Management Innovation Ideal Solution Evaluation Based on Grey Entropy Fuzzy Comprehensive Evaluation Method

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Abstract. The management innovation ideal solution has been widely used in industrial management system. In this paper, the management innovation ideal solution evaluation index system is established. However, because the article has adopted expert estimation method to confirm the index weight, the conclusion is influenced by too many human factors and it is difficult to realize the dynamic demand after the index weight has changed in the marketing environment. Expert estimation for some index is an interval to be described with grey number. Based on grey method, the grey entropy fuzzy comprehensive evaluation is proposed. The case of Hebei construction group reflects that the adjusting the organization structure is the most fit to solve the internal control problem.

Introduction

In the current economic globalization and competition internationalization under the condition of knowledge economy era, management innovation for an enterprise, an organization or even a country's healthy development has very important significance. The study of management innovation has been many scholars research hot topic at home and abroad. This paper discusses the relationship between innovation and economic growth. The earliest contemporary management scholar Peter drucker once said: the most fundamental functions of two one is marketing and another one is the innovation [1]. Management innovation significance has been agreed with the theoretical circle and the enterprise [2, 3], but the existing theoretical research is more focused on the significance of the management innovation, but the research of the theory system is very few and it is unable to provide a systematic method.

The enterprise system can be divided into similar subsystems until it becomes the basic elements of the system. According to the characteristics of the enterprise management system and the technology of different innovation model, we can adjust the angle of the corresponding research. The building management judgement index of ideal solution is a competitiveness of the whole enterprise system. The index system is mainly used for the comprehensive innovation system ideal solution evaluation, and in the local innovation process it also can choose the corresponding evaluation index of subsystem.

This paper is to analysis enterprise activity as the breakthrough. By an analysis of the competitiveness of enterprise systems, the enterprise system is decomposed into three subsystems system: technical system, business system and management system. The general index system of the ideal solution for evaluation management innovation will be established. And through the grey fuzzy comprehensive evaluation from the weight of each evaluation index are obtained.

Evaluation Index of the Management Ideal Solutions

Based on the analysis of enterprise system three yuan structure, management evaluation index of the ideal solution is divided into three categories, technical system competitiveness index system of competitiveness index system, business system and management system competitiveness index system, the index system, including several competitiveness index, overall management innovation ideal degree evaluation consists of three categories of 18 indexes (see table 1). Then, we called three categories of

evaluation indicators, expressed in the U_i (i = 1, 2, 3); 18 indexes as secondary indexes, use U_{ij} said, also can remember doing respectively U_{1j}(j=1, 2, …, 7), U_{2j}(j=1, 2, …, 7), U_{3j}(j=1, 2, 3, 4).

Table1 Management innovation ideal solution evaluation index system

Enterprise management innovation ideal degree (U)	Technology system competitiveness (U_1)	Developing the ability of new product/new process U_{11}
		Product quality assurance ability U_{12}
		Ability to adapt to changes in the order U_{13}
		The manufacturing cost control ability U_{14}
		Timely delivery guarantee ability to leave U_{15}
		Service support capability of new products U_{16}
		The ability to resist risk U_{17}
	Competitive business system (U_2)	Profitability U_{21}
		Market development/acquisition ability U_{22}
		New technology to obtain and application ability U_{23}
		Customer and market information control ability U_{24}
		The ability of social responsibility U_{25}
		Improve the ability of employee satisfaction U_{26}
		The ability to improve customer satisfaction U_{27}
	Management system competitiveness (U_3)	To control the organization, staff efficiency U_{31}
		The business plan and control the efficiency U_{32}
		Simplify the management work content, or program U_{33}
		Flexible of organization, team U_{34}

The evaluation index system from the enterprise carries out all kinds of management activities to analysis and abstracts the ideal level of evolution, rather than from the theoretical analysis of the management object system level to start with. The advantage of using this evaluation index system of basically has the following several aspects.

Grey Entropy Fuzzy Comprehensive Evaluation Model

Given the weight of each index in the index system of management innovation is obtained by using the method of expert scoring, has certain subjective factors, in order to eliminate the influence of subjective factors on the final solution, in this paper, the evaluation model of management ideal solutions using grey entropy fuzzy comprehensive evaluation method, this method can eliminate the influence of subjective factors to some extent.

