consideration for selection. Whether the explorers can adapt to the polar life well and quickly is an important indicator while personality trait is a predictor for adaptation and speed. Scientists have found that traits like extraversion and arbitrariness can reversely predict the ability to adaptation and adjustment under the extreme environment (Rosnet, Le Scanff, & Sagal, 2000). Palinkas mentioned in a report that more than half of the team members were considered unqualified for their emotional instability in an Antarctic research station in 1957 (Palinkas, 2003). It will avoid a lot of conflict if we can eliminate inappropriate team members of the station through personality trait selection. Rosnet's study in 2000 showed that people's lower extraversion can predict high mission performance (Rosnet et al., 2000). But Sarris's research in 2006 was just the opposite, and he thought high extraversion was more able to predict the high mission capability (Sarris, 2006).

As a similar extreme environment, there are lots of simulate experiments in space researches. Some researchers simulated the extreme, confine and isolated environment under the condition of weightlessness and measured the mood of the members. By monitoring the physiological indexes, it was found that the galvanic skin response decreased significantly after the simulated weightlessness, and even in the two days after the end of the experiment, it was not recovered to the baseline level. At the same time, the heart rate variability of the subjects significantly decreased after the weightlessness. The frontal EEG asymmetry in the prefrontal lobe of the team members also showed a linear trend after weightlessness (Liu et al., 2014).

With the application of virtual reality in military aerospace and industrial simulation, it has been extended to more extreme environments. Multiuser interaction in virtual reality leads to collaborative virtual environments that promote the development of social skills in teamwork, in particular with members in different geographic locations. (Gasca, Gloria et al, 2015) In the extreme environment, the automation of the processing process can make the habit of reaction rate more rapid. This reaction is unconscious and can reduce energy loss. It can form the process of automatic processing through the task training and can better predict the behavior of the team members in the mission (Xu, et al. 2014). At the same time, it can also save the cognitive resources of team members. So the task performance of the team members will be improved while they allocate more energy to the mission that require more resource.

The selection of psychological tests helps us eliminate the abnormal members and select in the members who may be more adapted to the extreme environment. Brain computer interface technology can select and extract the psychological qualities of the team members from a deeper level based on the response of computer output about the EEG and physiological indexes. And the training of automatic processing of members can help team to establish a better habit, improve task performance, reduce the cognitive loss and ensure the safety.

2. The development of the psychological selection in China

The program of psychological tests and selection for the Antarctic pre-selected team members in China is constantly revised and improved during the period of 2004-2015. In the previous selection, members were relatively scarce, the task was to maintain the normal operation of the over-winter stations and collect conventional scientific data, which was quite simple. At that time, the team members could not have a timely communication with command offices while the Antarctic has not been established a network system. The physical, psychological and social functions of the team members were significantly affected by isolated, confine and extreme environment, and there were obvious 3/4 phenomena, winter-over syndrome and so on. At the same time, the Great Wall Station and the Zhongshan Station were in the construction and expanded period. Therefore, the living facilities, working conditions and the environment on the whole were relatively tough.

With the increasing of the new stations, there will be more people to go to Antarctic. The increasing in personnel also means the opening of the selection approaches. There are more members to participate in the Antarctic winter team through an independent application. The increasing complexity of the members also leads to higher risk of over-winter in Antarctic. Team size and management difficulties, communication cost and accident risk are nonlinear proportional correlation. Secondly, higher requirements of cooperation ability, team awareness and behavior have been put forward with the establishment of the aviation systems. Finally, network in Antarctica makes the work environment change greatly and the living condition is getting better. Therefore, the requirements of team members' special technical will be higher and stricter. Quality management occupies a strategic place in organizations, in addition to use of it tools in information architecture aligned facilitates the challenge of accomplishing more with less by promoting competitiveness and sustainability (Freixo & Rocha, 2014).

These great changes make it more difficult for us to select the Antarctic members. We should strengthen our understanding of the members during the selection process, develop a proper selection project and evaluation method, reduce the risk in Antarctic and ensure the expedition successfully and safely.

This research has carried on a detailed analysis and summary about the psychological test results of the members from team 21-32 in China. The personality types and mental health of the pre-select Antarctic over-winter members were described. It provides the scientific support and guiding principles for the improvement of the existing management support system, the selection project and the training course.

3. Methods

3.1 Environment

They over-winter explorers need to stay in Antarctic for 12-17 months. Most of the team members undertake the task of maintaining normal operation of the whole station while some members assume the scientific research tasks. Now, the construction of network communication of Zhongshan Station and Great Wall Station is more perfect. The members can get in touch with family through satellite phone or network.

The Great Wall Station is located on the west side of the Antarctic, which is at the outer edge of the Antarctic Circle and the south of King George Island (62°12' 59' ' S, 58°57' 52" E). 85% of the island area is covered in ice. Annual average temperature of the island is -2.8°C. Its annual rainfall is 550 mm and the annual average wind speed is 7.2 m / s. Zhongshan Station is located on the east side of the Antarctic inside the Antarctic Circle. It is an ideal area for the Antarctic marine and continental scientific expedition while its geographic coordinates are 69°22' 24" S and 76°22' 24" E with typical Antarctic natural environment characteristics.

3.2. Subjects

According to the data of team 21-32, there is only one woman of the 476 members who have accepted the Antarctic over-winter psychological tests. Their ages are in the range of 22-59 years old and the average age is 38 years old. Statistical analysis of the age of each team found that the overall average age of each team is in the age of 36-39 years old.

3.3. Tools

16PF or 15FQ personality test

The 16PF is a questionnaire compiled by professor Cattell who comes from Illinois State University. The scale describes the personality characteristics of individuals from 16 aspects. It is widely applied in many fields. Not only suitable for individual tests, but also applicable to group testing. We can find out the outstanding personality traits of the Antarctic team members through the personality test.

MBTI

MBTI is a kind of personality assessment tool with forced selection and self-report. It is divided into 4 dimensions: the internal and external direction, the way of information acquisition, the decision method and the behavior way. Like other personality tests, the test results only reflect different action style of people. The content validity, criterion-related validity and construct validity of the Chinese version of the MBIT were good.

SCL-90, SAS, SDS

SCL-90 is also known as Self-reporting Inventory. Derogatis created the SCL-90 scale. The scale consists of nine symptom dimensions: somatic, obsessive-compulsive; sensitivity, depression, anxiety, hostility, anxiety of phobia, paranoia and mental quality. A lot of studies have shown that it has good reliability and validity in Chinese version (Xie Hua, Dai Haiqi, 2006).

Self-Rating Anxiety Scale (SAS) assesses the subjective anxiety of the people by the way of self-assessment. SAS was compiled by Zung in 1971. It is also a self-rating scale which is divided into 4 grades and contains 20 items. Many researches in China shows that SAS is one of the self-assessment tools with high reliability and validity.

Self-Rating Depression Scale, the prototype of SDS is Zung Depression Scale (Zung, 1965). It can reflect the depression degree of the subjects' subjective perception to some extent through the self-assessment method. It is generally believed that SDS is able to accurately reflect the depression degree of the subjects' subjective perception.

This study analyzes the available data by using SPSS 18.0.

4. Results

4.1. 16PF or 15FQ personality test

For the over-winter members, early teams like 21-26 are used the 15FQ personality test which is the British version questionnaire of 16PF. 15FQ is developed and revised in recent years and is one of the widely used personality tests. It follows the core of the 16PF personality test, and combines with the five factors of the big five personality test. It has high reliability and validity in Chinese personality test. After the analysis of all the data, the dimensions and factor scores are listed as follows.

Personality traits	N	Min	Max	Mean	Std. D	M(norm)	Std. D(norm)
<i>Warmth</i>	211	3.00	24.00	15.73	4.49	10.20	3.27
<i>Reasoning</i>	211	2.00	24.00	12.65	4.99	8.65	2.61
<i>Emotional Stability</i>	211	2.00	24.00	16.00	4.31	15.00	3.95
<i>Dominance</i>	211	3.00	23.00	13.09	3.62	12.77	3.6
<i>Liveliness</i>	211	2.00	22.00	12.44	4.35	12.39	4.4
<i>Rule-Consciousness</i>	211	2.00	24.00	17.11	4.08	12.63	3.31
<i>Social Boldness</i>	211	.00	24.00	12.78	5.21	11.07	4.43
<i>Sensitivity</i>	211	4.00	24.00	11.47	3.93	9.65	2.95
<i>Vigilance</i>	211	.00	20.00	8.82	4.29	10.95	3.06
<i>Abstractedness</i>	211	.00	20.00	7.75	4.51	10.89	3.51
<i>Privateness</i>	211	3.00	24.00	13.48	5.17	9.66	2.75
<i>Apprehension</i>	211	.00	23.00	9.59	4.51	8.53	3.64
<i>Openness to Change</i>	211	2.00	25.00	13.41	4.94	11.50	2.91
<i>Self-Reliance</i>	211	.00	21.00	8.02	4.37	12.95	3.34
<i>Perfectionism</i>	211	2.00	24.00	15.81	4.27	12.16	3.58
<i>Tension</i>	211	.00	23.00	6.80	4.48	10.78	4.01

Table 1 – Team 21-26 16PF scores (16PF&15FQ)

As can be seen from the table 1, the standard points of the members in 16 dimensions are above the middle level comparing with the norm level. They are outstanding in emotional stability, dependency, conscientiousness, agreeableness and dependence, which shows that the Antarctic explorers are emotional stability, friendly and apprehensive with strong emotional control ability and strong sense of responsibility and at the same time, the explorers tend to focus on the specific reality, and they are calm and gentle.

The result of analyzing candidates-out and candidates-in with independent t-test shows that there are no differences in the 16 dimensions of the test. Using ANOVA to analyze scores of members who have been there for different times in different dimensions and the result shows that there are no significant differences in the scores of 16PF or 15FQ in each dimension.

4.2.MBTI

MBTI tests are used to classify different types of personality. The statistical results of the behavior style of all participants in the selection of 21-32 teams are shown in Table 2.

Personality types		Frequency	Percentage
Attitudes	Extroversion	241	63.3
	Introversion	140	26.7
Perceiving functions	Intuition	58	15.2
	Sensing	323	84.8
Judging functions	Feeling	133	34.9
	Thinking	248	65.1
Lifestyle preferences	Judging	312	81.9
	Perception	69	18.1

Table 2 – Frequency and percentage distribution of MBTI

The result shows that the extroverted members of the team are significantly more than the introverted members. Most of the team members get information through their sensation while there are a small part of members accessing information through intuition. In terms of decision-making, most of the team members make decisions according to their deliberation while there are a small part of emotional decision makers. The vast majority of members are judgment behavior style and a few members act through their perception.

It can be known through the frequency statistics of each individual dimension that the behavior types of the Antarctic over-winter explorers are generally inclined to extroversion, sensing, thinking and judging (ESTJ). The frequency and proportion of the specific types were known from table 3.

381 Antarctic expedition team members in team 21-32 appear all kinds of behavior styles, in which ESTJ type is most representative with 31.0%. ISTJ accounts for 18.6%. Generally speaking, the psychological functions of the STJ accounts for 49.6% of all members when we put aside the introversion and extroversion of the personality. Nearly half of the members' functions is feeling, thinking and judging. In addition, ESFJ accounts for 15.2%, ISFJ accounts for 7.9%. Therefore except for introversion and extroversion, SFJ becomes the second commonest type in Antarctic which accounts for 23.1%.

type	frequency	proportion	type	frequency	proportion
ENFJ	7	1.8%	INFJ	8	2.1%
ENFP	5	1.3%	INFP	7	1.8%
ENTJ	15	3.9%	INTP	2	.5%
ENTP	9	2.4%	ISFJ	30	7.9%
ESFJ	58	15.2%	ISFP	7	1.8%
ESFP	11	2.9%	ISTJ	71	18.6%
ESTP	18	4.7%	ISTP	10	2.6%
ESTJ	118	31.0%	INTJ	5	1.3

Table 3 – Frequency and proportion distribution of personality types

From the result of independent t-test to candidates-in and candidates-out, it do not show a significant difference in the score except the dimension of introverted and extroverted ($P=0.06$). Every Antarctic expedition team has a different style, which is related closely to the personality and behavior style of each team member.

4.3.SCL-90, SAS, SDS

We made psychological tests on anxiety, depression and mental health for the 21-32 team members and we get the following results:

	N	Min	Max	Mean	Std. D
SAS	468	12.00	63.75	31.32	7.77

(Note: according to the 2003 psychiatric rating scale manual (Zhang Mingyuan, 2003), symptoms appear when the SAS score greater than 50 points)

Table 4 – The scores of SAS

Through the mean of SAS, we find that most of the candidates do not have anxiety symptoms and there are 14 candidates whose SAS score are more than 50 points according to the frequency table.

	N	Min	Max	Mean	Std. D
SDS	471	.13	54.00	34.42	8.62

(Note: according to the 2003 psychiatric rating scale manual (Zhang Mingyuan, 2003), symptoms appear when the SDS score greater than 53 points.)

Table 5 – The scores of SDS

Most of members do not have depressive symptoms. According to the frequency statistics and the maximum we can see that there are 20 members whose score are more than 50 points in SDS.

symptom	N	Min	Max	Mean	Std. D
somatization	474	.00	6.58	.38	.47
obsessive-compulsive	474	.00	5.40	.47	.48
interpersonal sensitivity	474	.00	7.00	.34	.50
depression	474	.00	3.46	.25	.39
anxiety	474	.00	3.60	.27	.37
hostility	474	.00	3.00	.19	.37
Phobic anxiety	474	.00	3.86	.18	.37
Paranoid ideation	474	.00	3.17	.26	.42
psychoticism	473	.00	2.20	.29	.38
additional items	473	.00	6.43	.40	.49
Global wellness index	474	.00	4.48	.31	.39
hardiness	474	.00	90.00	22.13	23.50
Symptom free	466	.30	2.58	1.19	.24

Table 6 – Scores of SCL-90

According to the psychological health evaluation report of the members we can conclude that their mental health condition is good in general. Only some individual values of few members are bigger than 2, there is a certain mental illness. We should pay attention to the mental health.

The t-test shows that the vast majority of candidates in the SAS, SDS and SCL-90 do not show symptoms and their mental health status are good. There are no significant differences in all dimensions for candidates-in and candidates-out.

The ANOVA between members in different posts shows that the SDS and SAS scores are significantly different ($F=5.58$, $p=0.007<0.01$ in SDS and $F=8.22$, $p=0.001<0.01$ in SAS). In the SAS test, the scores are significant difference between logistics and researches with $p=0.014<0.05$. The mean score of researchers is lower than logistics, which means that their mental state is better than logistics in the case of anxiety. Similarly, in the SDS test, the scores are significant difference between logistics and researches with $p=0.006<0.01$. The mean score of researches is lower than logistics.

Discussion

In this paper, we analyzed the selection data of Chinese Antarctic expedition teams in recent 10 years. We have a clearer and more comprehensive understanding to

the problem who can be a member of Antarctic expedition team through testing the different measurements. As the participations are selected and recommended through each unit, and audited by the Chinese Arctic and Antarctic Administration, so they have the homogeneity in all aspects to some extent. The evaluation results of these members have a good representative to the Antarctic selection index.

In the test of personality traits, when comparing the members of 21-26th team with the common norm, we find that the Antarctic members perform more prominent in sociability, conscientiousness, emotional stability, and team interdependence. In our selection process, we should pay more attention to candidates' ability of getting along well with others, conscientiousness, stable mood as well as physical and mental health and work ability.

We classified the participations in behavior styles and personality types according to MBTI. ESTJ is the most typical personality type which accounts for 31% of all members in the team. This shows to some extent that our members tend to be more extroverted. And previous literature also referred that people were more likely to select 'clown' members (Ye, Yan, 2010). It is not to say that an introverted person is not suitable to go to Antarctic, people who are ISTJ type also accounts for 19% and becomes the second largest personality type. There is no significant difference of personality types between explorers who have been there for various times. It indicates personality type has stability.

As mentioned in the previous, the selected candidates for the Antarctic are screened elaborately, so there is no difference in the performance of mental health. Most of the members' scores in the SCL-90, SAS and SDS are in the normal range. There are few members have mental health problem, which may be related to their work and living conditions. In addition, some members appear mild anxiety or depression symptoms, which may be related to their work condition or early experience. There is no obvious change rule after analyzing the data of members who have been there for many times.

Lack of data is an unavoidable problem in the study of extreme environmental problems. It not only requires collaborative effort of the researchers and the subjects, but also depends on the development of extreme environmental psychology. In current study, we mainly use the way of self-rating scale and behavior observation to classify and sketch the psychological characteristics of explorers. In the self-rating scale, there may be some problems like the social desirability or cognitive bias. With the combination of cognitive neuroscience and computer technology, we may use the virtual reality technology like the industrial simulation technology and emergency response technology to simulate the work and life situation in the Antarctic research stations. Through the brain-computer interaction technology, we can collect and decode the members' brain signals with different environments and tasks so that we can select in the well performed members. The analysis of the results of EEG signals under different tasks can also predict members' behavior in the follow-up EEG monitoring and play a role in a timely prevention. At the same time, it can reduce the physical and cognitive loss in the extreme environment through using BCI technology to complete some of the basic tasks.

In addition, we can also select-out and select-in members in the further training system. When faced with some basic tasks, the more skilled they operate, and even finish it unconsciously by automatic processing, the less consumption of their physical and

mentality. Through the training of automatic processing ability in some simple tasks, it can help us to pick out some excellent members. It will ensure the safety of work, reduce the risk of psychological abnormalities and improve work performance.

With the increasingly development of polar studies, researchers in many countries are more concerning about the researches of polar psychology. In consideration of lack of data, perhaps we can cooperate with other countries to design the selection and adaptation project. So that we can have a further exploration to the problems in the Antarctic region and make the cross-cultural study. As well as improve the selection of Antarctic team more systematic and scientific.

Conclusions

1. Chinese Antarctic explorers show higher sociability, conscientiousness, emotional stability and team interdependence on the 16PF than common crowd;
2. Most of the explorers are type STJ in the MBTI in China. Extroverts are more than introverts, but it does not show that the introverted persons are maladapted.
3. In general, Chinese Antarctic explorers are mental health in the SCL-90, SAS and SDS scores. There are few members having psychological symptoms to some degree and mental health will be selected as the psychological selection index.

We should take full advantages of psychological selection and find out what kind of consist of members with different personality types can really promote team operation and management. At the same time, according to the existing science and technology, we may apply the brain-computer interface and virtual reality to the selection of the Antarctic members, strengthen the task training of automatic process and grasp the work of psychological security, so as to provide long-term and sustained psychological support for Antarctic expedition.

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A Performance Analysis Model of the Ideological and Political Education in Colleges and Universities Based on the Extension Classification Method

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Abstract: Aiming at the features of multiple factors, multiple levels, uncertainty and complexity in ideological and political education in colleges and universities, we propose a performance analysis model based on extension classification method. The influence factors of the implementation of ideological and political education in colleges and universities are first analyzed with the establishment of an indicator system. For different types of indicators, the measure is normalized and the weights of each indicator are assigned based on AHP. Thus the extension distance and the correlation function in extension theory are built for the performance analysis of ideological and political education in colleges and universities. According to the features of the performance analysis indicators, the classical domain model and joint domain model or extension classification are built. Finally, the extension goodness evaluation model is obtained for performance analysis. The proposed model is verified through a specific case.

Keywords: extension classification method, performance analysis model, ideological and political education

1. Introduction

As the education for all-around development is deepening in colleges and universities, the ideological and political education for college students becomes one of the major tasks (Ding and Gong, 2011; Song, 2014). Besides the skills, virtues of the talents are another important aspect. Therefore, talent cultivation in colleges and universities should also pay attention to ideological and political education in addition to the teaching of specialized knowledge and basic knowledge (Yu and He 2013; Guo and Wang, 2010). However, there are no uniform standards and quantitative indicators for performance analysis of ideological and political education. The researchers in this aspect tend to adopt diverse standpoints and perspectives and their conclusions on the effect of ideological and political education differ greatly (Qiao, 2007; Yang and Wang, 2010; Yao and Liu, 2010; Zhu, 2010). Considering these limitations, we incorporate extension theory (Wang et al, 2014; Chao, 2014; Abels et al, 2014; Tan and Li, 2011; Chao and Chen, 2011) into the performance analysis of ideological and political education in colleges and universities and the extension distance and extension goodness are obtained. On this basis, we propose a performance analysis model for the ideological and political education in colleges and universities based on extension classification (Luís, 2014).

2. A performance analysis model

2.1 Principles for the selection

Performance analysis of ideological and political education in colleges and universities is a complex task. To ensure the validity, the following principles should be followed when selecting the performance analysis indicators:

Objectivity: The selection of indicators should be performed objectively and the influence of subjective factors should be minimized.

Scientificity: The indicators selected should reflect the current need of education and conform to the principle of scientific development, so that the results of performance analysis will be more reliable.

Comprehensiveness: The indicators selected should pertain to various levels and perspectives of ideological and political education so as to make the performance analysis more comprehensive.

Measurability: The indicators selected should be measurable quantitatively or qualitatively in order to guarantee the operability of the performance analysis.

2.2 Indicator system

Guided by the above principles, we carried out data analysis, survey, statistical process and combined the opinions of scholars and experts. The indicator system for performance analysis of ideological and political education in colleges and universities is established as shown in Table 1.

2.3. Unification of measure of the indicators

The indicators of performance analysis are of various types and dimensionality, which makes the unification of measure necessary. For qualitative indicators, they are measured by fuzzy membership function $f(x)$ with the value range

$$f(x) \in [0, 1] \quad (1)$$

For quantitative indicators, let the value of indicator i be $u_i = [u_i^a, u_i^b]$ so as not to lose generality, $u_i^a \leq u_i^b$; the allowable value range of the indicator is $[u_o^a, u_o^b]$. If it is a positive indicator, the normalized value v_i is

$$v_i = [v_i^a, v_i^b] = \left[\frac{u_i^a - u_o^a}{u_o^b - u_o^a}, \frac{u_i^b - u_o^b}{u_o^b - u_o^a} \right] \quad (2)$$

If it is a negative indicator, the normalized value v_i is

$$v_i = [v_i^a, v_i^b] = \left[\frac{u_o^b - u_i^b}{u_o^b - u_o^a}, \frac{u_o^b - u_i^a}{u_o^b - u_o^a} \right] \quad (3)$$

Target layer	Primary indicator	Secondary indicator
Indicator system for performance analysis of ideological and political education in colleges and universities U	Education input capacity U_1	Reasonability of institutional setting u_{11}
		Sustainability of institutional planning u_{12}
		Software and hardware input capacity u_{13}
		Internal and external environment u_{14}
		Investment in ideological and political education u_{15}
		Managerial capacity u_{16}
	Education implementation capacity U_2	Scientificity of the implementation plan u_{21}
		Innovativeness of the implementation method u_{22}
		Reasonability of the implementation pathway u_{23}
		Systematicity of the implementation process u_{24}
	Education development capacity U_3	Ratio of ideological and political education staff with senior professional title u_{31}
		Constructiveness of discipline base u_{32}
		Cultivation of educational talents u_{33}
		Practical ability in ideological and political education u_{34}
		Theoretical innovation and integration ability u_{35}
		Information processing ability u_{36}
	Competence of the education personnel U_4	Number of top-quality courses u_{41}
		Number of high-level scientific research topics u_{42}
		Number of high-level scientific papers u_{43}
		Awards u_{44}
		Basic competence u_{45}
	Talent cultivation capacity U_5	Comprehensive competence of students u_{51}
		Qualified rate of students u_{52}
		Ratio of party members u_{53}
		Activity implementation ability u_{54}
		Supervisory ability u_{55}
	Education output capacity U_6	Constructiveness of authoritarian culture u_{61}
		Ratio of students enrolled for “three supports and one assistance” u_{62}
		Ratio of students enrolled for “supporting western development program” u_{63}

Table 1 – Indicator system for performance analysis

If it is an intermediate indicator, the normalized value v_i is

$$v_i = [v_i^a, v_i^b] = \left[\frac{(u_o^a + u_o^b) / 2 - u_i^a}{(u_o^b - u_o^a) / 2}, \frac{(u_o^a + u_o^b) / 2 - u_i^b}{(u_o^b - u_o^a) / 2} \right] \quad (4)$$

It can be seen that the normalized values of the indicators lie within the interval of 0-1. Thus the differences between the performance indicators are eliminated.

2.4. Extension classification of performance indicators

The typical classification scale is used for the performance indicators of ideological and political education. The indicators are classified as excellent Lv_1 , good Lv_2 , medium Lv_3 and poor Lv_4 . According to the method in section 2, the classical domain basic element model for each category of indicators is built:

$$R_{Lv_x} = (N_{Lv_x}, C, V_{Lv_x}) = \begin{bmatrix} N_{Lv_x} & c_1 & v_1(Lv_x) \\ & c_2 & v_2(Lv_x) \\ & \vdots & \vdots \\ & c_n & v_n(Lv_x) \end{bmatrix} = \begin{bmatrix} N_{Lv_x} & c_1 & [v_1^a(Lv_x), v_1^b(Lv_x)] \\ & c_2 & [v_2^a(Lv_x), v_2^b(Lv_x)] \\ & \vdots & \vdots \\ & c_n & [v_n^a(Lv_x), v_n^b(Lv_x)] \end{bmatrix} \quad (5)$$

The joint domain basic element model R_{Lv_o} is derived as

$$R_{Lv_o} = (N_{Lv_o}, C, V_{Lv_o}) = \begin{bmatrix} N_{Lv_o} & c_1 & v_1(Lv_o) \\ & c_2 & v_2(Lv_o) \\ & \vdots & \vdots \\ & c_n & v_n(Lv_o) \end{bmatrix} = \begin{bmatrix} N_{Lv_x} & c_1 & [v_1^a(Lv_o), v_1^b(Lv_o)] \\ & c_2 & [v_2^a(Lv_o), v_2^b(Lv_o)] \\ & \vdots & \vdots \\ & c_n & [v_n^a(Lv_o), v_n^b(Lv_o)] \end{bmatrix} \quad (6)$$

where

$$v_k^a(Lv_o) = \min_{1 \leq x \leq 4} v_k^a(Lv_x), 1 \leq k \leq n, \quad v_k^b(Lv_o) = \min_{1 \leq x \leq 4} v_k^b(Lv_x), 1 \leq k \leq n.$$

2.5. Extension distance and extension goodness

The extension distance $\rho(v_i, R_{Lv_x})$ between the indicator i and the x -th classical domain basic element R_{Lv_x} is

$$\rho(v_i, R_{Lv_x}) = \left| v_i - \frac{v_i^a(Lv_x) + v_i^b(Lv_x)}{2} \right| - \frac{v_i^b(Lv_x) - v_i^a(Lv_x)}{2} \quad (7)$$

The extension distance $\rho(v_i, R_{Lv_o})$ between the indicator i and the joint domain basic element R_{Lv_o} is

$$\rho(v_i, R_{Lv_o}) = \left| v_i - \frac{v_i^a(Lv_o) + v_i^b(Lv_o)}{2} \right| - \frac{v_i^b(Lv_o) - v_i^a(Lv_o)}{2} \quad (8)$$

When the value of the indicator i $v_i = [v_i^a, v_i^b]$, the extension distance $\rho(v_i, R_{Lv_x})$ is expressed as

$$\rho(v_i, R_{Lv_x}) = \frac{\rho(v_i^a, R_{Lv_x}) + \rho(v_i^b, R_{Lv_x})}{2} \quad (9)$$

The extension distance $\rho(v_i, R_{Lv_o})$ is

$$\rho(v_i, R_{Lv_o}) = \frac{\rho(v_i^a, R_{Lv_o}) + \rho(v_i^b, R_{Lv_o})}{2} \quad (10)$$

Thus, the extension correlation coefficient $\kappa(v_i, R_{Lv_x})$ between the indicator i and the x -th classical domain basic element R_{Lv_x} is

$$\kappa(v_i, R_{Lv_x}) = \begin{cases} -\rho(v_i, R_{Lv_x}) / |v_i|, & v_i \in [v_i^a(Lv_x), v_i^b(Lv_x)] \vee [v_i^a, v_i^b] \in [v_i^a(Lv_x), v_i^b(Lv_x)] \\ \rho(v_i, R_{Lv_x}) / (\rho(v_i, R_{Lv_o}) - \rho(v_i, R_{Lv_x})), & v_i \notin [v_i^a(Lv_x), v_i^b(Lv_x)] \vee [v_i^a, v_i^b] \notin [v_i^a(Lv_x), v_i^b(Lv_x)] \end{cases} \quad (11)$$

2.6. Determination of weights of performance indicators

The weights are assigned to the indicators by AHP. Pairwise comparison of the elements in terms of importance degree is performed. The indicators are scored by experiments with respect to weight on the scale of 1-9. The judgment matrix A for indicators of the same layer is expressed as

$$A = [a_{ij}]_{n \times n} \quad (12)$$

where a_{ij} is the importance degree of indicator i relative to indicator j and its values are shown in Table 2.

Value	Meaning
1	Indicator i and indicator j are equally important
3	Indicator i is slightly more important than indicator j
5	Indicator i is more important than indicator j
7	Indicator i is much more important than indicator j
9	Indicator i is extremely more important than indicator j
2,4,6,8	Intermediate between any two adjacent values
Reciprocal of the value	For indicator j and indicator i , $a_{ji} = 1/a_{ij}$

Table 2 – Meaning of values of judgment matrix

Thus the absolute weight $w^* i$ of indicator i is a_{ji}

$$w_i^* = \left(\prod_{j=1}^n \left(a_{ij} / \sum_{i=1}^n \frac{1}{a_{ij}} \right) \right)^{\frac{1}{n}} \quad (13)$$

The absolute weight w_i of indicator i is

$$w_i = w_i^* / \sum_{i=1}^n w_i^* \quad (14)$$

The consistency indicator CI is

$$CI = \frac{\left(\left(\sum_{i=1}^n a_{ij} * w_i \right) / (n * w_i) \right) - n}{n - 1} \quad (15)$$

If $CR=CI/RI \leq 0.1$, the weights of the performance indicators are reasonable; otherwise, the judgment matrix A for the performance indicators should be reconstructed.

2.7. Realization of performance analysis model

As shown in Table 1, the indicator system of ideological and political education in colleges and universities has two layers. If the weight of secondary indicator i is $w_2 i$, the weighted extension goodness $\xi_x^1(v_i, R_{Lv_x})$ between the secondary indicator and basic element R_{Lv_x} is expressed as

$$\xi_x^1(v_i, R_{Lv_x}) = \sum_{i=1}^n \left(w_i^2 * \kappa(v_i, R_{Lv_x}) \right) \quad (16)$$

If the weight of the primary indicator j is $w_1 j$, the comprehensive weighted extension goodness $\xi_x(v_j, R_{Lv_x})$ between the primary indicator and the basic element R_{Lv_x} is

$$\xi_x(v_j, R_{Lv_x}) = \sum_{j=1}^m \left(w_j^1 * \xi_x^1(v_i, R_{Lv_x}) \right) \quad (17)$$

According to the principle of selecting the best in multi-attribute decision-making problem, if

$$\xi_s(v_j, R_{Lv_x}) = \max_{1 \leq s \leq 4} \{ \xi_x(v_j, R_{Lv_x}) \}, 1 \leq s \leq 4 \quad (18)$$

then the object of analysis is closest to the performance level s in ideological and political education

3. Case study

The data of interim performance evaluation in a university that implements education for all-around development are used to verify the performance analysis model of ideological and political education. Ideological and political education is an important part of education for all-around development. The performance data are acquired by survey and statistical analysis combined with experts' opinions, and the analysis results are shown in Table 3.

Using the extension distance function and extension correlation function, the extension distance and correlation coefficient with respect to different secondary indicators are obtained for each extension category. The results are shown in Table 4.

Similarly, using the extension goodness model, the extension goodness and comprehensive extension goodness with respect to different primary indicators are obtained for each extension category. The results are $\xi=(-0.1711,-0.0921,-0.1536,-0.4731)$. In accordance with the principle of selecting the best in multi-attribute decision-making problem, the object of analysis is classified as good, which agrees with the actual performance. This proves the validity of the proposed model.

Primary indicator	Weight	Secondary indicator	Weight	Value	Classical domain for each category			
					Lv_1	Lv_2	Lv_3	Lv_4
U_1	0.261	u_{11}	0.214	0.90-0.95	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{12}	0.068	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{13}	0.394	0.70-0.75	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{14}	0.026	0.80-0.85	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{15}	0.148	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{16}	0.150	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
U_2	0.130	u_{21}	0.25	0.70-0.75	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{22}	0.25	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{23}	0.25	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{24}	0.25	0.50-0.60	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
U_3	0.130	u_{31}	0.038	0.80-0.85	0.8-1.0	0.6-0.8	0.4-0.6	0-0.4
		u_{32}	0.370	0.70-0.75	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{33}	0.257	0.80-0.85	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{34}	0.173	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{35}	0.105	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{36}	0.057	0.70-0.75	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
U_4	0.174	u_{41}	0.154	12.5	20-25	15-20	10-15	0-10
		u_{42}	0.078	25	32-40	24-32	16-24	0-16
		u_{43}	0.048	150	160-200	120-160	80-120	0-80
		u_{44}	0.259	10	16-20	12-16	8-12	0-8
		u_{45}	0.461	0.70-0.75	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{46}	0.414	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
U_5	0.217	u_{51}	0.241	0.70-0.75	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{52}	0.135	0.65	0.8-1.0	0.6-0.8	0.4-0.6	0-0.4
		u_{53}	0.135	0.50-0.60	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{54}	0.075	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{55}	0.400	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
U_6	0.087	u_{61}	0.400	0.85-0.90	0.9-1.0	0.8-0.9	0.6-0.8	0-0.6
		u_{62}	0.300	0.85-0.90	0.4-1.0	0.2-0.4	0.05-0.2	0-0.05
		u_{63}	0.300	0.85-0.90	0.6-1.0	0.4-0.6	0.2-0.4	0-0.2

Table 3 – Performance indicator data

Secondary indicator	Weight	Extension category			
		Lv_1	Lv_2	Lv_3	Lv_4
u_{11}	0.214	0.500	-0.250	-0.625	-0.885
u_{12}	0.068	-0.167	0.250	-0.375	-0.688
u_{13}	0.394	-0.389	-0.083	0.225	-0.313
u_{14}	0.026	-0.300	0.250	-0.125	-0.563
u_{15}	0.148	0.500	-0.250	-0.625	-0.885
u_{16}	0.150	-0.167	0.250	-0.375	-0.688
u_{21}	0.25	-0.389	-0.083	0.225	-0.313
u_{22}	0.25	-0.167	0.250	-0.375	-0.688
u_{23}	0.25	0.500	-0.250	-0.625	-0.885
u_{24}	0.25	-0.438	-0.357	-0.100	0.083
u_{31}	0.038	-0.300	0.250	-0.125	-0.563
u_{32}	0.370	-0.389	-0.083	0.225	-0.313
u_{33}	0.257	-0.300	0.250	-0.125	-0.563
u_{34}	0.173	-0.167	0.250	-0.375	-0.688
u_{35}	0.105	0.500	-0.250	-0.625	-0.885
u_{36}	0.057	-0.389	-0.083	0.225	-0.313
u_{41}	0.154	-0.375	-0.167	0.500	-0.167
u_{42}	0.078	-0.318	0.125	-0.063	-0.375
u_{43}	0.048	-0.167	0.250	-0.375	-0.583
u_{44}	0.259	-0.375	-0.167	0.500	-0.167
u_{45}	0.461	-0.389	-0.083	0.225	-0.313

Table 4 – Extension correlation coefficient of secondary indicators

4. Conclusion

We propose a performance analysis model for ideological and political education in colleges and universities based on extension classification method. The first step is to build the indicator system along with the classification of extension category for different indicators. Then the extension distance function and extension correlation function are built, and the extension goodness model is obtained. On this basis, the category of the object of analysis is determined.

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Research on Cross Border E-commerce Logistics Service Based on Improved AHP algorithm

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Abstract: With the economic development and the technological progress, the electronic commerce is melting into people's lives rapidly and pulls the rising of the logistics industry. The scale of the foreign trade in China continues to be expanded. It brings the good opportunity for the development of the cross-border e-commerce enterprises. The cross border e-commerce not only reduces the transaction costs of enterprises, but also optimizes the price advantage in the international competition. The logistics is a very important part in the electronic commerce. The logistics service quality directly determines the operation efficiency of the enterprise. In this paper, we study the quality evaluation of the e-commerce logistics service for the cross-border enterprises. Then, we propose the improved AHP algorithm to evaluate and study the service of the cross-border e-commerce logistics. The experiment results show that the method has achieved the good effect.

Keywords: improved AHP algorithm, E-commerce logistics, numerical test

1. Introduction

The rising and the development of the cross-border e-commerce was the product of the financial crisis and the popularity of the Internet technology. With the continuous expansion scale of the foreign trade in China, the cross-border e-commerce developed rapidly. At the same time, the factors of the appreciation of the RMB, the rising labor costs and the serious situation for the foreign trade also promoted the development of the economic commerce. However, the cross-border e-commerce was facing many questions. The most outstanding question was the cross-border e-commerce logistics service (Gomez-Herrera et al., 2014).

The logistics service was always the important question in the electronic commerce. Because the longer distance and the higher logistics cost of the cross-border e-commerce, the cross-border e-commerce logistics had been concerned widely by many scholars (Grubert, 2003). Therefore, evaluating the logistics service of the cross-border e-commerce can help the enterprises to find their own problems and enhance the international competitiveness (Gessner and Snodgrass, 2015).

With the continuous process of the science, there were many evaluation methods (Lai et al., 2015). For example, we use the AHP method (Dong and Cooper, 2016; Hu and Yi,

2016), ANP method (Gölcük and Baykasoğlu, 2016), TOPSIS method (Chiu and Hsieh, 2016) and DEA method (Song and Wang, 2014) etc. however, these methods had some defects. Therefore, many scholars combined the traditional methods with other methods and proposed the improved evaluation methods. For example, there were Fuzzy-AHP, AHP-Entory, Grey-AHP and AHP-TOPSIS etc.

In this paper, we establish the evaluation system of the cross-border e-commerce logistics service. Then, this paper also proposes the improved AHP method to evaluate the logistics service of the economic commerce. In the final simulation results, the simulation results of the improved method have more error. It shows that the evaluation index that we establish has the rationality and the effect is ideal.

2. Evaluation index of the cross border e-commerce logistics service

Establishing the evaluation index of the cross border e-commerce logistics service has some principles. These principles are the scientific principle, legality principle, integrity principle, operability principle, quantitative principle and qualitative principle.

Based on the above principle, we establish the evaluation index of the cross border e-commerce logistics service. The indexes are as follows.

First order index	Second level index	Third level index
The evaluation index of the cross border e-commerce logistics service	Logistics capability of cross border e-commerce	Cross border e-commerce logistics model
		Cross border e-commerce logistics strategy
		Cross border e-commerce logistics function planning
		Cross border e-commerce logistics technology
		Cross border e-commerce shop coverage rate
		Customs clearance ability
		Overseas storage capacity
	Service quality of cross border e-commerce logistics	Online communication ability
		Order processing time
		Order tracking
		The cross-border insurance service provider
		The cross-border e-commerce customer service ability
	Transaction security of cross border e-commerce	The cross-border e-commerce platform registration information
		The cross-border e-commerce platform authentication information
		The cross-border e-commerce user privacy protection
		The payment of cross-border E-commerce
		The cross-border payment service provider
		Technical support for cross-border payments
	Other factors	Legal factors
		Regulatory factors
		Policy factors

Table 1 – The evaluation index of the cross border e-commerce logistics service

3. AHP method

AHP method is a simple, flexible and practical multi criteria decision making method which aiming at the qualitative question for the quantitative analysis. Since 1982, this method was introduced into our country. Then, it has applied in some fields widely. These fields are the energy system analysis, the urban planning, the economic management and scientific research evaluation etc.

The steps of AHP method are as follows.

