An effective human resource management mode via analytic hierarchy process

Chi Chen*, Zhongyi Zhang, Li Chen, Yongbo Lv

Institute of Systems Engineering and Control, School of Traffic and Transportation, Beijing Jiaotong University, Beijing, 100044 China

Received 1 November 2014, www.cmnt.lv

Abstract

With the rapid development of social economics, there are a large number of enterprises in China. However, the profitability of some enterprises is still not satisfied. The reasons lie in that human resource allocation and management ability of these enterprises should be improved. Therefore, in this paper, we focus on the problem of human resource management mode selection based on analytic hierarchy process. Functions of human resource management consist of basic work, routine work, and strategic work. Afterwards, a three level index system of the human resource management problem is provided which can cover the above three functions. Then, we propose a novel human resource management mode selection approach based on analytic hierarchy process, which is a multi-criteria decision-making calculating method via relative assessment and prioritization of alternatives. Finally, experiments are conducted using the data collected from listed companies. Experimental results show that the performance of the proposed method is quite close to the ground truth, and "Management rules", "Salary and welfare", and "Enterprise culture" are the most important factors in the proposed problem. Furthermore, we can find that 1) human resource management mode selection of a specific enterprise must be consistent with its business strategy, 2) enterprise culture and staff incentive mechanism are also have profound impact on modern enterprise development..

Keywords: Human resource management, Analytic hierarchy process, Index system, Comparison matrix of criteria

1 Introduction

With the rapid development of knowledge economy, human resources management has been a key part for companies to obtain competitive advantage. Furthermore, human resources management departments have been the strategic partner of the enterprises. But, in the field of human resource management, many human resources management divisions are in a very difficult position [1]. Therefore, the effective human resource management mode is of great importance, it not only satisfies organizational performance managements' requirements, but also improves the human resource management department performance [2].

In this paper, we define human resources as the overt talents and underlying characteristics which people holds. On the other hand, we define three important aspects in human resource management: 1) the individual, 2) the organizational and 3) the societal/global. In the academic field, human resource management mainly considers the requirements of managers to hire and the management method [3][4].

Competing globally will make china's companies to continuously promote their management quality, efficiency, and productivity. Hence, this mode will let all human resource managers to concentrate on how to design an effective human resource management mode[5]. Based on the above analysis, we will discuss which factors can influence the human resource management mode using Analytic hierarchy process, which refers to a widely utilized approach for multi-criteria decision support via the hierarchical decomposition of objectives, evaluation of preferences based on pairwise comparisons, and a subsequent aggregation into global evaluations. Afterwards, with the proposed method in this paper, quality of human resource management can be enhanced greatly.

The main innovations of this paper lie in that we introduce the analytic hierarchy process in human resource management mode design. The rest of the paper is organized as follows. In section 2, a survey of analytic hierarchy process is described. Section 3 illustrates the proposed problem. In section 4, the analytic hierarchy process based human resource management method is given. Section 5 provides experiments to verify the effectiveness of our algorithm. Finally, the conclusions are drawn in section 6.

2 Literature review

Chen et al. proposed an approach using the data from the testing of food-waste feed with comprehensive evaluation of its product safety by integrating fuzzy mathematics and the analytic hierarchy process model. Particularly, the authors exploited the EM algorithm and AHP process to compute the weights of the individual evaluation indices [6].

Durbach et al. combined the AHP technology with stochastic multi-criteria acceptability analysis, which denotes an inverse-preference approach to allow the pairwise comparisons. Furthermore, simulation experi-

* ***Corresponding author's*** e-mail: davidchenchi@163.com

ments demonstrate that the proposed model can discern the best alternative deteriorates as uncertainty increases [7].

Zhang et al. studied on the fuzzy analytic hierarchy process synthetic evaluation models, which integrate different kinds of data from multiple sensors to convert these data to health evaluating scores. Particularly, we select a piecewise distribution for membership functions, and then we define several fuzzy operators to construct fuzzy-AHP evaluation program [8].

Dong et al. presented a consensus reaching model for a group by using the Analytic Hierarchy Process model. The proposed model can help humans to enhance their group consensus quality via updating judgments. Particularly, in this model, we design a moderator to help decision maker making judgments. Moreover, this model can also support decision makers to make determination using the moderator [9].