In the process of fuzzy comprehensive evaluation, the evaluation index weight is decided by the analytic hierarchy process (AHP). The method is a combination of reasonable expert opinions. The weighing values of assessment indexes are based on the index of the relative importance of each other more without actual management innovation parameter values. In the specific evaluation process, the same experts to give the same indicators to evaluate, each expert score may be different. Often is not a specific value, but a range of values, such as the first kind of 10 experts on the index of "the ability to improve customer satisfaction" the average is 0.96, 0.96, 0.97, 0.97, 0.99, 0.96, 0.98, 1, 1, 0.96. We found that the value is among 0.96 and 1, so we consider the first kind of expert of flat value is [0.96, 1]. It is an interval grey Numbers. In this paper the concept of interval grey numbers and the method of entropy fuzzy comprehensive evaluation method to explore the problem management innovation evaluation.

In following study, the interval grey number will be used into entropy fuzzy comprehensive evaluation.

Definition 1. Let R be a real space, $a \le b, a, b \in R$. A number which is valued in $[a, b]$ is called the interval grey number valued in $[a, b]$, denoted by $\otimes=[a, b]$. In particular, if $a = b$, $\otimes = a = b$ is called the whiting value of grey number $\otimes$.

The calculation of interval grey number with three rules. Here we let $a \le b, c \le d, a, b, c, d \in R$.

Rule 1 Let $\otimes_1=[a, b]$ and $\otimes_2=[c, d]$, then $\otimes_1 + \otimes_2=[a+c, b+d]$.

Rule 2 Let $\otimes=[a, b]$, then $-\otimes=[-b, -a]$.

Rule 3 Let $\otimes_1=[a, b]$ and $\otimes_2=[c, d]$, then $\otimes_1 - \otimes_2 = \otimes_1 + (-\otimes_2)=[a-d, \quad b-c]$.

Grey information can not be compared like the real numbers. The experts give the evaluation values which are interval grey number. They are difficult to evaluate. The following two deffnition give

the solution way. Using Deffnition 2 and 3, an interval grey number can be converted into a real number.

Definition 2. Let R is a real space, $a \le b, a, b \in R, \otimes=[a, b]$ is an interval grey number, $E(\otimes)=\frac{1}{2}(a+b)$ is called the mean of $\otimes=[a, b]$.

It is not hard to see that $E(\otimes)$ is the principal index to describe the size feature of $\otimes=[a, b]$. Interval length b-a is the reliable degree of $E(\otimes)$ representing $\otimes=[a, b]$. We can see that if the interval length b-a is given, $E(\otimes)$ is bigger the representative of $E(\otimes)$ to $\otimes=[a, b]$ is better; if $E(\otimes)$ is given, the interval length b-a is bigger the representative of $E(\otimes)$ to $\otimes=[a, b]$ is better. There is a complementary and mutually restrictive relationship between $E(\otimes)$ and b-a.

Definition 3. $S(s, t)$ is called a synthesising effect function if it is following three conditions: 1) $S(s, t)$ is monotone non-decreasing on each s; 2) $S(s, t)$ is monotone non-increasing on each t; 3) $S(s, 0)$is monotone increasing on each s.

Let $s=E(\otimes), t=b-a$, $S(\otimes)=S(E(\otimes), b-a)$, following Definition 3 we can see that when $E(\otimes)$ is bigger or b-a is smaller, the representative of $E(\otimes)$ to $\otimes=[a, b]$ is better. There are many kinds of synthesising effect functions such as $S(s, t)=s/(1+t^a), a \ge 1$, $S(s, t)=s(1+e^{-b}), b \ge 1$.

With expert estimation method to confirm the index weight, the conclusion is influenced by too many human factors and it is difficult to realize the dynamic demand after the index weight has changed in the marketing environment. There are many researchers studying in this problem [4-9]. In [9], the method of three level fuzzy comprehensive evaluation based on grey relational analysis and entropy weights is proposed, this method can reduce the influence of human factors in fuzzy comprehensive evaluation. In bus lane evaluation, the expert estimation for some index is an interval which can be described as an interval grey number. The following method is an entropy fuzzy comprehensive evaluation with interval grey number which is different from [10].