1. Structuring the analytic hierarchy structure

According to the relationship among the various factors, we divide all the factors into different levels and determine the relation among them. Each superior level has a dominant effect on the lower level. At the same time, the lower level is the refinement for the superior level. The general level can be divided into three categories. They are the target layer, the middle layer and the lowest layer. The target layer usually has only one element. In general, it is the intended target of the analysis problem. The middle layer is the intermediate link for achieving the goals. It may include several levels. The lowest level is the program or decision-making rules. It is also the most direct evaluation factors.

2. Structuring the judgment matrix

$$A = \{a_{ij}\} \quad (1)$$

3. Standardizing judgment matrix

$$a_{ij} = a_{ij} / \sum_{k=1}^n a_{kj} \quad (i=1,2,\dots,n) \quad (2)$$

4. Calculating the sum of each row for the matrix

$$\omega_i = \sum_{j=1}^n a_{ij} \quad (i=1,2,\dots,n) \quad (3)$$

5. Standardizing the sum of each row for the matrix

$$\omega_i = \omega_i / \sum_{i=1}^n \omega_i \quad (i=1,2,\dots,n) \quad (4)$$

6. Calculating the largest eigenvalue of the judgment matrix

$$A\omega = \lambda_{\max}\omega \quad (5)$$

7. Random consistency test of the judgment matrix

The consistency index of the judgment matrix is,

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (6)$$

Where, $\lambda_{\max}$ is the largest eigenvalue of the judgment matrix.

Consistency ratio is as follows.

$$CR = \frac{CI}{RI} \tag{7}$$

When $CR < 0.1$, we think that the consistency of the matrix is acceptable.

The value of the RI is as follows.

Matrix order	1	2	3	4	5	6	7	8	9	10	11
<i>RI</i>	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52

Table 2 – Average random consistency test

4. The improved AHP method

The shortcoming of the AHP method is that the evaluation results are influenced by the subjective factors and the objectivity is poor. At the same time, the operation repeatability of the evaluation is larger. In addition, AHP evaluation method has no accumulation for the work experience. The historical data is difficult to have a positive impact on the subsequent assessment. Therefore, in order to improve the characteristics of the AHP method, we combined the BP neural network model with the AHP method and propose an improved AHP method. The BP network model is composed of the input layer, hidden layer, the output layer and the link connection weight of each layer. The results are shown as follows.

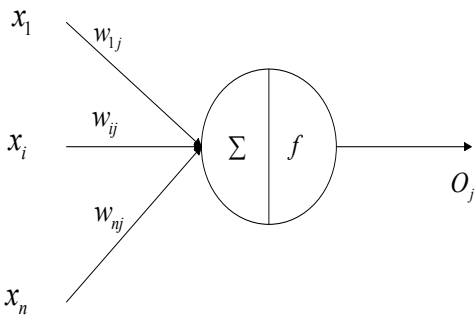


Figure 1 – Neuron model

During the iterative process, the BP neural network algorithm is easy to fall into the local minimum and the convergence rate is slow. Therefore, based on the back propagation

method, we produce the new weight change. The specific method is that we add the previous weight adjustment amount into the current weight adjustment amount. And we take it as the actual weight adjustment amount.

$$\Delta w_{ij}(n) = \alpha w_{ij}(n+1) + (1-\alpha)\eta \nabla f(w_{ij}(n-1)) \quad (8)$$

Where, η is the learning rate. n is the training times. $\nabla f(w_{ij}(n-1))$ is the gradient of the error function.

After we adopt the additional momentum method, the adjustment of weight value trend to the average direction of the error surface bottom. When the network weights are into the flat area, it can avoid the occurrence of $\Delta w=0$. It also help it to jump the local minimum of the error surface.

The basic idea of the adaptive learning rate method is that the learning rate can adjusted adaptively according to the chance of the error. During the training process, we adopt the following function of the learning rate adaptive adjustment mechanism. It can increase the stability and improve the convergence speed.

$$\eta(n) = \begin{cases} 1.1\eta(n-1), & (E(n) < E(n-1)) \\ 0.8\eta(n-1), & (E(n) > 1.05E(n-1)) \\ \eta(n-1), & \text{otherwise} \end{cases} \quad (9)$$

Where, $E(n)$ is the error of the n step.

Then, we establish the improved AHP model. The steps are as follows.

1. We establish the evaluation index.
2. We evaluate the sample data.
3. Standardized data
4. We take the standardized data as the input value of the BP neural network. The evaluation data that obtained by the AHP method is as the target data.
5. Determining the number of the nodes for the input layer, output layer and the hidden layer. Then, we initialize the weight and the thresholds of the neural network nodes.
6. We input the sample data. Then we calculate the errors of the output for each node.
7. Back propagation. According to the size of the set of the momentum coefficient, we modify the weight.
8. Calculating the error. When the error is smaller than the given target error, the neural network training ends. Otherwise, we go back to the step 6.
9. We obtain the training results of the part sample test.

5. Numerical test

We apply the improved AHP method to study the logistics service evaluation for one t cross-border electronic commerce. We take the haven sample data as the initial data. Among them, the first 25 data is as the training data and the last data is as the testing data. We score the logistics service level of the cross-border e-commerce enterprise. Among them, [80, 100] is excellent. [60, 80] is the good. [40, 60] is normal. [10, 40] is poor. [0, 20] is very poor. Firstly, we calculate the weight of each index and the results are shown as follows.

After that, according to the data that obtain by the AHP method, we make the BP neural network training. We set the error precision as e^{-10} . The maximum iterations number is 3000. The step is 0.02. The momentum coefficient is 0.2. The simulation results are shown as follows.

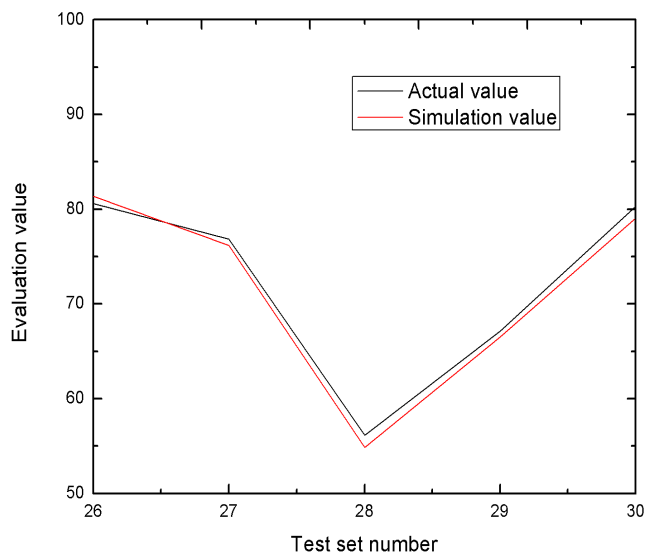


Figure 2 – Simulation result

According to the above figure, we can see the evaluation results intuitively. The simulation curve is similar to the actual curve. It shows that the simulation results are ideal.

The specific data are shown in the following table.

Second level index	Weight	Third level index	Weight
Logistics capability of cross border e-commerce	0.34	Cross border e-commerce logistics model	0.17
		Cross border e-commerce logistics strategy	0.17
		Cross border e-commerce logistics function planning	0.17
		Cross border e-commerce logistics technology	0.15
		Cross border e-commerce shop coverage rate	0.13
		Customs clearance ability	0.105
		Overseas storage capacity	0.105
Service quality of cross border e-commerce logistics	0.31	Online communication ability	0.25
		Order processing time	0.21
		Order tracking	0.11
		The cross-border insurance service provider	0.14
		The cross-border e-commerce customer service ability	0.29
Transaction security of cross border e-commerce	0.28	The cross-border e-commerce platform registration information	0.12
		The cross-border e-commerce platform authentication information	0.12
		The cross-border e-commerce user privacy protection	0.27
		The payment of cross-border E-commerce	0.20
		The cross-border payment service provider	0.13
		Technical support for cross-border payments	0.16
Other factors	0.07	Legal factors	0.33
		Regulatory factors	0.33
		Policy factors	0.33

Table 3 – Index weigh

Indicators	26	27	28	29	30
Simulation value	81.38	76.21	54.87	66.50	79.05
Actual value	80.60	76.82	56.13	67.15	80.31
error	0.96%	0.80%	2.30%	0.98%	1.59%

Table 4 – Simulation result

From the above table, the maximum relative error of the improved AHP simulation algorithm is 2.30%. It is lower than the general accuracy 5%. It shows that the evaluation of the improved AHP algorithm is good.

6. Conclusion

The normal cloud model is introduced to the distributed data aggregating system to perform data analysis. Inspired by the idea that the quantitative-to-qualitative conversion can be done using the cloud model, the shape of the cloud picture is used to determine the right computing node that should be fed with the data.

At present, all over the world attach the great attention to the electronic commerce of international trade. The cross-border e-commerce is as an important branch of e-commerce. It has become the important means for developing the international trade of the enterprises in our country. In addition, it has become the driving force of adjusting the structure for our country' foreign trade. The cross-border e-commerce reduces the cost of the enterprises and enhances the enterprise's price advantage. At the same time, the cross border e-commerce also enhances the international competitiveness of Chinese enterprises. During the development of the e-commerce, the logistics service has been an important part of e-commerce service and even affects the development of the whole enterprise. In this paper, firstly, we establish the evaluation system of the cross-border e-commerce logistics service. After that, we propose the improved AHP method to evaluate the cross-border e-commerce logistics service. The main work of this paper is as follows. Firstly, this paper establishes the evaluation system of the cross-border e-commerce logistics service. Secondly, this paper introduces simply the AHP method. Thirdly, this paper proposes the improved AHP method. Then it uses the method to evaluate the cross-border e-commerce logistics service. The higher precision of the simulation results show that the method has good operability.

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Research on the Multi-dimension Ideological and Political Education of College Students Based on Computer Platform

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Abstract: Ideological and political education of college students is a systematic project featuring complexity and multiple dimensions, the development of which is controlled by various factors. Computer technology and platform provide great support for college ideological and political education. In this paper, we carry out research on the multi-dimension college ideological and political education based on computer platform. We analyze the supportive computer platform of college ideological and political education from such dimensions as content, platform, method, reform, tool and management of teaching. Correspondingly, solving strategies and implementation ways are discussed. Meanwhile, to measure implementation effects of ideological and political education in various colleges, we present an evaluation index system for the multi-dimension ideological and political education of college students and establish an evaluation model based on entropy weight method. Finally, the presented model and methods are illustrated through case analysis.

Keywords: computer platform, multi-dimension analysis, evaluation model

1. Introduction

As an essential part of higher education, college ideological and political education is not only concerned with college students' moral education, political awareness and cultural and ideological progress, but of great significance to promote scientific development concept, core socialist values and comprehensive quality of college students (Liu, 2013; Li, 2011; Zhao, 2015). To effectively develop college ideological and political education, a series of multi-perspective and multi-level studies have been carried out in academia, providing some constructive suggestions, strategies and implementation ways and methods (Kan, 2014; Wang, 2009; Wu and Wu, 2012), which are positive to enhance the level and development of college ideological and political education. However, with the rapid development of computer and network technology, a variety of

explosive information highlights major limitations of traditional ideological and political education pattern, so how to effectively and efficiently research college ideological and political education is becoming a popular research topic (Liu, 2015; Liu, 2015; Zheng and Zheng, 2016). We should not only make the best of technical support offered by computer platform, but take into full account the comprehensive influences of the development of modern society on college ideological and political education in order to analyze its overall development situation. To this end, there is a need to research the feasibility and implementation strategy of college ideological and political education based on computer platform from a multi-dimension perspective (Zou, 2016).

2. Multi-dimension analysis

College ideological and political education based on computer platform mainly includes such analysis dimensions as teaching content, teaching method, teaching platform, teaching reform, teaching management and teaching tool.

2.1. Dimensional analysis of teaching content

Ideological and political education contains a wide range of content, including ideology and morality, politics, cultural and ideological progress, historical knowledge, patriotism, socialism, national defense and national unity. Without targeted planning and organization of such content, teaching effect would not be obvious. Because of this, ideological and political education should focus on constructing excellent, model, basic and experimental courses as well as Massive Open Online Courses (MOOCs) based on computer platform. Efficient reorganization, classification and integration can present, show and impart the extensive teaching content in a scientific manner, hence realizing effective deepening and absorption.

2.2. Dimensional analysis of teaching method

The rapid development of computer technology renders diverse implementation methods of ideological and political education, without merely relying on traditional classroom or blackboard teaching. The traditional teaching methods often fail to provide or demonstrate a larger amount of teaching information and to intuitively and vividly present teaching content from various perspectives. As a result, there exist some limitations of teaching effect and quality. For this reason, information push mechanism can be used to demonstrate and impart teaching content and information with the help of computer platform and network technology, for instance, teach online through MOOCs, launch star teachers, case analysis and other topic course columns using network platform and comprehensively show text, sound, images and video through computer and multi-media technology, in order to enhance teaching effect and quality.

2.3. Dimensional analysis of teaching platform

Based on analyzing the current situation of computer platform development for college ideological and political education, we believe that teaching platform can be developed in the following forms: (1) Interactive teaching platform. Teacher and students can have face-to-face interactions and real time communications. (2) Online teaching platform.

Teaching and learning content can be presented and imparted online. (3) Open teaching platform. Students can obtain educational resources without limitations. (4) Semi-open teaching platform. Assign the role of teachers or students and use the role to limit access to educational resources.

2.4. Dimensional analysis of teaching reform

Teaching reform of college ideological and political education is controlled by various factors, including soft power like faculty, teacher and management quality, hard power like education facilities, teaching base and platform, as well as teaching and scientific research factors. To use computer platform, there is a need to strengthen soft and hard power. That is to say, how should we effectively improve teacher quality, and how should we provide targeted support for ideological and political platform by improving college network (including campus and wireless network) and platforms of teaching and scientific research.

2.5. Dimensional analysis of teaching management

Teaching management dimension is mainly about how to use computer platform to effectively support and analyze various working procedures in ideological and political education. There is a need to set up management platform in such aspects as teaching, training, performance, scientific research and college instructor to realize effective, practical, convenient and simple management, hence providing greater support for promoting college ideological and political education.

2.6. Dimensional analysis of teaching tool

There are various forms of teaching tools for college ideological and political education based on computer platform, especially some intelligent software and platforms have contributed to intelligent and networked teaching tools. With regard to intelligence, corresponding software system can be developed to meet the demand of college ideological and political education, in particular well-developed computer software and hardware devices at this stage can be employed. In terms of network, technological means and platforms such as webpage (website), e-mail, WeChat, QQ, Micro Blog and BBS can be used to support college ideological and political education, so as to more effectively promote the teaching and learning.

3. Evaluation model based on entropy method

3.1. Evaluation index set

Evaluation of college ideological and political education can be performed comprehensively through questionnaires, statistical analysis and pert interviews. Evaluation subject can be a multi-subject model comprising teachers, students, managers and social experts and scholars. The selection of evaluation indexes requires adequate consideration of the above-mentioned multi-dimension analysis to reflect the reality of ideological and political education. To this end, this paper selects such indexes as knowledge enrichment r_1 , ability enhancement r_2 , teaching and learning integration r_3 , awareness raising r_4 , combination of theory with practice r_5 , result presentation r_6 and platform development ability r_7 , and the evaluation index set R of ideological and political education can be expressed as:

$$\mathbf{R} = \{r_1, r_2, r_3, r_4, r_5, r_6, r_7\} \quad (1)$$

3.2. Evaluation data processing

K experts are invited to judge the evaluation indexes of evaluation object in accordance with certain evaluation rules, and the data matrix of initial indexes can be derived

$$\mathbf{A} = \begin{bmatrix} a_{11} & \vdots & a_{1j} & \vdots & a_{1n} \\ \dots & \dots & \dots & \dots & \dots \\ a_{k1} & \vdots & a_{kj} & \vdots & a_{kn} \\ \dots & \dots & \dots & \dots & \dots \\ a_{K1} & \vdots & a_{Kj} & \vdots & a_{Kn} \end{bmatrix} \quad (2)$$

Then evaluation data sequence under index set R of K experts concerning the evaluation object can be written as

$$\begin{aligned} \widetilde{\mathbf{U}} &= \{u_1, \dots, u_j, \dots, u_n\} \\ &= \frac{1}{K} \left\{ \sum_{i=1}^K a_{i1}, \dots, \sum_{i=1}^K a_{ij}, \dots, \sum_{i=1}^K a_{in} \right\} \end{aligned} \quad (3)$$

If there are m evaluation objects, then data matrix of evaluation index set for evaluation objects based on K experts can be represented as

$$\mathbf{U} = \begin{bmatrix} u_{11} & \vdots & u_{1j} & \vdots & u_{1n} \\ \dots & \dots & \dots & \dots & \dots \\ u_{i1} & \vdots & u_{ij} & \vdots & u_{in} \\ \dots & \dots & \dots & \dots & \dots \\ u_{m1} & \vdots & u_{mj} & \vdots & u_{mn} \end{bmatrix} \quad (4)$$

To normalize dimensions of evaluation data, there is a need for normalization. If evaluation index j is featured by the larger the better, then normalization value can be calculated as

$$v_{ij} = \frac{u_{ij} - \min_{1 \leq i \leq m} (u_{ij})}{\max_{1 \leq i \leq m} (u_{ij}) - \min_{1 \leq i \leq m} (u_{ij})} \quad (5)$$

If evaluation index j is featured by the smaller the better, then normalization value can be calculated as

$$v_{ij} = \frac{\max_{1 \leq i \leq m} (u_{ij}) - u_{ij}}{\max_{1 \leq i \leq m} (u_{ij}) - \min_{1 \leq i \leq m} (u_{ij})} \quad (6)$$

In this way, normalization data matrix can be derived

$$\mathbf{V} = \begin{bmatrix} v_{11} & \vdots & v_{1j} & \vdots & v_{1n} \\ \dots & \dots & \dots & \dots & \dots \\ v_{i1} & \vdots & v_{ij} & \vdots & v_{in} \\ \dots & \dots & \dots & \dots & \dots \\ v_{m1} & \vdots & v_{mj} & \vdots & v_{mn} \end{bmatrix} \quad (7)$$

3.3 Evaluation model implementation

In this paper, entropy weight method (Alexi, 2016; Yao, 2015; Amit, 2015; Zhao, 2012) is used to establish evaluation model of college ideological and political education. Because the contributions of evaluation indexes to evaluation results are different, there is a need to consider weight of each index. Suppose v_{ij} is evaluation data of evaluation object i concerning index j upon normalization, then characteristic weight processing is performed for evaluation data v_{ij} , namely

$$b_{ij} = v_{ij} / \sum_{i=1}^m v_{ij} \quad (8)$$

It can be seen that $0 \leq b_{ij} \leq 1$.

Information entropy of evaluation index j can be calculated as

$$e_j = -\frac{1}{\ln(m)} \sum_{i=1}^m b_{ij} * \ln(b_{ij}) \quad (9)$$

In this way, entropy weight of evaluation index j can be formulated as

$$w_j = \frac{1 - e_j}{n - \sum_{j=1}^n e_j} \quad (10)$$

Then evaluation value of evaluation object i concerning evaluation index set can be calculated as

$$\lambda_i = \sum_{j=1}^n (w_j * b_{ij}) \quad (11)$$

A larger λ_i means a better result of object i in terms of college ideological and political education.

4. Case analysis

To continuously improve the level of college ideological and political education, there is a need to carry out a periodical evaluation of colleges. In this paper, the presented index system is used to evaluate the implementation of ideological and political education based on computer platforms in five colleges. Data of evaluation index set is obtained through expert advice and data statistics, as shown in Table 1.

Evaluation objects	r_1	r_2	r_3	r_4	r_5	r_6	r_7
A	100	100	100	90	85	80	100
B	90	100	80	100	90	80	80
C	100	100	90	80	80	100	90
D	100	90	100	85	100	80	90
E	85	100	85	100	90	90	80

Table 1 – Initial data of evaluation indexes

Table 2: Shows the results upon data normalization.

Evaluation objects	r_1	r_2	r_3	r_4	r_5	r_6	r_7
A	1.000	1.000	1.000	0.500	0.250	0	1.000
B	0.333	1.000	0	1.000	0.500	0	0
C	1.000	1.000	0.500	0	0	1.000	0.500
D	1.000	0	1.000	0.250	1.000	0	0.500
E	0	1.000	0.250	1.000	0.500	0.500	0

Table 2 – Data normalization

Table 3: Shows the results upon characteristic weight processing.

Evaluation objects	r_1	r_2	r_3	r_4	r_5	r_6	r_7
A	0.300	0.250	0.364	0.182	0.111	0	0.500
B	0.100	0.250	0	0.364	0.222	0	0
C	0.300	0.250	0.182	0	0	0.667	0.250
D	0.300	0	0.364	0.091	0.444	0	0.250
E	0	0.250	0.091	0.364	0.222	0.333	0

Table 3 – Characteristic weight processing

Information entropy of evaluation indexes is calculated and the sequence can be written as $e=\{0.816,0.861,0.785,0.785,0.791,0.395,0.646\}$. Entropy weight of evaluation indexes is calculated and the sequence can be expressed as $w=\{0.096,0.072,0.112,0.112,0.109,0.315,0.184\}$. The sequence of overall evaluation value of evaluation objects can be represented as $\lambda=\{0.212,0.093,0.323,0.174,0.198\}$. As can be seen evaluation object C has the premium result which is consistent with the periodical college evaluation result.

5. Conclusions

This paper analyzes college ideological and political education based on computer platform from multiple dimensions including content, method, platform, reform, management and tool of teaching. Then, we conduct research on evaluation of multi-dimension college ideological and political education based on computer platform. Evaluation index set is presented and an evaluation model of multi-dimension college ideological and political education method is established based on entropy weight. Finally, the presented model and methods are illustrated and verified through case analysis. The research is of vital significance for college ideological and political education based on computer platform. But there is a need to consider the actual situation of computer technology and ideological and political education in technologies of computer platform development.

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Research on the influencing factors of the college music teaching satisfaction

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Abstract: The music is a kind of an art. The music can not only edify the sentiment, but also can improve the students' quality education. Carrying out the college music course can not only enrich the student's cultural issues, but also enrich the students' emotional world. In this paper, we investigate and study the influencing factors of the college music teaching satisfaction. After establishing the hypothesis, we study the hypothesis according to the results of the investigation and analysis. Then, we judgment whether these assumptions establish or not. Through this research, we can understand the factors that affect the satisfaction degree of the college music teaching. According to the research results, the university can improve the teaching satisfaction of the music teaching.

Keywords: influencing factors, college music teaching satisfaction

1. Introduction

As an elegant art, the music is gradually into the campus. At the same time, the music has the certain popularity. People can often contact with the music (Ebru et al., 2016). The music provides the elegant art for the public. It also influences people's real life according to their own charm (Kantono et al., 2016). The music course cultivates people's sentiments, riches people's emotions and influences the character of people. The college students have their own understanding for the music. Although many colleges and universities have opened music courses, it has not obtained the good results. The class mode is different between the music courses and the professional courses. Therefore, the class modes of many specialized courses are not universal in music class. In order to improve the quality of teaching and study the college music teaching, it is very necessary to study the influence factors of the satisfaction (Zou, 2016).

We adopt the relevant knowledge of the statistics and analysis to study the influencing factors of the college music teaching satisfaction. Generally speaking, there are the positive distribution test (Namhyun, 2016), the parameter estimation (Nguyen, 2016), the T test, F test, the regression analysis (Venkatesan et al., 2015), the cluster analysis (Naiara et al., 2015) etc. Among these methods of statistics and analysis, we need to select the appropriate methods to study and analyze the problems of this paper.

In this paper, firstly, we put forward the research hypothesis. Then, we make the descriptive analysis of the investigation object. We verify the research hypothesis that we propose according to the sample reliability analysis, the validity analysis, the regression analysis and T test etc. the structure of this paper is as follows. The first part is the introduction. This paper introduces the related research background. The second part is the data analysis. In this part, we put forward the hypothesis and analyze the survey object. In addition, we make the reliability analysis, the validity analysis, the regression analysis and T test in order to verify our hypothesis. The third part is the conclusion.

2. Research hypothesis

H_1 : The music perception values that the students get from the different research atmosphere influence the teaching satisfaction of music teaching in Colleges.

The classroom atmosphere will influence the students willing to spend enough energy to participate in the classroom. When the classroom atmosphere is good, the students are more willing to participate in the music study actively and cooperate with the teacher's teaching. The better the classroom atmosphere is, the more willing to study the students are and the more willing to teach the teachers are.

Therefore, this paper proposes the hypothesis H_1 : the music perception values that the students get from the different research atmosphere influence the teaching satisfaction of music teaching in Colleges.

H_2 : The music perception values that the students get from the different teachers' strength influence the teaching satisfaction of music teaching in Colleges.

The excellent music teachers have the rich teaching experience. They can catch more sensitively the change of the students' psychology. At the same time, the excellent music teaching facilities can bring students more different experience and promote the teaching practice more effective. The school teacher strength is a manifestation for the school strength.

Therefore, this paper proposes the hypothesis H_2 : the music perception values that the students get from the different teachers' strength influence the teaching satisfaction of music teaching in Colleges.

H_3 : The music perception values that the students get from the different learning expectation influence the teaching satisfaction of music teaching in colleges.

In general, the optimal expectation of the students for the music classroom teaching quality will directly influence the enthusiasm that the students participate in the questions, research and scenario simulation in the classroom teaching. The love for the professional, the preference for the curriculum, the reliance on the teachers and the identification for the teaching environment and teaching mode will encourage the students to listen attentively, think actively and cooperate earnestly. The higher the students expect are, the more able to communicate with the music teachers to communicate the students are. Then, it is helpful to improve the quality of the music teaching.

Therefore, this paper proposes the hypothesis H_3 : The music perception values that the students get from the different learning expectation influence the teaching satisfaction of music teaching in colleges.

H_4 : The music perception values that the students get from the different classroom teaching quality influence the teaching satisfaction of music teaching in colleges.

The quality of the music teaching is the key factor to improve the students' performance. The main place where the students learn knowledge is in the classroom. Therefore, the level of the classroom teaching quality will influence directly the absorption degree of the knowledge for the students. One class only has a few minutes. The higher level music classroom teaching quality can enable the students to absorb a lot of knowledge in the few minutes.

Therefore, this paper puts forward the hypothesis H_4 : the music perception values that the students get from the different classroom teaching quality influence the teaching satisfaction of music teaching in colleges.

H_5 : The music perception values that the students get from the different forms of practice teaching influence the teaching satisfaction of music teaching in colleges.

If the students have the higher expectation for the diversity of the practice teaching, the funds guarantee and the benefit, they will have more interested in the practice of the teaching activities. According to actively participate in the practice of teaching activities, the students exercise a comprehensive ability, enhance the overall quality and achieve the more ideal enhance the overall quality. The higher expectations the students have the more abundant practice teaching experience and harvest the students obtain.

Therefore, this paper puts forward the hypothesis H_5 : the music perception values that the students get from the different forms of practice teaching influence the teaching satisfaction of music teaching in colleges.

3. Data analysis

3.1. Descriptive analysis of the investigation object

In order to study the validity of the above hypothesis, we need to analyze these assumptions. Firstly, we make a descriptive analysis for the survey objects. The survey objects are the music students. In order to study better the influence factors of the music class teaching satisfaction, we let these students count according to their own situation. The basic situation is shown in the following table.

3.2. Sample reliability analysis

In order to analyze whether the comprehensive evaluation system is stable and reliable, we analyze the reliability of the system. We adopt Cronbach α coefficient to analyze. In general, if the Cronbach α coefficient is more than 0.7, it shows that the scale is reliable. If the Cronbach α coefficient is more than 0.8, it shows that the scale has good reliability. If the Cronbach α coefficient is more than 0.9, it shows that the scale has excellent reliability (Pinto et al., 2014). The calculation formula of Cronbach coefficient is as follows.

$$\alpha = \frac{K}{K-1} \left(1 - \frac{\sum_{i=1}^K \sigma_{\gamma_i}^2}{\sigma_x^2} \right) \quad (1)$$

Where, K is the sample data. σ_x^2 is the variance of the total sample. $\sigma_{\gamma_i}^2$ is the variance of the observed sample. The sample reliability test table is shown in the following table.

Variable	Classification	Number	Proportion	Cumulative percent
Gender	Male	94	47.24%	47.24%
	Female	105	52.7%	100%
age	Less than 18	21	10.55%	10.55%
	18-23	92	46.23%	56.78%
	24-27	63	31.66%	88.44%
	27-31	14	7.04%	95.48%
	More than 31	9	4.52%	100%
Education	junior college	13	6.53%	6.53%
	undergraduate	116	58.30%	64.83%
	Master	57	28.64%	93.47%
	Doctoral	13	6.53%	100%
Time to learn music	Less than one year	21	10.55%	10.55%
	1-5 years	112	56.28%	66.83%
	5-7 years	54	27.14%	93.97%
	7-10 years	8	4.02%	97.99%
	More than 10 years	4	2.01%	100%
Music class time every month	Less than 20 hours	13	6.53%	6.53%
	20-30 hours	37	18.59%	25.12%
	30-40 hours	79	39.70%	64.82%
	40-50 hours	54	27.14%	91.96%
	More than 50 hours	16	8.04%	100%

Table 1 – Sample statistics table

From the above table, we can see that the Cronbach α coefficient of H_1 is 0.815. The Cronbach α coefficient of H_2 is 0.846. The Cronbach α coefficient of H_3 is 0.813. The Cronbach α coefficient of H_4 is 0.767. The Cronbach α coefficient of H_5 is 0.824. The total coefficient of the scale is 0.851 and $0.851 > 0.8$. It shows that the scale has good reliability.

3.3. Validity Analysis

The validity refers to the degree of correctness. The measurement tool can measure the degree of the characteristics of the measured object. If the validity is higher, it shows that the measured results can show the real features of the measured objects. The validity is relative and cannot be measured directly. It can only be measured indirectly. The validity divides into the content validity, criterion-related validity and the construct validity (Marcus, et al., 2016). The validity analysis results are shown in the following table.

Code	Cronbach's Alpha
H_1	0.815
H_2	0.846
H_3	0.813
H_4	0.767
H_5	0.824
Total gross list	0.851

Table 2 – Survey reliability test

KMO sample measure		0.831
Bartlett sphere test	Chi square estimator	1762.13
	freedom	38
	Significant	0.000

Table 3 – Perceived value KMO sample measure effect and Bartlett sphere test results

From the above table, we can see that the value of KMO is 0.831 and $0.831 > 0.7$. It shows that the factor analysis is appropriate. The goal of the Bartlett's sphere test is to determine whether the required data is fetched from the general of the multivariate normal distribution or not. If the value of the difference test is significant, it shows that the data are obtained from the normal distribution and they can be made depth analysis. If the significance of this study is 0, it shows that the data of the sample comes from the multivariate normal distribution. That is, the correlation matrix is not a unit matrix. Therefore, it can make the factor analysis.

3.4. Regression analysis

Firstly, we examine whether the data can make the regression analysis. Only through this test, is the model reasonable.

Correlation coefficient	determination coefficient	Adjusted determination coefficient	Estimation standard error of regression equation	DW test
0.846	0.772	0.784	0.512	1.946

Table 4 – Fitting test

From the above table, we can see that the discriminant coefficient was 0.772. The adjusted determination coefficient is 0.784. It shows that the fitting degree is better. At the same time, the DW test value is 1.946. It shows that the probability of the self-related situation among the errors is very small.

Total variance	freedom	F	Sig
234.13	13	54.240	0.000

Table 5 – F test

From the above table, we can see that the P value of the F test is approximate to zero. Therefore, the function goes through the F test. It can make the mathematical modeling.

Predictors: age, education, the time of learning music, the music class time every month, functional value, social value and emotional value.

Dependent Variable: classroom satisfaction

3.5. T test

After the regression analysis, we conduct T test. If the difference of correlation coefficient is not subject to the whole analysis and is not subject to t -distribution, we need to transform these two correlation coefficients (Kamal et al., 2016). We transform r_1 and r_2 to z_1 and z_2 . The specific formulas are as follows.

$$z = \frac{1}{2} \ln \frac{1+r}{1-r} \quad (2)$$

Where, $\ln$ is the natural logarithm.

After the transformation of the correlation coefficient, we calculate the difference between z_1 and z_2 . Then, we use the value to divide the joint standard error between z_1 and z_2 . The specific formulas are as follows.

$$\Delta Z = \frac{z_1 - z_2}{\sqrt{\frac{1}{n_1 - 3} + \frac{1}{n_2 - 3}}} \quad (3)$$

Where, n is sample size.

We obtain the correlation coefficient of T test. The specific data is as shown in the table.

Variable	active	boring	$ \Delta Z $
Function value	0.212	0.205	2.143
social value	0.178	0.213	2.058
Emotional value	0.165	0.214	2.125

Table 6 – The correlation coefficient of H_1 of T test table

From the table 6, we can see that the values of three $|\Delta Z|$ are more than 1.96. Therefore, H_1 goes through.

Variable	Abundant	Weak	$ \Delta Z $
Function value	0.214	0.225	2.428
social value	0.235	0.197	2.044
Emotional value	0.346	0.194	1.988

Table 7 – The correlation coefficient of H_2 of Ttest table

From the table 7, we can see that the values of three $|\Delta Z|$ are more than 1.96. Therefore, H_2 goes through.

Variable	Optimistic	Optimistic	$ \Delta Z $
Function value	0.152	0.243	2.353
social value	0.175	0.213	2.158
Emotional value	0.178	0.214	1.978

Table 8 – The correlation coefficient of H_3 of Ttest table

From the table 8, we can see that the values of three $|\Delta Z|$ are more than 1.96. Therefore, H_3 goes through.

Variable	Excellent	Poor	$ \Delta Z $
Function value	0.221	0.227	2.426
social value	0.164	0.207	2.134
Emotional value	0.194	0.242	2.113

Table 9 – The correlation coefficient of H_4 of Ttest table

From the table 9, we can see that the values of three $|\Delta Z|$ are more than 1.96. Therefore, H_4 goes through.

Variable	Combine	without practice	$ \Delta Z $
Function value	0.221	0.216	2.181
social value	0.223	0.196	2.147
Emotional value	0.215	0.259	2.645

Table 10 – The correlation coefficient of H_5 of Ttest table

From the table 10, we can see that the values of three $|\Delta Z|$ are more than 1.96. Therefore, H_5 goes through.

After the above analysis, the test results are as follows

Hypothesis	Test result
H1	qualified
H2	qualified
H3	qualified
H4	qualified
H5	qualified

Table 11 – Hypothesis validation results 4. Conclusion

The good music education can cultivate students' sentiment and improve the aesthetic taste. Under the background of the quality education, many colleges and universities have carried out the music curriculum education. However, not all colleges and universities are satisfied with the teaching effect. In the classroom teaching, there are many factors that affect the quality of the education. Therefore, it is the way to improve the teaching quality and to improve the teaching quality for the college music classroom. In this paper, we study the factors that affect the college music class satisfaction. According to putting and analyzing these hypotheses, we validate these hypotheses. This paper does the main work. Firstly, this paper introduces the relevant research background. Secondly, this paper puts forward the research hypothesis. Thirdly, this paper verifies the hypotheses. Through the study, we can understand the influence factors of the university music class satisfaction. Aiming at these factors, we improve the quality of the college teaching quality.

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PCRD–OPT Algorithm Improvement Based on Logarithm Function Form in the JPEG2000

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Abstract: In the Tier2 coding of JPEG2000, the calculation process is very complicated when applying PCRD to calculate the length-distortion slope. Moreover, we need to store the slope in floating point form and the slope data is huge, which requires big storage space. To solve this problem, this paper proposes to compare the length-distortion slope in the log-domain and adopts integer form to store the slope, which simplifies the algorithm and save the storage space. The experiment shows that applying this algorithm to compare the length-distortion slope in the log-domain and taking integer form to store the slope exert no influence on the quality of image coding and decoding.

Keywords: JPEG2000; PCRD

1. Introduction

JPEG2000 acts as a new international still image compression and coding standard that is formulated by the JPEG working group (Mar.J.An and Z.Cai, 2008). Based on wavelet transform, in combination with the newest embedded encoding technology, JPEG2000 is able to produce compressed bit streams with high performance and compression effects superior to the present JPEG standard (Eric J. Balster et.al, 2010). The markets and applications served by the JPEG 2000 standard are Internet, mobile communication, facsimile, medical imagery, digital libraries/archives, digital photography, remote sensing, and E-commerce.

The core algorithm of JPEG2000 is Embedded Block Coding with Optimized Truncation of the embedded bit-streams (EBCOT) by Taubman. The EBCOT encoder section is divided into Tier 1 encoder and Tier 2 encoder (Singara Singh et.al, 2012). First, Tier 1 encoder partitions wavelet coefficients of each subband into independent code blocks. Then, each of the code blocks undergoes separate bit plane encoding, and exports some parameters to Tier 2 encoder for use. During this process, bit plane scanning and tri-channel encoding (effectiveness channel, magnitude improvement channel, and clearance channel) are completed three times. The major task of Tier 2 encoder is optimized bitrate truncation and bit-stream packet such that the bitrates and bit streams conform to the format of JPEG2000 standard. On the basis of parameter output of Tier

1 encoder, T2 encoder uses rate distortion optimization to truncate and pack bitrates into bit streams, and export the bit streams. Bitrate scalability is achieved by hierarchy. The encoding data in each tile form L layers which is in the range of 0 to $L-1$, $L \geq 1$. In principle, every subsequent layer provides better image quality than the prior layer. The basis image lies in lower layers, and image details lie in higher layers (A. Przelaskowski et.al, 2008). Figure 1 is the schematic diagram of the hierarchy.

The tier 2 of EBCOT in the JPEG2000 adopts the PCRD-opt algorithm to conduct appropriate interception and hierarchical organization of embedded compressed potential flow of all code blocks, forming gradable compressed code stream with good quality of the whole image (LI Yu et.al, 2015). Each bit of code stream corresponding to each code block can be intercepted after being completed in whichever coding pass and the coding pass after the interception point will be discarded. PCRD ensures that the quality of compressed pictures is the best under given code rate.

In the EBCOT encoder, T1 encoder processes all the wavelet coefficients, and undertakes about 45%-55% of calculation work in the JPEG2000 encoder (WANG Chao and WANG Jiong, 2011). Data in T1 encoder are stored in the storage, waiting to be processed by T2 encoder. However, T2 encoder in operation discards most of the input data, which leads to great data loss. Colossal calculation volumes and tremendous internal storage become the bottleneck for JPEG2000 to realize on-time operation (Cheng Wang and Suming Zhu, 2015).

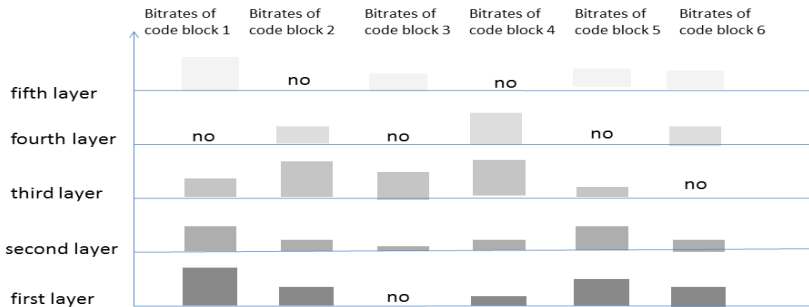


Figure 1 – The schematic diagram of the hierarchy

We define distortion-length slope $\lambda_i(z)$ to determine the method of optimal interception point in the PCRD. The calculation process is complicated and we use floating point method in terms of expression. And we need to store during the whole tier2 process. Floating point storage takes up large storage space, which is not applicable in the embedded system. To reduce the amount of stored information, this paper proposes to adopt logarithm function form to the express $\lambda_i(z)$ and store the result of logarithm function form in integer form.

2. PCRD-OPT algorithm analysis

PCRD-opt is the interception point set of optimized code block $\{n_i\}$, making minimum distortion D under the condition of overall code stream length R_{max} or maximum code stream length under certain distortion (Xue, J. et.al, 2011).