As a powerful computing tool, analytic hierarchy process can be widely used in many application fields. Parsons et al. utilized analytic hierarchy process model to help Local Government Authorities in England and Wales have statutory responsibility for the maintenance of Public Rights of Way, for example, pathways and byways open to non-motorised traffic [10]. Paul et al. exploited analytic hierarchy process to tackle the problem of waste treatment technology assessment in Mexico [11]. Ramanujan et al. used Stochastic Analytic Hierarchy Process to design for environment within an industry setting with quantitative measures of environmental performance [13]. Furthermore, analytic hierarchy process also can be applied in Axial vibration source identification[14], New Product Development Strategy[15], hydrogen storage systems for automobiles in Korea[16], agriculture[17], Technology Standards Battles[18], evaluating effect degree of damaged mountains[19], and Hospital Information Systems[20].

Using this template will enable you to prepare your paper in accordance with the instructions for authors for CM&NT papers with a minimal amount of manual styling a d formatting. Where appropriate you should overtype the different fields with your own text. Make sure that as you do this the correct style for the current paragraph is still displayed in the style box on the menu bar. If you need you can modify the style of a section of text using 1 column style for large formulas, figures and tables, or use a special Appendix at the end of the paper. Please read through the following sections for more information on preparing your paper. However, if you use the template you do not have to worry about setting margins, page size, and column size etc. as the template already has the correct dimensions.

3 Problem statements

In this section, we will introduce the problem of human resource management mode design, which is the key step of this paper. As is shown in Fig.1, functions of human resource management are mainly made up of three parts: 1) Basic work, 2) Routine work, and 3) Strategic work. In this paper, we aim to design an effective human resource management mode to effectively management the three parts of functions.

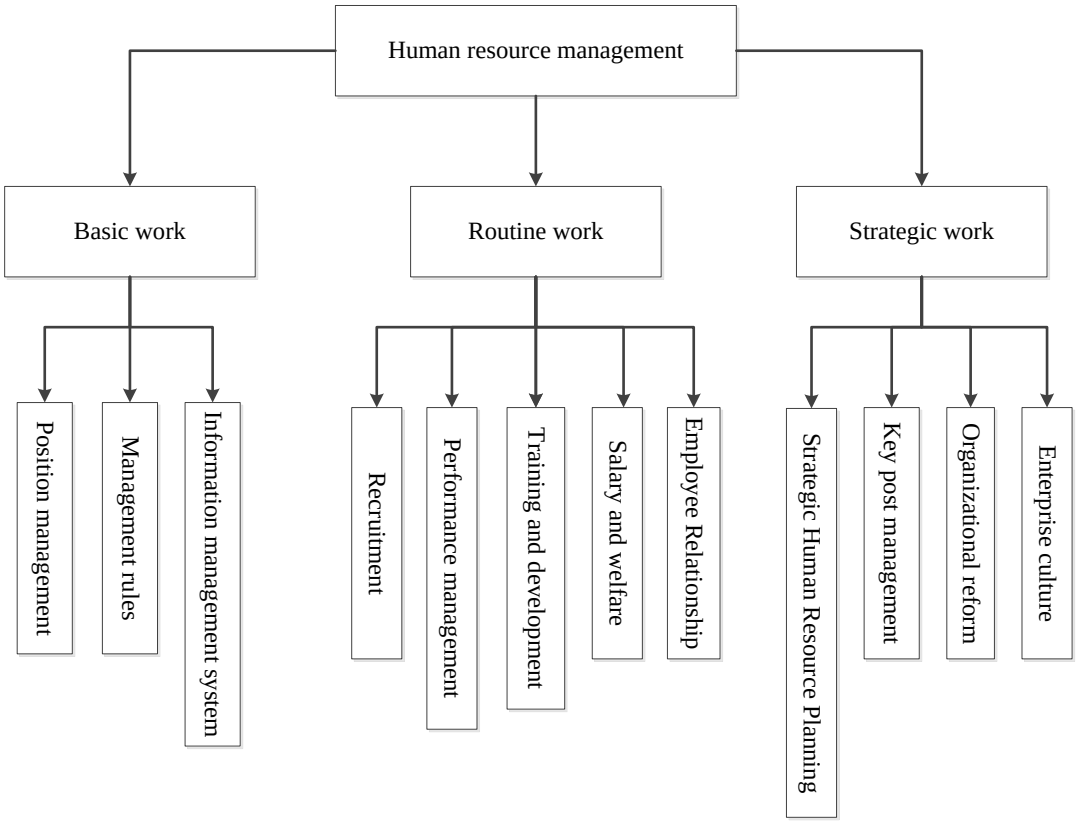


FIGURE1. Functions of human resource management.