The grey fuzzy relationship evaluation matrix (indicator sample data matrix) is R. Some of the indicators that need to be estimated are divided into several categories as the different attribute, with each category as an assessment of factors. All assessment factors set a comprehensive evaluation model assessment factors set: $U=\{U_1, U_2, \mathbf{L}, U_m\}$, the overall assessment of the assets will be assessed by the factors set composition. With n-assessment staff to participate in the evaluation of an asset, each of the evaluators to assess each factor $U_k(k=2, \mathbf{L}, m)$ respectively for evaluation, the judge's assessment is set as follows: $V=\{V_1, V_2, \mathbf{L}, V_n\}$. According to assess each staff on the assessment made by the individual factors U_k asset evaluation results $\otimes_{ik}(i=1, 2, \mathbf{L}, n, k=1, 2, \mathbf{L}, m)$ which is an interval grey number, will be the first k indicators judge set the single-factor: $\otimes_k=(\otimes_{1k}, \otimes_{2k}, \mathbf{L}, \otimes_{nk})^T$. V is set reviews on fuzzy sets. Consolidated m assets judge set the single factor on the overall assets constitute a grey fuzzy relationship evaluation matrix $\otimes$, also known as sample data matrix indicators

$$\otimes=(\otimes_1, \otimes_2, \mathbf{L}, \otimes_m)=\begin{bmatrix} \otimes_{11} & \otimes_{12} & \mathbf{L} & \otimes_{1m} \\ \otimes_{21} & \otimes_{22} & \mathbf{L} & \otimes_{2m} \\ \mathbf{M} & \mathbf{M} & \mathbf{M} & \mathbf{M} \\ \otimes_{n1} & \otimes_{n2} & \mathbf{L} & \otimes_{nm} \end{bmatrix}.$$

When we consider the mean of expert estimation, we can get the following matrix

$$S(\otimes)=(S(\otimes_1), S(\otimes_2), \mathbf{L}, S(\otimes_m))=\begin{bmatrix} S(\otimes_{11}) & S(\otimes_{12}) & \mathbf{L} & S(\otimes_{1m}) \\ S(\otimes_{21}) & S(\otimes_{22}) & \mathbf{L} & S(\otimes_{2m}) \\ \mathbf{M} & \mathbf{M} & \mathbf{M} & \mathbf{M} \\ S(\otimes_{n1}) & S(\otimes_{n2}) & \mathbf{L} & S(\otimes_{nm}) \end{bmatrix}.$$

Using entropy method we can get the important factors to assess the extent of the right vector W. Orders $Z=(z_{ik})_{n\times m}$. Then $z_{ik}=S(\otimes_{ik})/\sum_{i=1}^{n}S(\otimes_{ik})$.The assessment value of the entropy of factors: $e_k=-c\sum_{i=1}^{n}z_{ik}\ln z_{ik}$, Here $c=(mn)^{-1}$, $0\le e_k\le 1$. Therefore factors can be important to assess the extent of the objective to empower Vector: $W=(w_1,w_2,\mathbf{L},w_m)$. Here $w_k=(1-e_k)/\sum_{k=1}^{m}(1-e_k)$, $k=1,2,\mathbf{L},m$. The indicators are to be assessed fuzzy comprehensive evaluation sets: $B=W\mathbf{o}(S(\otimes))^T=(w_1,w_2,\mathbf{L},w_m)\mathbf{o}(S(\otimes))^T=(b_1,b_2,\mathbf{L},b_n)$ The evaluators weight distribution parameters used in vector-under: $V=(v_1,v_2,\mathbf{L},v_n)^T$.Comprehensive assessment of the evaluation of all views, be grey entropy-fuzzy comprehensive evaluation results $d=B\mathbf{o}V=(b_1,b_2,\mathbf{L},b_n)\cdot(v_1,v_2,\mathbf{L},v_n)^T$.

This section using grey entropy fuzzy comprehensive evaluation process model and a concrete problem of management innovation, management innovation solution set of an ideal solution, and show a more integrated management innovation of the problem solving process.

A Case of Hebei Construction Group Internal Control Problem

In Hebei construction group internal control, due to the problems involved in the each subsidiary company's controls, involving all kinds of functions, the system will be the implementation of the new controls. So this problem can be seen as the comprehensive innovation evaluation process.