The fundamental principle of the PCRD algorithm: assuming that D is the distortion of the whole restored image; n_i is the truncation point; and $D_i^{n_i}$ is the distortion of the code block B_i . Supposing that the distortion degree of code blocks is additive, then

$$D = \sum_i D_i^{n_i}$$

If $R_i^{n_i}$ represents the bitrate of embedded bit streams of B_i at n_i , the total bitrate of the image R is

$$R = \sum_i R_i^{n_i}$$

Setting $R_{\max}$ is the maximum value of final code stream output, not considering the expense of recognizing the contribution of each code block, then the length restrictive condition is:

$$R = \sum_i R_i^{(n_i)} \leq R_{\max} \quad (1)$$

Under the circumstances, if we want to make the optimal of interception point $\{n_i\}$, we need to make minimum distortion D while satisfying the condition in Formula (1). This is the issue of conditional extremum. In general case, the method to solve conditional extremum issue is to get the extremum value under this condition applying Lagrange algorithm (Y.M. Yeung and Oscar C. Au, 2005). Namely, find a λ to make the minimum value of the following formula:

$$D(\lambda) + \lambda L(\lambda) = \sum_i (D_i^{(n_i, \lambda)} + \lambda L_i^{(Z_i, \lambda)}) \quad (2)$$

If we can find a λ value that can satisfy $R(\lambda) = R_{\max}$ and make the minimum value of formula (2), then the series of n_i corresponding to this λ must be the optimal solution. Of course, these interception points are discrete, so we cannot find a λ value making $R(\lambda)$ completely equal to $R_{\max}$ (Freixo, J., & Rocha, Á, 2014). However, we can find a minimum λ value, making $R(\lambda)$ less than or equal to $R_{\max}$.

In JPEG2000, the coding is conducted taking code block as independent unit, so the minimization problem in formula (2) can be summed up as the minimization problem of single code block. Namely, find interception point n_i corresponding to B_i , making the minimum of $D_i^{(n_i, \lambda)} + \lambda L_i^{(Z_i, \lambda)}$.

At interception point n_i , the distortion slope is

$$\lambda_i^{n_i} = \frac{D_i^{n_k} - D_i^{n_i}}{R_i^{n_i} - R_i^{n_k}} \quad (3)$$

The n_k is another feasible interception point of code block B_i .

According to formula (3), we apply lagrange algorithm to adjust λ_i^{ni} until we find the optimal λ_{opt} , thus obtaining a group of interception point $\{ni\}$, satisfying $\lambda_i^{ni} > \lambda_{opt}$, and $R \approx R_{max}$ for all code blocks.

3. Improvement of PCRD algorithm based on logarithm function form

From the previous analysis of PCRD algorithm, we can see that only when we have calculated all actual λ_i^{ni} i can we obtain the λ_{opt} in the process of seeking optimal interception point. In other words, it is necessary for T1 encoder of EBCOT to encode each bit plane of code blocks in the image according to context-based arithmetic encoder. There is no doubt that this operation is time-consuming and requires enormous computation volumes. In addition, all the exported bit streams from T1 encoder demand to be stored for T2 encoder's use. However, as T2 encoder discards most of the input data, many resources and the working efficiency of T1 encoder have been wasted. Colossal calculation volumes and tremendous internal storage render it difficult for JPEG2000 to realize on-time operation. We need to store all the λ_i^{ni} and conduct comparison. λ_i^{ni} is calculated and stored in floating point mode. However, it is resource-consuming and time-consuming to adopt floating point calculation in actual hardware. And it only involves the comparison of slope λ_i^{ni} and we don't need to know the exact value of λ_i^{ni} when seeking optimal interception point. Moreover, monotonicity changes are detected with the change of output in logarithmic function. To avoid floating point calculation and reduce storage space, this paper compares the λ_i^{ni} in the log-domain to base natural number and stores the data in integer form.

Name	Loge λ_i^{ni} of Max
Natural large image	Bike
	Cafe
	Woman
Natural small image	Goldhill
	Hotel
	Tools
Popular image	Lenna
	Barbara
Unnatural image	Chart
	Cmpdl
Hybrid image	Finger
	txtur1

Table 1 – Maximum Value of Five Kinds of Images When Coding

Table 1 is the maximum value of λ_i^{ni} of five kinds of images when coding. The first kind of test images are composed of high resolution ISO/IEC test images Bike (2560×2048), Café (2560×2048) and Woman (2560×2048). The second kind of test images are composed of low resolution ISO/IEC test images Goldhill (576×720), hotel (576×720)

and Tools (1200×1524). The third kind is 512×512 test images “Lenna” and “Barbara”. The fourth kind is unnatural ISO/IEC test images Chart (2347×1688) and Cmpd1 (68×512). The fifth kind is other test images Finger (512×512) and txtur1 (1024×1024).

We can see from Table 1 that the maximum of $\log_e \lambda_i^{ni}$ won't be too big when conducting coding of different kinds and different size of images.

Table 2 is the value of λ_i^{ni} calculated respectively in one code block expressed in original method and natural logarithm. The experiment images adopted are the bmp image corresponding to lena image. The wavelet transform adopts level 5 5/3 transform, the tile is 512×512 and the bit rate is 0.1. The data is the first 19 values of λ_i^{ni} that needs to be calculated in the first code block.

Serial number	Original λ_i^{ni} value	Logarithm expression $\log_e \lambda_i^{ni}$
1	15507773.02161	16.556851941
2	40701657.76402	17.521779380
3	30843181.12569	17.244426250
4	3725363.519101	15.130674994
5	25610312.58939	17.058505663
6	30843181.12569	17.244426250
7	21401668.53741	16.878979445
8	13180635.40339	16.394259295
9	3851437.049775	15.163956896
10	4746141.743285	15.372842581
11	30843181.12569	17.244426250
12	21401668.53741	16.878979445
13	13180635.40339	16.394259295
14	4279339.294497	15.269309185
15	2417789.543847	14.698364269
16	800712.6695252	13.593257446
17	590286.4730970	13.288363245
18	175645.0069358	12.076220231

Table 2 – Comparison Between Original λ_i^{ni} Value and $\log_e \lambda_i^{ni}$ Expressed in Natural Logarithm

We only need to compare the result of λ_i^{ni} when coding and don't need to conduct precise calculation. We can see from Table 1 that we are able to compare two values correct to six decimal places when adopting logarithm to express λ_i^{ni} after a great deal of experiments.

We can see from previous analysis that we can apply long integer to express $\log_e \lambda_i^{ni}$ in actual hardware. Namely get the natural logarithm of λ_i^{ni} and then multiply the value by 10^6 , taking integer part. We use long integer to store and calculate, which simplifies the calculation process and saves the storage space.

4. Experiment result

This paper conducts computer experiment of the previous five kinds of images, applying level 5 5/3 wavelet transform, 0.1bpp bit rate and 512×512 tile. The result of the experiment is shown in Table 3.

We can see from Table 3 that about 50% of storage space can be saved applying long integer to store in this paper.

Name		Number of code blocks	Number of calculation	Original storage space needed	Storage space needed applying this method	Space saved
Natural big image	Bike	1286	67383	527k	263.5k	263.5k
	Cafe	1286	72915	570k	285k	285k
	Woman	1286	56925	445k	222.5k	222.5k
Natural small image	Goldhill	265	5352	42k	21k	21k
	Tools	493	29100	228k	114k	114k
Popular image	Lenna	210	2991	24k	12k	12k
	Barbara	210	2675	21k	11.5k	11.5k
Unnatural image	Chart	1094	43555	341k	170.5k	170.5k
	Cmpdl	278	4501	36k	18k	18k
Hybrid image	Finger	210	2449	20k	10k	10k
	txtur1	345	14374	113k	56.5k	56.5k

Table 3 – Experiment Result

Figure 2 gives respectively the images of lenna (512×512) after decompression applying original method and the method in this paper when the bit rate is 0.1bpp.

We can see from Figure 2 that this algorithm and original algorithm have identical signal-to-noise ratio under the same bit rate, which is because this algorithm compares the length-distortion slope in the log-domain and stores in integer, exerting no influence on the quality of image coding. Therefore, this algorithm can simplify the calculation and save about 50% of storage space when comparing the length-distortion slope, exerting no influencing on the coding and decoding performance of images at the same time.

5. Conclusions

In Tier2, floating point mode is adopted to calculate length-distortion slope to determine the optimal interception point when allocating bit rate applying PCRD. The length-distortion slope needs to be stored, which occupies large storage space. This paper proposes to compare the length-distortion slope in the log-domain and store in integer, which simplifies the calculation and saves the storage space while not affecting the coding



(a) Original Method PSNR=29.31 Db (b) This Algorithm PSNR=29.31 dB

Figure 2 – Reconstructed Images of Original Method (left) and Improved Algorithm (Right) under 0.1bbp

and decoding performance of images. The effect is more obvious in the application of embedded coding when resources are limited.

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Research on the Selection Mechanism of Entrepreneurial Platform and Opportunity Based on the Analysis of Computer Algorithm

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Abstract: With the continuous deepening of the entrepreneurial research, many organizations providing services for entrepreneurs have emerged in reality. The emergence has greatly reduced many problems for entrepreneurs and improve the odds of success, however, in the entire entrepreneurial process, the entrepreneurs are still the dominant ones and the probability of entrepreneurial failure is still considerable. The paper tries to put forward a new organization- big data processing platform which can solve various problems in the entrepreneurial process in the form of team entrepreneurship. Moreover, it also discusses the construction of big data processing platform from four aspects: components of the big data processing platform, organizational structure, construction mode and operation process. The index system for opportunity selection of big data platform is put forward which mainly includes three parts: the core technology competitiveness, the comprehensive quality of the entrepreneurial team and the market potential. Then, the empirical analysis is carried out by using the fuzzy-grey clustering method. Big data processing platform has greatly improved the success probability of entrepreneurship and improve the efficiency of social resources, so it has a good reference value of practice.

Keywords: insert a maximum of five words, divided by semicolons.

1. Introduction

One of the core topics for entrepreneurship research is entrepreneurial opportunities. In overseas academic field, the major representative figures are Kirzner and Shane (Rocha, 2012). Schumpeter puts forward that entrepreneurial opportunity is the possibility for the entrepreneur to make organic combination of resources and create value so as to meet the market demand (Vaghely and Julien, 2010). Kirzner thinks that the core of the entrepreneurship is to discover the entrepreneurial opportunities and the market's completeness leads to the entrepreneurial opportunity, that is to say, the integration of resources are able to meet market demand (Sine and David, 2003). Venkataraman points out that entrepreneurial opportunities include a set of ideas, beliefs, and actions. The products and service which are created by them are actually in short supply in the current market (Plummer, Haynie and Godesiabo, 2012). Shane makes main line for studying entrepreneurship highlighted on the entrepreneurial opportunity and thinks

that people's recognition of the entrepreneurial opportunities are mainly affected by two aspects: getting information to find out the opportunities; identify the features to evaluate the opportunities (Mcmullen, Plummer and Acs, 2007). Eckhard defines the entrepreneurial opportunities as a situation in which the manufacturing of new products and services, the utilization of new material, new market development and the formation of new organization are realized by establishing new method, new object or new relationship between the new method and new object.

ZuoLingbi, a Chinese scholar thinks that entrepreneurial opportunities are the business opportunities that entrepreneurs can use (Wood and Mckinley, 2010). This opportunity must be attractive, durable and timely, moreover, the product or service involved in this opportunity must be able to create certain value for its buyers or end users.

From the perspective of the paper, the entrepreneurial opportunities are derived from various chaos situations including technology, enterprise, the transformation of market and policy (Wang, Ellinger and Wu, 2013). Therefore, from the perspective of the author, the entrepreneurial opportunities are mainly from three aspects: the changes of the macro environment of the market, the changes of the life cycle of industries and the innovation of technology and knowledge.

2. Criteria of selection

The author puts forward the selection index system of big data platform for entrepreneurial opportunities according to the experience of successful implementation of big data processing platform which is specifically divided into core technology competitiveness, the overall quality of the entrepreneurial team and the market prospect (Hmieleski and Baron, 2008). There are several sub-indexes and the specific construction of the system is shown in the table 1.

3. The selection of evaluation model

In the comprehensive evaluation for project of entrepreneurial investment, as many evaluation rules are fuzzy, the fuzzy evaluation method has been widely applied and promoted (Bryant, 2007). At the same time, as the ability and preference of judges are different, the evaluation information is endowed with certain degree of gray-scale and the grey theory is more and more applied in the comprehensive evaluation of entrepreneurial investment projects (Suddaby, Bruton and Si, 2014).

The construction of fuzzy grey comprehensive evaluation model takes into consideration the situation that the information in the process of evaluation is not completed (Grichnik, Smeja and Welp, 2011). Grey clustering theory is used to obtain the gray statistics so as to construct the fuzzy membership matrix. Finally, the fuzzy algorithm is used to calculate the risks with the evaluation of the project being carried out (Yue, 2016).

3.1. Establishing the evaluation index system

In this paper, the index system designed in previous content is taken as an example to explain the calculation steps of the model, which is shown in figure 1.

The target layer	Factors layer	Index layer
Big data platform for business chance to choose the evaluation index system	Core technology competitiveness X1	Technology of gold x11
		Technology of gold x12
		Alternative technology x13
		Mature technology reliability x15
		Technology research and development cycle x15
	Entrepreneurial teams overall quality X2	Entrepreneur's background and experience x21
		Entrepreneurial leadership x22
		Entrepreneur's integrity x23
		Centrality of team members x24
		Team members' knowledge and experience complete rate x25
	Market prospect X3	The size of the market and consumption forecast x31
		Policy and law the completeness and stability x32
		The current competition situation x33
		Market barriers to entry x34
		The industry development stage x35

Table 1 – Big data platform for business chance to choose the evaluation index system

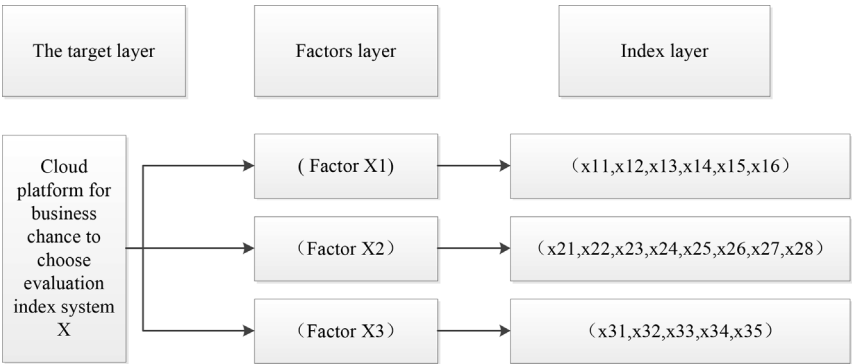


Figure 1 – Big data platform for business chance to choose evaluation index system

3.2. Determines the weight of each factor

The principle of analytic hierarchy process is to decompose the problem into different components according to the nature of the problem and the general goal required to be reached (Andrew & Robin, 2013). According to the correlation between the factors and the relationship of membership degree, comparison is carried out layer by layer and the judgment matrix is constructed, after that, the maximum eigenvalue of the judgment matrix and the corresponding eigenvalue are calculated with the order of importance of individual level factors corresponding to the upper level factors being obtained. Then the weight vector is obtained. The specific steps are shown in the following content:

Step one: analyze the relationship between the various factors in the system. Firstly, a structure model for hierarchical analysis is constructed in which, we decompose the complex problems into various influencing factors (Singh, 1998). According to the attributes, these factors are divided into several groups and different levels.

Step two: various factors on the same level related to importance degree of one certain criteria in the previous level are compared two by two so as to construct the judgment matrix (Heneman & Tansky, 2002). The judgment scale of importance is assigned with value according to the ratio in table 1-9. Its specific implication is shown in table 2.

Suppose that there are several index factors in the same level $X_1, X_2, \dots, X_n$, five experts compare the elements two by two so as to make judgment of importance. The constructed judgment matrix is A which is shown in table 3.

Step three: calculate the maximum eigenvalue λ_{max} and eigenvector. There are many ways to calculate the maximum eigenvalue λ_{max} and eigenvector. The eigenvalue of the judgment matrix is solved by sum-product method and the numerical value of sub factors weights is determined.

scale	meaning
1	Factors i and j is relatively some attributes are equally important
3	Factors i and j relative to a slightly more important attribute
5	Factors i and j is obviously important relative to a particular attribute
7	Factors i and j a relatively strong important attribute
9	Factors i and j it is absolutely important relative to a particular attribute
2、4、6、8	The above two adjacent judgment of values
reciprocal	Factor j is more important than factors irrelative to a particular attribute

Table 2 – 1-9 percentage scale and its meaning

A	X1	X2		Xn
X1	A11	A12	A13	A14
X2	A21	A22	A23	A24
.....	A31	A32	A33	A34
Xn	A41	A42	A43	A44

Table 3 – Judgment matrix A

The values	0.9	0.7	0.5	0.3	0.1
The level	optimal	good	General	poor	very poor

Table 4 – Index factor j on the upper factors influence degree coefficient table

Step four: in terms of the consistency test of judgment matrix, the ideal judgment matrix should meet: $a_{ij}=(a_{ik})/(a_{kj})$, $I, j, k=1,2,...,n$, at the same time, $\lambda_{max}=n$, the rest characteristic roots are:

Step five: consistency test for combination.

3.3. Determine the membership matrix R

1. Determine the evaluation criteria which is shown in table 4.
2. Set the sample matrix for evaluation. Suppose that there are totally r experts have evaluated the index level according to the evaluation criteria. The evaluation vector of j th index of i th factor is $v_{ij}=(v_{ij1}, v_{ij2}, \dots, v_{ijk}, \dots, v_{ijr})$. Therefore, the sample matrix for evaluation of all the indexes j of i factor can be shown as $V_i=(v_{1j}, v_{2j}, \dots, v_{ij})$.
3. Carry out fuzzy comprehensive evaluation

The comprehensive value the factor B_i is $B_i=[b_{i1}, b_{i2}, b_{i3}]=W_i^T R$.

Accordingly, the membership vector of each index in the first-level index subsystem can constitute a general evaluation function matrix R

$$R = \begin{bmatrix} B_1 \\ B_2 \\ \dots \\ B_m \end{bmatrix} = \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ \dots & \dots & \dots \\ b_{m1} & b_{m2} & b_{m3} \end{pmatrix} \quad (1)$$

Fuzzy matrix operation for R is carried out with the fuzzy judgment matrix B of the system being obtained:

$$B = W^T R = [B_1, B_2, B_3]$$

Normalization processing is made for B , so:

$$\overline{B_j} = \frac{B_j}{\sum_{j=1}^n B_j} \quad (2)$$

$$B^* = (\overline{B_1}, \overline{B_2}, \overline{B_3}) \quad (3)$$

According to the principle of maximum membership degree, it is judged that: when $\overline{B_1} = \max(\overline{B_1}, \overline{B_2}, \overline{B_3})$, the project is inferior one; when $\overline{B_2} = \max(\overline{B_1}, \overline{B_2}, \overline{B_3})$, the project belongs to medium one; when $\overline{B_3} = \max(\overline{B_1}, \overline{B_2}, \overline{B_3})$, the project is superior project.

4. Empirical analysis

1. Determine the weight of each factor

X	X1	X2	X3	weight
X1	1	3	1/3	0.33
X2	1/3	1	3	0.33
X3	3	1/3	1	0.33

Table 5 – Judgment matrix X

2. Construct the membership degree matrix

Firstly, the directors score each index according to actual situation of Hong Xin Electronics to determine the situation of each sub-index. The specific information is shown in table 9.

The judgment matrix obtained is:

$$V_1 = \begin{bmatrix} 0.7 & 0.5 & 0.3 & 0.7 & 0.8 \\ 0.5 & 0.6 & 0.8 & 0.5 & 0.3 \\ 0.6 & 0.5 & 0.7 & 0.7 & 0.4 \\ 0.5 & 0.8 & 0.6 & 0.6 & 0.6 \\ 0.9 & 0.6 & 0.4 & 0.5 & 0.7 \end{bmatrix} \quad (4)$$

Afterwards, the grey-class evaluation and whitening weight function are determined. According to specific situation, the quantity of grey-class evaluation is set up and grey-class evaluation based on historical data is established. Suppose that there are 3 grey-class evaluation, they are respectively “inferior”, “medium” and “superior”. The corresponding gray number and whitening weight function are shown in the following content:

X1	x11	x12	x13	x14	x15	weight
x11	1	2	3	4	7	0.491
x12	1/3	1	3	2	5	0.232
x13	1/5	1/3	1	1/2	1	0.092
x14	1/4	1/2	2	1	3	0.138
x15	1/7	1/5	1/2	1/3	1	0.046

Table 6 – Judgment matrix X1

X2	x21	x22	x23	x24	x25	weight
x21	1	4	2	3	3	0.353
x22	1/4	1	1/3	1/2	1/2	0.114
x23	1/2	3	1	5	4	0.297
x24	1/3	2	1/5	1	1/3	0.106
x25	1/3	2	1/4	3	1	0.130

Table 7 – Judgment matrix X2

X3	x31	x32	x33	x34	x35	weight
x31	1	5	3	4	2	0.387
x32	1/5	1	1/2	3	4	0.254
x33	1/3	2	1	3	1/2	0.215
x34	1/4	1/3	1/3	1	1/2	0.042
x35	1/2	1/4	2	2	1	0.121

Table 8 – Judgment matrix X3

	Director a	Director b	Director c	Director d	Director e
x11	0.7	0.5	0.3	0.7	0.8
x12	0.5	0.6	0.8	0.5	0.3
x13	0.6	0.5	0.7	0.7	0.4
x14	0.5	0.8	0.6	0.6	0.8
x15	0.5	0.8	0.6	0.6	0.8

Table 9 – Core technology competitiveness play table board

The “difference” in the first category ($e=1$), suppose the grey number is $\otimes_1 \in [-, -, 0.3, 0.5]$, so the function which belongs to inferior competitiveness is:

$$f_1 = \begin{cases} 1, x \in (0, 0.3) \\ \frac{0.5-x}{0.2}, x \in (0.3, 0.5) \\ 0, x \notin (0, 0.5) \end{cases} \quad (5)$$

The “difference” in the second category ($e=2$), suppose the grey number is $\otimes_2 \in [0, 0.3, 0.5, 0.7]$, so the function which belongs to general competitiveness is:

$$f_2 = \begin{cases} 0, x \in (0.3, 0.7) \\ \frac{x-0.3}{0.2}, x \in (0.3, 0.5) \\ \frac{0.7-x}{0.2}, x \notin (0.5, 0.7) \end{cases} \quad (6)$$

The “difference” in the third category ($e=3$), suppose the grey number is $\otimes_3 \in [0.6, 0.9, -, -]$, so the function which belongs to superior competitiveness is:

$$f_3 = \begin{cases} 0, x \in (0, 0.6) \\ \frac{x-0.6}{0.3}, x \in (0.6, 0.9) \\ 1, x \notin (0.9, \infty) \end{cases} \quad (7)$$

Calculate the grey evaluation coefficient. For index x_{11} , suppose the evaluation coefficient of e th grey evaluation category is X_{11e} , the calculation is shown in the following content:

$$e=1 \quad X_{111} = \sum_{r=1}^v f_1(v_{11r}) = f_1(0.7) + f_1(0.5) + f_1(0.7) + f_1(0.8) \quad (8)$$

$$e=2 \quad X_{112} = 1, e=3, X_{113} = 4/3 \quad (9)$$

The total grey evaluation number X_{11} which belongs to each grey evaluation of index x_{11} is:

$$X_{11} = \sum_{e=1}^3 X_{11e} = 10/3 \quad (10)$$

$$r_{111} = \frac{X_{111}}{\sum_{e=1}^3 X_{11e}} = 10/3 \quad r_{112} = \frac{3}{10} \quad r_{113} = \frac{4}{10} \quad (11)$$

Therefore, by referring to $r_{11} = \left(\frac{3}{10}, \frac{3}{10}, \frac{4}{10}\right)$, it is obtained that:

$$r_{12} = \left(\frac{6}{25}, \frac{3}{5}, \frac{4}{25}\right) \quad (12)$$

$$r_{13} = \left(\frac{1}{7}, \frac{4}{7}, \frac{2}{7} \right) \quad (13)$$

$$r_{14} = \left(0, \frac{2}{5}, \frac{3}{5} \right) \quad (14)$$

$$r_{15} = \left(0, \frac{9}{17}, \frac{8}{17} \right) \quad (15)$$

So, the index for core technology competitiveness is x_{ij} ($j=1,2,\dots,5$). For the grey evaluation matrix of each kind of grey evaluation, that is so say the membership degree matrix R_i is:

$$R_1 = \begin{bmatrix} r_{11} \\ r_{12} \\ r_{13} \\ r_{14} \\ r_{15} \end{bmatrix} = \begin{pmatrix} 3/10 & 3/10 & 4/10 \\ 6/25 & 3/5 & 4/25 \\ 1/7 & 4/7 & 2/7 \\ 0 & 2/5 & 3/5 \\ 0 & 9/17 & 8/17 \end{pmatrix} \quad (16)$$

In the same principle, the membership matrix of the comprehensive quality and the market potential R_2, R_3 of the entrepreneurial team can be obtained.

$$R_2 = \begin{bmatrix} r_{21} \\ r_{22} \\ r_{23} \\ r_{24} \\ r_{25} \end{bmatrix} = \begin{pmatrix} 0 & 3/17 & 14/17 \\ 0 & 3/10 & 7/10 \\ 1/4 & 1/4 & 1/2 \\ 1/9 & 2/9 & 2/3 \\ 1/11 & 5/11 & 5/11 \end{pmatrix} \quad (17)$$

$$R_3 = \begin{bmatrix} r_{31} \\ r_{32} \\ r_{33} \\ r_{34} \\ r_{35} \end{bmatrix} = \begin{pmatrix} 2/15 & 2/5 & 7/15 \\ 1/5 & 3/5 & 1/5 \\ 1/10 & 2/5 & 1/2 \\ 1/6 & 1/2 & 1/3 \\ 0 & 1/3 & 2/3 \end{pmatrix} \quad (18)$$

3. Carry out fuzzy comprehensive evaluation

The comprehensive value B_i of the calculation factor is:

$$B_1 = W_1^T R_1 = [0.2077, 0.4723, 0.3407] \quad (19)$$

$$B_2 = [0.0977, 0.2531, 0.6745] \quad (20)$$

$$B_3 = [0.1127, 0.4082, 0.4822] \quad (21)$$

So the total evaluation function matrix R can be composed by membership vector of each index in the index subsystem.

$$R = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \end{bmatrix} = \begin{pmatrix} 0.2077 & 0.4723 & 0.3407 \\ 0.0977 & 0.2531 & 0.6484 \\ 0.1127 & 0.4082 & 0.4822 \end{pmatrix} \quad (22)$$

Then fuzzy matrix operation of R is carried out with the fuzzy evaluation matrix B in the system being obtained:

$$B_1 = W_1^T R_1 = [0.1521, 0.3486, 0.5127] \quad (23)$$

After normalizing processing for B, it is obtained $B' = [0.1501, 0.3440, 0.5059]$

The calculation results show that the “inferior” “medium” “superior” projects of Hong Xin Electronics are respective taking the proportion of 15.01%, 34.40%, 50.59%, so this project belongs to the superior project and investment in it is feasible. And practical implementation has also proved that the investment of Hong Xin Electronics is very successful in the big data processing platform.

5. Conclusion

The choice of entrepreneurial opportunities is an important component of big data processing platform. Firstly, this paper defines the entrepreneurial opportunities and then puts forward the measurement standards for judging the superiority and inferiority of entrepreneurial opportunities of big data processing platform: three three indicating system of core technology competitiveness, the overall quality of the entrepreneurial team, the market potential. Finally, an empirical analysis is carried out by using the fuzzy-grey clustering method with Xiamen Hong Xin big data processing platform as an example. The conclusion shows that the fuzzy-grey clustering method is especially suitable for the selection mechanism of entrepreneurial opportunity, which is of positive significance for the development of the entrepreneurial platform.

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Research on Enterprise Knowledge Management System based on Computer Big Data Processing

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Abstract: The coming of the era of knowledge economy makes knowledge become an essential component of enterprise core competence. Knowledge is becoming a decisive production factor of social economy operation gradually. Under the current and future environment condition, the essence of enterprise management, especially high-technology enterprise management, is knowledge management. This paper analyzes the enterprise collaborative knowledge flow and sets up knowledge intelligence push model and proposes one general framework of collaborative knowledge management system in IT start-up companies based on knowledge flow. Compared with traditional technology, big data processing can save and process unstructured knowledge data in a better way. Big data processing can provide a good management platform for the management of knowledge resources, which decreases the work complexity of knowledge manager, improves the efficiency of knowledge management, realizes knowledge sharing to a greater extent and realizes collaborative knowledge management.

Keywords: enterprise management, management system, big data processing.

1. Introduction

The coming of the era of knowledge economy makes knowledge become an essential component of enterprise core competence (Bhatt, 2001). Management master Peter Drucker has pointed out that “in the new century of post capitalism, production does not refer to capital or means of production but knowledge; the concept of taking knowledge as resources has been accepted gradually”. Under the current and future environment condition, the essence of enterprise management, especially high-technology enterprise management, is knowledge management. Knowledge is becoming a decisive factor of production of social and economic operation (Tiwana, 2002). Because knowledge exists in each branch system and subsystem of enterprise, which makes the knowledge system of enterprise become extremely complicated (Gallupe, 2001). Enterprise lacks systematic and organized knowledge management in the utilization and management of knowledge resources. At present, there are also some problems, such as departmentalization of knowledge resources, knowledge can't be highly shared, hidden knowledge can't be conversed effectively, institutional barriers restrict knowledge reuse degree and traditional organization form is not good for implementing knowledge management (Mårtensson, 2000).

Collaborative knowledge management has been introduced to make up for these shortages (Wiig, 1997). Collaborative knowledge management integrates collaborative technology and knowledge management technology. Collaborative technology exists in classification framework based on time and space, which can support different contexts of same time and same place, same time and different places, different time and same place, different time and different place. Collaborative technology is technical support provided by knowledge management subject in synergy environment; knowledge management technology is the technical support provided by knowledge management object in synergy environment (Chen and Huang, 2007). It depends on the knowledge flow from knowledge discovery to knowledge utilization; the knowledge management is actually the management for the flow of knowledge flow.

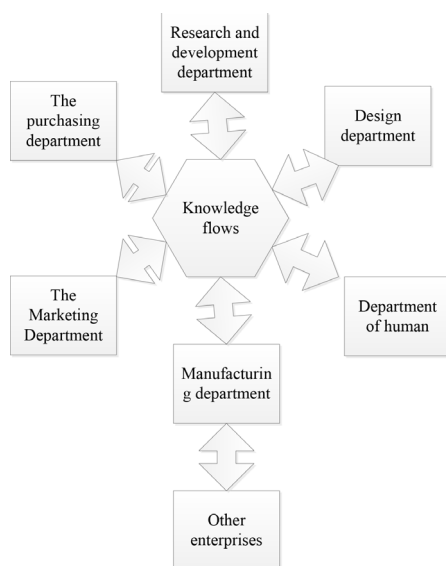


Figure 1 – Enterprise knowledge flow hierarchy

Big data processing is called as “the third revolutionary of IT technology”, big data processing is with great computing power, and storage capacity is connected with simple and high efficient programming and makes infinite cooperation possible. These advantages enable the big data processing to attract the attention of industry and academia successfully (Thompson and Walsham, 2004; Peng, 2016). Compared with traditional knowledge management, the application of big data processing to collaborative knowledge management can storage and process unstructured knowledge data in a better way, which is because that big data processing has better storage and processing program for this unstructured knowledge data. The new model of this knowledge resources management realizes “attain based on demand and use based on demand”, which provides a good management platform for the management of knowledge resources, decreases work complexity of knowledge manager, improves the efficiency of knowledge management and realizes knowledge sharing and makes infinite cooperation become possible to a great extent.

2. Construct enterprise coordination knowledge management big data framework

2.1 Analyze the knowledge flow in collaborative knowledge management

The flow of knowledge among individuals, groups and organizations is called as knowledge flow. Therefore, in the general sense, knowledge flow is an interactive process of delivering the attained knowledge from knowledge sender to knowledge receiver through various tools (Johannessen, Olsen and Olaisen, 1999). From the angle of enterprise knowledge resources, knowledge flow can be divided into two layers: the first layer is the knowledge flow within the enterprise, such as product design and R&D development, product production department, product testing department, product improvement department, knowledge sharing, creating, transferring and sharing between market department and other departments, which is the micro level of enterprise knowledge flow. The second layer is knowledge flow between enterprise and external, including enterprise customer base, competitors, other enterprises and scientific research institutes etc, which is the macro level of enterprise knowledge flow (Kakabadse, Kakabadse and Kouzmin, 2003). The layer structure of enterprise knowledge flow is as shown in figure 1

Enterprise knowledge flow has macro and micro two layers, but the knowledge flow of these two layers are closely connected. Generally speaking, the knowledge flow at macro layer can only affect enterprise business only through micro knowledge, for example, the design department needs to understand the customer demand for product design before designing, this demand is explicit knowledge (such as design demand manual), and then the designer needs to compile the customer demand; compilation process is from explicit knowledge to the flow of explicit knowledge and then deliver the complied explicit knowledge to each department to increase the knowledge stock of enterprise.

2.2. Knowledge intelligence push

Taking IT collaborative design of electronic components as example and learning from the collaborative product design knowledge push model of Cuiqingjiang etc., the push idea of knowledge intelligence push model under the perspective of big data processing is: collaborative designers receive design tasks and make tasks analysis collaboratively under big data environment; first load knowledge demand of collaborative designers in knowledge big data based on knowledge demand model in collaborative design process, and then make semantic extension for concentrated knowledge source in knowledge module, and then search in collaborative design knowledge base based on these knowledge sources and mapping of knowledge sources and finally push to collaborative designers selectively based on filtration of collaborative designers.

1. Design knowledge demand model collaboratively

The establishment of collaborative design process model can combine the design process and knowledge management closely, which can describe the requested knowledge of designer in the implementation of design tasks. The initialization of knowledge module adopts experts' suggestions and also draws upon useful opinions in way of brainstorming (Plessis, 2007). To make the knowledge demand model in collaborative design process more perfect, it needs to update model from time to time and make use of designing practical experience to improve the knowledge demand model in collaborative design

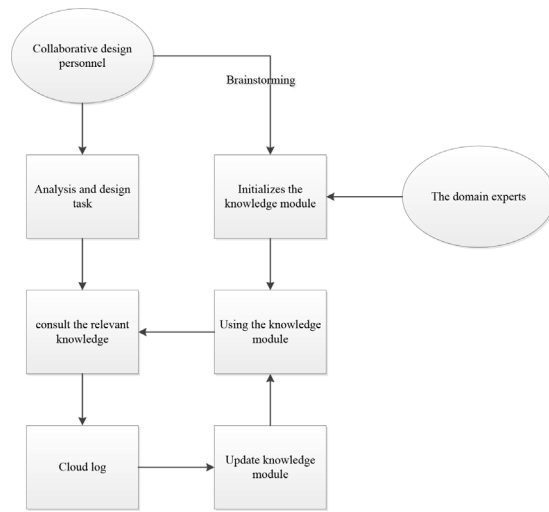


Figure 2 – Collaborative design process knowledge demand model

process. The knowledge demand model in collaborative design process is as shown in figure 2.

In knowledge demand model of collaborative design process, it includes updating knowledge module set; updating knowledge module set mainly includes the adding of knowledge module and deleting of knowledge module.

2. Increase and decrease of knowledge module

During the process of collaborative designers in accomplishing design task, there must difference between requested knowledge and pushed knowledge, to remove the difference, collaborative designers need to search for the requested knowledge from knowledge base. When searched for the requested knowledge, if the knowledge meets the relation condition in existing knowledge module, and then add it into this knowledge module; if does not meet the relation condition in existing knowledge module, and then create new knowledge module. If one knowledge module plays a small role for collaborative designer, and then it means this knowledge module can be deleted (McKeen, Zack & Singh, 2006). The adding process of knowledge module is as shown in figure 3

3. Design knowledge searching model

Yongyue Chen and Huosong Xia etc. have designed knowledge retrieval model through extracting and visualizing knowledge. Intelligence push requires that the retrieval process should be different from traditional retrieval process; traditional retrieval process requires the user to input retrieval type; in intelligence push model, retrieval process is that system retrieves related knowledge actively based on knowledge demand model in collaborative design process, and then push to designers through knowledge filtration . Collaborative design knowledge retrieval model is as shown in figure4.

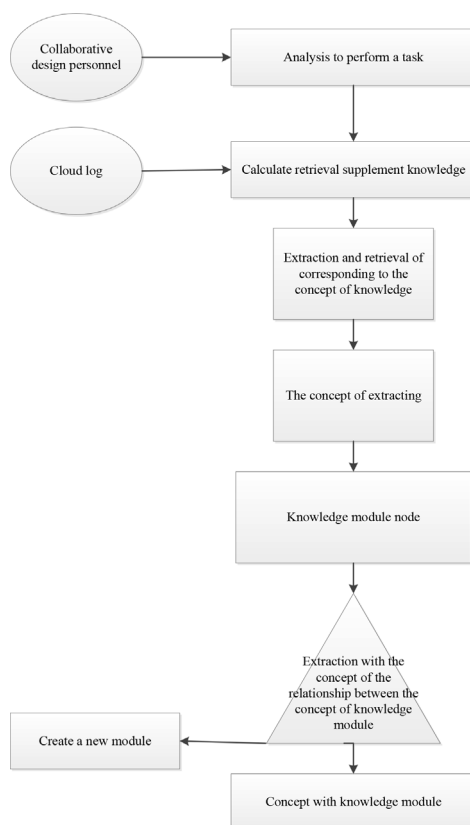


Figure 3 – Added knowledge module in the collaborative design process

4. Collaborative design knowledge put model

The intelligence knowledge push model of collaborative design of electronic components is as shown in figure 5 and the push idea is: collaborative designers receive design tasks and make tasks analysis; first attain knowledge demand of collaborative designers based on knowledge demand model in collaborative design process, and then make semantic extension for concentrated knowledge source in knowledge module, and then search in collaborative design big data knowledge base based on these knowledge sources and mapping of knowledge sources and finally push to collaborative designers selectively based on filtration of collaborative designers.

2.3. Construct logical framework of collaborative knowledge management

Apply big data processing into collaborative knowledge management and during implementing collaborative knowledge management system, the role of senior management of the company is to inspect the IT environment of the company and use this to understand its advantages, disadvantages, opportunities and threats in instructing the

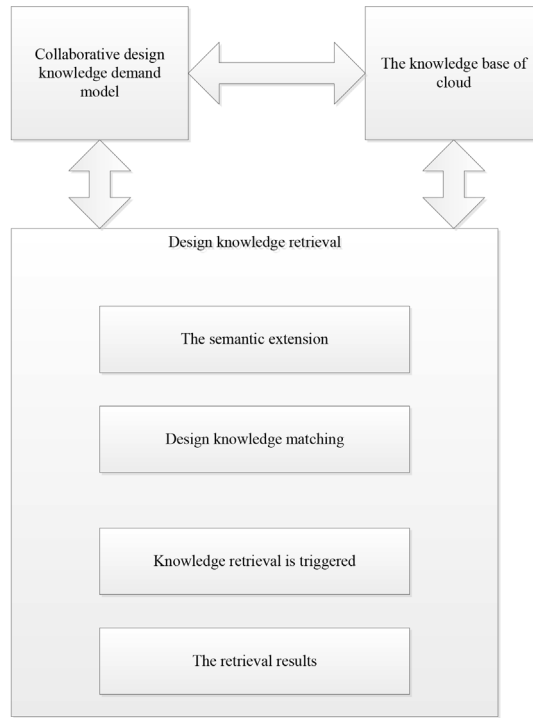


Figure 4 – Collaborative design knowledge retrieval model

knowledge management activity. Managers should make suitable knowledge technology design for establishing collaborative knowledge management framework under big data processing and cooperate with other departments and staffs to optimize all demand analysis.