To tackle the proposed problem, we should know what are influencing factors about human resource management in advance. Therefore, in the following section, we should illustrate the index system of human resource management (shown in Table.1).

TABLE 1 Index system of the human resource management problem

First level index	Second level index	Third level index
Basic work	Position management	I1: Perfect post management measures
		I2: Objective and fair post evaluation
		I3: Accuracy of post establishment
		I4: Update frequency of post establishment
	Management rules	I5: Reasonable work flow
		I6: Normative rules
		I7: Perfect employee handbook
		I8: Standardization of labor contract management
	Information management systems	I9: Easy to use
		I10: Maintenance and updating in time
Routine work	Recruitment	I11: Average cost of staff recruitment
		I12: Rationality of human resource structure
	Performance management	I13: Timeliness of performance appraisal management
		I14: Employee satisfaction
		I15: Statistical data error rate
	Training and development	I16: Training times per person
		I17: Ratio of training effect satisfaction
		I18: Completion rate of training plan
	Salary and welfare	I19: Salary fairness satisfaction
		I20: Total salary control rate
	Employee Relationship	I21: Staff attendance rate
		I22: Number of labor disputes
		I23: Separation rate
Strategic work	Strategic Human Resource Planning	I24: Rationality of strategic human resource planning
		I25: Participating of strategic planning participation
		I26: Satisfaction degree of human resources management department
	Key post management	I27: Timely rate of key positions staff recruitment
		I28: Key employee turnover
	Enterprise culture	I29: Integration degree of human resource management and enterprise culture
	Organizational reform	I30: Active participation of enterprises organizational changing
		I31:Actively carrying out the reform of human resources
	Financial index	I32: Labor productivity of enterprise per person
		I33: Profit level per person

4 Human resource management mode selections by the analytic hierarchy process

The Analytic Hierarchy Process is initially developed by Thomas Saaty, which refers to a multi-criteria decision-making computing framework with relative assessment and prioritization of alternatives. Furthermore, AHP is designed via the application of pair-wise comparisons.
Analytic hierarchy process may achieve a priority of the importance of each alternative. In this way, an overall object is positioned at the top level, and the criteria in the middle level denotes to the overall object. The elements at a given level are denoted as $X_1, X_2, \cdots, X_n$. Exploiting the relative evaluations computed by a decision maker, a pairwise comparison matrix is given as follows.

$$A = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \tag{1}$$

In the above equation, the condition $a_{ij} \cdot a_{ji}$ is equal to one, and the derivation of priorities at some levels is executed by the pairwise matrix in the above equation as well. Then, the pairwise comparisons matrix is defined as follows.

$$A = \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{pmatrix} \tag{2}$$

Where the vector $w = (w_1, \cdots, w_n)$ is satisfied. Next, exploiting the matrix A, a priority vector is calculated by the following equation.

$$Aw = nw \tag{3}$$

$$Aw = \lambda_{\max} w \tag{4}$$

Where $\lambda_{\max}$ denotes to the largest eigenvalue of matrix A and w refers to the weight vector. Afterwards, by using parameter $\lambda_{\max}$, the consistency index is calculated as follows.

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{5}$$

Based on the above analysis, EV method is utilized to tackle the eigenvector problem, and the executing process of the analytic hierarchy process model is illustrated in Figure2.