Problems can be abstracted as a conflict between "institutionalized" and "efficiency". It means that the excessive institutionalization will lead to a drop in efficiency. It is trying to maintain the appropriate institutional level and at the same time the efficiency of the present insufficient situation. By checking conflict resolution matrix table management, we can get some principles of innovation: asymmetry, anti-gravity, segmentation, change colors, flexibility, local quality, dynamic, combined with the company's actual situation, through experience, can consider to anti-gravity, segmentation, flexible and dynamic as the available principle of the specific problems. In addition, the control problem can be abstracted as the conflict between "diversity" and "efficiency". The sustainable development of the business and diversified expansion is at the same time, and it still want to keep the high efficiency of work and decision.

Using the innovation of the management conflict resolution matrix is available original solutions: anti-gravity, segmentation, flexible, dynamic, replication and multidimensional. Then we can get four solutions:

1) We can introduce the foreign investors or the investment institution (anti-gravity) and use the foreign institutions mature framework and innovation project for reference (replication).

2) "Multidimensional" and "segmentation" principle. The business can be divided according to the supply chain (upstream, midstream and downstream business), or it can be divided according to the channel (wholesale, retail business, terminal services).

3) Adjusting the organization structure. We can adopt more flexible flatter company structure (flexible), and take the initiative to adopt innovative organizational structure (dynamic). For example, combined with the division of business, the boundaries between the staff and departments in the matrix structure are more ambiguous, change more quickly.

4) We can use flexible employment mechanism (dynamic, flexibility) and many indicators, assessment (multidimensional).

Then, the (1) - (4) four schemes are the ideal solutions.

Through the above four ideal solutions we considered by the three categories of experts to evaluate the Table 1. The score is between 0 and 1. If the score is close to 1 it shows that the more optimized. If the score is close to 0 it tends to deterioration.

A total of three categories of experts, the first category for the executives, the second for relevant scholars, the third type of middle managers for the enterprise. Plan 1 rating score are shown in table 2.

Table 2 Scheme evaluation grey score table of Plan 1

	U_{11}	U_{12}	U_{13}	U_{14}	U_{15}	U_{16}	U_{17}	U_{21}	U_{22}
Expert 1	[0.6, 1]	[0.8, 1]	[0.7, 1]	[0.7, 1]	[0.7, 1]	[0.7, 1]	[0.3,0.6]	[0.4, 1]	[0.5, 1]
Expert 2	[0.4, 1]	[0.6, 1]	[0.5, 1]	[0.6, 0.8]	[0.5, 0.9]	[0.5, 0.6]	[0.7, 0.8]	[0.3, 0.4]	[0.8, 0.9]
Expert 3	[0.5, 0.7]	[0.8, 1]	[0.5, 0.9]	[0.6, 0.7]	[0.5, 0.9]	[0.7, 0.8]	[0.7, 0.8]	[0.7, 0.8]	[0.5, 0.7]
	U_{23}	U_{24}	U_{25}	U_{26}	U_{27}	U_{31}	U_{32}	U_{33}	U_{34}
Expert 1	[0.4, 0.7]	[0.8, 0.9]	[0.4, 0.5]	[0.8, 0.9]	[0.8, 0.9]	[0.5, 0.8]	[0.5, 0.8]	[0.8, 0.9]	[0.5, 0.6]
Expert 2	[0.4, 0.7]	[0.7, 1]	[0.7, 1]	[0.5, 1]	[0.5, 0.9]	[0.8, 0.9]	[0.6, 0.9]	[0.6, 0.9]	[0.6, 0.9]
Expert 3	[0.4, 0.5]	[0.9, 1]	[0.9, 1]	[0.6, 0.7]	[0.3, 0.7]	[0.6, 0.9]	[0.8, 0.9]	[0.8, 0.9]	[0.6, 0.7]

Let $S(s,t) = s/(1+t^3)$. Grey entropy value method is used to determine the important degree of each evaluation factor for the weight vector W=(0.06, 0.04, 0.08, 0.07, 0.06, 0.04, 0.03, 0.03, 0.05, 0.02, 0.10, 0.06, 0.07, 0.04, 0.05, 0.06, 0.07, 0.07). Stay evaluation index set of fuzzy comprehensive evaluation B=(0.74, 0.63, 0.68).