The knowledge flow management model of enterprise is established by enterprise staffs that create and use organization knowledge. Realize the reconstruction and optimal decision making of process on the big data platform of enterprise collaboration. The logical framework of enterprise collaborative knowledge management based on knowledge flow includes four parts: source of knowledge, big data platform of knowledge management and interaction, enterprise big data knowledge base and business process of enterprise. The logical structure diagram is as shown in figure6.

The establishment of collaborative management logical framework in enterprise based on knowledge flow should start from the construction of organization, establishment of big data platform and reconstruction of process etc, integrate knowledge flow into business process and integrate it into enterprise collaborative knowledge management big data platform (Wong and Aspinwall, 2005). Design the flow route of knowledge through standardizing the flow of knowledge and based on the demand of process optimization and then improve the efficiency of knowledge flow and make the knowledge management of enterprise can be implemented in a better way.

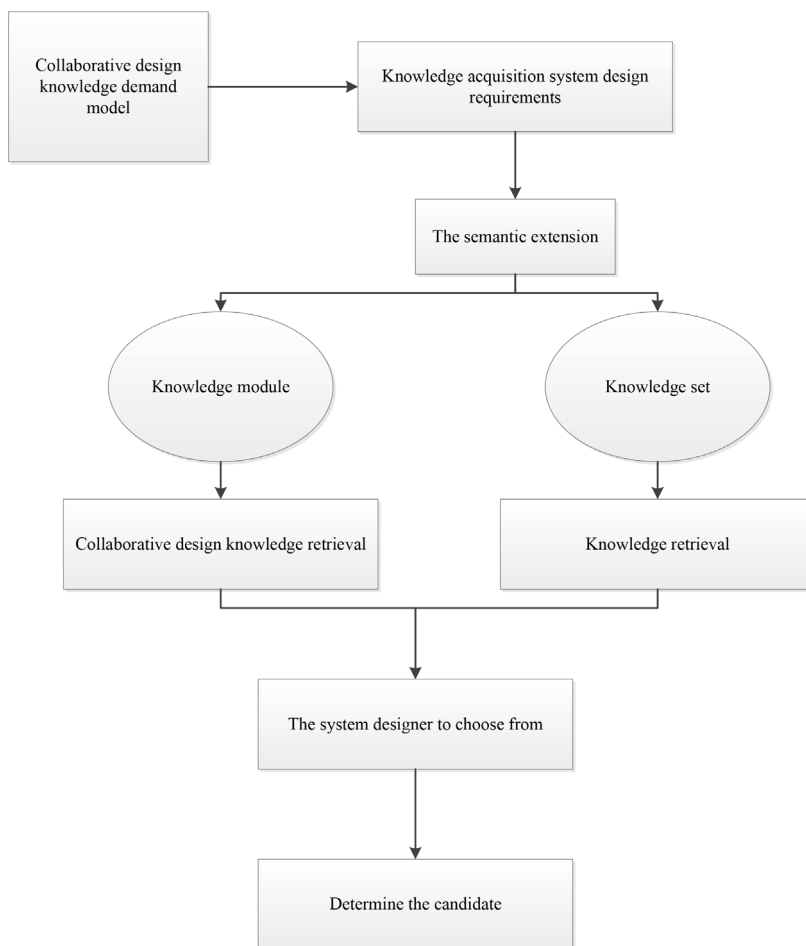


Figure 5 – Collaborative design model of intelligent push

3. Construct the overall framework of collaborative knowledge management system

3.1. Establish collaborative knowledge management process

Knowledge is dynamic and the value of knowledge can be realized through flow knowledge demand people of knowledge using the needed knowledge. As shown in figure7, that is the generation of needed knowledge-knowledge acquisition-knowledge transfer and communication-knowledge sharing-knowledge innovation-knowledge adoption-knowledge production. Each process of collaborative knowledge management system has been integrated with the whole process of optoelectronic devices. Different enterprise staffs produce new knowledge after using new knowledge and combining practical experience and own experience, therefore, the knowledge management process is a circular structure.

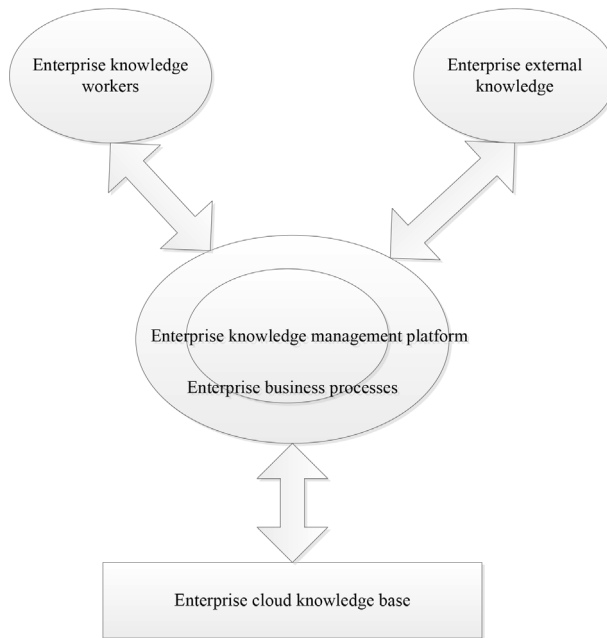


Figure 6 – Collaborative knowledge management logic framework

From collaborative pre-design to successful collaborative design process of optoelectronic devices, knowledge management is cycling and is a process of adoption and feedback process of knowledge, as shown in figure8.

In the production, testing and improvement processes of optoelectronic devices, combining the knowledge of design process with production process, testing process with improvement process closely is the stage of large amount adoption of knowledge and is also a stage where collaborative knowledge management plays an important role. For the data and knowledge produced in design process, use PDM (product data management) for management, package MIS, CAD/CAM and other software on PDM and realize knowledge integration in design process; adopt MRPII to manage the data and knowledge produced in production process, testing process and improvement (Wilson, 2002). In the collaborative production, collaborative testing and collaborative improvement and management process of optoelectronic devices, combine PDM and MRP II together to make integrated management for data and knowledge through information platform interface, which can realize sharing of knowledge resources effectively to control the quality and cost of products. The knowledge integrated model of collaborative design process and production, collaborative testing and collaborative improvement process of optoelectronic devices is as shown in figure9.

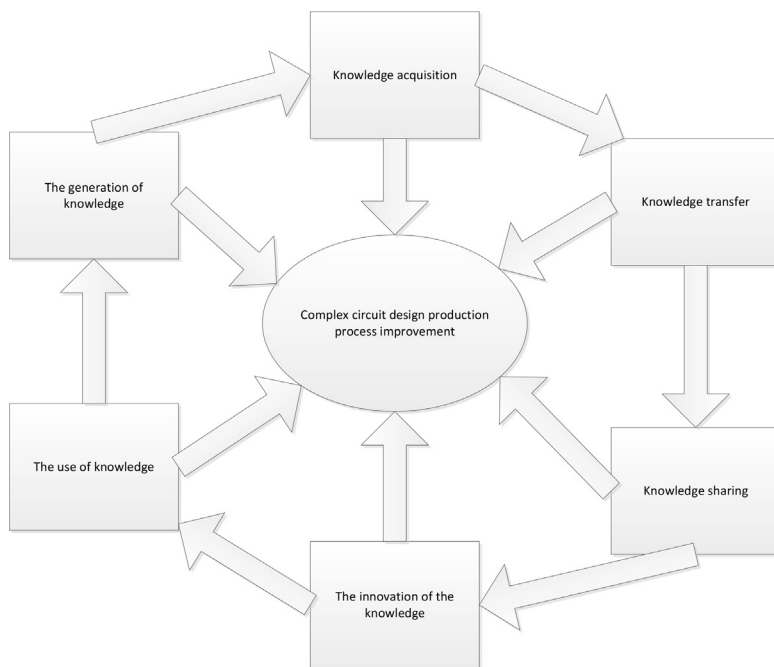


Figure 7 – Collaborative knowledge management system in the process

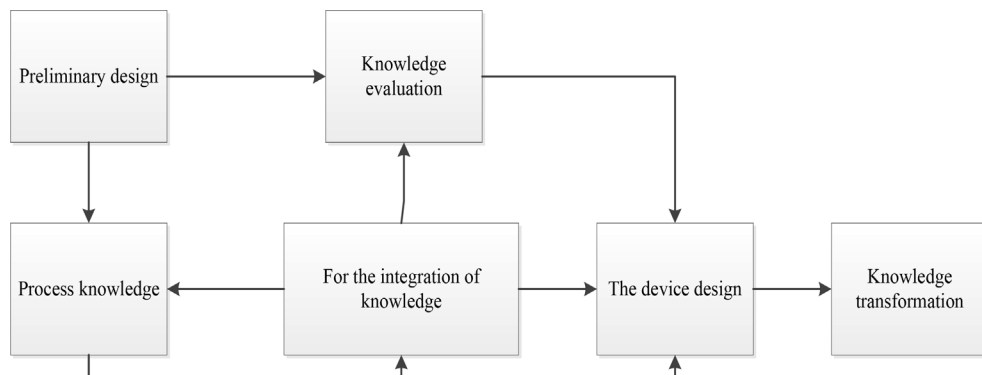


Figure 8 – Product knowledge management in the process of the design to the collaborative design process.

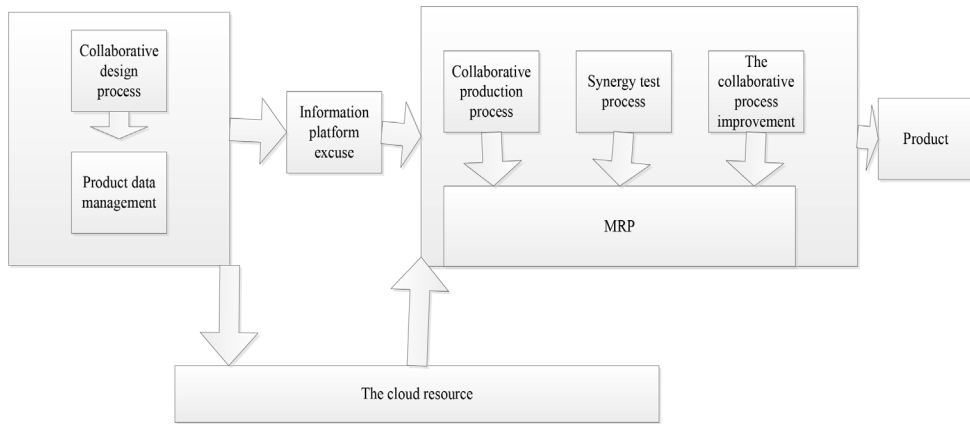


Figure 9 – The knowledge integration pattern

Under collaborative knowledge management framework, the integration of product design and production in IT start-up companies is not only based on work flow but more importantly based on knowledge flow.

3.2. Overall framework of collaborative knowledge management system

In the era of knowledge economy, the importance degree of knowledge in IT start-up companies is becoming more and more obvious and it becomes increasingly urgent to design a collaborative knowledge management system suitable for company development, therefore, one overall framework of collaborative knowledge management system in IT start-up companies based on knowledge flow has been proposed, as shown in figure10.

4. Conclusions

Collaborative knowledge management is the management for knowledge; the flow of knowledge in enterprise is knowledge flow; this paper starts from the research on knowledge flow and the main work is summarized as following:

1. The paper has analyzed the knowledge flow in collaborative knowledge management and divided the knowledge flow into two layers from the perspective of sources of enterprise knowledge: the first layer is the knowledge flow within enterprise, which is the micro layer of enterprise knowledge flow.
2. The paper has proposed the knowledge intelligence push process of designers in collaborative design process. Knowledge intelligence push is the management of knowledge flow. The push idea is that collaborative designers receive design tasks and make tasks analysis; first attain knowledge demand of collaborative designers based on knowledge demand model in collaborative design process, and then make semantic extension for the concept of knowledge module concentration, and then search in collaborative design knowledge base based

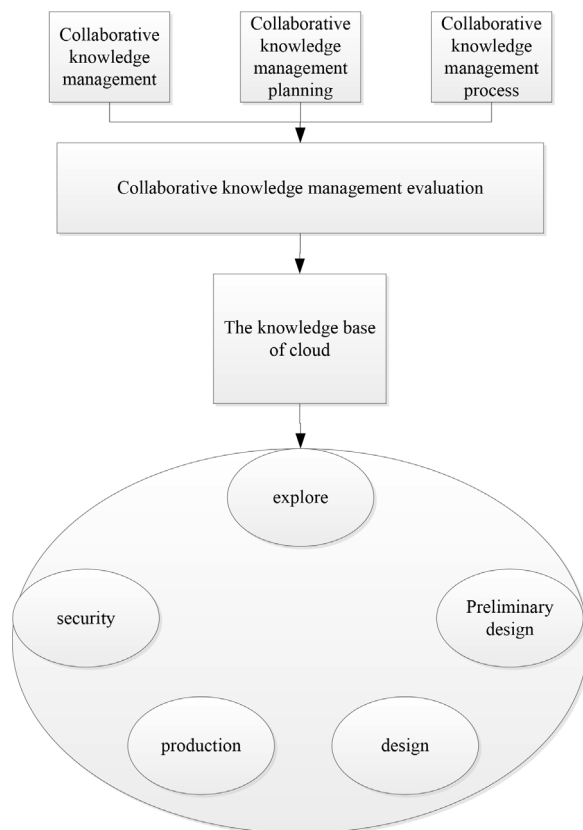


Figure 10 – Collaborative knowledge management synergy overall framework

on these concepts and mapping of knowledge sources and finally push to collaborative designers selectively based on knowledge level filtration of collaborative designer.

3. The paper has constructed collaborative management logical framework of enterprise based on knowledge flow from four aspects of source of knowledge, big data platform collaborative knowledge management and interaction, enterprise big data knowledge base and business process of enterprise; described logical framework from support layer, business layer, expression layer, analysis layer and application layer.
4. This paper has analyzed the basic functions of collaborative knowledge management system, constructed total process of collaborative knowledge management and set up overall framework of collaborative management system for IT start-up companies based on knowledge flow

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Intelligent Early-Warning analysis of financial risk of listing Corporation based on improved neural network algorithm

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Abstract: With the development of market economy, joint-stock companies become the basis of the foundation and development of securities markets. Meanwhile, the growing listed companies have become the main body of the securities market. Their operating condition and performance are widely concerned by the investors, creditors, shareholders, operators and managers who have interests. Compared to the enterprises in the developed countries, Chinese enterprises still exist certain gap in the management level and the competitiveness. It is inevitable to encounter the risk in the process of economic globalization. Therefore, the financial crisis early warning has important significance in enhancing the management level and risk prevention capacity of the enterprises. In this paper, the AHP method is used to classify the financial early warning indicators, and artificial intelligence technology is used to predict the development of enterprises and forecast the risk so as to support the decision. Firstly, 10 experts have been selected from the financial field. They score for 9 kinds of financial indicators listed in the paper. The average value of the results is adopted and divided in to five grades. Secondly, we use the 3rd-level attribute evaluation matrix and 3rd-level attribute comprehensive weights to obtain the score. Thirdly, we construct a neural network model based on the additional momentum and adaptive learning rate, and smallest hidden layer number is found to make the minimum of fitting error through many tests. Finally, financial data of a listing Corporation between 2012 to 2014 is selected as the research sample, and the simulation samples are analyzed as a case study. On the one hand, empirical research is developed to find the root cause of the further deterioration for the company with the financial crisis. On the other hand, publicly available data can be used to predict the company which will have the financial crisis in the next year. This method can help the enterprise managers to make enterprise development strategy and provide the investors with investment decisions.

Keywords: improved neural network algorithm, analytic hierarchy process, intelligent Early-Warning analysis

1. Introduction

With the development of market economy, joint-stock companies become the basis of the foundation and development of securities markets. The growing listed companies, which develop through long term capital accumulation, have become the main body of

the securities market. Their operating condition and performance are widely concerned by the investors, creditors, shareholders, operators and managers who have interests. Compared to the enterprises in the developed countries, Chinese enterprises still exist a certain gap in the management level and the competitiveness. Therefore, it is inevitable to encounter the risk in the process of economic globalization. How to deal with the financial risk is directly related to the enterprise's survival. Therefore, the financial crisis early warning has important significance in enhancing the management level and risk prevention capacity of the enterprises (Yang, 2012; Huang and Bu, 2014; Wu, 2005).

According to the different types of information used in the financial crisis early-warning field, the forecast model can be divided into the financial situation prediction model, the cash flow forecast model and the market yield prediction model. Altman (1968), Haldeman and Narayanan (1977) and other scholars use conventional financial indicators, including debt ratio, current ratio, asset returns, to establish a financial crisis prediction model. Aziz, Emanuel, Lawson (1989) and Piatt (1991) use the cash flow model in the study. They believe that the sum of the present value of cash flow generated by the business activities, the financing activities of the creditor's rights and the financing activities of the equity investment reflects the value of the enterprise. However, with the deepening research on the financial crisis prediction, different information variables are contained in a same model. Except for the indexes mentioned above, growth ability index and qualitative factors have also appeared. Model classification only containing one type of information will be no longer representative. Under this condition, a quantitative research method of financial crisis warning has been developed. It is mainly divided into statistical methods and artificial intelligence methods.

Neural network is an information processing tool, which is formed according to the abstraction, simplification and simulation of the structure and function of the neural network of human beings (Khan, 2016). Neural network is mainly used in pattern recognition, speech recognition, knowledge processing, intelligent robot control, data compression and other fields. Therefore, scholars have made a lot of research on neural network methods applied in financial early warning. Odom and Sharda (1990) apply the three-layer feed-forward neural network model in the study of financial crisis early-warning. Financial index which is the same as Altman used is adopted, and the multiple linear discriminant method is taken as a standard for comparison. And Kiang (1992) uses an artificial neural network theory to establish a three layer neural network model with 19 input nodes and one output node. Experimental results show that the proposed method is more accurate than the traditional statistical methods. Zhou and Wang (2002) combine the fuzzy optimization and neural network model for the dynamic measurement, learning and reasoning on the financial crisis, which emphasizes the dynamic characteristics of neural network in the application of financial crisis early warning.

2. The basic knowledge of AHP

AHP is a simple, flexible and practical multi objective decision method that combining qualitative analysis with quantitative analysis. It changes the present situation of the optimization method only being used in the quantitative analysis, and can make a quantitative analysis for the non-quantitative events. On the whole, the AHP method is a method of measuring the multiple criteria problem which is difficult to be quantified.

And with the implementation of the process, AHP provides three research methods which are system hierarchy analysis, dualistic relative comparison method with 1-9 scale, and the feature vector method with weight ranking.

The steps and applications of AHP are modeled as follows:

1. According to the scaling theory, the judgment matrix A for pair wise comparison is constructed:

$$A = (a_{ij})_{n \times n} \quad (i=1, 2, \dots, n), a_{ij} = 1, a_{ji} = 1/a_{ij} \quad (1)$$

2. The judgment matrix A is normalized:

$$a_{ij} = a_{ij} / \sum_{k=1}^n a_{kj} \quad (i=1, 2, \dots, n) \quad (2)$$

3. The sum of each row in judgment matrix A is calculated by:

$$\omega_i = \sum_{j=1}^n a_{ij} \quad (i=1, 2, \dots, n) \quad (3)$$

4. The normalization process for the sum of each row in judgment matrix A :

$$\omega_i = \omega_i / \sum_{i=1}^n \omega_i \quad (i=1, 2, \dots, n) \quad (4)$$

5. Calculate the biggest characteristic root and its feature vector according to $A\omega = \lambda_{\max}\omega$.
6. Carry out the consistency checking.

3. Using GA algorithm to optimize the parameters of BPNN

Next, we will introduce the basic knowledge of BPNN model. BPNN (Back Propagation neural network) is a Multilayer Feed-forward Neural Networks based on the error back propagation algorithm. The basic structure is shown in Figure 1.

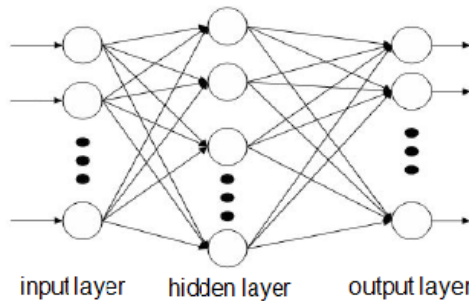


Figure 1 – Specific process of the BPNN algorithm

The input layer is provided with M input signal, and an arbitrary signal is represented by m ; the hidden layer is provided with I neuron, and an arbitrary neuron is represented

by i ; the output layer is provided with p neuron, and an arbitrary neuron is represented by p ; the weight of the input layer and the hidden layer is expressed by w_{mi} ; and the weight of the hidden layer and the output layer is expressed by w_{ip} ; the input of the neuron and excitation output are represented as u and v , respectively. u and v represent the layer when they are superscript, and represent certain neuron when they are subscript. A training sample set is $X=[X_1, X_2, \dots, X_k, \dots, X_N]$, which is correspond to any training sample $X_k=[X_{k1}, X_{k2}, \dots, X_{kM}]^T$, $k \in (1, 2, \dots, M)$. The expectation output is $D_k=[d_{k1}, d_{k2}, \dots, d_{kp}]^T$. Set n as the number of iterations, the weights and the actual output is a function of n .

Input training sample X_k , it can be acquired by the forward propagation:

$$u_i^I = \sum_{m=1}^M w_{mi} x_{km}, v_i^I = f(u_i^I) = f\left(\sum_{m=1}^M w_{mi} x_{km}\right), (i=1, 2, \dots, I) \quad (5)$$

$$u_p^P = \sum_{i=1}^I w_{ip} v_i^I, v_p^P = \phi(u_p^P) = \phi\left(\sum_{i=1}^I w_{ip} v_i^I\right), (p=1, 2, \dots, P) \quad (6)$$

$$y_{kp} = v_p^P \quad (7)$$

Error signal of the neuron p in output layer will be:

$$e_{kp}(n) = d_{kp}(n) - y_{kp}(n) \quad (8)$$

If define the error energy of the neuron as $\frac{1}{2}e_{kp}^2(n)$, the total error energy of neuron in the output layer is:

$$E(n) = \frac{1}{2} \sum_{p=1}^P e_{kp}^2 \quad (9)$$

Through the output of the network, the learning error can be calculated, and the forward propagation is finished. In the reverse propagation process, the error signal is transmitted from the backward to the forward layer to modify the connection weights. The BP neural network algorithm is easy to fall into local minimum and slow convergence in the iterative process. In this paper, the additional momentum method and the adaptive learning rate method are used to solve these problems. In the additional momentum method, a value which is proportional to the change of the previous weight is added to each weight based on the back propagation method, and the new weight is generated according to the back propagation method. The specific method is that a part of the previous weight adjustment amount is added to the weight adjustment amount according to the error calculation. Therefore, the actual value of weight can be calculated by:

$$\Delta \omega_{ij}(n) = \alpha \Delta \omega_{ij}(n-1) + (1-\alpha) \eta \nabla f(\omega_{ij}(n-1)) \quad (10)$$

Where, η is the learning rate; n is the times of training; α is the momentum factor; $\nabla f(\omega_{ij}(n-1))$ is the gradient of the error function.

4. Simulation experiment and result analysis

1st level	2nd level	3rd level	Comment	The Score and Normalization of the first half of 2012		The Score and Normalization of the second half of 2012	
Financial risk index	Enterprise market value index	Earnings per share	Excellent	3	0.6	1	0.2
			Good	1	0.2	3	0.6
			General	1	0.2	1	0.2
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
		Net asset value per share	Excellent	0	0	1	0.2
			Good	3	0.6	4	0.8
			General	2	0.4	0	0
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
		Cash flow per share	Excellent	3	0.6	1	0.2
			Good	1	0.2	3	0.6
			General	1	0.2	1	0.2
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
	Enterprise profitability index	Business income	Excellent	0.2	0.2	0	0
			Good	0.6	0.6	5	1
			General	0.2	0.2	0	0
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
		Return on equity	Excellent	1	0.2	2	0.4
			Good	4	0.8	3	0.6
			General	0	0	0	0
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
		Net interest rate	Excellent	0	0	2	0.4
			Good	5	1	3	0.6
			General	0	0	0	0
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
	Enterprise solvency index	Current ratio	Excellent	2	0.4	1	0.2
			Good	3	0.6	4	0.8
			General	0	0	0	0
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
		Quick ratio	Excellent	3	0.6	1	0.2
			Good	1	0.2	3	0.6
			General	1	0.2	1	0.2
			Qualified	0	0	0	0
			Unqualified	0	0	0	0
		Asset-liability ratio	Excellent	0	0	1	0.2
			Good	5	1	4	0.8
			General	0	0	0	0
			Qualified	0	0	0	0
			Unqualified	0	0	0	0

Table 1 – Scoring results of financial crisis early warning indicators of a listing Corporation

The investigation on the early warning system in this paper is aiming at assisting decision support. This system uses AHP method to classify the indexes and uses artificial intelligence technology to forecast the enterprise development according to the financial situation and data analysis of the corporate governance structure of the listing corporation. Therefore, various aspects of the enterprise are considered in the choice of early warning indicators of financial crisis, and three aspects of content are included in the ultimately established financial crisis early warning index system. Not only the selected financial indicators are included in financial risk analysis, non-financial indicators of corporate equity structure and governance structure are also included.

Firstly 10 experts have been selected from the financial field. They score for nine kinds of financial indicators listed in the paper. The average value of the results is adopted and divided in to five grades. The score results are listed in Table 1. Because of the limitation of content, the data of 2013 and 2014 is omitted.

Then according to the comments in Table1, we get the normalized three-level index evaluation matrix $L = (L_{ij})$. Next, we use the 3rd-level attribute evaluation matrix and 3rd-level attribute comprehensive weights to obtain the score. Based on $E_i^j = T_i^j \cdot V$, the $V = \{90, 80, 70, 60, 50\}$, we can calculate the risk assessment indexes of the 9 two-level index layers from 2012 to 2014. The i means indicators content and $i=1, 2, \dots, 9$.

	$j=1$	$j=2$	$j=3$	$j=4$	$j=5$	$j=6$
E_1^j	83.251	82.267	83.298	84.124	85.428	85.647
E_2^j	78.214	79.328	79.354	81.263	83.407	85.271
E_3^j	82.321	82.141	84.149	83.241	84.630	87.528
E_4^j	80.314	81.653	85.141	85.112	86.257	88.458
E_5^j	83.641	84.921	84.851	87.245	88.811	89.533
E_6^j	83.242	83.530	83.422	86.997	88.292	90.015
E_7^j	82.222	82.441	84.626	85.246	85.927	87.225
E_8^j	80.239	82.125	83.471	85.596	85.926	85.211
E_9^j	83.253	82.267	83.391	84.444	85.429	85.511

Table 2 – The financial risk assessment index

In this paper, the result of the scoring is used as the input value of the improved BP neural network. As the neural network model of this paper is a 9-X-1 model, we carry out the training of the sample according to principle. The principle is that the number of nodes

in the hidden layer is 3/4 of the number of nodes in the input layer. It can be known that the number of hidden layer nodes is $X=5$, and the system fitting residual is the smallest.

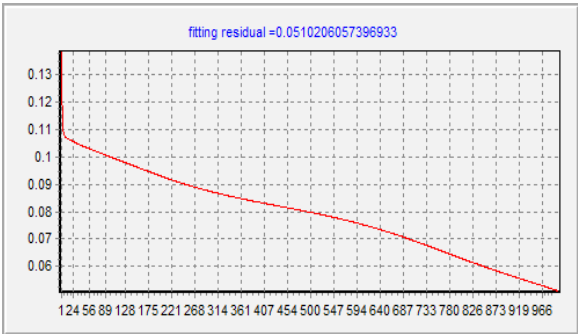


Figure 2 – The number of hidden layer nodes is 5 in neural network training

It can be seen from the test results of Figure 2, the node number and the initial value in this paper can effectively shorten the convergence time, accelerate the training speed, and make the fitting precision of the residual error reach the highest. Based on the above risk attributes which are showed in Table 2, the improved BP neural network model will be used to forecast the risk assessment indexes of the next four periods: the first half and the second half of 2015 and 2016 are showed in Table 3. Generally, the corporation’s financial indicators listed has a good trend, and the risk is in the controllable range.

	The first half of 2015	The second half of 2015	The first half of 2016	The second half of 2016
E_1^j	88.2	88.4	88.6	89.2
E_2^j	85.2	85.7	86.2	86.5
E_3^j	87.9	88.5	88.8	88.8
E_4^j	88.1	88.3	88.6	89.1
E_5^j	89.6	89.9	91.2	92.2
E_6^j	90.1	90.8	91.2	91.6
E_7^j	88.2	88.6	87.2	87.6
E_8^j	86.3	86.2	85.7	87.1
E_9^j	85.9	85.5	85.5	86.2

Table 3 – The prediction results

5. Conclusion

In this paper, the AHP method is used to classify the financial early warning indicators, and artificial intelligence technology is used to predict the development of enterprises and forecast the risk so as to support the decision. Firstly, 10 experts have been selected from the financial field. They score for 9 kinds of financial indicators listed in the paper. The average value of the results is adopted and divided in to five grades. Secondly, we use the 3rd-level attribute evaluation matrix and 3rd-level attribute comprehensive weights to obtain the score. Thirdly, we construct a neural network model based on the additional momentum and adaptive learning rate, and smallest hidden layer number is found to make the minimum of fitting error through many tests. This method can help the enterprise managers to make enterprise development strategy and provide the investors with investment decisions.

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A Research on the College English Teaching Pattern from the View of Inter-cultural Communication

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Abstract: With the increasing of the openness degree, the English teaching pattern reform of Chinese tertiary institutions also arouse a heat discussion. This paper basing on the state quo and problems of Chinese college English teaching, explored the advantages and disadvantages of the college English teaching pattern from the view of inter-cultural communications and prompted structure and frame of it in the large sense.

Keywords: inter-cultural Communication, College English Teaching Pattern

1. Introduction

Since the Opening Up and Reform, Chinese gained a high-speed development. When push forward firmly the opening up policy, China also cultivated plenty of high-quality and high-level talents who started to go global and took part in the multi-cultural communication. Meanwhile, the college teaching pattern - cultivating transnational communicated talents especially the college English teaching pattern attracted the extensive attention from the academic circles and the public. How to maintain the Chinese talents to be invincible has already the focus of the social discussion. Based on the above, this paper explored Chinese college English teaching new model from the view of inter-cultural communication so as to provide the reference theories for Chinese college English teaching (Zhang, 2016).

2. The State Quo and Problems

With the pressing ahead of the Opening Up and Reform, the English started to be popularized. The colleges and universities make the English as the necessary courses and demand every graduates reaccepting higher education to master English as the basic communication skills. Objectively, over the several years, the English teaching also gained many gratifying achievements. At the same time, it is undeniable that there are still some problems in the present stage.

2.1. The Function of Ignoring the Culture

Language as the important tools for cultural heritage contains a tacit relationship with the culture. Without the language transmission and communication, the culture

is hardly to exist and develop; vice versa, without culture, the language would lose its meaning and value (Barbaranelli et al, 2015). Thus, we must pay more attention to the culture when exercise the English teaching. Currently, during the English teaching, most colleges and universities still lack the real knowledge of the cultural function and directly lead to ignore the culture during the English teaching. In the present stage, the college English teaching mainly focus on the theoretical teaching and teaching English with English (Guo, 2013). The English teaching only teaches the English Grammar and meaning rather than introducing and teaching the English and English-speaking countries. That's why the students know the how, not the why, the limitation of the teaching results and monotonous of the teaching pattern (Wu, 2016).

2.2. Lacking Experience

As a foreign language, the English also hides the culture. If the college English teachers could not seize the difference and similarities and features between Chinese and foreign cultures, they would be difficult to teach English vividly and get great breakthroughs about teaching results. In fact, the phenomenon of lacking inter-cultural experience is very serious. In the present stage, the teachers of the colleges and universities maintain a little experience on the overseas study and life. The teachers with inter-cultural experience in “211 Project” universities and above is rare and precious (Windiarti and Ferris, 2014). Most academic leaders for the universities or the English department and the common

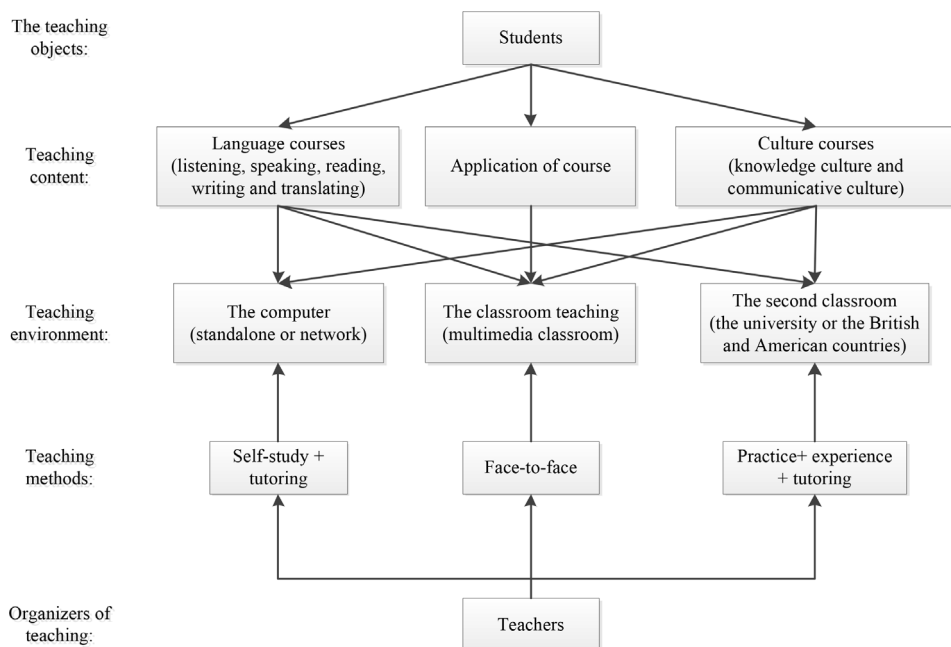


Figure 1 – University English teaching mode and cross-cultural communication exchange program

English teachers all lack the experience of studying and living overseas. Objectively, the fact provides that the English teaching lacks inter-cultural experience.

2.3. Lacking Awareness

To now, although the academic circles strengthened the reorganization for Inter-cultural Communication, it is still limited to apply them into the practice. The theories about the inter-cultural communication cannot be used effectively into the practice. It also the fundamental reason for Chinese colleges and universities lacking the inter-cultural awareness. Currently, it is very limited for the English teachers who exercise the research on the inter-cultural communication. This kind of persons mainly distributed in the comprehensive colleges and universities (Liang, 2011). Even though, it is even rarer and more precious to apply the results into the practical teaching especially the college English teaching. Thus, the disjunction of the theories and the practice of the inter-cultural communication directly lead the lack of the awareness.

2.4. Lacking Inter-cultural Training

The necessary training is the precondition for commanding a skill. The college English teaching has regulations to abide by and is a teaching art (Knight et al, 2006). The extent of English teaching results enjoys a close relationship with the teachers' guidance. The more the teachers contact and train the teaching method and skill, the larger possible to gain the teaching results. As the research shown, regarding the number of the college English teaching results as the dependent variable and the number of the teachers contacting and training the teaching method and skill as the independent variable, this author made a simple linear regression model and got the amendment coefficient of determination reached 0.862. This shows that the number of the teachers contacting and training the teaching method and skill could bring an effective influence to the teaching results number. Thus, increasing the number of the teachers contacting and training the teaching method and skills the most effective way to improve the teaching results. However, the real situation is not ideal. Currently, most our colleges and universities teachers lack the inter-cultural communication training. During the research data, most English teachers didn't receipt the systemic inter-cultural communication training. Because the systemic learning does not mean that they could totally master and apply in the future work so as to improve their teaching ability. Thus it can be seen, the shortage of the contacting and training is the prominent and urgent problem.

3. Advantages and Disadvantages

Any teaching model has its inherent advantages and disadvantages. So to speak, how to choose the different teaching model is a kind of art. So how to combine and integrate the various and featured teaching method then give full play their advantages and avoid their disadvantage must be a kind of art. This paper focuses on the application of the inter-cultural communication in the college English teaching. It is undeniable that the teaching model both contains the prominent advantages and the disadvantages.

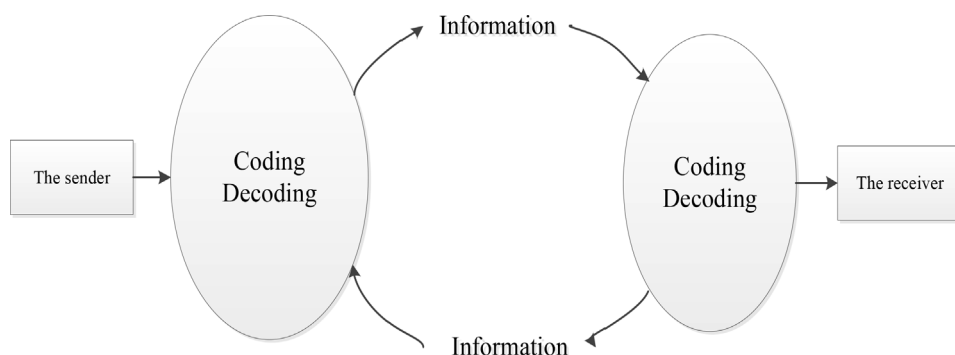


Figure 2 – Communication model for Shalimar

3.1. Advantages

Firstly, based on the college English Teaching from the view of inter-cultural communication, the author seizes the English form the connotation and essence so that the English teaching could yield twice the result with the half effort. As a language, English could be achieved the expected results by strengthening the understanding of its connotation and essence. Culture is the fundamental factor to foster language. Though the English, as the language especially in the real communication doesn't have the fixed norms and regulations, its hidden culture has the fixed regulations. If the teachers could give a clear elaboration about the foreign culture, the students could get unexpected effects in understanding and applying the English. As it was, without the integration of the inter-cultural communication model, the college English teaching is hard to yield twice the result with half the effort. Secondly, the college English teaching from the view of inter-cultural communication is good to increase the interactive between the teachers and students so as to raise the animation of the teaching. In the new century, the focus of the college teaching is innovation. Thus, only the innovation could simulate the students' enthusiasm and energy. As a language, English's culture basement contains a large difference with Chinese's. Thus, it is inevitable for the students arise the in-adaption and disgust. But it should be noted that the adolescent students possess strong curiosity and thirst for knowledge for the new things. The appropriate application could simulate these characters so that the students perform actively in the class and highly understand and accept the class content. In a manner of speaking, without the integration of the inter-cultural communication, the present English teaching is difficult to be improved.

3.2. Disadvantages

Firstly, the disadvantages for the college English Teaching from the view of inter-cultural communication is bad to the coordination between the foreign culture and domestic's. Objectively, once the college English teachers melt the inter-culture in to the teaching pattern, it is inevitable to publicity prominently the foreign culture. Whether the method is fair or not will directly influence the students' ideologies. From the experience of my college teachers, we could see that most of them lack deep understand

of the Chinese traditional culture and even very shallow. It is very dangerous. Because the undergraduates are on the formation stage of their outlook of world, life and value, they would influence heavily if they fail to differ the essence and dross of the foreign culture. That would even pose a huge challenge to the Chinese cultural heritage. From the inheritance of the national culture, failing to coordinate the relationship between the foreign and domestic culture will deviate the teaching from the original intention.

Secondly, the disadvantages for the college English Teaching from the view of inter-cultural communication is bad to control the class rhythm and teaching progress. All the time, China press ahead the exam-oriented examination, which make the students be accustomed to receive the knowledge passively. On the contrary, the inter-cultural communication model focuses on the interactive and exchange between teachers and students, seize the key points and improve the quality and ability. According the authors' several years' experience, once the open teaching model is implemented, the class rhythm and teaching progress is difficult to control. On the on hand, the teachers' quality is not enough to control the class appropriately. On the other hand, the students will perform the "release equal to disorder" under this teaching mode. If it is happened, not mention to the excellent could gain a good result. Hence, although the inter-cultural communication model contain a great number of advantages, it also is difficult to press ahead.