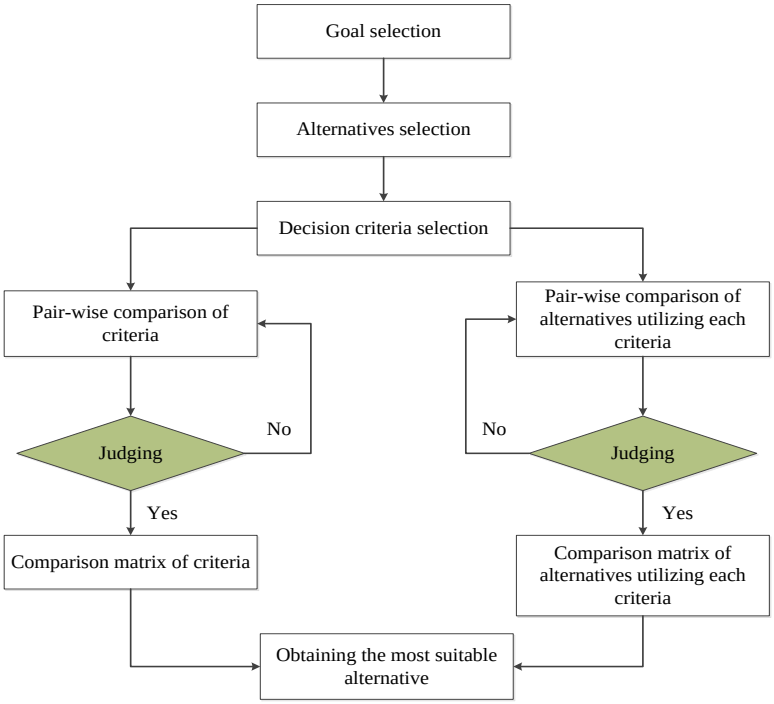


FIGURE 2 Executing process of the analytic hierarchy process model.

If the hierarchy is constructed, a numerical scale is given to each pair of n alternatives $\left(A_i, A_j\right)$ by experts. Afterwards, the symbol α_{ijk} represents the individual judgment of the k^{th} expert which is related to alternative A_i compared with A_j, and then all expert judgments are organized to construct the following matrix:

$$M = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \tag{6}$$

Where the following conditions $a_{ij} > 0$ and $a_{ij} \cdot a_{ji} = 1$ should be satisfied.

Using the above analytic hierarchy process model, we can solve the human resource management mode selection problem by computing the index weights in Table.1. Then, important factors in this problem have higher value of weight. To promote the effectiveness human resource management, managers should pay more attentions to the factors with higher values of index weights.

5 Experiments

In this section, a series of experiments are designed using the dataset which is collected from ten different listed companies. For each company, the data we collected can cover the above 33 indexes, which are shown in Table.1. Furthermore, utilizing the analytic hierarchy process model, weight of each index in the proposed index system can be obtained (shown in Figure.3)

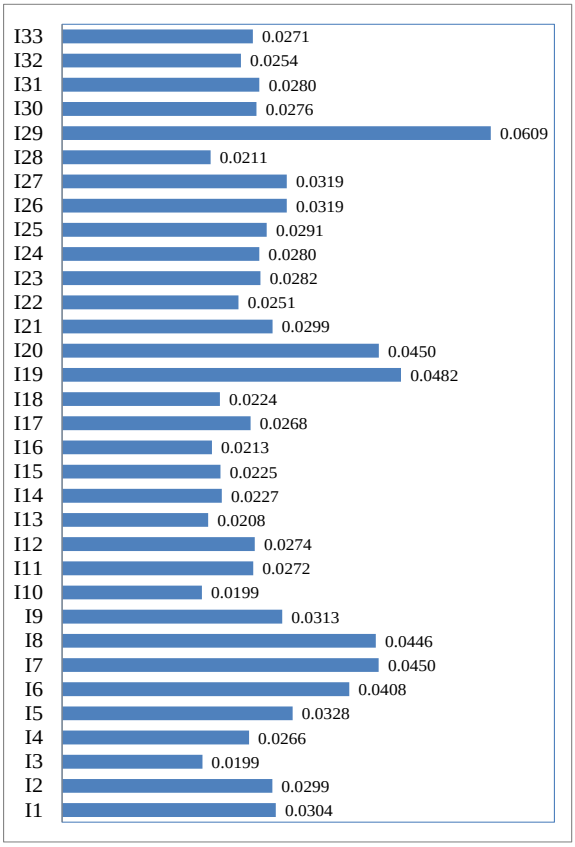


FIGURE 3 Weight of each index in the index system

Figure3. demonstrates the weight of each index computing by AHP, and the experimental results show that indexes with highest weights are I29, I19, I20, I7, I8, I6 and I5 respectively. That is, "Management rules", "Salary and welfare", and "Enterprise culture" are the most important in the human resource management problem. Next, to testify the effectiveness of our proposed method, performance evaluation based on ten different listed companies is given in Fig. 4 as follows.