By actual conditions, three kinds of evaluation personnel executives, relevant scholars and enterprise middle managers weighting coefficients were 0.4, 0.3, 0.3, by the grey entropy fuzzy comprehensive evaluation model of comprehensive evaluation results to: d_1=(0.74, 0.63, 0.68)$\circ$(0.4, 0.3 0.3)^T=0.689.

Table 3 Scheme evaluation grey score table of Plan 2

	U_{11}	U_{12}	U_{13}	U_{14}	U_{15}	U_{16}	U_{17}	U_{21}	U_{22}
Expert 1	[0.7, 0.9]	[0.8, 1]	[0.8, 1]	[0.6, 0.8]	[0.5, 0.7]	[0.5, 0.7]	[0.6, 0.8]	[0.8, 1]	[0.7, 1]
Expert 2	[0.85, 1]	[0.95, 1]	[0.5, 0.8]	[0.7, 1]	[0.5, 0.7]	[0.5, 0.7]	[0.7, 0.9]	[0.7, 0.8]	[0.5, 0.6]
Expert 3	[0.7, 0.8]	[0.8, 0.9]	[0.6, 0.9]	[0.6, 0.7]	[0.6, 0.8]	[0.6, 1]	[0.5, 0.6]	[0.5, 0.9]	[0.7, 0.9]
	U_{23}	U_{24}	U_{25}	U_{26}	U_{27}	U_{31}	U_{32}	U_{33}	U_{34}
Expert 1	[0.6, 1]	[0.6, 1]	[0.8, 0.9]	[0.6, 0.8]	[0.8, 0.9]	[0.8, 0.9]	[0.6, 0.7]	[0.7, 0.8]	[0.95, 1]
Expert 2	[0.7, 0.9]	[0.5, 0.6]	[0.6, 0.7]	[0.6, 0.7]	[0.55, 1]	[0.8, 0.9]	[0.8, 0.9]	[0.7, 0.8]	[0.6, 0.7]
Expert 3	[0.5, 0.6]	[0.8, 0.9]	[0.8, 0.9]	[0.8, 0.9]	[0.95, 1]	[0.7, 0.8]	[0.6, 0.7]	[0.8, 0.9]	[0.75, 1]

Table 4 Scheme evaluation grey score table of Plan 3

	U_{11}	U_{12}	U_{13}	U_{14}	U_{15}	U_{16}	U_{17}	U_{21}	U_{22}
Expert 1	[0.6, 0.7]	[0.7, 0.8]	[0.5,0.9]	[0.8, 0.9]	[0.7, 0.8]	[0.35, 1]	[0.95, 1]	[0.75, 1]	[0.7, 0.8]
Expert 2	[0.75, 1]	[0.75, 1]	[0.6, 0.8]	[0.7, 0.8]	[0.8, 0.9]	[0.75, 1]	[0.6, 0.7]	[0.7, 0.8]	[0.75, 1]
Expert 3	[0.7, 0.8]	[0.75, 1]	[0.5, 0.6]	[0.7, 0.8]	[0.7, 0.8]	[0.6, 0.7]	[0.4, 1]	[0.6, 0.7]	[0.6, 1]
	U_{23}	U_{24}	U_{25}	U_{26}	U_{27}	U_{31}	U_{32}	U_{33}	U_{34}
Expert 1	[0.8, 0.9]	[0.6, 0.8]	[0.6, 0.7]	[0.8, 0.9]	[0.5, 0.7]	[0.4, 0.5]	[0.95, 1]	[0.8, 0.9]	[0.7, 0.8]
Expert 2	[0.7, 0.8]	[0.7, 0.8]	[0.7, 0.8]	[0.8, 0.9]	[0.7, 0.8]	[0.9, 1]	[0.7, 0.8]	[0.95, 1]	[0.7, 0.8]
Expert 3	[0.8, 0.9]	[0.5, 0.6]	[0.5, 0.6]	[0.5, 0.6]	[0.8, 0.9]	[0.9, 1]	[0.8, 0.9]	[0.6, 0.8]	[0.6, 0.7]