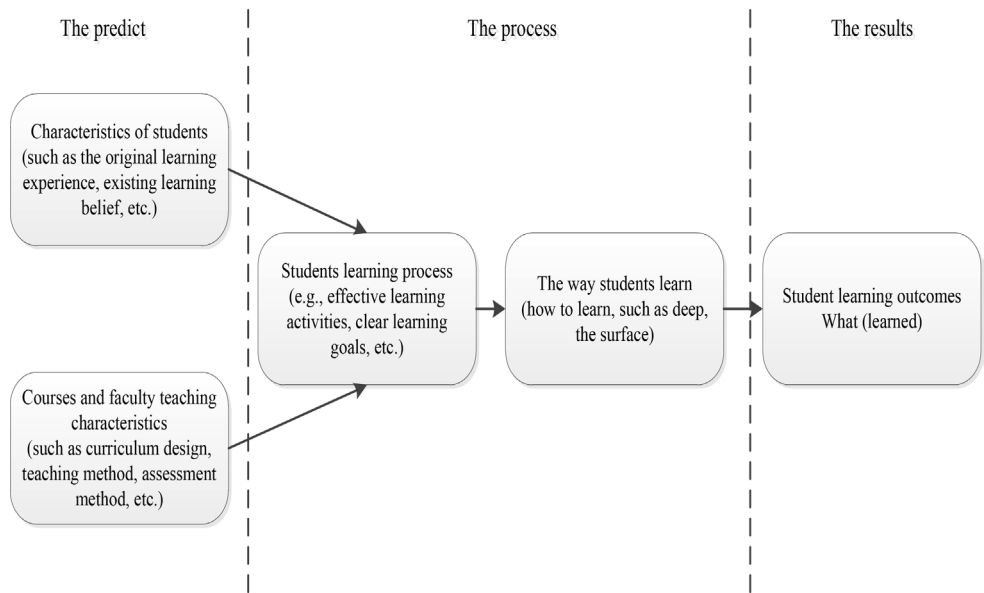


Figure 3 – Effective classroom teaching three aspects analysis theoretical model

3. College English Teaching' Construction

Although the inter-cultural communication model has pros and cons, it as a totally new teaching model, has the feasibility to push forward. The author believes to construct the

inter-cultural college English teaching pattern. Firstly, the teachers should make the well preparation before the class including understanding the foreign culture and customs ahead and the development history of English. Some qualified universities and colleges should provide the teachers with Chinese and foreign cultures so that they could have a real sensation about the Chinese and foreign cultures. Secondly, in the class, the teachers should lead the students to view the English with different cultural basement with the exoteric posture and simulate them to compare and analyse the Chinese and foreign cultures and languages. Then, the teachers should encourage the students to express their inspiration by various ways. On the one hand, it could reinforce the acquaintance; on the other hand the students could easier recognize the beauty and practicability. Finally, the teachers also should extend teaching to off-class so that the students could make full application of the school resources, search and integrate the related materials on the Chinese and foreign cultures and languages and increase their reading. In that way, the students could be released from the cramming teaching method and reinforce their autonomy and initiative.

The disadvantages for the college English Teaching from the view of inter-cultural communication is bad to the coordination between the foreign culture and domestic's. Objectively, once the college English teachers melt the inter-culture in to the teaching pattern, it is inevitable to publicity prominently the foreign culture. Whether the method is fair or not will directly influence the students' ideologies. From the experience of my college teachers, we could see that most of them lack deep understand of the Chinese traditional culture and even very shallow. It is very dangerous. Because the undergraduates are on the formation stage of their outlook of world, life and value, they would influence heavily if they fail to differ the essence and dross of the foreign culture. That would even pose a huge challenge to the Chinese cultural heritage. From the inheritance of the national culture, failing to coordinate the relationship between the foreign and domestic culture will deviate the teaching from the original intention.

4. Expanding Actively & Extending Research

We put stress on the construction of the provincial student scientific research projects and cultivate some national-level student scientific research projects. Meanwhile, we also should reinforce and extend the strong national-level projects and try to gain an excellent level in the national level discipline competition of the students. After the school-level projects made the conclusion, we should provide the contribution fee to the students who are the first author of the articles and add some subsidies for the material manufacturing. Since the Hunan undergraduates innovative experimental plan for the five years, the students who took part in gained plentiful fruits above the provincial-level competitions. In 2011, the students gained the first prize in the National College Electronic Design Contest and National College English Speech Contest. They also achieved the accessed in the National University Students Mathematics Modelling Contest and the first prize for the group in the Provincial Sports Basic Skills Contest. As well, they still received successively second national prize and national Outstanding Organization Award.

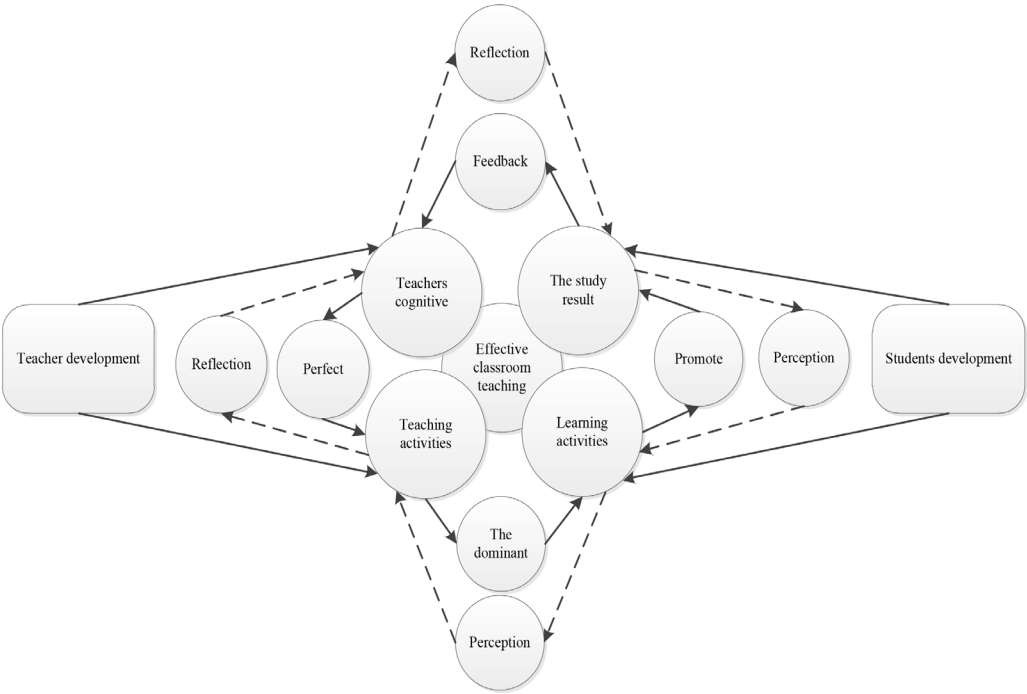


Figure 4 – Promote the coordinated development between teachers and students of college students’ English classroom effective teaching theory model

5. Conclusion

The construction of the long-term college innovative experiment mechanism of the local universities of science and engineering is good to cultivate students’ innovative ability and improve the higher education teaching level. Hunan Institute of Science and Technology, the Up-and-Coming, took the lead in declaration and review of the newly granted Master’s degree conferment gift from 2008 to 2015. In 2012, it also accomplished the final acceptance of the State Council Academic Degree Committee. In 2013, it will official start the cultivation of the graduate, laying a solid foundation for the sustainable development. Educational Department of Hunan Province fully affirmed the implementation of my university’ college research study and innovative experiment and successively award us more declaration quota from 2010 to 2013. At the same time, the establishment of the master granted unit also provides the evident the improvement of the cultivate level. The graduate cultivation gains more and more attention and the college experiment mechanism will welcome a new round of development opportunities.

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Research on the Implementation Strategy and the Comprehensive Fuzzy Evaluation Model of Entrepreneurship Education for College Students

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Abstract: As a new-type pedagogical pattern suitable for China's national conditions, entrepreneurship education is of great significance to the promotion and improvement of modes and systems of higher education. The paper conducted research into the implementation strategy and the comprehensive fuzzy evaluation model of entrepreneurship education for college students. Specifically, the paper analyzed first problems arising from the implementation of entrepreneurship education under the current pedagogical mode; on this basis, tentative analysis and discussion were undertaken on multi-platform, multifaceted development strategies; then, by constructing an evaluation index system and a comprehensive fuzzy evaluation model, the paper evaluated implementation effects of entrepreneurship education under the guidance of the strategies; finally, the paper carried out empirical analysis of relative implementation strategies and models.

Keywords: implementation strategy, comprehensive fuzzy evaluation, college students

1. Introduction

Entrepreneurship education provides a new access for the society and colleges to cultivate high caliber entrepreneurial talents, and serves as an important measure of educational innovation in the course of socialized development in China. This pedagogical pattern is born of the domestic development of higher education and the high-tech-based era of knowledge-driven economy, aiming to match their needs (Liu 2014; Mu 2014). The reception of entrepreneurship education can arm high caliber talents with various entrepreneurial supports necessary for business start-up, including entrepreneurial consciousness, mind, skills, knowledge, environments and platforms. Entrepreneurship education hence plays a positive role in promoting social employment and economic growth, and has significant meaning for educational progress and social development as well (Wan 2014; Li 2016; Shi 2010). It has gradually blossomed into the research focus and frontier in terms of modern post-secondary education, becoming one of the striking trends of development and reform of tertiary education in China (Li 2015; Xiang 2014; Liu 2012). In particular, the promulgation of *Opinions on vigorously promoting innovative entrepreneurship education and undergraduate*

entrepreneurship in colleges and universities in 2010 has sparked manifold studies and discussions about entrepreneurship education, resulting in the production of a series of corresponding research achievements and advices such that the development of entrepreneurship education has been greatly enhanced in China (Ge, 2014; Huang, 2013; Feng, 2013; Feng, 2013). However, due to the above phenomenon, there still lacks a fixed, uniform implementation pattern of domestic entrepreneurship education, and corresponding theoretical and empirical studies have great room for growth. How to render entrepreneurship education more systematic, timely, practical, and enduring needs to be discussed and analyzed in a deeper level.

2. Problems in the course of present implementation

By analyzing existing research documents and their achievements, and in combination of investigation and survey concerning entrepreneurship education, the paper found that problems in the course of present implementation of entrepreneurship education were mainly reflected in the following aspects:

1. Unclear target location: different from vocational, professional, and essential-qualities-oriented schooling, entrepreneurship schooling has its unique educational target and fundamental destination, namely the enhancement of entrepreneurial capacity.
2. Out of line with market demands and social growth: entrepreneurship education is supposed to focus on demands of social growth, especially on mainstream market demands, which is crucial to increasing entrepreneurial success rate.
3. Insufficient consideration of entrepreneurial settings, and lack of effective social supporting system: the design of curriculum and activities of entrepreneurship education fails to take into full account actual situations of social development. As a result, the implementation of entrepreneurship education sticks in the mud and cannot adapt to changes of time and environment.
4. Monotonous means and methods: entrepreneurship education should not only incorporate rudimentary knowledge and professional knowledge, but also take account of complementary practices and social activities. Therefore, one ought to integrate various means and methods into the implementation of entrepreneurship education.
5. Poor quality of teachers: this serves as the vulnerable link of entrepreneurship education. The reason is that the lack of a uniform educational mode for entrepreneurship education restricts relative educational units from recruiting and training selective teachers.
6. Lack of systems: entrepreneurship education at present resembles more vocational education in a way that is biased toward breeding professional skills rather than improving entrepreneurship capacity. Therefore, there is unbalanced curriculum design for entrepreneurship education. Another reason for lack of systems lies in the diversity of occupation orientation.
7. Imperfect mechanism of supervision, approval, and appraisal: there is no uniform, standard patterns and evaluation criteria of entrepreneurship education. As a consequence, different kinds of entrepreneurship education are done in educational units and institutions to preferably match their own needs of

- development. However, there lacks effective supervision, approval, and appraisal on the goals, methods, systems, and results of entrepreneurship education.
8. Old-style pattern and poor integration between theories and practice: traditional entrepreneurial education gives more weight to imparting theoretical knowledge, but lacks cultivation of innovative capacity that adapts to the development of the era. To foster creative ability is closely related to launching practical activities.
 9. Short of cultivation of innovative mind and creative ability: innovative mind and creative ability is the most urgent requirement of entrepreneurship education under the context of modern social development, and serves as an important link in successful entrepreneurship.

3. Multi-level, multifaceted implementation strategies

3.1. The combination between entrepreneurship education and vocational & professional education

Professional education gives more priority to imparting professional knowledge, aiming to help students improve professional competence; while vocational education pays more attention to counterpart training of technologies and skills, with the intention of seizing job opportunities. In comparison, as a new-type educational mode and idea, entrepreneurship education not only attaches importance to spreading professional knowledge, but also takes into account potential technical and skillful issues to arise from business start-up, so that entrepreneurship education capacity can be enhanced.

3.2. The combination between college education and social training

Strictly speaking, university education is more like frame type knowledge education. It depends mostly on classic theoretical curriculum, and ranges multiply from course setting, specialty planning, teacher allocation, to system formulation. With respect to student cultivation, teachers under university education tend to spoonfeed students, who hence lack dynamic adaptability to social and era development. Whereas social training, with not much systemic knowledge though, is able to provide plenty of social practice opportunities. This phenomenon is meaningful to fostering professional techniques, because the transformation of training and education can be done rapidly and targetedly along with social development and market change. The organic integration between social training and university education will uplift theoretical education and practice to a new level, having positive significance to enhancing the level of entrepreneurship education.

3.3. Industry-university-research cooperation

Industry-university-research cooperation provides a highly efficient approach for colleges and universities to cooperate technically with high-tech enterprises. Despite abundant scientific and research resources, technical talent pools, and innovative research achievements in the theoretical level, colleges and universities lack backgrounds of popularization and application of technical and scientific fruits. As a complementarity, high-tech enterprises always have urgent needs for scientific and technical application. This means that such enterprises can provide broad settings for colleges and universities to put scientific and research results into application. The measure of expanding industry-university-research cooperation to entrepreneurial education will facilitate

high-quality configuration of educational contents in industries, universities, and the field of research, and will optimize the associations among them. It will also help students keep in line with era and have better chance to start up a business successfully.

4. The comprehensive fuzzy evaluation model

4.1. Determination of the comprehensive fuzzy evaluation index set

Under the support of multi-level, multifaceted implementation strategies of entrepreneurship education, the paper conducted integral evaluation on entrepreneurship education from the perspectives of specialty planning, teaching, practice, and social output, respectively. Details of evaluation indices are listed below.

Specialty planning C_1 : Rationality of planning C_{11} , skill fosterage C_{12} , combination of theories and practice C_{13} , teaching and practice course management C_{14} , industry-university-research cooperation C_{15} .

Teaching C_2 : Teaching level C_{21} , teaching organization C_{22} , quality of teachers C_{23} , entrepreneurial contest and research participation C_{24} , entrepreneurial teaching and research achievements C_{25} .

Practice C_3 : Entrepreneurial environment construction C_{31} , entrepreneurial communication and instruction platform C_{32} , entrepreneurial training and practice base construction C_{33} , entrepreneurial service and its supportability C_{34} , entrepreneurial program construction C_{35} .

Social output C_4 : Social satisfaction degree C_{41} , entrepreneurial achievement transformation C_{42} , entrepreneurial success rate C_{43} , social profitability C_{44} .

4.2. Determination of index weight (Claudio 2016; Hong 2013)

m experts were invited to evaluate index weights, and the score of the I th expert on evaluation index j was r_{ij} . Given that the magnitudes of evaluation indices should remain uniform, the paper undertook normalized processing on r_{ij} to acquire its normalized magnitude u_{ij} :

$$u_{ij} = r_{ij} / \sum_{i=1}^M r_{ij}, 0 \leq u_{ij} \leq 1 \quad (1)$$

And the obtained normalized evaluation matrix U was expressed as

$$U = [u_{ij}]_{M \times N} \quad (2)$$

Then, the weight information entropy E_j of the evaluation index j was given as:

$$E_j = -\ln(m)^{-1} \sum_{i=1}^M (u_{ij} * \ln(u_{ij})) \quad (3)$$

The importance degree of the evaluation index j relies on the difference H_j between E_j and 1, namely

$$H_j = 1 - E_j \quad (4)$$

Thus the weight w_j of the evaluation index j was defined as:

$$w_j = H_j / \sum_{j=1}^n H_j \quad (5)$$

And the corresponding weight sequence W was expressed as

$$W = \{w_1, \dots, w_j, \dots, w_N\}^T \quad (6)$$

4.3. Determination of the remark set

The paper classified fuzzy evaluation of entrepreneurship education into five grades (Qi et al., 2016): excellent EG_1 , favorable EG_2 , medium EG_3 , ordinary EG_4 , and poor EG_5 . Thus, the remark set EG could be defined as

$$EG = \{EG_1, EG_2, EG_3, EG_4, EG_5\} \quad (7)$$

The hundred-mark system was employed for fuzzy scoring, and the corresponding remark magnitude sequence V_{EG} was obtained as

$$V_{EG} = \{90-100, 80-90, 70-80, 60-70, 0-60\} \quad (8)$$

4.4. Establishment of the fuzzy evaluation matrix

Once the fuzzy membership degree $\psi(j, k)$ of the evaluation index j to the fuzzy evaluation grade k was acquired, the paper could build up the fuzzy membership degree evaluation matrix ψ , namely

$$\psi = [\psi(j, k)]_{N \times K} \quad (9)$$

$\psi(j, k)$ can be obtained by means of computing fuzzy distance, establishing fuzzy membership function, or undergoing fuzzy scoring by experts. Given the maturity of relative research, the paper will not discuss it in the paper.

4.5. Establishment of the fuzzy evaluation model

On the basis of w and ψ , the paper obtained the comprehensive fuzzy membership degree sequence θ of the entrepreneurship education evaluation targets to fuzzy evaluation grades, namely

$$\begin{aligned}\widetilde{\psi} &= \left\{\widetilde{\psi}_1, \cdots, \widetilde{\psi}_k, \cdots, \widetilde{\psi}_K\right\} \\ &= \mathbf{W}^T \otimes \psi = \begin{bmatrix} w_1 \\ \vdots \\ w_j \\ \vdots \\ w_N \end{bmatrix} \otimes \left[\psi(j, k)\right]_{N \times K}\end{aligned}\tag{10}$$

By analyzing $\widetilde{\theta}$ of different evaluation indices at each grade, and according to the optimum principle, the final value of $\widetilde{\theta}$ could be determined as

$$\widetilde{\psi}_o = \max \left\{\widetilde{\theta}\right\} = \max \left\{\widetilde{\psi}_1, \cdots, \widetilde{\psi}_k, \cdots, \widetilde{\psi}_K\right\} = \widetilde{\psi}_t\tag{11}$$

And the fuzzy evaluation grade t of the entrepreneurship education evaluation targets could be acquired.

5. Empirical analysis

The paper took entrepreneurship education in a certain university as an example for analysis, and obtained the initial scoring results (Table 1) and the fuzzy membership degree of evaluation indices to fuzzy evaluation grades (Table 2).

experts	evaluation indices								
	C_1	C_2	C_3	C_4	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}
1	60	100	90	80	100	90	70	95	60
2	80	90	100	90	100	85	80	90	80
3	90	100	100	60	100	80	70	90	85
4	100	90	90	80	100	90	80	85	80
5	80	100	80	80	100	90	80	90	80
experts	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}	c_{31}	c_{32}	c_{33}	c_{34}
1	100	90	90	80	80	90	100	100	90
2	90	100	100	80	80	90	100	100	90
3	80	100	90	70	70	95	100	90	90
4	90	100	80	80	80	85	90	100	95
5	80	90	100	80	80	90	100	100	90
experts	c_{35}	c_{41}	c_{42}	c_{43}	c_{44}				
1	85	90	100	100	95				
2	90	85	100	100	90				
3	85	90	100	100	90				
4	90	85	100	100	80				
5	85	85	100	100	80				

Table 1 – Scoring results of evaluation index weight

Evaluation indices	fuzzy evaluation grades				
	EG_1	EG_2	EG_3	EG_4	EG_5
C_{11}	0	0.40	0.60	0	0
C_{12}	0.30	0.60	0.10	0	0
C_{13}	0	0.20	0.70	0.10	0
C_{14}	0	0	0.60	0.30	0.10
C_{15}	0.20	0.80	0	0	0
C_{21}	0	0.30	0.60	0.10	0
C_{22}	0	0	0.20	0.70	0.10
C_{23}	0	0.10	0.80	0.10	0
C_{24}	0	0	0.20	0.60	0.20
C_{25}	0.10	0.70	0.20	0	0
C_{31}	0	0	0.10	0.70	0.20
C_{32}	0	0.20	0.60	0.20	0
C_{33}	0	0	0	0.30	0.70
C_{34}	0	0	0.20	0.60	0.20
C_{35}	0	0.20	0.60	0.20	0
C_{41}	0.10	0.70	0.20	0	0
C_{42}	0	0.80	0.20	0	0
C_{43}	0	0.40	0.60	0	0
C_{44}	0.10	0.20	0.70	0	0

Table 2 – The fuzzy membership degree of evaluation indices to fuzzy evaluation grades

With the help of the given computation method of comprehensive fuzzy membership degrees, the paper obtained the fuzzy membership degrees of criteria levels to fuzzy evaluation grades (Table 3).

criteria	fuzzy evaluation grades				
	EG_1	EG_2	EG_3	EG_4	EG_5
C_1	0.0964	0.393	0.0781	0.0804	0.0209
C_2	0.0181	0.2089	0.409	0.3056	0.0584
C_3	0	0.0798	0.298	0.3965	0.2257
C_4	0.0466	0.5301	0.4233	0	0

Table 3 – The fuzzy membership degrees of criteria to fuzzy evaluation grades

The paper further acquired the comprehensive fuzzy membership degree sequence of the evaluation target, namely $\psi=\{0.0381,0.2902,0.3048,0.2780,0.0806\}$. It could be seen that the entrepreneurship education of the targeted university fell into the medium grade. The above evaluation results at different grades concerning evaluation criteria and evaluation indices were suggested to be referred to by the university in taking targeted measures to improve effectively the level of its entrepreneurship education.

6. Conclusion

The paper discusses the implementation mode and performance evaluation of entrepreneurship education, and analyzes problems in the course of enforcing entrepreneurship education. Multi-level, multifaceted implementation strategies of entrepreneurship education are put forward, with the establishment of a comprehensive fuzzy evaluation index system. What's more, on the foundation of information entropy, the paper determines the weights of evaluation indices, builds up a comprehensive fuzzy evaluation model, and expounds the strategies and the model through empirical analysis. Further research needs to be conducted on theories and practice of early-adopter entrepreneurship education to the advantage of supporting the follow-up development of high-quality entrepreneurship education.

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Analysis of informatization evaluation on preschool education specialty in Universities

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Abstract: First, an index system for informatization evaluation on preschool education specialty in universities was established in the paper. Then, whitening values of the grey numbers in the corresponding informatization evaluation model were determined, and the grey matter elements for each tier-one evaluation index were further decided. On this basis, the grey matter element model was built up, with which the informatization evaluation on preschool education specialty in universities was simulated and calculated.

Keywords: informatization evaluation, Grey matter element model, Simulative calculation, preschool education

1. Introduction

Recently, the technology of educational informatization has developed greatly in China, which drives reform in education. However, among current studies, there is rare research on preschool education informatization. Along with continuous social development, preschool education has become an increasing focus. As a result, the national government has promulgated new policies encouraging the development of preschool education, and states clearly that preschool education is the crucial part of national educational system in China (Cai, 2005; Huang, 2016).

2. Index system for informatization evaluation

According to reference data and expertise, the paper constructed an index system for informatization evaluation on preschool education specialty in universities (Cheng and Xie, 2011), as shown in Table 1.

3. Grey matter element model

3.1. Determination of whitening values of the grey numbers

A triad of grey matter elements was used to describe preschool education informatization in universities, including preschool education informatization in universities, informatization characteristics, and whitening values of the grey numbers. The formula for the description was:

Informatization evaluation on preschool education specialty in universities P	Tier-one evaluation index	Tier-two evaluation index
	informatization infrastructure construction A	Provision of multi-functional classrooms A ₁ ; the number of computers and its installation A ₂ ; construction of information network interaction platform A ₃ ; information network safety equipment A ₄ ;
	Information resource construction B	Preschool education multimedia courseware B ₁ ; network resource construction B ₂ ; preschool education online courses B ₃ ; preschool education high-quality courses B ₄ ;
	Informatization application C	Preschool education informatization level C ₁ ; the application of information technology to teaching C ₂ ; the application of information technology to student management C ₃ ; the application of information technology to specialty construction C ₄ ;
	Talent team construction D	Informatization-oriented training for teachers D ₁ ; Informatization-oriented training for students D ₂ ; Informatization-oriented training for logistic staff D ₃ ;

Table 1 – An index system for informatization evaluation

$$\tilde{\otimes} R = \begin{bmatrix} N \\ c & \tilde{\otimes} \end{bmatrix}$$

Where N denoted preschool education informatization in universities, and c represented the main influential factors of informatization evaluation on preschool education specialty in universities (Guo et al., 2010).

First, according to statistics and advices from geological experts, the informatization evaluation on preschool education specialty in universities was divided into four grades, namely advanced, favorable, average, and backward (Liu and Lu, 2007). Table 2 is the evaluation grade classification conditions.

Grade	Scale
Advanced	(8,10)
Favorable	(6,8)
Average	(4,6)
backward	(1,4)

Table 2 – Grades of informatization evaluation (10-point system)

Then, according to the grades, the whitening weight functions for the informatization evaluation on preschool education specialty in universities were determined as:

$$f_1(d) = \begin{cases} \frac{d}{8}, & 0 \leq d \leq 8 \\ 1, & d > 8 \\ 0, & d < 0 \end{cases} \quad f_2(d) = \begin{cases} \frac{d}{8}, & 0 \leq d \leq 8 \\ 2 - \frac{d}{8}, & 8 < d \leq 16 \\ 0, & d > 16, d < 0 \end{cases} \quad f_3(d) = \begin{cases} \frac{d}{6}, & 0 \leq d \leq 6 \\ 2 - \frac{d}{6}, & 6 < d \leq 12 \\ 0, & d > 12, d < 0 \end{cases}$$

$$f_4(d) = \begin{cases} 1, & 0 \leq d \leq 4 \\ 2 - \frac{d}{4}, & 4 < d \leq 8 \\ 0, & d > 8, d < 0 \end{cases}.$$

Experts were invited to mark preschool education informatization in universities. All the expert marks constituted an evaluation matrix D_{ji} , and $D_{ji}^{(A)}$ denoted the evaluation matrix of the j th tier-two index under tier-one index A by expert i . $D_{ji}^{(A)}$ and $f_k(d_{ji})$ were referred to in calculating the grey evaluation coefficient of tier-two index j under tier-one index A and at the k th grey grade, and the corresponding formula was $\tilde{\otimes}_{ji}^{(A)} = \sum_{i=1}^n f_k(d_{ji})$.

3.2. Determination of grey matter elements

M_j denoted the j th evaluation grade, C_j denoted the i th tier-one evaluation index at the j th evaluation grade, and $\tilde{\otimes}_{ji}$ ($j=1,2,\dots,m$; $i=1,2,\dots,n$) represented corresponding whitening values of the grey numbers. Thus the n -dimensional grey matter elements at the j th evaluation grade were expressed as

$$\tilde{\otimes}R_{jn} = \begin{bmatrix} M_j \\ c_1 & \tilde{\otimes}_{j1} \\ c_2 & \tilde{\otimes}_{j2} \\ \vdots & \vdots \\ c_n & \tilde{\otimes}_{jn} \end{bmatrix}.$$

n -dimensional grey matter elements at m evaluation grades were clustered into a n -dimensional composite grey matter element, namely

$$\tilde{\otimes}R_{mn} = \begin{bmatrix} M_1 & M_2 & \dots & M_m \\ c_1 & \tilde{\otimes}_{11} & \tilde{\otimes}_{21} & \dots & \tilde{\otimes}_{m1} \\ c_2 & \tilde{\otimes}_{12} & \tilde{\otimes}_{22} & \dots & \tilde{\otimes}_{m2} \\ \vdots & \vdots & \vdots & & \vdots \\ c_n & \tilde{\otimes}_{1n} & \tilde{\otimes}_{2n} & \dots & \tilde{\otimes}_{mn} \end{bmatrix},$$

Where m was the number of evaluation grades, and n denoted the number of tier-one evaluation indices for informatization evaluation on preschool education specialty in universities.

3.3. Construction of n -dimensional grey matter elements

The aggregation of optimal values that were selected from each of the m evaluation grades constituted the ideal set of preschool education informatization in universities. Therefore, the n -dimensional grey matter elements for the ideal set of preschool education informatization in universities were constructed as:

$$\tilde{\otimes} R_o = \begin{bmatrix} M_o \\ c_1 & \tilde{\otimes}_{o1} \\ c_2 & \tilde{\otimes}_{o2} \\ \vdots & \vdots \\ c_n & \tilde{\otimes}_{on} \end{bmatrix}.$$

3.4. Grey correlation analysis

First, $\tilde{\otimes}'_{ji} = \frac{\tilde{\otimes}_{ji} - \min \tilde{\otimes}_{ji}}{\max \tilde{\otimes}_{ji} - \min \tilde{\otimes}_{ji}}$ ($j=1, 2, \dots, m; i=1, 2, \dots, n$) with the principle of “the larger, the better” was used to conduct non-dimensional processing on original data.

Next, the n -dimensional composite grey matter element at m evaluation grades was built up as:

$$\tilde{\otimes} R_{\xi} = \begin{bmatrix} M_1 & M_2 & \cdots & M_m \\ c_1 & \tilde{\otimes}_{\xi 11} & \tilde{\otimes}_{\xi 21} & \cdots & \tilde{\otimes}_{\xi m1} \\ c_2 & \tilde{\otimes}_{\xi 12} & \tilde{\otimes}_{\xi 22} & \cdots & \tilde{\otimes}_{\xi m2} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ c_n & \tilde{\otimes}_{\xi 1n} & \tilde{\otimes}_{\xi 2n} & \cdots & \tilde{\otimes}_{\xi mn} \end{bmatrix},$$

where $\tilde{\otimes}_{\xi ji}$ denoted the whitening value of the standardized correlation coefficient of the i th tier-one evaluation index at the j th evaluation grade, and $\tilde{\otimes}_{\xi ji} = \frac{\Delta \min + \rho \Delta \max}{\Delta_{ji} + \rho \Delta \max}$.

Third, AHP was used to calculate the weight ω_k of indices in the informatization evaluation on preschool education specialty in universities, where ω_k denoted the weight of tier-one evaluation indices, and ω_n denoted the weight of the n th tier-two indexes under the k th tier-one index. Then, weighted calculation was conducted on the preschool education informatization in universities, resulting in the total grey correlation degree of

its evaluation grade k : $\tilde{\otimes} A_k = \omega_k \cdot \tilde{\otimes} R_{\xi}$.

Finally, based on the principle of the maximum membership degree, the evaluation grade of the preschool education informatization in universities was determined.

4. Simulative calculation

AHP (Chen, 2007) was used to calculate the weight of each index in the informatization evaluation on preschool education specialty in a randomized university, as shown in Table 3.

Objective	Tier-one evaluation index	weight	Tier-two evaluation index	weight
informatization evaluation on preschool education specialty in universities P	Informatization infrastructure construction A	0.1595	Provision of multi-functional classrooms A1	0.2507
			the number of computers and its installation A2	0.2690
			construction of information network interaction platform A3	0.2431
			information network safety equipment A4	0.2372
	Information resource construction B	0.0949	Preschool education multimedia courseware B1	0.241
			network resource construction B2	0.049
			preschool education online courses B3	0.469
			preschool education high-quality courses B4	0.241
	Informatization application C	0.6830	Preschool education informatization level C1	0.2672
			the application of information technology to teaching C2	0.2458
			the application of information technology to student management C3	0.2757
			the application of information technology to specialty construction C4	0.2113
	Talent team construction D	0.0627	Informatization-oriented training for teachers D1	0.6548
			Informatization-oriented training for students D2	0.2499
			Informatization-oriented training for logistic staff D3	0.0953

Table 3 – The weight of each index in the informatization evaluation

Four experts were invited to mark every tier-two evaluation index in the preschool education informatization in the university (Li, 2015). The result was shown in Table 4.

As could be seen from Table 4,

$$D^{(A)} = \begin{pmatrix} 8.0 & 7.8 & 6.6 & 8.2 \\ 8.2 & 7.8 & 8.3 & 7.5 \\ 8.1 & 8.5 & 8.8 & 7.6 \\ 6.5 & 7.0 & 7.3 & 8.1 \end{pmatrix}, D^{(B)} = \begin{pmatrix} 6.9 & 7.8 & 8.6 & 7.5 \\ 7.5 & 8.3 & 8.8 & 7.2 \\ 7.5 & 8.6 & 7.8 & 8.0 \\ 7.0 & 6.2 & 7.1 & 6.9 \end{pmatrix},$$

$$D^{(C)} = \begin{pmatrix} 8.1 & 8.2 & 7.8 & 7.2 \\ 6.2 & 5.4 & 7.2 & 6.8 \\ 6.3 & 6.8 & 7.8 & 7.2 \\ 7.2 & 7.5 & 7.8 & 7.8 \end{pmatrix}, D^{(D)} = \begin{pmatrix} 6.6 & 7.6 & 8.2 & 7.4 \\ 6.8 & 6.8 & 7.8 & 6.4 \\ 8.2 & 7.8 & 8.3 & 7.5 \end{pmatrix},$$

Tier-two evaluation index	Expert 1	Expert 2	Expert 3	Expert 4
Provision of multi-functional classrooms A1	8.0	7.8	6.6	8.2
the number of computers and its installation A2	8.2	7.8	8.3	7.5
construction of information network interaction platform A3	8.1	8.5	8.8	7.6
information network safety equipment A4	6.5	7.0	7.3	8.1
Preschool education multimedia courseware B1	6.9	7.8	8.6	7.5
network resource construction B2	7.8	8.3	8.8	7.2
preschool education online courses B3	7.5	8.6	7.8	8.0
preschool education high-quality courses B4	7.0	6.2	7.1	6.9
Preschool education informatization level C1	8.1	8.2	7.8	7.2
the application of information technology to teaching C2	6.2	5.4	7.2	6.8
the application of information technology to student management C3	6.3	6.8	7.8	7.2
the application of information technology to specialty construction C4	7.2	7.5	7.8	7.8
Informatization-oriented training for teachers D1	6.6	7.6	8.2	7.4
Informatization-oriented training for students D2	6.8	6.8	7.8	6.4
Informatization-oriented training for logistic staff D3	8.2	7.8	8.3	7.5

Table 4 – Expert marks of every tier-two evaluation index

The evaluation coefficients of the four grey grades for the first tier-two index under tier-one index A were computed separately:

$$\tilde{\otimes}_{111} = \sum_{l=1}^4 f_1(d_{1l}) = f_1(8.0) + f_1(7.8) + f_1(6.6) + f_1(8.2) = 3.8;$$

$$\tilde{\otimes}_{211} = \sum_{l=1}^4 f_2(d_{1l}) = f_2(8.0) + f_2(7.8) + f_2(6.6) + f_2(8.2) = 3.7;$$

$$\tilde{\otimes}_{311} = \sum_{l=1}^4 f_3(d_{1l}) = f_3(8.0) + f_3(7.8) + f_3(6.6) + f_3(8.2) = 2.9;$$

$$\tilde{\otimes}_{411} = \sum_{l=1}^4 f_4(d_{1l}) = f_4(8.0) + f_4(7.8) + f_4(6.6) + f_4(8.2) = 0.4.$$

Similarly, the evaluation coefficients of the four grey grades for the rest of tier-two indices under tier-one index A were computed separately:

$$\tilde{\otimes}_{112} = 3.9, \tilde{\otimes}_{212} = 3.8, \tilde{\otimes}_{312} = 2.9, \tilde{\otimes}_{412} = 0.4;$$

$$\tilde{\otimes}_{113} = 4.0, \tilde{\otimes}_{213} = 3.8, \tilde{\otimes}_{313} = 2.5, \tilde{\otimes}_{413} = 0.1;$$

$$\tilde{\otimes}_{113} = 3.6, \tilde{\otimes}_{213} = 3.5, \tilde{\otimes}_{313} = 3.2, \tilde{\otimes}_{413} = 0.8.$$

Thus, the grey evaluation coefficient matrix of tier-one index A was obtained as:

$$\tilde{\otimes}R_A = \begin{pmatrix} 3.8 & 3.7 & 2.9 & 0.4 \\ 3.9 & 3.8 & 2.7 & 0.2 \\ 4.0 & 3.8 & 2.5 & 0.1 \\ 3.6 & 3.5 & 3.2 & 0.8 \end{pmatrix}.$$

Guided by the principle of “the larger, the better”, the optimal scheme for tier-one index A was determined as:

$$\tilde{\otimes}R_o^{(A)} = \begin{bmatrix} M_o \\ c_1 & 3.8 \\ c_2 & 3.9 \\ c_3 & 4.0 \\ c_4 & 3.6 \end{bmatrix}.$$

The grey matter element for the correlation degree of tier-one index A was computed as:

$$\tilde{\otimes}R_{\xi}^{(A)} = \begin{pmatrix} 1 & 0.97 & 0.74 & 0 \\ 1 & 0.97 & 0.68 & 0 \\ 1 & 0.95 & 0.62 & 0 \\ 1 & 0.96 & 0.86 & 0 \end{pmatrix}.$$

Referring to the weight, it was calculated that

$$\tilde{\otimes}A = (0.2507, 0.2690, 0.2431, 0.2372) \begin{pmatrix} 1 & 0.97 & 0.74 & 0 \\ 1 & 0.97 & 0.68 & 0 \\ 1 & 0.95 & 0.62 & 0 \\ 1 & 0.96 & 0.86 & 0 \end{pmatrix} = (1, 0.96, 0.72, 0).$$

Similarly,

$$\tilde{\otimes}B = (0.98, 0.96, 0.75, 0); \tilde{\otimes}C = (0.92, 1, 0.63, 0); \tilde{\otimes}D = (0.92, 1, 0.86, 0).$$

Finally, the overall correlation coefficient for the informatization evaluation on preschool education specialty in the university was obtained as:

$$\tilde{P} = (0.94, 0.99, 0.67, 0),$$

According to the principle of the maximum membership degree, the evaluation grade of the preschool education informatization in the university was “favourable”.

5. Conclusion

The development of preschool education informatization is a dynamic, continuous process. In this regard, evaluation on preschool education informatization depends on the pre-determination of the evaluation index system, whose indices should change with and adapt to the development of informatization construction. The proposed method in the paper acts as a professional, scientific, rational mathematic approach to informatization evaluation on preschool education specialty on campus, and provides theoretical basis for studies on preschool education informatization in universities.

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TSP based approaches to flow shop scheduling problem

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Abstract: Flow shop scheduling problem (FSP) is a NP-hard problem, which is worthy analyzed in actual producing. We studied on a cigarette factory and abstracted the reality into FSPs. A discussion was conducted on producing techniques, production categories and producing environment so that the statement of the producing process was clear. Based on Traveling Salesman Problem (TSP), we formulated several models including time-constrained, asymmetric time changing, and multi-producing lines models. Finally, with the use of genetic algorithm, we analyzed the actual data, and the speed and results reacted well. It is verified that TSP-based modeling of FSP is feasible and efficient, and can reach the demand of production.

Keywords: flow shop scheduling problem, Traveling Salesman Problem, modeling Analysis, Genetic algorithm, cigarette production

1. Introduction

In China, the annual taxation from the tobacco industry that occupies around 10% of the total taxation is of vital importance to national treasury. After the implementation of technological reforms during the 11th and 12th “five-year” plans, some indicators in the tobacco industry including production automation level, process ability, equipment performance and capacity have reached the advanced international level. Against the background of high levels of production automation, any delay in manufacturing will cause a great loss. This poses high demands to production organization. The promotion of make-to-order and market-oriented reform in this industry require much better production planning and scheduling (Guo et al., 2015). Traditional regular production planning and scheduling were formulated manually. Even control data in planning-related information systems were based on manual input. For a handful of vendors that attempted to optimize production scheduling, rule-based methods had their preference rather than optimization approaches. A few domestic corporations actually introduced the foreign advanced planning scheduling (APS) system, but rarely succeed in its application due to management complexity (Wu et al., 2013; Liao et al., 2013; Wang et al., 2010; Xie & E, 2007).