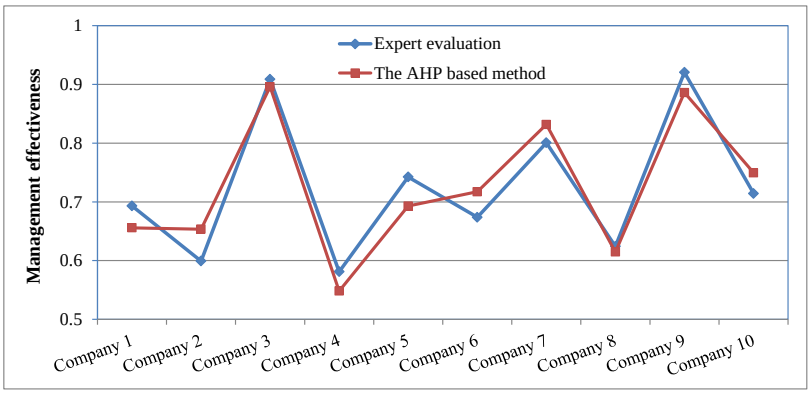


FIGURE4. Comparison of management effectiveness

In Figure4, our proposed AHP based method is compared with expert evaluation using management effectiveness. Particularly, we invite six experts to evaluate the management effectiveness for the ten listed companies, and experiment evaluation results are regarded as the ground truth. Combining all the results of the given ten listed companies, the average error rate between our method and ground truth is 4.87%.

In a word, based on the above experimental results, several suggestions for human resource management can be obtained. Firstly, enterprise human resource management mode selection must conform to its business strategy. Secondly, enterprise culture and staff incentive mechanism are another two important factors for modern enterprise management.

6 Conclusions

In this paper, we propose an effective human resource management mode selection method via analytic hierarchy process. To tackle this problem, a three level index system of the human resource management problem is designed in advance. Afterwards, we select human resource management mode through a multi-criteria decision-making calculating process using relative assessment and prioritization of alternatives. Experimental results provide some useful suggestions for human resource managers.

Reference

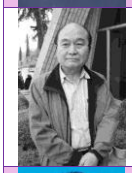
[1] Crowley-Henry Marian, Heaslip Graham, Short-term international assignments. Military perspectives and implications for international human resource management, European Management Journal, 2014, 32(5): 752-760.
[2] Boxall Peter, The future of employment relations from the perspective of human resource management, Journal of Industrial Relations, 2014, 56(4): 578-593.
[3] Jacobson Willow S., Sowa Jessica E., Lambright Kristina T., Do Human Resource Departments Act as Strategic Partners? Strategic Human Capital Management Adoption by County Governments, Review of Public Personnel Administration, 2014, 34(3): 289-301.
[4] Deadrick Diana L., Stone Dianna L., Human resource management: Past, present, and future, Human Resource Management Review, 2014, 24(3): 193-195.
[5] Nkomo Stella, Hoobler Jenny M., A historical perspective on diversity ideologies in the United States: Reflections on human resource management research and practice, Human Resource Management Review, 2014, 24(3): 245-257.
[6] Chen Ting, Jin Yiying, Qiu Xiaopeng, Chen Xin, A hybrid fuzzy evaluation method for safety assessment of food-waste feed based on entropy and the analytic hierarchy process methods, Expert Systems with Applications, 2014, 41(16): 7328-7337.
[7] Durbach Ian, Lahdelma Risto, Salminen Pekka, The analytic hierarchy process with stochastic judgements, European Journal of Operational Research, 2014, 238(2): 552-559.
[8] Zhang Wei, Sun Ke, Lei Changzheng, Zhang Yuncong, Li Huixin, Spencer Bill F., Jr., Fuzzy Analytic Hierarchy Process Synthetic Evaluation Models for the Health Monitoring of Shield Tunnels, Computer-aided Civil and Infrastructure Engineering, 2014, 29(9): 676-688.
[9] Dong Qingxing, Saaty, Thomas L., An analytic hierarchy process model of group consensus, Journal of Systems Science and Systems Engineering, 2014, 23(3): 362-374.
[10] Parsons David John, Angus Andrew, Brawn Martyn, Morris Joe, A decision support tool for Public Rights of Way officers based on the Analytic Hierarchy Process, Journal of the Operational Research Society, 2014, 65(9): 1387-1395.
[11] Taboada-Gonzalez Paul, Aguilar-Virgen Quetzalli, Ojeda-Benitez Sara, Cruz-Sotelo Samantha, Application of analytic hierarchy process in a waste treatment technology assessment in Mexico, Environmental Monitoring and Assessment, 2014, 186(9): 5777-5795.
[12] Kabir Golam, Sumi Razia Sultana, Power substation location selection using fuzzy analytic hierarchy process and PROMETHEE: A case study from Bangladesh, ENERGY, 2014, 72: 717-730. Kabir et al. introduced fuzzy analytic hierarchy process in power substation location selection, and proposed a case study from Bangladesh[12].
[13] Ramanujan Devarajan, Bernstein William Z., Choi Jun-Ki, Koho Mikko, Zhao Fu, Ramani Karthik, Prioritizing Design for Environment Strategies Using a Stochastic Analytic Hierarchy Process, Journal of Mechanical Design, 2014, 136(7), Article No. 071002.
[14] Liang Xingyu, Wen Yonghui, Shu Gequn, Wang Yuesen, Wang Xu, Axial vibration source identification of engine crankshaft based on auto-regressive and moving average model and analytic hierarchy