Table 5 Scheme evaluation grey score table of Plan 4

	U_{11}	U_{12}	U_{13}	U_{14}	U_{15}	U_{16}	U_{17}	U_{21}	U_{22}
Expert 1	[0.6, 1]	[0.7, 0.8]	[0.75, 1]	[0.5, 0.6]	[0.5, 0.6]	[0.75, 1]	[0.75, 1]	[0.9, 1]	[0.8, 0.9]
Expert 2	[0.6, 0.8]	[0.6, 1]	[0.6, 1]	[0.6, 0.8]	[0.75, 1]	[0.75, 1]	[0.9, 1]	[0.7, 0.8]	[0.5, 0.6]
Expert 3	[0.6, 1]	[0.6, 1]	[0.6, 1]	[0.7, 0.8]	[0.75, 1]	[0.75, 1]	[0.6, 0.7]	[0.4, 0.5]	[0.75, 1]
	U_{23}	U_{24}	U_{25}	U_{26}	U_{27}	U_{31}	U_{32}	U_{33}	U_{34}
Expert 1	[0.8, 0.9]	[0.75, 1]	[0.8, 0.9]	[0.9, 1]	[0.8, 0.9]	[0.7, 0.8]	[0.8, 1]	[0.9, 1]	[0.8, 1]
Expert 2	[0.6, 0.8]	[0.6, 0.7]	[0.6, 0.8]	[0.5, 0.6]	[0.6, 0.7]	[0.7, 1]	[0.7, 0.8]	[0.75, 1]	[0.75, 1]
Expert 3	[0.6, 0.8]	[0.7, 0.8]	[0.6, 0.7]	[0.5, 0.6]	[0.6, 0.8]	[0.7, 0.8]	[0.6, 0.7]	[0.6, 0.7]	[0.6, 0.7]

Using grey entropy fuzzy comprehensive evaluation method we can get the second scheme evaluation results d_2 = 0.752, project evaluation results of three d_3 = 0.894, scheme evaluation results of four d_4 = 0.533.

Conclusion

The management innovation ideal solution evaluation index system includes 18 concrete indexes. This paper used the entropy fuzzy comprehensive evaluation with the synthesizing effect of interval

grey number to build an evaluation index system for the management innovation ideal solution, and presented the instructive and significant results through empirical research. In Hebei construction group internal control problem, the evaluation result of the ideal solution "Adjusting the organization structue" is 0.896 which is the largest score. It shows that the ideal solution "Adjusting the organization structure" is the most fit to solve the Hebei construction group internal control problem.

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References

[1] G. S. Altshuller, Creativity as an exact science, Gordon & Breach Science Publishers, New York. 1984.

[2] J. Nieves, M. Segarra-Ciprés, Management innovation in the hotel industry, Tourism Management. 46 (2015) 51-58.

[3] K. Vishnevskiy, O. Karasev, D. Meissner, Integrated roadmaps and corporate foresight as tools of innovation management: The case of Russian companies, Technological Forecasting and Social Change. 90 (2015) 433-443.

[4] Z. Y. Jia, C. M.Wang, Z. W. Huang, G. Zhang, Evaluation research of regional power grid companies' operation capacity based on entropy weight fuzzy comprehensive model, Procedia Engineering. 15 (2011) 4626-4630.

[5] Z. Y. Zhou, X. J. Zhang, W. Y. Dong, Fuzzy comprehensive evaluation for safety guarantee system of reclaimed water quality, Procedia Environmental Sciences. 18 (2013) 227-235.

[6] Y. Wang, W. F. Yang, M. Li, X. Liu, Risk assessment floor water inrush in coal mines based on secondary fuzzy comprehensive evaluation, International Journal of Rock Mechanics and Mining Sciences. 52 (2012) 50-55.

[7] D. W. Liu, L. Yu, B. Li, Fuzzy-entropy theory comprehensive evaluation method and its application in building construction safety, Procedia Engineering. 43 (2012) 137-142.

[8] K. Han, F. M. Li, H. Y. Li, J. W. Cheng, Fuzzy comprehensive evaluation for stability of strata over gob influenced by construction loads, Energy Procedia. 16 (2012) 1102-1110.

[9] H. Liu, W. D. Liu, The study of CIQ inspection rate's setting problem based on gray-fuzzy comprehensive evaluation theory, Physics Procedia. 24 (2011) 1521-1545.

[10] X. L. Liu and B. W. Song, Three level fuzzy comprehensive evaluation based on grey relational analysis and entropy weights, 2008 International Symposium on Information Science and Engieering. 2 (2008) 32-35.