The cut tobacco processing line is the fundamental procedure in the entire tobacco production. The production process is relatively stable, as such batches of brand are processed in sequence along one or more continuous production lines. As the processing time vary with brand types, switch between different brands costs some time. Therefore,

scheduling of cut tobacco processing is regarded as a typical FSP with limited lot sizes (Chris & Mikhail, 2000). FSPs, crucial in real life production, are widely involved in the production fields for fast moving consumer goods such as daily chemicals, food and pharmacy. Due to the NP-hard feature and the complexity of practical production, they are lack of accuracy. Consequently, FSP is difficult to tackle in real engineering practice (Garey et al., 1976; Gonzalez et al., 1978).

This paper mapped FSPs and all kinds of constraint mechanisms to travelling salesman problems (TSPs), through which a large volume of achievements concerning TSP model and its algorithm is obtained (Wang, 2012; Tapan et al., 2006). With the aim of solving practical FSPs, the paper first studied on real production scheduling issues with the tobacco manufacturing as an example. Then, a TSP-based model was established to satisfy requirements of different situations. Finally, with the use of genetic algorithm, the model was tested in real cases in each situation.

2. Production environment analysis

2.1. The whole production process

The whole production process, a classic hybrid production process, is characterized by multi-stage, multi-variable and strong coupling. It is a matter of great urgency to optimize tobacco production plans. Figure 1 is a diagram of a two-phase tobacco production process, which is divided into tobacco cutting (phase 1) and cigarette packing (phase 2). Phase 2 is the downstream output of finished products, playing a “pulling” role to phase 1. They are connected to each other through multiple parallel feeding processes (numbered in A, B, C, etc.) Generally, there is one or more production lines to cut tobacco, while a parallel unit is used for the packing phase. Therefore, to ensure continuous and in-time packing production, requirements are noticeably strict for tobacco cutting.

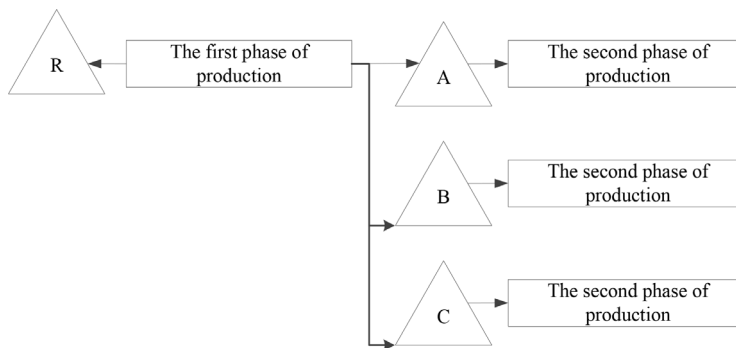


Figure 1 – The whole process of production

2.2. Sections and Subsections

Cut tobacco process is a non-stop production process accompanied by physical changes and chemical changes. It plays an important role in manufacturing high-quality

cigarette. Figure 2 presents its production process. There are several production lines in the cut tobacco workshop, such as the main line of leaf tobacco and the subsidiary lines of stem tobacco process and expanded tobacco process. The main line is composed of five segments: leaf feeding, leaf processing, leaf cutting, blending and perfuming, and storage. At the blending and perfuming segments, stem tobacco and expanded tobacco are blended with each other according to the given proportion of finished cut tobacco; the mixture is perfumed then; and finally the end product is outputted for storage.

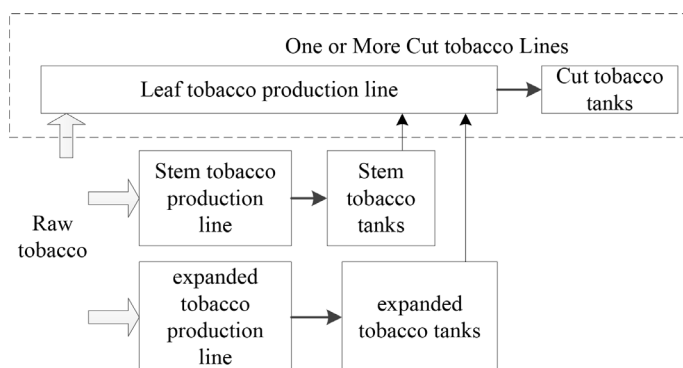


Figure 2 – cut tobacco production process

Corporations at different producing scales may build up one or more leaf tobacco lines, and each of them operates independently.

2.3. Product characteristics

In light of the demand for homogenized products, one type of product corresponds to one fixed proportion of raw materials that needs to be fed and processed strictly. The parallel unit production in phase two causes it hard for the batches with the same grade of cut tobacco to produce continuously. Switch between batches of the same grade costs the minimum time span, whilst switch between batches of different grades costs much time. In real producing practice, switch between batches of the same grade can be divided into two categories: high-to-low-end switch, which costs less time without regard of production line cleaning, and low-to-high-end switch, which costs the maximum time because the production line should be cleaned at each switch.

2.4. Scheduling requirements

First and foremost, tobacco cutting as an upstream process is expected to be scheduled in the way that satisfying the downstream requirements of non-stop feeding of materials. In addition, considering switch costs, a second significant matter is how to schedule feeding orders (Xia and Wei, 2009).

The cut tobacco processing resembles flow shop processing in that all inputs are manufactured along duplicate production lines. Once the feeding sequence is determined, all the production tasks in the main production line are accordingly acquired by calculation. Stem tobacco and expanded tobacco will be mixed in given proportion,

and production schedule is controlled by the main line and organized according to semi-product storage.

3. Problem modeling

Based on the semiotic principle described by Graham, the production mode in tobacco processing workshops can be represented in the form of $\alpha|\beta|\gamma$, where α or F_m indicates the number of production stages in the flow shop, $\beta = \{k_1, k_2, \dots, k_m\}$ is the quantity of machines at each of the production stages, $k_i = 1$ in default of β ; $\gamma \in \{C_{max}, L_{max}, \sum C_i, etc.\}$ represents the objective of FSP optimization; if $\gamma = C_{max}$, then C_{max} is the optimal principle, i.e. the objective becomes minimum production time (Chris and Mikhail, 2000; Allahverdi et al., 2008). The problem for research in this paper is $F_m|JS|C_{max}$, for which tasks are sequenced in a flow shop with m parallel production lines in order to minimize the completion time or to gain the most economical batch switch in another sense. Tobacco production FSPs can be modeled in the following several situations: disregard of time constraints, in consideration of time constraints, asymmetric time changing, and multi-producing lines. They will be expounded in section 3.1-3.4. All but section 3.4 are an analysis of a flow shop with a single production line, i.e. $m = 1$.

The entire production task is divided into n batches, whose completion and switches each have time cost. In this model, these batches are seen as n vertices in the image G . When batch i switches to batch j , an arc from i to j is constructed, and the unit cost for the switch is recorded as the unit distance cost ct_{ij} ; for a production model with time requirements, the maximum delayed processing time for batch i is equal to the latest time allowed to reach the vertex i . Meanwhile, the time cost for batch i dt_i is seen as the dwell time at the vertex i . Therefore, a weighed graph is drawn out as $(G, ct) = ((Prod, link), ct)$, where the point set $Prod = \{1, 2, \dots, n\}$, the line set $link = \{l_{ij} | i, j \in Prod\}$, the cost set $ct = \{ct_{ij} | l_{ij} \in link\}$, the time-constraint set $ProdT = \{L_i | i \in Prod\}$, and the dwell time set $ProdD = \{dt_i | i \in Prod\}$. Supposing that the variable $z_{ij} = 1, i, j \in Prod$ represents batch i to j switch, or the journey of a salesman from city i to j in G ; the variable $z_{ij} = 0, i, j \in Prod$ denotes that i does not switch to j , i.e. there is no journey from city i to j in G . In this way, FSPs is transformed into a solution for TSP in a weighted graph G .

3.1. A symmetric FSP model disregard of Batch Time Requirements

Under the circumstance that storage for finished cut tobacco is large enough or that the cut tobacco production lead time is abundant enough, time requirements for batches can be ignored. Meanwhile, assuming that switch time demanded for tobacco batches of different grades is the same, then the mere requirement for scheduling is that all vertices in the diagram $G_1 = ((Prod, link), ct)$ are traversed. A variable $u_i \in \{1, 2, \dots, n-1\}$, $i = 2, 3, \dots, n$ is introduced in this model, representing the number of vertices to pass on the way to vertex i

Obj

$$\min \sum_{i=1}^n ct_{ij} z_{ij}$$

s.t.

$$\sum_{j=1}^n z_{ij} = 1, \quad \forall i \in Prod$$

$$\sum_{i=1}^n z_{ij} = 1, \quad \forall j \in Prod$$

$$u_j \geq u_i + 1 - n \cdot (1 - z_{ij}), \quad j \geq i$$

$$u_i \in \{1, 2, \dots, LOTN - 1\}, \quad i = 2, 3, \dots, n$$

$$z_{ij} \in \{0, 1\}, \quad i, j \in Prod$$

$$u_1 = 0$$

Variables:

ct_{ij} : Switch cost from i to j

z_{ij} : A binary variable that decides whether to switch from i to j or not

u_i : The number of vertices to pass on the way to i

n : The number of vertices

$LOTN$: The total volume of batches

3.2. Asymmetric Flow Shop Scheduling Model Not Considering Batch Time Requirement

In practical production, the cost of switching from the high-end brand to the low-end brand is usually lower than that of switching from the low-end brand to high-end brand. Therefore, the switching time from batch i to batch j is equal to the switching time from batch j to batch i ($i \neq j$). That is to say, $ct_{ij} = ct_{ji}$, then G is symmetric graph; or else, G is asymmetric graph. That is to say, $ct_{ij} \neq ct_{ji}$. The model expression of symmetric or asymmetric graph G is the same, but the solution to the problem is different.

3.3. Flow Shop Scheduling Model Considering Batch Time Requirement

To improve the intensive level, the lead time of cut tobacco production is only eight hours in many cases. Therefore, to guarantee the 24-hour production and the supply of materials in the phase two, specific time requirements are posed for the finishing of every cut tobacco batch. To solve the batch scheduling problem of the latest production time, set the actual production time of batch i as $lotT_i$, namely the time needed to reach the vertex i is $lotT_i$. The objective function is:

$$\min \sum_{i=1}^n \sum_{j=1}^n ct_{i,j} z_{i,j} + M \cdot \max[lotT_i - L_i, 0]$$

The first item $\sum_{i=1}^n \sum_{j=1}^n ct_{ij} z_{ij}$ represents the total time of all vertexes in the ergodic *Prod*.

The second item $M \cdot \max[lotT_i - L_i, 0]$ represents the time constraint. If arriving at the city i at (or before) the latest arrival time, which is the $lotT_i \leq L_i$, then fetch zero for the second item; or else, $\max[lotT_i - L_i, 0] > 0$, and we will acquire a very large positive number multiplying by the large number M . When the objective function achieves best optimization, $\max[lotT_i - L_i, 0] = 0$, which ensures reaching the vertex i before the latest required time. Introduce variable $y_i = \max[lotT_i - L_i, 0]$ to transform the objective function into linear function (Wu et al., 2011). Therefore, the following model can be built:

Obj

$$\min \sum_{i=1}^n \sum_{j=1}^n ct_{i,j} z_{i,j} + M \sum_{i=1}^n y_i$$

s.t.

$$\sum_{j=1}^n z_{ij} = 1, \forall i \in Prod$$

$$\sum_{i=1}^n z_{ij} = 1, \forall j \in Prod$$

$$u_j \geq u_i + 1 - n \cdot (1 - z_{ij}), j \geq i$$

$$u_i \in \{1, 2, \dots, LOTN - 1\}, i = 2, 3, \dots, n$$

$$z_{ij} \in \{0, 1\}, i, j \in Prod$$

$$y_i \geq lotT_i - L_i$$

$$y_i \geq 0$$

$$u_1 = 0$$

Explanation of new variables:

$lotT_i$: Actual production time of batch i

L_i : The latest require production time of batch i

M : A big number

3.4. Flow Shop Scheduling Model of Multiple Production Lines without Time Constraint

In the first two sections, we discuss the flow shop scheduling model of $F_1|JS|C_{max}$. For the flow shop scheduling problem in the form of $F_m|JS|C_k$, $m \neq 1, k = 1, 2, \dots, m$, which means there are m parallel assembly lines in the cut tobacco workshop, we have two modeling approaches. The first is to divide each batch into m equal divisions and then produce on each assembly line, which is to transform into the model discussed in section 3.1. the second is to add a fictitious starting point s and s can reach any vertex. Moreover, set $ct_{sj} = 0, j \in Prod$ and construct Multiple Travelling Salesmen Problem (m-TSP) on the graph $G = (\{s\} \cup Prod, link)$. Divide graph G into m subgraphs (spanning trees), corresponding to the production sequence of m production lines and seek the optimal path to minimize the switching cost (Gornuejols et al., 1985).

m-TSP is to provide given travelling cost c_w among finite point set V , salesmans and each counter point $u, v \in V$ and find out m tours to minimize the access cost while ensuring every point in the V is visited by a salesman. Figure 3 gives the two examples of 2-TSP of five vertexes when adding a new source s . The access sequence shown in (a) is 2, 1 and 5, 4, 3 and the corresponding production sequence is that the production scheduling order is 2, 1 for assembly line 1 and the production scheduling order is 5, 4, 3 for assembly line 2. Similarly, the access sequence shown in (b) is 2, 3, 1 and 5, 4, corresponding to the production scheduling order of 2, 3, 1 for assembly line 1 and the production scheduling order of 5, 4 for assembly line 2.

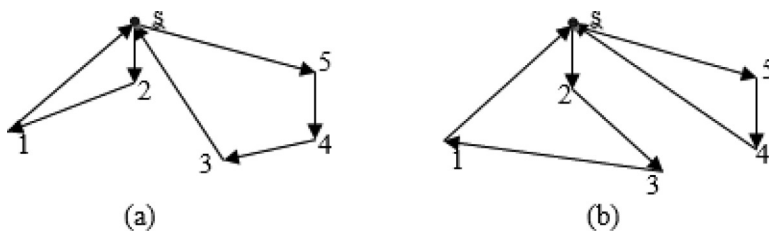


Figure 3 – Single source 5 vertex 2-TSP

For every subgraph $G_k = (Prod_k, ct_k, ProdT_k, ProdD_k), k = 1, 2, \dots, m$, set the objective function $c_k = \sum_{i,j \in Prod_k} ct_{i,j} Z_{i,j} + M \sum_{i \in Prod_k} y_i$ and the $y_i = \max\{lotT_i - L_i, 0\}, i \in Prod_k$ is time constraint. Then the objective function of TSP in graph G can be expressed as:

$$\min \max_{k=1,2,\dots,m} c_k$$

Then we can seek the earliest time needed to complete the process of each assembly line. Meanwhile, two constraints are added:

$$\bigcup_{k=1,2,\dots,m} G_k = G$$

$$G_i \cap G_j = \emptyset$$

These two constraints represent dividing graph G into m disjoint subgraph and every production line is responsible for the production of a series of products.

The following model can be obtained:

$$z = \min \max_{k=1,2,\dots,m} c_k$$

s.t.

$$\sum_{j \in Prod} x_{sj} = m \quad (1)$$

$$\sum_{j>i} x_{ij} + \sum_{j<i} x_{ji} = 2, (i = 2, 3, \dots, n-1) \quad (2)$$

$$\sum_{1 \leq i < j \leq n} x_{ij} = n \quad (3)$$

$$\sum_{i \in Prod, j \in Prod, i < j} x_{ij} \leq |G_k| - 1, \text{ Any } G_k \subset Prod \quad (4)$$

$$x_{ij} \in \{0, 1\}, (1 \leq i, j \leq n) \quad (5)$$

$$c_k = \sum_{i,j \in Prod_k} ct_{i,j} Z_{i,j} + M \sum_{i \in Prod_k} y_i \quad (6)$$

$$\bigcup_{k=1,2,\dots,m} G_k = G \quad (7)$$

$$G_k \cap G_l = \emptyset, k, l = 1, 2, \dots, m, k \neq l \quad (8)$$

Explanation of new variables:

$lotT_i$: Cost of each sub tour

$Prod_k$: Subset of vertex set $Prod$, representing the product sets of the k production line

Constraint (1) indicates that all m travelling salesmen start from source s , and the manifestation in actual production is that m assembly lines start working at the same time. Constraint (2) and Constraint (3) indicates that every vertex is visited by certain travelling salesman only once. In actual production, if given batch starts production on certain $i, i \in Prod$ production line, it will not be produced by other production lines. Constraint (4) indicates that no sub tour exists in the result. The whole graph can be divided into m spanning trees, ensuring the maximum utilization of all m production lines and not to produce certain batch of products repeatedly. Constraint (5) indicates the value range of decision variable x_{ij} . If $x_{ij}=1$, then the production line producing the cut tobacco of brand i will switch to brand j ; if $x_{ij}=0$, then the production line producing the cut tobacco of brand i will not switch to brand j . Constraint (6) is time constraint. For flow shop scheduling problem without time constraint, constraint (6) can be deleted. For flow shop scheduling problem with time constraint, we need to produce certain quantity of products before given time. We can add the time constraint $y_i \geq lotT - L_i, i \in Prod$ and

$$y_i \geq 0 \text{ and modify the objective function as } z = \min[\max_{k=1,2,\dots,m} \sum_{i,j \in Prod_k} ct_{i,j} z_{i,j} + \sum_{i \in Prod} M \cdot y_i].$$

Constraint (7) and constraint (8) guarantee that m sub tours are mutually disjoint and each vertex is strictly visited only once.

4. Solution Algorithm

The flow shop scheduling problems in this paper can all be transformed into TSP problems, and thus the intelligent optimization algorithms which can effectively solve TSP problems can be applied here, including simulated annealing algorithm, tabu search algorithm, ant colony algorithm, genetic algorithm and particle swarm optimization algorithm (Buthaninah & Hamza, 2008; Oliveira et al., 2014). This paper adopts the genetic algorithm to solve TSP problems based on MATLAB software platform, Windows10 operating system and PC environment.

Population initialization. Real number coding method is adopted, which is the random permutation of real number 1 to n . n is the batch number of cut tobacco and each batch appears once only. This process starts from a given brand batch and the subsequent batches needed to be produced are generated randomly. Considering the batches of cut tobacco every day in actual production environment do not exceed 30, which is the TSP problem of small scale. Therefore, the initialization parameter setting is that the number of population $M=200$, crossover probability $P_c=0.9$ and mutation probability $P_m=0.05$.

Fitness function. The objective function of TSP is to calculate the minimum value of the target and thus the fitness function can be directly selected as the objective function.

Stopping criterion. Because of the strong randomness of genetic algorithm, we set several stopping criteria: (1) if iteration is conducted for 500 times, then terminate the algorithm; (2) if the quotient of the average fitness of chromosome in certain generation of population and the current best chromosome fitness is larger than 0.9, then terminate the algorithm; (3) if the best chromosome is maintained for ten generations, then terminate the algorithm.

5. Analysis of Examples

There are two main lines in the workshop of certain enterprise and the production capability is 6000KG/H. there is one stem tobacco line but no expanded tobacco line. There are four brands of finished cut tobacco and these four brands are marked with A, B, C and D in the sequence from high-end to low-end. The feeding quantity of every batch of each brand is 6000Kg/batch. The switching time matrix of each brand is shown in Table 1 (I represents symmetry constraint, II represents asymmetrical constraint).

Brand	A		B		C		D	
	I	II	I	II	I	II	I	II
A	5	5	30	20	30	20	30	20
B	30	30	5	5	30	20	30	20
C	30	30	30	30	5	5	30	20
D	30	30	30	30	30	30	5	5

Table 1 – Batch switching time matrix (unit: min)

Take the data from 0 o'clock to 24 o'clock on March 9th, 2015. The feeding quantity of each brand and the latest feeding time are shown in Table 2.

Brand	1 st batch	2 nd batch	3 rd batch	4 th batch
A	0	480	960	/
B	0	360	720	1080
C	0	/	/	/
D	0	/	/	/

Table 2 – Batches of the latest time requirements (unit: min)

According to the need of model solution, the TSP problems containing 9 pieces of finished cut tobacco batches are built and the solution can be acquired without considering time constraint (Table 3)

Feeding Sequence	1	2	3	4	5	6	7	8	9
Corresponding Brand (Symmetry Constraint)	A	A	A	C	B	B	B	B	D
Corresponding Brand (Asymmetrical Constraint)	A	A	A	B	B	B	B	C	D

Table 3 – The results without considering the time constraints

Analysis: each brand is produced in a continuous manner, conforming to the requirement of minimum switching cost.

After considering the time constraint and the processing time on the first segment of each brand (residence time 60 minutes), the following optimization results can be obtained (lead time of cut tobacco production is 480 minutes) (Table 4).

Feeding Sequence	1	2	3	4	5	6	7	8	9
Corresponding Brand	A	A	A	C	D	B	B	B	B
Corresponding Actual Finish Time	-420	-355	-290	-200	-110	-20	45	110	175

Table 4 – The result of the symmetric model under time constraints (unit: min)

Analysis: under the condition of satisfying time constraint, each brand is produced in a continuous manner and switching cost is the lowest.

Considering two main lines of leaf tobacco (line 1 and line 2), the following optimization results are obtained when the lead time is 240 minutes (Table 5).

Feeding Sequence	1	2	3	4	5
Corresponding Brand of Line 1	A	A	A	B	B
Actual Finish Time	-180	-115	-50	40	105
Corresponding Brand of Line 2	C	D	B	B	
Actual Finish Time	-180	-90	0	65	

Table 5 – The result of multi production line without time constraint (unit: min)

Analysis: under the condition of satisfying time constraint, each brand is produced in equilibrium state. Moreover, each brand is produced in a continuous manner and the switching cost is the lowest.

6. Conclusion

The flow shop scheduling problem is a sort of key problems that have wide application prospect in production operations. In order to conduct research on the flow shop scheduling problem taking advantage of the maturity models and solution methods in TSP, this paper takes the cut tobacco production as the research object and maps several kinds of typical scenes in the flow shop scheduling to travelling salesmen problem. The feasibility of this method is verified through the example verification of small scale. The subsequent researches should concentrate on two aspects: the first is the research on the algorithm with mutual adaptation and rapid convergence for model of multiple scenes; the second is the model analysis under the condition of emergency replenishment or special requirements of the technics in the production process. Under this condition, the scale of the problem is enlarging, present multidimensional characteristics.

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Research on customer satisfaction measurement and influence factors of fitness club based on large data

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Abstract: It researches the customer satisfaction of the fitness club members according to the management of the club from the perspective of satisfaction based on the big data of computer. And in the research the questionnaire survey method expert interview method and other research methods are used. The results show that customer satisfaction of the fitness club includes 19 test indicators and 5 dimensions, which is the environment facilities factor, teaching setting factor, logistics service factor, price factor and coaching factor. To improve the satisfaction of members, 5 measures are put forward to improve the club. Based on the analysis results of computer large data, it is strengthening environmental facilities, optimizing course structure, enhancing service awareness, setting flexible and diverse charges, and improving the coaching level of personal instructors.

Keywords: computer; customer satisfaction; fitness club; influence factors

1. Introduction

Nowadays, with the popularization of computer technology and Internet, the industry has benefited from the vast amounts of information, reliable storage, easy to use, instant transmission, processing, computing accurate, easy search and other functions (Shumin Qiu, 2013). Fitness club management as a branch of modern management, the same cannot be separated from the participation of computer and Internet technology (Bo He, Gege Li, 2015). A fitness club is the institution or place where the fitness facilities and services are provided for the members. In China, there are 3 kinds of fitness clubs, the clubs in Star-rated hotels to supply service for the hotel customers, the clubs in community based on the government to serve the public for free, and commercial clubs with individual investment. The commercial fitness club usually has a certain fitness equipments and coaches indoor to provide courses and lectures to the members for the purpose of profit. Its main mode is to sale member cards (Tangxun Yang, 2015). This paper studies the commercial fitness clubs, and analyses the influence factors to improve the management of fitness clubs.

Customer satisfaction is the degree of satisfaction of the customers' requirements (Cheng Deng, Yanhui Zhu, 2016). The public satisfaction theory based on customer satisfaction has been used and researched widely. Because the service of fitness club belongs to public service, it makes sense to combines the service with the customer satisfaction (Xuetao Tang, Caiming Xu, 2014). In the fitness club, the customers are the members of

the club, and so the customer satisfaction is the satisfaction of members. The purpose of the analysis of customer satisfaction is to find the influencing factors of the club and improve the satisfaction (Xiuling Cao, Haiyan Zhao, 2014). The assessment of customer satisfaction is a means to improve service and the satisfaction of members for fitness club, which has important significance.

In the index research of the assessment of customer service in fitness club at present, there is no related study that focuses on the assessment of customer satisfaction. Though there are more than less researches choose fitness club as the study object, there barely exist any research aimed at service quality or customer satisfaction while many study just one side like employee satisfaction or the coach quality and other just analyse current situation without any countermeasures (Tao Chen, Xinghan Li, 2014). In the Research, the fitness club members are the survey object, and the result is got through the distribution of the fitness club customer satisfaction survey. There are 27 variables totally in this questionnaire, and the data is analysed by SPSS and Excel. After the factor analysis, the final analysis of 19 factors in 5 categories is found out. According to the analysis results, the factors of customer satisfaction of fitness club in Hubei province are obvious, and it is convenient to improve the management and satisfaction. It researches the customer satisfaction of the fitness club members according to the management of the club from the perspective of satisfaction. That is strengthening environmental facilities, optimizing course structure, enhancing service awareness, setting flexible and diverse charges, and improving the coaching level of personal instructors.

2. Research object and method

2.1. Survey object

This study adopts the stratified sampling and the investigation object is composed of the commercial fitness club members from Wuchang District, Qiaokou District, Jiangnan District, Hongshan District and Jiang'an District in Wuhan City.

2.2. Research method

2.2.1. Method of questionnaire survey

Basic information of research object is shown in Table 1. The survey was distributed in 795 copies. Among them 713 copies of the recycling, Effective number 662, 89.69 percent of the recovery rate, 92.85 percent of the efficiency. Please check the distribution and recovery of the questionnaire (Shown in Table 2).

Item	Sex		%
	Male	Female	
18 years old and below	30	33	5.5%
19-24 years old	72	142	18.6%
25-34 years old	256	430	59.6%
35-45 years old	32	98	11.3%
46 years old and above	23	35	5%
N	413	738	

Table 1 – Basic information of research object (N=795)

District	Distribution number	Recycling number	Valid number	Rate of recovery (%)	Efficiency (%)
Hongshan District	160	148	136	92.50	91.89
Wuchang District	165	153	143	92.73	93.46
Qiaokou District	145	125	119	86.21	95.20
Jiang'an District	165	146	138	88.48	94.52
Jiangnan District	160	141	126	88.13	89.36
Total	795	713	662	89.69	92.85

Table 2 – The distribution and recovery of the questionnaire (N=795)

2.2.2. Method of expert interview

It adopted the method of expert interview to check the setting and the validity of initial questionnaire. There were nine experts whom are professors in social sports research field. The content of interview mainly involved in the dimensions of service composition and the rationality and validity of the questionnaire. Then according to the views of the experts, it conducted a classification. Finally, it determined 27 test items of the questionnaire (shown in Table 3).

2.2.3. Method of mathematical statistics

It used Excel to do a simple analysis of the original data and used SPSS17.0 to do project analysis and exploratory factor analysis of the initial test questionnaire.

3. Research results

3.1. Project analysis

Before the analysis of exploratory factor, the project analysis of the initial questionnaire should be done first. The purpose of the project analysis is to test whether the project of the initial questionnaire reflects assessing content of customer satisfaction.

There were many methods to analyse the project, and the critical ratio method was used in this paper, which is widely recognized by everyone (Guoying Yuan, 2015). The 562 sample data of initial questionnaire was added up, and then ranked by size. The top 27% was the high score group, the corresponding post 27% was low score group (the critical value of high score group was 106, the value of low score group was 84). Then data in each group was averaged in each test item to do the T test. The results were as shown in the 33 tests, the T value of 12 test items was less than the critical value 3.000, and the P value was not significant. So test item A7, B5, B6, C5, C6, D4, D5, D6, E4, E6, E7 and E8 were removed, and the questionnaires included 21 test items (shown in Table 3).

Item	Index	Item	Index
A1	Fitness equipment type and quantity	A2	Configuration of fitness equipment
A3	Club surroundings	A4	Fitness atmosphere
A5	Fitness environment comfort	A6	Indoor ground construction
A7	Security facilities	B1	Club Health Seminar
B2	Fitness classes	B3	Fitness project settings
B4	Update teaching content	B5	Rich teaching content
B6	Group setting arrangement	C1	Sanitary condition
C2	Service personnel initiative	C3	Service and communication skills
C4	Ability to solve problems	C5	Additional services provided
C6	Service perfection	D1	Preferential measures
D2	Charge price is reasonable	D3	Club payment method
D4	charging standard	D5	Charging projects set up
D6	Private teaching standards	E1	The teaching level of the coaches
E2	Care for members	E3	Coaches professional quality level
E4	The image qualities of coaches	E5	Coach's guidance ability
E6	The coach teaching attitude	E7	The coach teaching methods
E8	The coach teaching way		

Table 3 – Test item of fitness club customer satisfaction

3.2.Exploratory factor analysis

The analysis of exploratory factor to 21 test items was carried on by using SPSS statistical analysis software. In order to determine whether the sample data was suitable for exploratory factor analysis, 562 samples were tested for KMO and Bartlett (shown in Table 4). The results showed that the value of Bartlett was 0.850, KMO was $X=3828.073$, the degree of freedom was 210, and the probability of significance was $P=0.000$ ($P<0.005$). Therefore, to reject the null hypothesis, that is, the sample data is suitable for exploratory factor analysis.

The principal component analysis was used to analyse 21 dominant variables. The maximum variance method was chosen in the rotating dialog, and the results were analysed by the maximum orthogonal rotation to get the total variance factor load matrix. 5 factors were analysed (shown in Table 5), and their cumulative contribution rate was 57.039%. After the orthogonal rotation, the factors whose Characteristic value is more than 1, and cumulative contribution rate is more than 50%, was chosen by the extraction method of Kaiser. Based on the analysis results, the 5 main factors and 19 high load

indexes were further analysed and named. The five factors influenced and interacted with each other, and acted in the satisfaction of the college students. The exploratory factor analysis of 19 item at the same time, to validate the reliability of the item of five dimensions for reliability test (shown in Table 6). Questionnaire total Cronbachs Alpha value is 0.851, the dimensions of Cronbachs Alpha values are far greater than 0.65, so after factor analysis of 19 test items is stable and reliable.

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Extracting common degree
A1	0.745					0.585
A3	0.758					0.611
A4	0.695					0.515
A5	0.647					0.451
A6	0.534					0.504
B1		0.673				0.550
B2		0.705				0.559
B3		0.761				0.610
B4		0.694				0.547
C1			0.630			0.503
C2			0.749			0.622
C3			0.756			0.588
C6			0.595			0.553
D1				0.780		0.697
D2				0.872		0.812
D3				0.784		0.686
E1					0.718	0.564
E2					0.735	0.627
E5					0.552	0.479
Characteristic value	2.889	2.555	2.383	2.376	1.775	
Variance Explained (%)	13.759	12.168	11.347	11.313	8.453	
Cumulative Variance explained (%)	13.759	25.926	37.273	48.586	57.039	

Table 4 – Results of the exploratory factor analysis of customer satisfaction in fitness club (N=562)

Sampling sufficient Kaiser-Meyer-Olkin	0.850
Bartlett test of Spherical degree	Approximate chi square
	3828.073
	df
	210
	Sig.
	0.000

Table 5 – KMO and Bartlett Spherical test (N=562)

	Cronbachs Alpha	item number
Environmental facilities	0.761	5
Teaching design	0.755	4
Logistics service	0.713	4
Price setting	0.837	3
Coach	0.785	3

Table 6 – Cronbachs Alpha reliability (N=562)

4. Discussion strategies

4.1. Strengthening environmental facilities

Consumers usually know a club through media or friends. They often evaluate the club from the club's external image, traffic, and then decide whether they will come to this club (Qingshan Hu, Zhan Shen, 2015).

So the clubs should strengthen their external image. The choice of site should be scientific and reasonable. The club is the direct place for customers to enjoy the service, and it should be arranged scientific and healthy. So a spacious and comfortable club with high quality fitness facilities will be the attracting point for the consumers.

4.2. Optimizing course structure

Fitness clubs should set special courses according to the requirements of all kinds of consumers. The club should improve continuously the open breadth and depth of course, listen carefully to the reasonable opinion of the club member, and optimize the structure of course (Xuejuan Chen, Xiaohong Niu, 2014). Besides keeping the original number of fitness groups, it is necessary to expand the new consumer groups. It is important to improve the profitability of the club for the purpose of the development of the club.

4.3. Enhancing service awareness

Commercial fitness clubs mainly focus on the white collar, while the white collars pay more attention to the quality of service. So the club should enhance service. It is needed to improve the overall quality of staff, including their professional skills, education level, etiquette, professional ethics and other aspects. Service consciousness is a kind of instinct and habit of service staff, which can be formed by training, education and training. The fitness club should regularly do the training on the service and make the relevant regulations for the examination. A good sense of service can also promote a repeat purchase of consumers, which has a positive meaning for the development of fitness club (Yun Tang, 2015).

4.4. Setting flexible and diverse charges

The charges of commercial fitness club have relatively large span to meet the needs of various types of consumers. The fee of course suits a variety of occupations, and all kinds of income groups can find a suitable club, so people who love fitness will be

direct beneficiary. Nowadays, courses of Fitness club are set for relatively concentrated consumer groups and can only meet some demand. For people with low income, the course fee is still relatively high. So it is a great loss for the national fitness. The fitness club should supply a variety of health services and to develop a flexible charging standard to meet the needs of different groups of people.

4.5.Improving the coaching level of personal instructors

Because of their high income and high propensity to consume, most of the club members need personal instructor and private teaching. So the fitness instructors should have rich professional knowledge and higher professional quality of teaching theory and service skills to be more competitive. Otherwise the fitness instructors should also practice basic skills, improve their self-efficacy, and strengthen depth, breadth and expanding frontiers of the professional field.

5. Conclusions

In summary, it has been found out that the fitness club customer satisfaction model includes 5 factors through exploratory factor analysis and confirmatory factor analysis, that is environmental facilities, teaching design, logistics service, price and coaching. Through the analysis of exploratory factors, customer satisfaction of the fitness club includes 5 dimensions, the environment facilities factor, teaching setting factor, logistics service factor, price factor and coaching factor, and 19 test indicators. Through the investigation of the satisfaction of the members of the commercial fitness club, the main factors which affect customer satisfaction are found, and the corresponding measures are put forward to improve the customer satisfaction. The club should strengthen environmental facilities, optimize course structure, enhance service awareness, Set flexible and diverse charges, and improve the coaching level of personal instructors. And the using of the method above makes the test content of the fitness club customer satisfaction model more objective and accurate (Xinxin Feng, 2014).

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The Application in Basketball Technical Actions analysis by Data Mining

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Abstract: In a key basketball game, it is an effective way to promote the development of basketball industry by analyzing the relevant technical action of basketball, and data mining technology is a common method. In this paper, the data mining technology is applied in the analysis of basketball technology, and the data is processed in advance to classify the technical actions of basketball game. Firstly, some common techniques of data mining are studied, such as preprocessing, classification, clustering and so on. The decision tree classification algorithm is analyzed to do the classification tasks, and process of ID3 and J4.8 decision tree on the classification of technical actions are studied in this paper. Finally, the experiments are conducted to analysis the classification of basketball game, and the results are show to provide some theoretical basis for basketball game.

Keywords: data mining, decision tree classification, basketball technical actions analysis

1. Introduction

With the rapid development of computer technology, the information revolution is rapidly changing our lives, the technical movement's data of basketball game also appears the rapid growth. In these massive data sets, only a small part of them are what we care and need. It is very difficult to find the effective rules by the traditional method. Especially, it takes a lot of time and energy to do with a very large data sets. It makes the traditional method can't adapt to the needs of the increasing large-scale data processing tasks. In order to control the game in time and effective management, it is imperative to use advanced computer technology to carry out technical movement analysis (Bhandari, 1997). On the other hand, the form of data is not structured, but it is always in the form of structured data in traditional database, which makes the common data mining technology is not applicable. Therefore, the extraction method of such a data source is used to get the potentially useful patterns and hidden information, so that the technical action of basketball game mining becomes a topic of data mining (Han, 2001; Xu and Xue, 2016).

Basketball technical action processing is one of the application technology of big data processing. With the rapid development of information storage technology and communication technology, the number of basketball technical data is increasing day by day. It is time-consuming and laborious to organize the huge original technical movement

data set by artificial method, and the effect is not very ideal (Agrawal R. et al. (1993)). In contrast, if the data of the technical action can be processed by the computer directly, and the information that players and coaches are interested in can help them do reasonable training and competition. In the era of the use of computers, players and coaches often rely on observation and simple analysis to find the wrong action (Liu et al., 2003). With the increase of the information and the popularization of the computer, the information service system can take the initiative to classify the latest technical movement data information, and then push them to the players and the coaches. Therefore, data mining is a basic and important function, it can help the players and coaches to sort and obtain information, which has a certain value (Usama et al., 1996)).

In this paper, the data preprocessing technology, such as classification and other data mining techniques are used to analyze the common technical skills of basketball. It provides relevant information for the players and coaches, so that the players in the usual training can do more targeted training to improve the level of competition to win the game.

2. Data mining

Data mining is the process of discovering new useful associations, patterns, and trends from a large number of stored data, which is the process of extracting potentially useful information and knowledge from a large number of incomplete, noisy, fuzzy and random data (Heikki, 1991). It is valuable to extract information from a large number of data through data mining, which can help people to make scientific and reasonable decision. The process of data mining includes multiple steps, which are connected with each other. Specific steps are as follows.

1. The establishment of a target data set. Select a data set or a set of data.
2. Data cleaning and preprocessing. Remove noise or irrelevant data and blank data domain, and consider the change of time sequence and data.
3. Data conversion. Find the features of the data to encode it to reduce the number of effective variables.
4. Data mining algorithm. Select a particular data mining algorithm (such as clustering, classification, regression, etc.) for the use of data mining, data mining model.
5. Evaluation knowledge. Put these knowledges into the practical system to see the role of these knowledge, or to prove that knowledge. Examine and resolve possible conflicts with prior knowledge.

Data mining mainly has the following kinds of technology, such as classification, clustering, association rules, time series analysis, regression analysis outlier analysis and so on.

2.1. Classification

Classification is used to extract models that describe important data classes, which are also called classifiers. The model maps the data items of the data to be analyzed into one of the given classes. In order to construct the classifier, the training sample data set is used as the input to find an accurate description or model for each class through the

performance of the data in the training set. The resulting model is used to classify the test data, classification is usually used to predict the category of the unknown data instance (Yun et al., 2000). Classification is to find out the concept description of a category, which represents the whole information of this type of data. It is generally represented by a number of rules or decision models, the model can map a tuple in a database into one of the given class. The content description of a class is divided into two categories, there are feature description and the discriminative description. Feature description is a description of the common features of objects in the class, and a discriminative description is a description of the difference between two or more classes (Widom, 1995).