process method, Journal of Vibration and Control, 2014, 20(8): 1185-1198.
[15] Yuen Kevin Kam Fung, Fuzzy Cognitive Network Process: Comparisons With Fuzzy Analytic Hierarchy Process in New Product Development Strategy, IEEE Transactions on Fuzzy Systems, 2014, 22(3): 597-610.
[16] Gim Bongjin, Kim Jong Wook, Multi-criteria evaluation of hydrogen storage systems for automobiles in Korea using the fuzzy analytic hierarchy process, International Journal of Hydrogen Energy, 2014, 39(15): 7852-7858.
[17] Reed Brinton, Chan-Halbrendt Catherine, Tamang B. B., Chaudhary Narendra, Analysis of conservation agriculture preferences for researchers, extension agents, and tribal farmers in Nepal using Analytic Hierarchy Process, Agricultural Systems, 2014, 127: 90-96.
[18] van de Kaa Geerten, van Heck Eric, de Vries Henk J., van den Ende Jan, Rezaei Jafar, Supporting Decision Making in Technology Standards Battles Based on a Fuzzy Analytic Hierarchy Process, IEEE Transactions on Engineering Management, 2014, 61(2): 336-348.
[19] Zhang Yongwei, Li Shucai, Meng Fanqi, Application of extenics theory for evaluating effect degree of damaged mountains based on analytic hierarchy process, Environmental Earth Sciences, 2014, 71(10): 4463-4471.
[20] Kimiafar Khalil, Sadoughi Farahnaz, Sheikhtaheri Abbas, Sarbaz Masoumeh, Prioritizing Factors Influencing Nurses' Satisfaction With Hospital Information Systems A Fuzzy Analytic Hierarchy Process Approach, CIN-Computers Informatics Nursing, 2014, 32(4): 174-181.

Authors

< Chi Chen >, <1985.07>,<Haidian, Beijing, P.R. China>

Current position, grades: the graduate student of School of Beijing Jiaotong University, China.
University studies: received the bachelor's degree in communication from Beijing Jiaotong University, China in 2008
Scientific interest: His research interest fields include system engineering, virtual intelligent resource
Publications: more than 3 papers published in various journals.
Experience: He has assistant teaching experience of 1 years, has completed 1 scientific research project.



< Zhongyi Zhang >, <1944.09>,<Haidian, Beijing, P.R. China>

Current position, grades: a researcher and doctoral supervisor at Beijing Jiaotong University, China.
University studies: received the master's degree in systems engineering from Beijing Jiaotong University, China in 1986.
Scientific interest: He research interests include Information systems engineering and management systems engineering theory research and engineering practice.
Publications: published more than 150 papers in conferences and magazines..
Experience: He has teaching experience of 35 years, has completed 120 scientific research project.

< Li Chen >, <1985.07>,<Haidian, Beijing, P.R. China>

Current position, grades: the graduate student of School of Beijing Jiaotong University, China.
University studies: received the bachelor's degree in Mathematics and Applied Mathematics from Chongqing University, China in 2008
Scientific interest: His research interest fields include management system engineering and Iron and steel factory logistics
Publications: more than 7 papers published in various journals.
Experience: He has assistant teaching experience of 2 years, has completed 3 scientific research project.

< Yongbo Lv >, <1961.03>,<Haidian, Beijing, P.R. China>

Current position, grades: a researcher and doctoral supervisor at Beijing Jiaotong University, China.
University studies: received the Ph doctor's degree in systems engineering from Beijing Jiaotong University, China in 1990.
Scientific interest: Her research interests include management system engineering, intelligence resource sharing and Iron and steel factory logistics.
Publications: published more than 130 papers in conferences and magazines..
Experience: She has teaching experience of 30 years, has completed 100 scientific research project.