Classification is obtained by using the training sample set (a sample of known database tuple and class). Data classification operations usually have the following two steps. In the first step, according to the given training set, and finding the appropriate mapping function to set as the model. This step is often referred to as the training step of the model. In the second step, the models got in the first step is used to predict the category of data, or the function model is used to describe each category of the data set to form the classification rules. The classification mainly has the following several algorithms. 1) Decision tree methods. The popular methods include ID3, C4.5, J4.8, etc. The decision tree is like a tree structure of a flow graph, where each of the internal nodes is represented in a property. 2) Bias classification. It is a statistical classification method and uses the Bias theorem to classify. 3) Neural network classification and others, such as KNN classification, genetic algorithm, rough set classification and so on.

2.2. Clustering

The process of grouping a set of physical or abstract objects into a number of sub sets of similar objects is called clustering, and clustering is a common operation for several data sets. The learning process of classification is a supervised learning process, which is based on a scalar, but clustering learning process is an unsupervised learning process. The distance between individuals in the same category is small, and the distance between individuals in different categories is larger. Clustering enhances people's understanding of the objective reality through the establishment of macro concept. The content of cluster analysis is very rich, and it comes from a lot of research fields. Clustering algorithms can be roughly divided into the following categories based on the model method, partition method, hierarchical method, density based method and grid based method (Meo et al., 1996).

1. Model Based Method. It is assumed that a model for each cluster to look for the best fitting of the data for a given model. It is possible to locate the cluster by constructing a density function that reflects the spatial distribution of the data points.
2. Partitioning Method. These clustering methods are suitable for the medium scale databases. In order to cluster the large data sets and to deal with the complex clustering, the partition based methods is needed to be further extended.
3. Hierarchical Method. It decomposes the set of given data objects, the hierarchical decomposition is determined the bottom-up or top-down formation. The hierarchical clustering method can be further divided into agglomeration and division. The disadvantage of the hierarchical clustering method is that once a step (merge or split) is completed, it cannot be undone, so that it can't correct the wrong decision.

4. **Density Based Method.** Density based clustering method adopts a multi resolution network data structure. The object space is quantized into a finite number of elements to a grid structure, and all the clustering operations are performed on this grid. The main advantage of this method is its processing speed is very fast, because its processing time is independent of the number of data objects but related to the number of elements in each dimension in the quantized space.

3. Pre-processing for data of basketball technical action

Data preprocessing is an important stage in data mining, and it is also a part of a large amount of work. The data collected will often contain a large number of the irrelevant records and redundant items. These redundant information need to be processed to get the data that is suitable for the data mining method. The process of data preprocessing is generally to do data cleaning, remove the noise of the data and correct the inconsistent data from collected data. Data integration is the integration of data from multiple sources into a consistent data. Data reduction can compress data gathered through deleting redundant features or clustering processing. These preprocessing techniques can greatly improve the quality of the data mining model, and reduce the time required for the actual mining.

4. Analysis of technical actions based on decision tree classification

4.1. Overview of classification methods

The classification processing is to find a model that can describe and distinguish the data classes to use the model labeled object class. Classification models can be expressed in various forms, such as classification (IF-THEN) rules, decision trees, mathematical formulas or neural networks. Decision tree is a tree structure that is similar to the flow chart, each node represents a test on a property value, and each branch represents an output of the test, the leaf represents the class. Data classification is made up of a two processes (W P Yan, et al. (1995)).

4.2.ID3 decision tree

C4.5 is the successor version of ID3, which is based on the ID3 algorithm and it is set as the core of the complete decision tree generation system, and training samples are used to estimate the accuracy of each rule (Santer, 1989). This leads to an optimistic estimate of the accuracy of the rule, so the C4.5 uses a pessimistic rule to estimate of the compensation bias. As a choice, it can be used to assess the accuracy of a set of test samples based on independent of the training samples. In machine learning, J4.8 is the WEKA version of C4.5. J4.8 algorithm is actually a modified version of the C4.5, which is a newer and slightly improved version. The information gain on each node of the tree is used to measure the test features. This metric is called the metric of attribute selection or the superior measure of division. The attribute that has the highest information gain is selected as the test attribute of the current node.

Let S be a collection of s data samples, assume that the sample has a m kinds of classes $C_i (i=1,2,...,m)$. and let s_i be the number of samples in class C_i . The desired information for the classification of a given sample is represented by the following Formula 1.

$$I(s_1, s_2, \dots, s_m) = - \sum_{i=1}^m p_i \log_2(p_i) \quad (1)$$

Where, p_i the probability of the sample in C_i . The logarithmic function with 2 as the base, because the information in binary encoding.

Set attribute f to have l different values $\{f_1, f_2, \dots, f_l\}$, S can be divided into l sub sets $\{S_1, S_2, \dots, S_l\}$ with the attribute f . S_i in S contains such a number of samples, which have a value of f_i from the f . Let S_{ij} be sample number sample in S_i with C_i . The entropy of samples that is divided by feature f is calculated by the Formula 2.

$$E(f) = \sum_{i=1}^l \frac{s_{1j} + s_{2j} + \dots + s_{mj}}{s} I(s_{1j}, s_{2j}, \dots, s_{mj}) \quad (2)$$

Where, $(S_{1j} + S_{2j} + \dots + S_{mj})/(s)$ is the weight of the j th subset, which is equal to the number of samples in subset divided by the total number of samples in the S . The smaller the entropy is, the higher accuracy is. For a given subset S_j .

$$I(s_{1j}, s_{2j}, \dots, s_{mj}) = - \sum_{i=1}^m p_{ij} \log_2(p_{ij}) \quad (3)$$

Where, $p_{ij} = (S_{ij})/(\cdot S_j)$ Is the probability of S_j in the sample belonging to the class C_i . The coded information obtained from the feature A is as follows.

$$Gain(f) = I(s_1, s_2, \dots, s_m) - E(f) \quad (4)$$

Algorithm is used to compute the information gain of each attribute, and attribute selection with higher information gain is set as the attribute of the given set S . A node is created to creates a branch for each value of the attribute, and that sample set is divided into subset. The establishment of decision tree can be divided into two parts. One is build the continuous division of nodes, the other is to prune the tree from the leaf node.

4.3. Classification of basketball technical movement data by using decision tree

Let S be a set of s basketball technical action samples and all action samples have m class labels. Define m different kind classes $C_j, j=1, 2, 3, \dots, m$, and let n_j be the number of samples in class C_j . Set attribute f to have l different values $\{f_1, f_2, \dots, f_l\}$, S can be divided into l sub sets $\{S_1, S_2, \dots, S_l\}$ with the attribute f . S_j in S contains such a number of samples, which have a value of f_j from the f . The entropy of samples that is divided by feature f is calculated by the Formula 2. The smaller the entropy is, the higher accuracy is.

The following steps to generate a basketball technical action decision tree is as follows (Bishop, 1975).

Algorithm: Generate_decision_tree: Produce a decision tree by a given basketball technical action training data.

Input: samples: the technical action training sample that is expressed by the discrete value attribute; attribute_list: the set of candidate actions.

Output: a decision tree for technical action.

Method:

1. Create node N .
2. If all the samples are in the same technical action class C , then
3. Return the N as a leaf node, and the class C is set as the label.
4. If attribute_list is empty.
5. Return the N as a leaf node, and samples is set as the most common class.
6. The technical action with the highest information gain from attribute_list is selected as test_attribute.
7. The node N is set as test_attribute.
8. For Known value a_i from each test_attribute.
9. A branch is grown from a node N when test_attribute = a_i .
10. Let S_i be a set of technical action samples of samples. Where test_attribute = a_i .
11. If S_i is empty, then.
12. Add a leaf to mark the most common technical action class in samples.
13. Add a node returned by Generate_decision_tree.

The model is used to determine the classification of the technical action of the basketball technical training sample set

5. Experiments and analysis

5.1. data sets

The data used in this paper is technical action transaction statistics of the highest level of NBA League in 2010-2015. Training data elements of basketball technology actions is shown in Table 1.

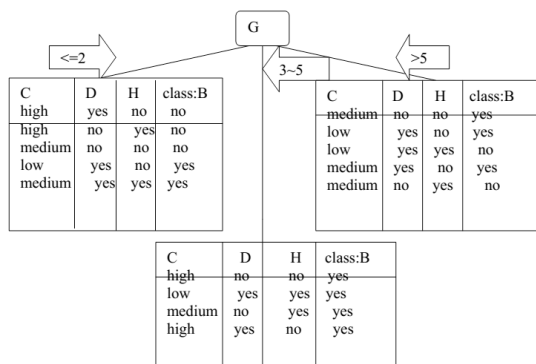


Figure 1 – Action G as the root node of test property

Breaking(G)	The quality of the rebound (R)	Steals (S)	Pick-roll (P)	Two-point (T)
<=3	High	No	No	No
<=3	Medium	Yes	No	Yes
3-5	high	No	Yes	Yes
>5	Medium	No	No	Yes
>5	Low	Yes	Yes	No
>5	Low	Yes	Yes	Yes
3-5	Medium	no	Yes	Yes
<=3	High	No	No	No
>5	Low	Yes	Yes	No
3-5	Medium	Yes	Yes	Yes
>5	Medium	No	No	No
<=3	Low	Yes	Yes	No
3-5	Medium	No	No	Yes
3-5	high	no	no	no

Table 1 – Training data elements of basketball technology actions

Because the information gain of G is highest in the attribute, it is selected as the test action attribute. The final decision tree returned by the algorithm is shown in Figure 1.

5.2. Results and analysis

Two-points is set as a class attribute for this technique analysis, and 10-fold cross validation is used to conduct the experiments (Shi Xilai, 1991). The training data in Table 1 is used as training samples to obtain the experimental results as shown in Figure 2.

The experimental results are interpreted as follows. Root node is G (breakthrough), the left node is S (Steals), the right node is P (Pick-roll), the left node of S is R (rebounds), all leafs are T (two-point). From the results in Figure 2, we can get some conclusions. When the number of breaking is less than 2, if stealing exists, then the player gets two-point. If the number of breaking is 3-5, then the player gets two-point goal. If the number of breaking is more than 5, it depends on stealing.

From the results, we can find that there are 8 examples of correct classification, which are accounting for 57.1429%. There are 6 instances of incorrect classification, which are accounting for 42.8571%. The mean absolute error is 0.4286, the root mean square error is 0.6546, and the relative error rate is 90%. The positive rate of class Yes is (TP rate) 0.667, the rate of false positive (FP) rate is 0.6, the precision of decision fine is 0.667, the rate of recall is 0.667 and F-measure metric value is 0.667. The last part is the confusion matrix, there are 3 instances of yes are divided into the class no, and 3 no instances are divided into the yes class.

Classification rules can also be extracted from the decision tree. For example, if the number of breaking is less than 3 and stealing exists, then they can get 2-point. If the

Correctly Classified Instances	8	57.1429 %
Incorrectly Classified Instances	6	42.8571 %
Kappa statistic	0.0667	
Mean absolute error	0.4286	
Root mean squared error	0.6547	
Relative absolute error	90 %	
Root relative squared error	132.6919 %	
Total Number of Instances	14	
=== Detailed Accuracy By Class ===		
TP Rate	FP Rate	Precision
0.667	0.6	0.667
0.4	0.333	0.4
Recall	F-Measure	ROC Area
0.667	0.667	0.533
0.4	0.4	0.533
		Class
		yes
		no
=== Confusion Matrix ===		
a b <-- classified as		
6 3	a = yes	
3 2	b = no	

Figure 2 – Classification result of decision tree by using WEKA tool

number of breaking is 3-5, then there must be a goal. This information gives the player and coach a guiding role.

6. Conclusion

With the rapid development of the computer technology, our life is changing rapidly by the revolution of information. The data in basketball matches is increasing too, but in the large amount of these data collections, there is a little information that we are interested in. This paper discusses the application of data mining for basketball technology actions in the case of only a few paper and reference about data mining on basketball technology actions. The aim of this paper is to pre-process basketball technology actions, and classify these actions with data mining technology to mine association rules between them. The paper discusses basketball technical actions mine both on a small scale and a large scale, J48 decision tree classification mining algorithm are applied, all these research results have useful instruction to basketball team.

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Computer-Aided Foreign Language Teaching Mode

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Abstract: The university English teaching reform advocated by the Ministry of Education aims to solve low language application ability of students and relieve the problem of serious shortage of foreign education resources caused by expansion of universities and a wholly new foreign language teaching mode is proposed. How to implement this wholly new teaching mode? Treat computer as an auxiliary tool of teaching or a necessary organic component of foreign language courses becomes the key for the effective implementation and smooth development of reform of the new mode. This thesis will start from the typical foreign language teaching living examples in the current universities and discuss about and analyze the position of computer in the new mode and the features of computer-aided teaching from the ecological perspective and points out that merely adoption of computer as the auxiliary tool can not be conducive to the realization of the reform target, computer website should be comprehensively integrated with foreign language courses so as to reach the target of teaching reform.

Keywords: human-computer society, integration, computer-aided, collision checking

1. Introduction

It is commonly held that the level of Chinese students' English learning lags far behind those in European countries, India, Pakistan, Singapore, and the Philippines, especially in the area of listening and speaking capabilities, which is far worse for Chinese students than students in other countries (McGraw et al., 2009). This is because in these countries students have many opportunities to hear and speak English outside the classroom, which is not the case in China. This is the difference between English-learning as a second language (ESL) and as a foreign language (EFL). The wide range of research on English learners from all over the world indicates that there are great distinctions between learning English as a second language and as a foreign language in language use, language acquisition manner and goals as well as the language environment.

From the above comparative analysis between the second language and the foreign language learning environments, their distinctions indicate at least the following problems. Firstly, in the language environment, those countries and regions adopting English as the second language use the target language in a wide range. Secondly, in the learning motive, foreign language learners are basically utilitarian, because they must adapt to the surrounding society and meet various demands that arise from competition

which will naturally help them to acquire and master the target language (Dorr, 1997). On learning methods, utilitarian learners pay more attention to the acquisition of the language knowledge, rather than the training of language communicative ability.

The differences	Second Language	Foreign Language
Regional	Non-native language mastered and used, is the main language of the local environment	Non-native language mastered and used, is not the main language of the local environment
Status	Almost the same with that of the student's mother tongue,	Lower than that of the student's mother tongue,
Purpose	Fully participate in the national political, social and economic life	Travel abroad, foreign exchanges, read foreign literature,
Environment	Wide support of language environment, not depending solely on in-class teaching	No language support outside the classroom

Table 1 – The second language and foreign language environments

To solve the environment problem of language learning, mere dependence on computer-aided teaching is far from enough, as computer-aided techniques cannot be basically conducive to the creation of an ideal foreign language learning environment. However, a virtual language environment can be created on a website with the help of modern information technologies, which may make it possible for the students to “acquire” the target language in a virtual language environment and enhance their application capability (Lin and Fang, 2010; Xiuming, 2016). Therefore, website-centered information technology must be integrated with foreign language courses in an effective manner.

2. Establishment of a human-computer society

As mentioned above, an ideal environment for learning foreign language is of great significance to learning a foreign language well. While in China where adopting English as a foreign language, an ideal environment for learning foreign language should be created with the modern information technology centered on a computer website. The creation of this environment is absolutely feasible, as with the quick development of computer technologies, the roles of computers have been far more than auxiliary functions and fully permeated various aspects of people's daily lives. In foreign language learning, learners and computers can also form a human-computer society. From the ecological perspective, when learners and computers are in a human-computer society, computers should be included from this ecological system in the form of a key biological chain in this ecological system overall (Jia, 2012). This phenomenon can be noticed in the development of computer technology and the comparative relations between human beings and computers, as seen in Figure 4.

Computer technology development	The computer	The user
Large computer	Single machine	Multiple machines
Personal computer	Single machine	Single machine
network	Multiple machines	Multiple machines

Table 2 – The man-machine relationship contrast

Recently, although information technologies center on websites are widely applied in our teaching and teaching reform, the computer's "auxiliary" role in the teaching process remains unchanged. Therefore, we should basically change our notion and fully recognize the vital role of computers in foreign language learning and allow for its full potential.

In a word, the goal of university English teaching reform is to relieve or solve the shortage of foreign language education resources and enhance students' ability to use the language in practical settings. To solve these problems, it is evidently not enough to consider the computer as an auxiliary teaching tool, for the following reasons. The computer's "auxiliary" position cannot be conducive for students to escape the red tape of class and textbooks and create an ideal learning environment. Furthermore, the computer's "auxiliary" position cannot be conducive to utilize wider teaching resources and realize a wider share. Therefore, to solve these problems, the information technologies centred on websites must be integrated with courses.

3. Integration between website and courses

3.1. Break the limits of classes+textbooks

Computer aided teaching still remains based on classes and textbooks, which indicates that textbooks are the sole source of students' knowledge. The teaching dominated by textbooks is expressed in the following procedures:

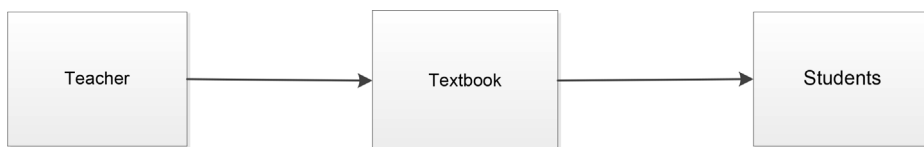


Figure 1 – Teaching Dominated by Textbooks

The relationship between teacher, textbook and students are as follows: the teacher controls the class and imparts knowledge to students through utilization, analysis and explanation (Ferreira and Atkinson, 2013). The textbook is just a media of communication between teacher and students, and students learn (adopt) knowledge through the analysis and explanation of the teacher. The teacher guides the teaching and the students are fully passive and become the objects the knowledge being imparted to, although the teacher utilizes the computer as the auxiliary teaching tool, the effect is as seen in Figure 2:

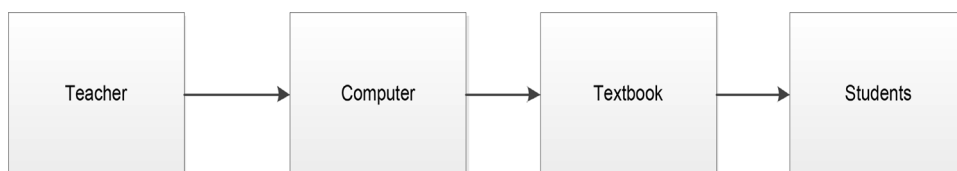


Figure 2 – Traditional Computer Aided Teaching

In this setting, the teacher merely imparts textbook knowledge to students through computer demonstration or explanation (as seen in Figures 1 and 2), and the computer

is used only to enhance the teaching effect and means. However, the situation where the traditional teaching form of class+textbook and textbooks are the only knowledge source of students has not been broken (Foti and Hannafin, 2014)). Whereas, the integration of website and courses can improve this situation, as the teaching framework experiences a basic change, as shown in Figure 3:

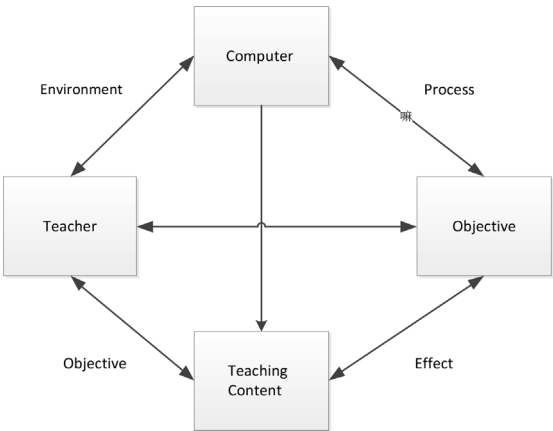


Figure 3 – Computer and foreign language courses integration framework

Given teaching elements, the relationship between teacher, students, computer and teaching contents are not all one-directional, but rather are two-way interrelations, interactions, interdependence and mutual conversion. In this framework integrating computer and courses, the role of the teacher has a basic transformation. They are not the center of teaching in class, as students become initiative constructors of knowledge from negative passive receiver of knowledge, and the scope of students' knowledge sources expands as shown in Figure 4

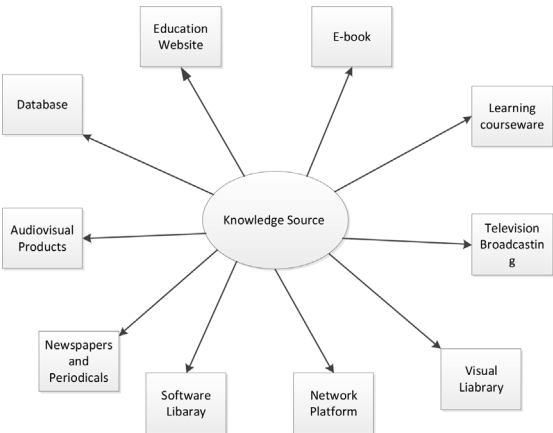


Figure 4 – Source of knowledge

We can see from Figure 4 that, in the whole learning process, knowledge that can be accessed by students has far exceeded the scope of textbooks. Students can take the initiative in constructing knowledge in meaningful manners through multiple methods.

3.2. Create ideal teaching and learning environment and methods

The integration of websites and foreign language courses is beneficial to the creation of the ideal teaching and learning environment. This ideal environment benefits from the rapid development of computer network technologies and creates conditions for student-centered learning.

3.2.1. Ideal environment and computer technologies

The ideal foreign language teaching environment and the development of computer technologies are closely related, especially AI. Digitalized and networking technologies make this ideal environment possible. AI technologies make the computer intelligent, which means the computer can think like human beings and can perform as a person in class. A computer's personified thinking can create a computer teaching system that acts like person-to-person, making human-computer interaction natural, the teaching process reasonable and sophisticated tasks agency-based, etc. Furthermore, computer intelligence can help foreign language teaching system realize the following objectives. Personalized teaching: use AI to construct a smart teaching system which can teach and provide assistance to students according to their different personalities and needs. Virtual environment: AI can virtualize the teaching scene, which also indicates that the teaching activity can go beyond the limit of physical space and time and fully exceed the mere aiding function of a computer. Automatic management: the intelligence of the computer can make teaching management fully automated, including computer tests, assessment, learning problems diagnosis and learning missions allocation, etc. (Orton et al, 2011). From this it can be said that AI lays a core foundation for the creation of an ideal teaching environment.

3.2.2. Deepening design

From the perspective of the theory of foreign language communication, the ideal foreign language teaching environment is a learning environment centered on students. Learning environment centered on students is mainly based on the following three basic presumptions. First, student-centered learning emphasizes the understanding of the human world, rather than simple simulation. Understanding is the result of learner's renovating and transiting information, and students take the initiative to handle information to understand the human world. Second, student-centered learning emphasizes that students should make efforts to narrow the difference between the known line and the unknown line. The cognitive dissonance caused by this difference is the provocative factor of the establishment of new understanding so as to resolve the difference. Third, student-centered learning emphasizes coordinated learning and assessment of individual understanding so as to segment the knowledge gained by individuals. Students check their own understanding by other students and review others' understanding, which provides conditions and an environment for well-established knowledge innovation through individual assessment and recognitive understanding.

Based on these three above assumptions, an ideal teaching environment centered on students should include contextualized learning and cooperative studying strategy that includes the following conditions.

1. Contextualized learning. Traditional textbooks and the teaching process will be separated. The effectiveness and appropriateness of this method are sometimes doubted by the educators. Whereas, after the integration of computer networks and foreign language courses, the content-themed bank can be reflected in the form of a virtual banking environment of computer networks, through which students can learn true language on an opening account, convertible to a closed account, etc.. This VR cannot be realized without computer networks, which can truly meet the students' needs for the training of listening and speaking communicative abilities.
2. Cooperative learning. In the teaching environment centered on students, more cooperation is needed between the teacher and students (Ono et al., 2015). After integration, the teaching structure does not consider the teacher as the sole decision-maker. Teacher and students should all be members of one team, and should be strongly adaptive and effectively communicate and discuss with others. The teacher should not only make himself or herself a good example for cooperation in his or her own work, but also promote the cooperation among students in the teaching process and foster students' communicative ability in foreign language through cooperation. Therefore, it is of great significance to separate teaching methods featuring promoting cooperation and the development of social skills from traditional group learning. See Figure 5.

Cooperative Team	Traditional Team
Heterogeneous	Homogeneous
Focus on social skills	Set social skills
Focus on mission and team maintenance	Only focus on mission
Teacher observation and promotion	Teacher ignores team function
Share leadership and responsibilities	Single leadership and individual responsibility
Mutual assistance	No mutual assistance

Table 3 – Comparisons between Cooperative Team and Traditional Team

In this ideal teaching environment, students can view the computer network as a tool of cognitive discussion and emotional encouragement and collaborative communication (Ibáñez et al., 2011)

4. Collision checking

The integration of a computer network and foreign language courses can not only create an ideal teaching environment, but also basically change the teaching structural system. The traditional teaching structure centred on “teaching” is changed into the teaching structure that prioritizes “learning and teaching”, namely the teaching structure guided by the teacher with students as the major body, see Figure 5.

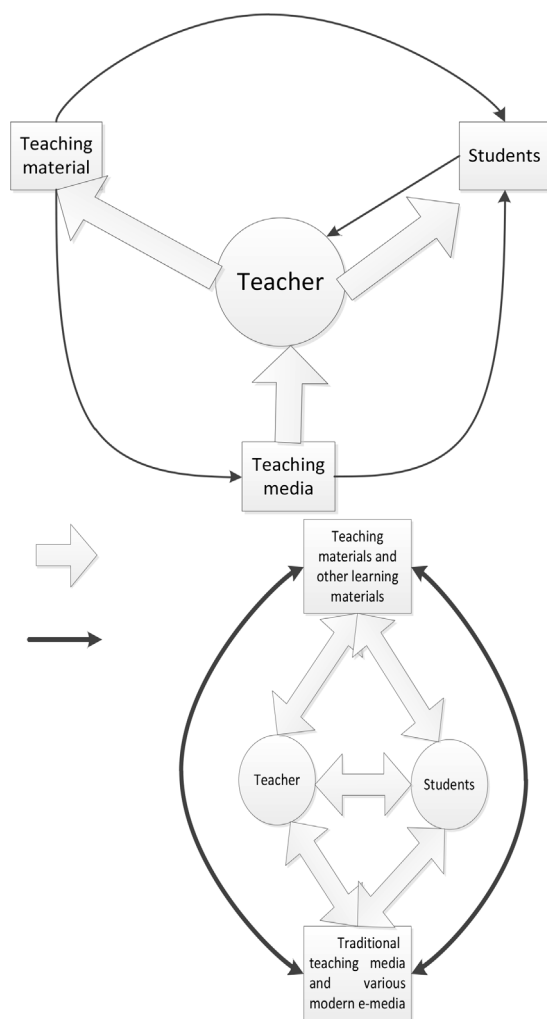


Figure 5 – The teaching center structure

1. Teacher predominance is mainly reflected by its roles. In this teaching structure, the teacher should fully recognize the changing teaching structure so as to change its traditional roles. Therefore, the teacher should firstly experience how to utilize the potential of the computer to acquire new knowledge. Additionally, this environment can help teachers recognize what problems and frustrations students may encounter in learning activities, and carry out specifically targeted work with a reasonable structure.
2. Student subject is mainly reflected on student-centered learning methods. In the predominant subject teaching structure, students will change their image as a learner receiving information to having more initiative and being more active

in the learning process. This learning process emphasizes applying knowledge into the practice to solve problems. The knowledge gained will be fully and effectively deepened through the cooperation with classmates and teachers through active participation in discussion.

5. Conclusion

The current university English teaching reform mainly targets solving students' ability to apply knowledge into practical settings and relieve the shortage of education resources. Therefore, the Ministry of Education proposes a wholly new foreign language teaching mode. Whereas, given the current teaching situation, most universities still operate under the traditional mode of computer-aided teaching centered on teachers. Whereas, to reach the objective of teaching reform, it is not enough to merely consider the computer as the aiding tool. In order to make effective reform in foreign language teaching, we should change our traditional opinions and integrate computer networks with foreign language courses in a comprehensive manner. Integrating the foreign language courses will go beyond the limit of class+textbooks and can use computer technologies to create an ideal foreign language teaching environment so as to change the existing teaching structure. Only in this way, the university English teaching objective can possibly reach the target to solve the problem of poor language application capability and relieve the severe shortages of foreign language educational resources.

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Development and Study of Electric Performance Support System for Capacity Development of Educational Technology of Teachers from Institutions of Higher Learning

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Abstract: On account of the investigation and the analysis on the current situation of educational technology capabilities of teachers from institutions of higher learning in Gansu Province, an electric performance support system is designed and developed. This system provides training support, expert support, training aids and other modules, which offers teachers with favorably comprehensive support for the capacity development of educational technology, saves learning time, reduces training cost, improves training performance, and holds certain application value.

Keywords: teachers from institutions of higher learning, educational technology, capacity development, electronic performance system.

1. Introduction

With the rapid development of higher education in China, issues concerning the quantity, the quality and the structure of teachers have become increasingly apparent. In order to improve the overall education level of teachers, the Ministry of Education and the academic institutions have carried out trainings in various forms and at various levels, and some progress have been made. However, some problems inevitably occur. Gansu province, the poverty-stricken area in the Western China, is selected in this research to exert certain demonstration effects. So currently, what is the status quo of educational technology capabilities of teachers from colleges and universities in Gansu Province? How do we solve this? Based on the above questions, the author has carried out an investigation on the present situation, and has conducted analysis and organization with an aim to provide a factual basis and a decision-making reference for the post-employment training and other related research.

2. Research Introduction

2.1. Research Subject

The survey is carried out in eight representative universities in Gansu Province. Teachers from principles like literature, history, science, etc. are sampled according to a certain

proportion. 780 questionnaires are distributed and 658 are collected, with a recovery rate of 84.36%. Among them, 598 effective questionnaires meet the requirements with an effective rate of 90.88%.

2.2. Research Content

With reference to the relevant studies at home and abroad, Questionnaires on Educational Technology Capabilities of Teachers from Institutions of Higher Learning in Gansu Province is prepared. There are a total of 30 items, including: (1) teachers' awareness and attitude towards educational technology; (2) the situation of teachers' usage of instructional media; (3) the situation of teachers' possession, access and management of teaching resources; (4) teachers' effective instructional design and learning needs; (5) teachers' teaching evaluation and innovation capabilities. In the questionnaire design, topics like attitude and awareness adopt the design of Likert-type.

2.3. Research Method

This research mainly adopts the method of questionnaire survey, supplemented by literature review, interview, observation and other study approaches. Statistical analysis employs software like Spss 16.0 and Excel 2010.

2.4. Scale Reliability and Validity Analysis

A. Analysis On Scale Reliability

According to the reliability analysis, Cronbach Alpha of the total scale in this survey is illustrated as Table 1.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of items
0.958	0.958	30

Table 1 – Reliability Statistics

In most cases, when $0.3 < \text{Cronbach's Alpha} < 0.5$, the scale is reliable; when $0.5 \leq \text{Cronbach's Alpha} < 0.8$, the scale is highly reliable. The scores of consistency coefficient of all the subjects in each test fall between 0.341 and 0.693. The reliability of the total scale reaches 0.946, which indicates favorable internal consistency of the scale and relatively high reliability.

B. Analysis On Scale Validity

According to the analysis given by the statistician, Kaiser, the value of KMO is greater than 0.6, which is fit for the factor analysis. The scale $p = 0.000$, less than 0.05 (see Table 2), so its null hypothesis is rejected, which suits the factor analysis.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.918
Bartlett's Test of SphericityApprox.	Chi-Square	13228.560
	Df	536.000
	Sig.	0.000

Table 2 – KMO and Bartlett's Test

Generally speaking, the factor loading with an absolute value greater than 0.3 is considered significant. Factor loadings in all the questions of this questionnaire are above 0.3 and are distributed between 0.387 and 0.804. Thus, this questionnaire has a preferable structure validity.

3. Research Findings

3.1. Educational technology capabilities need to be improved

In terms of the processing of acquired teaching information, 38.7% of the teachers are able to “independently manage and process it into information required by teaching”, 23.5% of the teachers are able to “independently identify and evaluate information”, 25.4% of the teachers are able to “manage and process it into information required by teaching with the help of others”, and 12.4% of the teachers are able to “identify and evaluate information with the help of others”.

According to teachers' urgency degree of learning needs for educational technology knowledge, they are listed as: instructional design theory and method (59.65%), operation skills of instructional media (52.26%), network technology associated with teaching (43.65%), educational technology theory (40.38%), development technology of teaching resources (37.36%), gathering skills of teaching information (26.73%), and evaluation methods of informationized teaching (19.86%).

It is found out that teachers' most desired skills are instructional design, media operation skills and computer-related technology, while the relatively neglected skills are the collection and processing of teaching information, teaching tracking, and other aspects with higher educational technology capabilities.

3.2. Lack of teaching evaluation and innovation capabilities

Teaching evaluation pays more attention to summative evaluation, and evaluation methods are relatively simplified. In terms of evaluation methods, the top four are: test paper (92%), evaluation form (54%), question bank system (51%) and computer-aided testing system (46%). Others methods such as gauges and portfolio bags are rarely visited.

Teachers should effectively cultivate their learning strategies and focus on their learning progress. Otherwise, in the future, the phenomenon of differentiation would be highly likely to occur, and colleges and universities would fail to realize their functions of education and guidance.

3.3. Training is not able to meet actual demands

Concerning the means of enhancing educational technology capabilities, the most popular approaches are training (58.61%), teamwork (17.94%), expert lectures (14.68%) and independent learning (8.77%), which greatly contrasts with the actual training approaches including self-learning (58.68%), lectures (24.08%), and school time (13.66%). In the future, we should focus on studying and exploring the effective training mode of “problem-training (learning)-solution” that improves the educational technology capabilities of teachers.

4. Solutions

To solve the existing problems like weak educational technology capabilities of teachers, insufficient application, and lack of cultivation, based on a comprehensive study, it is a must to understand the capability factor and the learning feature of teachers' educational technology, to select appropriate training carriers and approaches, and to design a feasible training program, so as to achieve fruitful training results and production efficiency.

4.1. EPSS

EPSS (Electric Performance Support System) is a computer system that is developed and applied with the concept of performance support, which integrates software tools, knowledge and learning experience. A relatively mature EPSS consists of information base, expert system, skill training system, help system, productivity tools, application software, monitoring system and other parts, which are integrated in a unified user interface.

4.2. System Function

EPSS for the educational technology training of teachers from colleges and universities applies the theory and the method of performance technology into teacher trainings. This computer system is able to provide learners with real-time knowledge support, friendly learning environment and learning tracking help, which saves learning time, reduces training cost and improves training performance (see Figure 1).

4.3. Structural Model of the System

The operating system is Windows 2013 Server, the Web server is Tomcat 6. 0, and the platform database is SQL Server 2012. B/S three-tier structure is applied (see Figure 2).

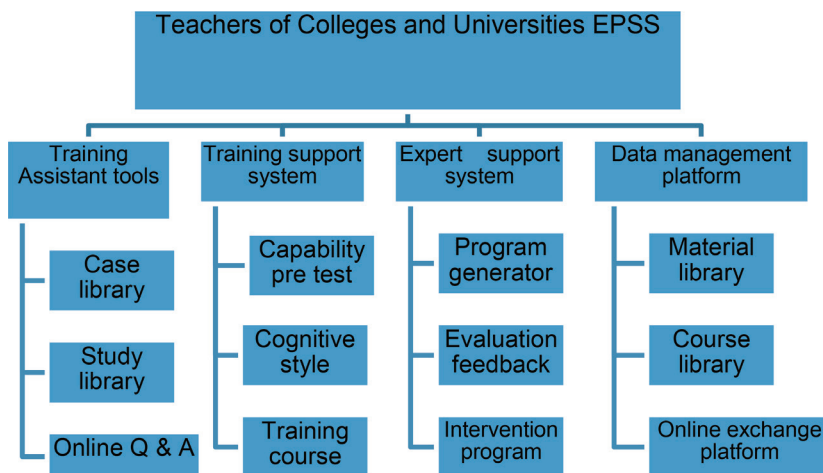


Figure 1 – The structure function module diagram of EPSS for the educational technology training of teachers from colleges and universities

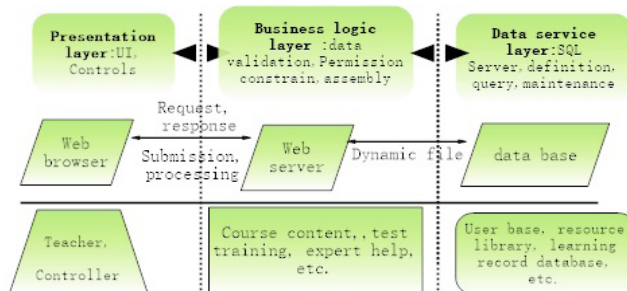


Figure 2 – Structural Application Model of the System

1. **Presentation Layer:** it is primarily responsible for providing logged-on users with data display, beautiful pages and human interaction and other related services.
2. **Business Logic Layer:** it mainly implements the business function of the main modules, including business rules, E-R modeling, data validation and authority constraint.
3. **Data Services layer:** it maintains the security and the integrity of data through the database system's definition of data, update and query and other operations, transfers to the business logic layer through the database interface, and finally present itself as a web page.

4.4. Realization of Key Technology

The system has been operating well (see Figure 3).



Figure 3 – Screenshots of system home page

A. Course content: this module combines, stores and maintains the course content by means of the structured approach. Also, it realizes addition through the approach of tree coding, including curriculum, subject, unit of knowledge and mission (see Figure 4). Its realization methods are as follows.



Figure 4 – Tree Structure Chart of the Course

1. Call “TreeViewBind ()” to build the structure tree.
2. Realize business entity loading through “MknowlClass”, and the code is as follows:

```

Public class MKnowlClass
{Public int id {get; set;} // The following are the basic entity attributes of the
category of knowledge point.
Public string classCode {get; set;}
.....//
Public string creatorName {get; set} // The following are the attributes of
entity interface.
Public string parentName {get; set;}}
  
```

3. Click the input box, the onclick event responses, and open the constructed classification tree.

B. Exam Training System: on the basis of modularized learning at earlier stages, learners carry out learning tests and training tasks according to test questions or tasks automatically (or manually) generated by teachers, and topics are able to realize their association with the related tasks and the knowledge points. Key codes of the customized test paper (such as multiple choices) and the screenshots are illustrated in the following Figure 5:

28. 了解并熟悉媒体、资源和环境的选择与设计，创设和优化教学情境：★

- ☐ 非常符合
- ☒ 比较符合
- ☐ 不确定
- ☐ 比较不符合
- ☐ 非常不符合

Figure 5 – Interface of Online Exam

```
<ConnectionString="<%%$ConnectionStrings:epssConnectionString%">
SelectCommand="select*from dbo. t_exam_libaray t1, t_exam_paper_detail t2
where t1. type='1'
and t1. status='1'
and t1. Id=t2. titleId
and t2. paperId=@PaperID">
<SelectParameters>
<asp:QueryStringParameter Name="PaperID"
QueryStringField="PaperId"/>
</SelectParameters>
```

C. Auxiliary lesson preparation system: free teachers from complex, abstract theories; offer a normalized platform with models of teaching design, where teachers are allowed to download, upload and/or review teaching plans and teaching tasks in class. Figure 6 is a screenshot of the system's key code (Group Cooperative Learning (GCL) mode, for example)



Figure 6 – screenshots of upload documents function in teaching preparation system

```
<%
if request("button")="teaching preparation system" then
set sc=server. CreateObjCt("adodb. recordset")
sesql="select * from GCLdesign where id=" & session("sid") & ""
sc. open scsql, conn, 1, 3
sc("d_tag")=1
sc. update
```

```

end if %>
<%
set full=server.CreateObject("adodb.recordset")
fullsql="select * from GCLdesign where id=" & session("sid") & ""
full.open fullsql, conn, 1, 3
if full("introduc") <> "" and full("task") <> "" and
full("sources") <> "" and full("conclude") <> "" then %>
<form action="webdeg.asp" method="post">
<input name="button" type="submit" class="bnt" value="teaching preparation
system">
</form>
<% end if %>

```

5. Concluding Remarks

The improvements of educational technology capabilities is not just a long-term process of accumulation, but also a spiral process that requires teachers to constantly reflect on, to construct self-meaning and to internalize it into discipline research capabilities. As a supplement to the regular trainings, this system provides learners with real-time knowledge support, friendly and collaborative learning environment, and learning tracking help, brings the participants' sense of accomplishment and self-learning initiative into full play, and expands and improves the traditional trainings. This study is based on the survey of colleges and universities in Gansu Province, but it still acts as the reference to the similar academic institutions in China as well as a preferable choice in the current school or regional training.

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Research on Current Situation of Moral Construction for Contemporary College Students under the Perspective of Computer Network on Case Study of Yao-moral Culture

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Abstract: Based on the contemporary college students' network behavior, the moral status of active learning communication, ethics, education and other multi-disciplinary resources, analyzing the cause of the present college students' network moral problems, discusses the corresponding countermeasures, and Yao-moral culture. Focus on college students' network moral accomplishment and eventually improve the comprehensive ability of educators to give reasonable suggestions.

Keywords: moral construction, contemporary college students, computer network, Yao-moral culture.

1. Introduction

Presently, at the end of the last month of 2012, China has more than 564 million net citizens, and over 42.1% of Chinese have been using internet, according to the data issued by China Internet Network Information Center (CNNIC). Chinese society, with the impetus of computer technology and communication technology, has transited from the mid-nineties of the 20th century to the era of internet and realized the rapid development for social network within the first decade of 21st century (Ezawa and Nakashiba, 2003; Liu, 2016). As the Chinese higher education enrolled in an increasing speed, and as the Chinese higher education popularized at the end of 20th century, enormous Chinese college students have now become the group more active and with more exploring spirit than any other social group in China. Accordingly, through the boom of internet, Chinese college students' new lifestyle, learning style, communication means, recreational mode, means of expression, as well as the way of thinking have been forged (Ryan et al, 1998).

On the objective perspective, people's new way of communication, network communication, has exerted magnificent influence to accelerating the socialization of contemporary college students (Xiaomei, 2011). Firstly, the network communication broadens the horizon of college students, especially in the aspect of developing college students' creative thinking ability. Secondly, the network communication boosts the

information sharing realized among the globe, providing broad learning space for college students. Thirdly, being highly interactive, as one of the characteristics of the network communication, stimulates the self-awareness and initiative of college students (Ping-Xiu, 2011). Fourthly, the network communication provides the brand new platform for college students to communicate socially and to present themselves and realize their values (Sun and School, 2013).

On the other hand, the network world is not absolute equal. What power a person has corresponds to the discourse power the person has in the network world. As developed countries build the network, they transit and penetrate the strong and powerful culture through this undefended border into our mindset (Hwa and Mukti, 2004). As a result, college students who are not ideally, politically and morally matured will be exerted negative influence by using the network.

The cause of internet Yao-moral culture issue for contemporary college students and the according countermeasures are analyzed and discussed on the basis of current situation of contemporary college students' network behavior and Yao-moral cultureity, and multi-disciplinary resources including communication, Yao-moral culture philosophy and pedagogy(Wang , 2012).

2. Characteristics of Internet Morality

The network communication has completely been different in the characteristics like single-direction communication and the strong and powerful status of communicator compared with former media through the recombination action posed by computer technology and communication technology (Tatsushima, 2008). Accordingly, a simple information communication technology has been gradually formed, which creates a combined and comprehensive platform for social communication and social lives (Huang and Rao, 2009). Thus, the Yao-moral culture rule of internet behavior is relatively different from the traditional morality in characteristics and contents.

1. Initiative Self-discipline as Internet Morality Develops

Viewing the present world, one of the major powers allowing Yao-moral culture individual to abide by the social ethics standard is the powerful pressure from public opinion, and in other word, the Yao-moral culture individual is passively disciplined much of the time while behaving morally in the present world(Jiao, 1997). However, speaking of the highly open internet, the virtual space with obvious anonymity, the impact of Yao-moral culture consensus has been obviously lowered, and the social ethics standard exerts less influence in constraining individuals (Warnick, 2004). Under the mentioned circumstance, the Yao-moral culture behavior shall be achieved by net citizens on their perspective of clear awareness of Yao-moral culture and ethnic's standard requirements and the consciously abiding by the Yao-moral culture rule.

To be specific, as the network communication enjoys its global openness and highly interactive characteristic, it is more possible for internet behavioral subjects to autonomously behave (Stivers, 1999). The virtual space created by network communication makes it possible to keep network behavioral subjects away from the actual social supervision and constraint, and accordingly living freely to communicate

and interact, the network behavioral subjects become freer and more unconstrained. However, this unconstraint will exert influence to the emerging of Yao-moral culture network behavior and the immoral network behavior. The network behavioral subjects being weakly willing to abide by the morality can probably behave immorally under the less constrained and relatively freer cyberspace. The network behavioral subjects behave morally abiding by the Yao-moral culture rule mainly due to the self-discipline of morality. Therefore, the motivation of network behavioral subjects behaving morally is derived from the power of Yao-moral culture self-discipline, the highly Yao-moral culture character.

2. Open Status of Internet Morality

As internet is globally open, network behavioral subjects are commonly overloaded for the information. This overloading phenomenon is not only the field of information capacity exceeding problem, but also, under the Yao-moral culture perspective, presents the major gathering of complex Yao-moral culture, ideology and behavioral information over the globe, marking the overloading status of Yao-moral culture perspective.

As the network is globally open, the Yao-moral culture cognition of network behavioral subjects cannot be the isolated and self-sufficient Yao-moral culture knowledge and conception forged by actual and real social behavioral subjects in the closed daily life any longer but the Yao-moral culture ideas and knowledge gained after having got in touch with other cultures and civilizations through the wide platform of internet by network behavioral subjects (Li, 2010). Accordingly, the Yao-moral culture cognition of network behavioral subjects is changed from closed status to open status. At the same time, the Yao-moral culture cognition, as the basis of network behavioral subjects' Yao-moral culture philosophy, is deeply influenced by the open internet so that the open Yao-moral culture scene can not only allow net citizens to get in touch with various Yao-moral culture systems, and through which net citizens can further keep the faith of the original Yao-moral culture cognition, but also make net citizens lost in the multifarious Yao-moral culture systems. Moreover, the open Yao-moral culture scene can make some of the net citizens get overtaken by those wrong conduct featured with intensified sensory stimuli and the confusion.

3. Comprehensively Upgrade the Network Yao-moral culture Accomplishment of College students

3.1. Improve the Cognition of Internet Morality

First of all, give full play to the governing and integrative function of internet Yao-moral culture cognition for college students' network behavior. The governing function of Yao-moral culture cognition means through original Yao-moral culture cognitive structure, Yao-moral culture individual is able to acquire Yao-moral culture cognitive elements. The integrative function of Yao-moral culture cognition means the original Yao-moral culture cognitive structure is refreshed and upgraded through conducting the internal adjustment of new element of Yao-moral culture cognition entering the structure. If the acknowledging and learning process of people is initiatively conducted and has the succession, the governing and integrative function can be realized in the Yao-moral culture cognition.

Secondly, take full advantage of the behavior orientation function of internet Yao-moral culture cognition. Yao-moral culture cognition can target the behavior. The relation between Yao-moral culture cognition and behavior targeting can be demonstrated as the relation between knowledge and action(Zhao and Dai, 2015). This targeting function can be analyzed in two sub-meanings, firstly the psychological preparation for launching individual's Yao-moral culture behavior and secondly value selection while interests conflict appears in choosing multiple behaviors. The behavioral targeting function of Yao-moral culture cognition requires us to help college students build the cognition for internet Yao-moral culture and internet Yao-moral culture behavior on the perspective of contextualizing and practicing Yao-moral culture education.

3.2. Increase the Emotion of Internet Morality

Firstly, we shall give full play to the catalytic action of Yao-moral culture emotion. The practice of morality is not the instinctive adaption and must abide by the Yao-moral culture cognition. Whether the Yao-moral culture cognition can be completed and the complete status is deeply decided on Yao-moral culture emotions which could be positive and negative (Johnson, 1999). If the Yao-moral culture emotion is positive, the Yao-moral culture emotion exerts constructive and proactive influence to people's Yao-moral culture cognition, allowing the Yao-moral culture individuals to accept the Yao-moral culture education. If the Yao-moral culture emotion is negative, the Yao-moral culture emotion obstructs the generation of Yao-moral culture cognition. The negative psychology caused by negative Yao-moral culture emotion factors will be bound to be the affective disorder while launching the Yao-moral culture education.

Secondly, give fully play to the selection function of Yao-moral culture emotion. Yao-moral culture selection means Yao-moral culture subjects Yao-moral culture accept or reject the behavior made by oneself under the perspective of special Yao-moral culture value concept. Yao-moral culture selection is the complex behavior selection which not only includes the selection of Yao-moral culture behavioral motive, but also Yao-moral culture behavior orientation, process and the Yao-moral culture result. If the catalytic action launched by Yao-moral culture emotion in Yao-moral culture cognition and Yao-moral culture behavior is only the surface meaning of multi-Yao-moral culture emotions, the selection function of Yao-moral culture emotion is aimed to force Yao-moral culture behavioral subject to make the correct Yao-moral culture selection and consciously assume the Yao-moral culture responsibility in the unsteady Yao-moral culture phenomena. Thus is the deep function of Yao-moral culture emotion.

	Number of people	percent	Total percent
Weekend	198	49.5	49.6
At ordinary times	69	25.0	72.3
There is no set time	104	26.5	100
The total number	325	100	

Table 1 – College students' Internet time

	Number of people	percent	Total percent
Once a week	105	27.4	27.5
Two or three times a week	192	45.6	75.4
Surf the Internet every day	64	14.2	95.2
other	29	7.9	100
The total number	385	100	

Table 2 – College students' Internet frequency

3.3. Building Strong Willpower of Internet Morality

Firstly, consistency of college students' morality and willpower exceeds the variability of morality. For the existence, Yao-moral culture willpower has consistency and variability. The Yao-moral culture behavioral subjects have clear purposes for behaving and deeply approve the Yao-moral culture significance of morality, consciously behave abiding by the social Yao-moral culture requirements and practice the morality, which are the embody of the consistency of Yao-moral culture willpower(Pickering, 1995). However, various values in the open internet usually induce the changing of college students' Yao-moral culture willpower, which obviously obstructs the formation of college students' Yao-moral culture willpower consistency.

Secondly, the discipline of Yao-moral culture willpower also means the surpassing of the decisiveness of willpower to flexible characteristic. The difference of Yao-moral culture willpower demonstrated while selecting morality is the difference between the decisiveness and flexible characteristic of morality. The decisiveness of Yao-moral culture willpower is the volitional quality made by Yao-moral culture behavioral subject for selecting morality and firmly executing the Yao-moral culture behavior.

	Number of people	percent	Total percent
Internet cafes	16	4.1	4.8
In the home	115	25.3	64.2
Mobile phone	145	56.8	100
The total number	365	100	

Table 3 – The Internet site survey

Thirdly, the discipline of Yao-moral culture willpower means the surpassing of self-control of morality to the self-willed of morality. The self-control of morality refers to the meaning that while Yao-moral culture subject is practicing morality, he effectively adjusts the emotional state and constrains his volitional quality. Living in the internet world with abundant attractions, college students shall constantly discipline their Yao-moral culture self-control, constantly abide by the morality principle, be firm to the Yao-moral culture faith and withstand every immoral attraction as to strengthen the morality willpower.

3.4.Strengthen the Faith of Internet Morality

We select the Yao-moral culture examples according to the advancement, lofty, contemporary characteristic, transcendence, infection and rallying point, truth and proximity. To mound a good Yao-moral culture example and propagandize the example, we should make the following two efforts (Liu, 2015). Firstly, we shall set up various examples. For internet morality, we should at least select examples from characters or groups like smashing internet writers, internet public opinion leaders with public knowledge quality, scholars insisting on the internet academy, social activists organizing public benefit activities via internet, as we seek to allow college students to feel the positive power of internet space in every aspect of internet morality.

Secondly, we should be clear that Yao-moral culture examples are not perfect. The perfect popularization towards Yao-moral culture examples in the past cannot be beneficial for effectively educating and will leave the bad impression that Yao-moral culture examples are making a show. On the basis of the information mentioned above, the Yao-moral culture model shown to the educate shall be real, lively and complete. Thirdly, as we popularize the Yao-moral culture example, we shall not only deliver the information via traditional newspapers and periodicals, specialized learning materials, broadcasting and television, but also transit the message via smart phone which is highly dependent by college students, and new media like internet as to effectively popularize the Yao-moral culture examples.

4. Improve the Comprehensive Abilities of Yao-moral culture Educators in Colleges and Universities

4.1.Strengthen the Yao-moral culture Theory Accomplishment for Yao-moral culture Educators in Colleges and Universities

The Yao-moral culture education theory of existentialism is built on the basis of existentialism philosophy (Ling et al, 2014). The existentialism philosophy can be traced back to the Danish philosopher, Soren Abase Kierkegaard and the German philosopher Friedrich Wilhelm Nietzsche from the second half of the 19th century, and it was thrived in Germany and France at 20th century respectively. As the extension of existentialism philosophy in Yao-moral culture education field, the Yao-moral culture education theory of existentialism was formed in 1950s and proposed clearly the teleology of education, psychodynamic theory of Yao-moral culture behavior.

The existentialism philosophy is definitely opposed to the existence of permanent knowledge hierarchy. This philosophy concept is demonstrated in the aspect objecting to treating education as the process of mastering human accumulating knowledge. According to the existentialism educator, the effective learning process shall be internally initiated by learners. The essence of education is character education (Miao and Li-Sheng, 2011). On the basis of emphasizing the individual peculiarity, existentialism educators criticize the teaching method setting students in the same educational pattern, and propose the individualized instruction pattern featured with Socrates idea. As a result, the Yao-moral culture education can meet different students' requirements individually in temperament, interest and growing up.

4.2. Derive the Essence from Chinese Traditional Yao-moral culture Education Theory

1. Example is Better than Precept.

Chinese ancient educators have proposed the thinking that example is better than precept. Confucius once mentioned of the ruler acts properly, the common people will obey him without being ordered to. Xuncius had clearly proposed that teachers shall set themselves as the example of positive behaving, and give full play to the exemplary role. Han Yu further illustrated the idea that once you became teachers, you shall be teachers constantly for thousands of years. Wang Tingxiang, the ideologist in Ming Dynasty, criticized the literati and officialdom atmosphere. He said that ancients taught others by their own examples, but the present people just taught students in language. How can students acquire any knowledge? As the internet Yao-moral culture educator, teaching students by our own examples is increasingly important.

	Number of people	percent	Total percent
Internet cafes	16	4.1	4.8
In the home	115	25.3	64.2
Mobile phone	145	56.8	100
The total number	365	100	

Table 4 – The Internet site survey

	Number of people	percent	Total percent
To find the information	326	84.2	82.1
Communicate to chat	241	56.2	136.5
Reading the news	148	12.5	174.2
Play the game	242	24.5	223.6
Watching movies, listening to music	197	26.3	241.2
For the learning services	126	21.3	23.1
other	395	12.8	319

Table 5 – The Internet purpose

2. Teach Students in Accordance of Their Aptitude

While Confucius educated the morality, he attached great importance to this principle. With reference of analects of Confucius, Ran Qiu, a student of Confucius, was timid, but Zhong You was relatively bold. Confucius taught these two students differently. He taught Ran Qiu not to be timid. Once you grasp the opportunity, you should initiate. He taught Zhong Yu not to be rash. He shall ask opinion from his parents. As the college

students' personalized features are increasingly distinctive and obvious in the era of internet, teaching students in accordance of their aptitude is attached great importance.

	Number of people	percent	Total percent
Have no effect	75	18.5	18.5
Help to study/Growth of knowledge	254	74.2	90.2
Communication entertainment	136	64.5	159.4
addictive	69	61.4	142.6
other	358	15.4	204.3

Table 6 – Impact on the Internet

	Number of people	percent	Total percent
The online world magic	288	74.5	75.4
The network is virtual	178	42.3	118.5
The online world is boring	58	21.5	140.6
Online help to learn	236	25.3	199.5
other	42	11.9	222.9

Table 7 – College students' attitude towards network and views

4.3.Cultivate the Open Thinking of Internet Yao-moral culture Educators

The open thinking refers to the thinking process with multi characteristics. It is a thinking method observing and thinking of a thinking subject under different perspectives as to draw on each other's strength. In the world of internet, there are commonly various viewpoints for a certain subject with different sources and different standpoints. Especially, the different Yao-moral culture idea systems coexist in the world of internet exerting complex influence to college students in their Yao-moral culture thinking and Yao-moral culture behavior.

The internet Yao-moral culture educators shall face the objective truth of diversified Yao-moral culture ideas existing in the internet and reach the overall cognition of different commentaries towards a certain Yao-moral culture subject through open thinking mode. More specifically, firstly, we shall follow the comment of mainstream media and thoroughly interpret these mainstream ideas. Secondly, we shall wieldy collect other different comments from representative medias and carefully find out their standing points, value standpoint, social influence and assets. Thirdly, on the basis of comprehensively understanding different viewpoints, we shall synthesize the correct value as to realize the goal of internet Yao-moral culture education.

Network behavioral subjects are commonly overloaded for the information. This overloading phenomenon is not only the field of information capacity exceeding problem, but also, under the Yao-moral culture perspective, presents the major gathering of complex Yao-moral culture, ideology and behavioral information over the globe, marking the overloading status of Yao-moral culture perspective.

The Yao-moral culture cognition of network behavioral subjects cannot be the isolated and self-sufficient Yao-moral culture knowledge and conception forged by actual and real social behavioral subjects in the closed daily life any longer but the Yao-moral culture ideas and knowledge gained after having got in touch with other cultures and civilizations through the wide platform of internet by network behavioral subjects (Li, 2010). Accordingly, the Yao-moral culture cognition of network behavioral subjects is changed from closed status to open status. At the same time, the Yao-moral culture cognition, as the basis of network behavioral subjects' Yao-moral culture philosophy, is deeply influenced by the open internet so that the open Yao-moral culture scene can not only allow net citizens to get in touch with various Yao-moral culture systems, and through which net citizens can further keep the faith of the original Yao-moral culture cognition, but also make net citizens lost in the multifarious Yao-moral culture systems. Moreover, the open Yao-moral culture scene can make some of the net citizens get overtaken by those wrong conduct featured with intensified sensory stimuli and the confusion.

4.4.Cultivate the Theory Thinking of Internet Yao-moral culture Educators

The theory thinking refers to the thinking mode revealing the internal essence and law of a subject systematically. The internet world is overloading in information including life information, academic information and entertainment information. People are becoming confused and puzzled about the overloading information. As for college students without abundant experiences in living, they are dizzying about the complex information on the internet, and they face difficulties in resolving and distinguishing the harmful information, which requires internet Yao-moral culture educators to see through the appearance to perceive the essence and constantly improve the abstract thinking ability for various subjects on the basis of scientific word outlook and the extensive knowledge accumulation.

More specifically, the Yao-moral culture educators shall firstly strengthen the knowledge of basic principle of Marxism and appreciate the world outlook and methodology of dialectical materialism and historical materialism deeply. Secondly, Yao-moral culture educators shall pay close attention to the historical context and the latest achievements of socialist theory system with Chinese characteristics and understand the relation between theory and practice more deeply. Lastly, the Yao-moral culture educators shall strengthen the qualities and accomplishments of Yao-moral culture philosophy and the relation between morality and law, as to enhance the insight of Yao-moral culture phenomenon.

The existentialism philosophy can be traced back to the Danish philosopher, Soren Abase Kierkegaard and the German philosopher Friedrich Wilhelm Nietzsche from the second half of the 19th century, and it was thrived in Germany and France at 20 century respectively. As the extension of existentialism philosophy in Yao-moral culture

education field, the Yao-moral culture education theory of existentialism was formed and proposed clearly the teleology of education, psychodynamic theory of Yao-moral culture behavior.

This philosophy concept is demonstrated in the aspect objecting to treating education as the process of mastering human accumulating knowledge. According to the existentialism educator, the effective learning process shall be internally initiated by learners. The essence of education is character education. On the basis of emphasizing the individual peculiarity, existentialism educators criticize the teaching method setting students in the same educational pattern, and propose the individualized instruction pattern featured with Socrates idea. As a result, the Yao-moral culture education can meet different students' requirements individually in temperament, interest and growing up.

5. Conclusion

In face of multiple Yao-moral culture psychology and Yao-moral culture behavior problems of college students while initiating network behavior, multiple factors including the reasons from college students themselves, higher education, network communicative characteristic and other factors, are discussed and analyzed under the perspective of psychology, pedagogy and communication. Also the following countermeasures are proposed on the basis of predecessors' foundation:

1. We shall pay much attention to the strengthening of college students' internet morality and quality. More specifically, we shall enhance college students; internet morality, self-discipline, academic accomplishments, internet language civilization and other fields as to comprehensively cultivate college students' internet quality.
2. We shall be bound to boost the comprehensive abilities of Yao-moral culture educators in colleges and universities as to realize the educational goal of cultivating college students' internet morality and quality. More specifically, it is the key and vital effort for enhancing Yao-moral culture educators' comprehensive abilities to strengthen Yao-moral culture education theory accomplishments, innovative thinking patterns and establish modern education concept. At the same time, we shall perfect the network environment for constructing college students' internet morality. This paper firstly proposes that we shall master the basic principle of Marxism in the field of internet management, secondly proposes that the controllability, comprehensiveness, reality and coherency of campus network make the internet environment perfection possible, and thirdly puts forward the primary network environment perfection scheme on the basis of information type of internet and the interpersonal space type of internet.

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Research on the Teaching Quality Evaluation Model in Colleges and Universities Based on Probabilistic Neural Network

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Abstract: Teaching practices are an important link in colleges and universities; and teaching quality acts as a key index that measures teaching levels in colleges and universities. For existing problems in teaching quality evaluation in colleges and universities, and for reasonable index selection and evaluation objectivity in particular, the paper researched on index selection and evaluation model concerning teaching quality evaluation in colleges and universities. With the help of Probabilistic Neural Network (PNN, for short), the paper established a teaching quality evaluation model based on PNN, with student assessment as subjects and expert assessment as guidance. In the model, 12 typical evaluation indices were selected as input information, and teaching quality evaluation grades as outputs. Simulative analysis was carried out on instances of the model, the results showing that this model could conduct effective evaluation on teaching quality in colleges and universities.

Keywords: probabilistic neural network, teaching quality evaluation model, MATLAB simulation and analysis

1. Introduction

Effective teaching quality evaluation is the most efficacious means of teaching management in colleges and universities (Li, 2014; Wang, 2015; Guo, 2012). Teaching quality evaluation in colleges and universities acts as a significant approach to teaching quality management. The construction of scientific, systematic, and valid teaching quality assessment system and its operating mechanism in colleges and universities plays an important role in the improvement of teaching evaluation, teacher management theories, and teaching quality as well (Cai, 2014; Liu et al., 2016; Xie, 2012; Wen, 2014). There are currently various teaching quality evaluation methods in colleges and universities at home and abroad (Chen, 2011; Wang, 2007; Feng, 2013; Dubg, 2003), including expert evaluation, AHP, fuzzy comprehensive evaluation, gray correlation degree, and neural network model. Quantitative or qualitative analysis on evaluation results that are obtained from different angles and scopes is the way to guaranteeing scientificity, objectiveness, and justice during the process of teaching quality evaluation for the above methods. PNN is a parallel algorithm developing from Bayesian classification and the Parzen window probability

density function estimator (Umamaheswari, 2016; Shih, 2016). Due to the ability of precise solution using nonlinear algorithms in replacement of linear algorithms, PNN is deemed as simpler than other intelligent algorithms. In addition, thanks to the equivalency between instance distribution and weights which saves users' efforts in adjusting them during training, PNN satisfies the requirement of real-time processing (Ashok, 2016; Hua, 2015; Yahya, 2015). Therefore, the paper chose PNN as a basis in designing the teaching quality evaluation model in colleges and universities.

2. University teaching quality evaluation indices

The paper evaluated teaching quality in colleges and universities from such 4 aspects as teaching attitude, teaching content, teaching method, and teaching result, with a total of 12 typical characteristics as evaluation indices. Specifically,

2.1. Teaching attitude

X_1 : Professional and diligent. Won't come to work late or leave early. Won't adjust classes or suspend classes for no reason.

X_2 : Care for students' after-class learning. Have many communications with students.

X_3 : Be adequately prepared before class. Full of spirits in class. Answer questions with conscientiousness and responsibility.

2.2. Teaching content

X_4 : Clear teaching objectives. Prominent key points and difficult points.

X_5 : Be familiar with teaching contents and their fields.

X_6 : Pay attention to linking theory with practice. Include a proper number of scientific achievements or relevant contents in teaching contents.

2.3. Teaching method

X_7 : Teach students in accordance with their aptitudes. Full discover talents of different students.

X_8 : Follow the guidance of syllabus closely. Be practice-related. Use proper examples.

X_9 : Arouse enthusiasm and initiative concerning learning and thinking in students.

2.4. Teaching result

X_{10} : By the end of this course, students have mastered basic knowledge and methods, and gotten their practical ability strengthened at the same time.

X_{11} : By the end of this course, students' self-study ability with respect to follow-up courses has been greatly improved.

X_{12} : By the end of this course, students' analytical ability and problem-solving ability have been significantly enhanced.

Students and experts scored the above 12 indices under the hundred-mark system, and classified the evaluation grades into 5 grades: excellent (5), favorable (4), middle-level (3), barely passed (2), and failed (1).

3. The teaching quality evaluation model in colleges and universities based on Probabilistic Neural Network

3.1. Design flow

With the help of strong nonlinear classification in PNN, the evaluation index instance space was mapped to the evaluation grade space. This sparked the formation of a strongly fault-tolerant evaluation network system with structural adaptability, which was to increase the accurate rate of teaching quality evaluation in colleges and universities. The design flow of the teaching quality evaluation model in colleges and universities based on Probabilistic Neural Network is shown in Figure 1 as follows.

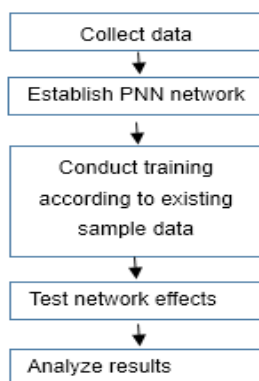


Figure 1 – Design flow of the teaching quality evaluation model in colleges and universities based on Probabilistic Neural Network

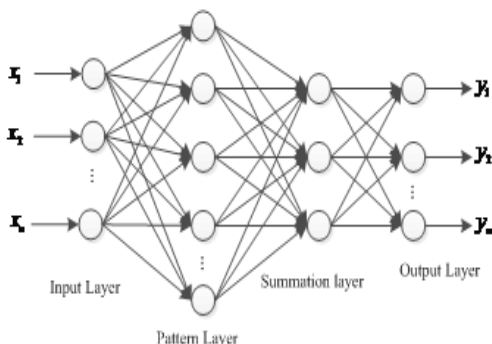


Figure 2 – The basis architecture of PNN

3.2. Establishment of the PNN model

PNN, a kind of radial basis function network, is particularly applicable to solution to problems of classification and model identification. If the distribution density approaches 0, then PNN constitutes a kind of nearest-neighbor classifier; if the distribution density is high, PNN forms the near classifier to several training samples. The PNN architecture is composed of neurons in four layers: input layer, pattern layer, summation layer, and output layer, as shown in Figure 2 as follows.

Training samples enter PNN through the input layer, and produce corresponding feature vectors. The number of neurons in the input layer is determined by how many features the input vectors have, namely the input vectors' dimensions. The pattern layer computes the matching relations between input feature vectors and every pattern in training groups. The number of pattern neurons is equivalent to the sum of numbers for the training samples of each classes. The outputs of each neuron in the pattern layer were:

$$f(X, W_i) = \exp \left[-\frac{(X - W_i)^T (X - W_i)}{2\delta^2} \right] \quad (1)$$

Where W_i denoted the connection weights between the input layer and the pattern layer, and δ represented the smoothing factor that weighed greatly in classification and pattern identification.

The summation layer chiefly sums the probability of a given sample being corresponded to a certain class, aiming to calculate the probability density function of each class using the given training examples. Each class corresponds to one unique summation unit, which merely connects to the pattern unit that correspond to the category from which the training pattern was selected. Therefore, the summation units simply sum the inputs from the pattern units that correspond to the category from which the training pattern was selected.

Neurons in the output layer is kind of competitive. In the paper, the neurons in the output layers represent final evaluation grades. One neuron corresponds to only one grade. In other words, the number of the output neurons is equal to that of grades. These neurons receive various classes of probability density functions coming from the summation layer, and produce a 1 (positive identification) for the chosen class with the maximum function value (owning the evaluation grade corresponding to the sample for identification) and a 0 (negative identification) for non-targeted classes.

3.3. PNN learning algorithm

Step 1: conduct normalization processing on the input matrix. In this way, smaller variables will not be immersed in larger variables, and system errors will be reduced. Assuming the original matrix was:

$$X = \begin{bmatrix} X_{11} & X_{12} & \dots & X_{1n} \\ X_{21} & X_{22} & \dots & X_{2n} \\ \dots & \dots & \dots & \dots \\ X_{m1} & X_{m2} & \dots & X_{mn} \end{bmatrix} \quad (2)$$

Where m denoted the number of inputs, n denoted the number of characteristic attributes for the inputs. B^T matrix was calculated before the normalization indices are determined:

$$B^T = \left[\frac{1}{\sqrt{\sum_{k=1}^n x_{1k}^2}}, \frac{1}{\sqrt{\sum_{k=1}^n x_{2k}^2}}, \dots, \frac{1}{\sqrt{\sum_{k=1}^n x_{nk}^2}} \right] \quad (3)$$

Then:

$$C_{m \times n} = B_{m \times 1} [1, 1, \dots, 1]_{1 \times n} \bullet X_{m \times n} = \begin{bmatrix} \frac{x_{11}}{\sqrt{M_1}} & \frac{x_{12}}{\sqrt{M_1}} & \dots & \frac{x_{1n}}{\sqrt{M_1}} \\ \frac{x_{21}}{\sqrt{M_2}} & \frac{x_{22}}{\sqrt{M_2}} & \dots & \frac{x_{2n}}{\sqrt{M_2}} \\ \dots & \dots & \dots & \dots \\ \frac{x_{m1}}{\sqrt{M_m}} & \frac{x_{m2}}{\sqrt{M_m}} & \dots & \frac{x_{mn}}{\sqrt{M_m}} \end{bmatrix} \quad (4)$$

$$= \begin{bmatrix} C_{11} & C_{12} & \dots & C_{1n} \\ C_{21} & C_{22} & \dots & C_{2n} \\ \dots & \dots & \dots & \dots \\ C_{m1} & C_{m2} & \dots & C_{mn} \end{bmatrix}$$

Where $M_1 = \sum_{k=1}^n x_{1k}^2, M_2 = \sum_{k=1}^n x_{2k}^2, \dots, M_m = \sum_{k=1}^n x_{mk}^2$.

The learning matrix that had underwent normalization processing was C . “ $\bullet$ ” in equation (4) was equal to “multiply” or “times”.

Step 2: through the input layer, the normalized m inputs entered the network. Sample data could be classified into c classes, each of which possessed the same number (K) of inputs. Therefore,

$$m = k * c \quad (5)$$

Step 3: calculate the pattern distance between the elements in input matrix and the corresponding ones in learning matrix. As a result, p n -dimensional vectors formed a matrix for identification. Thus, the input matrix for identification was equal to a normalized matrix:

$$D = \begin{bmatrix} d_{11} & d_{12} & \dots & d_{1n} \\ d_{21} & d_{22} & \dots & d_{2n} \\ \dots & \dots & \dots & \dots \\ d_{p1} & d_{p2} & \dots & d_{pn} \end{bmatrix} \quad (6)$$

Calculate the Euclidean distance: the distance between the input vectors for identification and the central vectors of various neurons in the pattern layer.

$$E = \begin{bmatrix} \sqrt{\sum_{k=1}^n |d_{1k} - c_{1k}|^2} & \sqrt{\sum_{k=1}^n |d_{1k} - c_{2k}|^2} & \dots & \sqrt{\sum_{k=1}^n |d_{1k} - c_{mk}|^2} \\ \sqrt{\sum_{k=1}^n |d_{2k} - c_{1k}|^2} & \sqrt{\sum_{k=1}^n |d_{2k} - c_{2k}|^2} & \dots & \sqrt{\sum_{k=1}^n |d_{2k} - c_{mk}|^2} \\ \dots & \dots & \dots & \dots \\ \sqrt{\sum_{k=1}^n |d_{pk} - c_{1k}|^2} & \sqrt{\sum_{k=1}^n |d_{pk} - c_{2k}|^2} & \dots & \sqrt{\sum_{k=1}^n |d_{pk} - c_{mk}|^2} \end{bmatrix} = \begin{bmatrix} E_{11} & E_{12} & \dots & E_{1m} \\ E_{21} & E_{22} & \dots & E_{2m} \\ \dots & \dots & \dots & \dots \\ E_{p1} & E_{p2} & \dots & E_{pm} \end{bmatrix} \quad (7)$$

Step 4: the neurons of the radial basis function in the sample layer was activated. After the learning samples and the samples for identification were normalized, usually the Gaussian function with the standard deviation $\sigma=0.1$ was chosen for activation, hence changing into the following initial probability matrix:

$$P = \begin{bmatrix} -\frac{E_{11}}{e^2 \sigma^2} & -\frac{E_{12}}{e^2 \sigma^2} & \dots & -\frac{E_{1m}}{e^2 \sigma^2} \\ -\frac{E_{21}}{e^2 \sigma^2} & -\frac{E_{22}}{e^2 \sigma^2} & \dots & -\frac{E_{2m}}{e^2 \sigma^2} \\ \dots & \dots & \dots & \dots \\ -\frac{E_{p1}}{e^2 \sigma^2} & -\frac{E_{p2}}{e^2 \sigma^2} & \dots & -\frac{E_{pm}}{e^2 \sigma^2} \end{bmatrix} = \begin{bmatrix} P_{11} & P_{12} & \dots & P_{1m} \\ P_{21} & P_{22} & \dots & P_{2m} \\ \dots & \dots & \dots & \dots \\ P_{p1} & P_{p2} & \dots & P_{pm} \end{bmatrix} \quad (8)$$

Step 5: calculate the total initial probability such that every sample corresponds to every class in the summation layer.

$$= \begin{bmatrix} \sum_{l=1}^k P_{1l} & \sum_{l=k+1}^k P_{1l} & \dots & \sum_{l=m-k+1}^m P_{1l} \\ \sum_{l=1}^k P_{2l} & \sum_{l=k+1}^k P_{2l} & \dots & \sum_{l=m-k+1}^m P_{2l} \\ \dots & \dots & \dots & \dots \\ \sum_{l=1}^k P_{pl} & \sum_{l=k+1}^k P_{pl} & \dots & \sum_{l=m-k+1}^m P_{pl} \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} & \dots & S_{1c} \\ S_{21} & S_{22} & \dots & S_{2c} \\ \dots & \dots & \dots & \dots \\ S_{p1} & S_{p2} & \dots & S_{pc} \end{bmatrix} \quad (9)$$

Where S_{ij} denoted the sum of the initial probability in the samples for identification that the i th sample pertained to the j th type.

Step 6: calculate $prob_{ij}$, namely the probability that the i th sample pertained to the j th type.

$$prob_{ij} = \frac{S_{ij}}{\sum_{l=1}^c S_{il}} \quad (10)$$

4. MATLAB simulation and analysis

4.1. data processing

The proposed model in the paper was established in MATLAB. According to the chosen evaluation indices, the number of input neurons was set as 12, and the number of output neurons 5. As could be seen from network trainings under different distribution densities, the optimal result came as the distribution density was set as 1.0. Sample data was chosen to train the model. Part of sample data was shown in Table 1.

No.	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	Assessment grades
1	0.91	0.88	0.89	0.84	0.9	0.91	0.9	0.83	0.94	0.91	0.9	0.88	5
2	0.8	0.85	0.81	0.82	0.81	0.85	0.84	0.74	0.6	0.83	0.86	0.85	4
3	0.84	0.9	0.81	0.67	0.77	0.65	0.75	0.81	0.84	0.76	0.77	0.82	4
4	0.57	0.45	0.82	0.63	0.57	0.62	0.7	0.9	0.75	0.85	0.84	0.75	3
5	0.65	0.61	0.71	0.73	0.75	0.81	0.75	0.86	0.72	0.67	0.75	0.71	3
6	0.54	0.63	0.71	0.67	0.6	0.76	0.61	0.64	0.67	0.63	0.8	0.65	3
7	0.72	0.62	0.67	0.55	0.71	0.7	0.55	0.67	0.59	0.61	0.71	0.7	2
8	0.74	0.81	0.56	0.83	0.55	0.57	0.64	0.61	0.65	0.55	0.67	0.72	2
9	0.54	0.42	0.48	0.81	0.2	0.4	0.62	0.57	0.7	0.75	0.55	0.8	1
10	0.7	0.5	0.65	0.63	0.65	0.56	0.5	0.51	0.65	0.5	0.7	0.45	1

Table 1 – Sample data for training

Normalize sample data. The normalization formula was selected as:

$$y = \frac{x - x_{\min}}{x_{\max} - x_{\min}} \quad (11)$$

Where y denoted the normalized value, x denoted the actual value, $x_{\max}$ denoted the corresponding maximum feature value, and $x_{\min}$ denoted the corresponding minimum feature value.

4.2.network training and test

Normalized data was regarded as the input information for neurons in the input layer when the model was trained. The evaluation results by the end of the training were shown in Figure 3, and the corresponding training errors were shown in Figure 4.

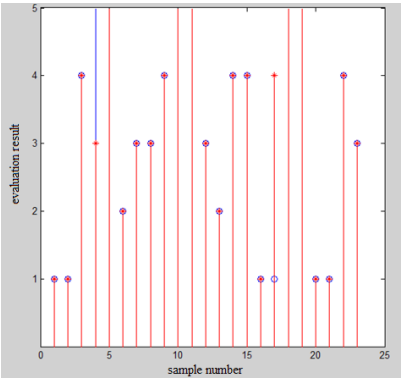


Figure 3 – Evaluation results by the end of the training

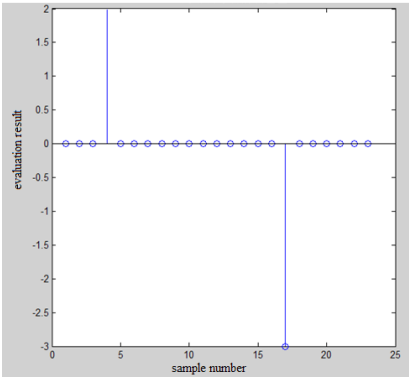


Figure 4 – Corresponding training errors

As could be seen, the evaluation precision of the proposed model in the paper was as high as 92%. Certain test sample data were used to measure the training network, the results being shown in Figure 5.

Figure 5 demonstrated that the proposed model possessed a 100% accuracy rate, thus effective evaluation on teaching quality in colleges and universities could be done with this model.

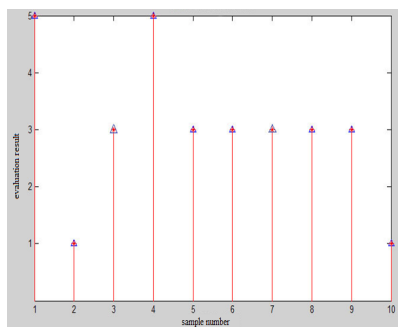


Figure 5 – Test results

5. Conclusion

The proposed teaching quality evaluation model in colleges and universities based on Probabilistic Neural Network avoids inherent complexity in traditional processes of teaching quality evaluation; instead, it is characterized by more practical simulation results and precisions, and have effectively reduced interference from human factors. According to the simulation test, this simple, fast-convergent, and stable model possesses advantages of easy sample number adjustments and strong robustness. What's more, with an objective and justified assessment on teaching quality in colleges and universities, the model contributes a lot to mobilizing teaching initiatives, improving teaching quality, and cultivating excellent talents as well. This model has given full play to the advantages of artificial neural networks, and stands out as a new evaluation method on teaching quality in colleges and universities.

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