Journal of Computing and Information Technology - CIT 22, 2014, Special Issue on LISS 2013, 53–61
doi:10.2498/cit.1002274

Research on Construction and Application of Individual Knowledge Management Maturity Evaluation Model

Dan Chang[1], Xiaoying Han[1] and Baowei Chen[2]

[1] School of Economics and Management, Beijing Jiaotong University, Beijing, China
[2] Junior College of Zhejiang Wanli University, Ningbo, China

Individual knowledge management is basic component of organizational knowledge management, and the maturity of individual knowledge management has a significant impact on organizational knowledge management. This research introduces scientific idea of capability maturity model into individual knowledge management, building corresponding assessment criteria combined with features of individual knowledge management, and constructing an individual knowledge management maturity model with gray comprehensive evaluation method. In the fourth part of this paper, the validity of the model has been verified by applying the model on an instance. This research is made in order to provide references and suggestions on improving the level of individual knowledge management in knowledge-based organizations.

Keywords: individual knowledge management maturity model, gray comprehensive evaluation method, whitenization weight function

1. Introduction

Knowledge management can help staff of an organization in adapting to changing and innovating in time to add value to the organization. Knowledge has been the capital of competition between organizations in this knowledge-based economy age. Therefore, how to manage knowledge is in the spotlight by both academy and industry. Knowledge management is the process of organizational and individual advantage of knowledge which creates value on business goals and economic performance. In this process, production, sharing, application and innovation of knowledge have been achieved through information technology and the sources of knowledge are various. Individual knowledge management is applying ideas and methods of knowledge management on individuals. This is effective scientific method to manage individual knowledge. Exchange and sharing knowledge between individuals of an organization can generate new knowledge continually, accumulate and expand knowledge resources, and improve the efficiency of the organization's knowledge management. Individual knowledge management is essential part of organizational knowledge management and it is critical in organizational knowledge management. The maturity of individual knowledge management has a significant impact on organizational knowledge management, thus individual knowledge management maturity evaluation is a crucial research topic. At present, much of domestic and foreign research of knowledge management focused on ideas, implementation method and technology of organizational knowledge management, the research about individual knowledge management, is unusual (Ma, Jiang, & Kang, 2004).

Capability maturity model is a set of criteria to evaluate capability and maturity of software which is put forward by Carnegie – Mellon University Software Engineering Institute (SEI). The management idea of capability maturity model can be traced back to earlier product quality control principles (Paulk, Chrissis, &Weber, 1993). In the 1930s, Shehwart developed the quality statistical control principle.

The first and abridged version of this paper appeared originally in LISS 2013, Reading, UK, August 21–24, 2013.
Published in partnership with ICIR of Beijing Jiaotong University.

Deming, Juran and Crosby proposed the idea of changing quality principles to maturity framework, and described the five stages of quality events with the quality management maturity Grid (QMMG). Afterwards, Humphrey combined the principles of the Deming, the content of Juran improvement, as well as the quantitative maturity of Crosby, applied together, to the software development process, increasing the concept of maturity level, and gradually developed into the capability maturity model. Robinson et al proposed that the maturity model can help an organization construct and implemented knowledge management, measure the final performance of implemented knowledge management projects and cases, and put forward a conceptual diagram of the knowledge management maturity (Robinson, Anumba, & Carrillo, et al., 2006). Liu Yu, Li Guangling, and Hu Wei constructed industry group knowledge management maturity model and evaluation index system (Liu, Li, & Hu, 2013). Zhang Ruihong built the three levels fuzzy comprehensive evaluation model of knowledge management performance evaluation index system using analytic hierarchy constructed from a balanced scorecard perspective, and combined AHP-FCE method and the model to evaluate knowledge management performance (Zhang, 2011). Zhu Xiaomin put forward a four-dimensional individual teacher individual knowledge management performance evaluation system, and evaluated it using the comprehensive evaluation method that the LWD and LOWA operator construct Feng Changli, Li Tianpeng and Yan Yutao research on the influence factors of knowledge sharing in supply chain based on the perspective of knowledge characteristics (Feng, Li, & Yan, 2011). Syed Nausheen and Lin Xiaoyan explored the linkage between knowledge management practices and company performance, and knowledge management was positively related to company performance (Syed & Lin, 2013).

This research introduces scientific idea of capability maturity model into individual knowledge management, building corresponding assessment criteria combined with features of individual knowledge management, and constructing an individual knowledge management maturity model with gray comprehensive evaluation method. In fourth section of this paper, the validity of the model has been verified by applying the model on an instance. This research is made in order to provide references and suggestions on improving the level of individual knowledge management in knowledge-based organizations.

2. Individual Knowledge Management Maturity Level and Characteristics Determination

Knowledge Management Maturity Model (KMMM) evolved by the Capability Maturity Model (CMM), is used to measure the degree of enterprise knowledge management. Capability Maturity Model has five levels: the initial level, repeatable level, defined level, management level and optimization level. Except the first level, other levels consist of some key process areas, and each level is interdependent. The upper layer contains the lower's objectives and practices, and each level is continuous. The CMM-based Knowledge Management Maturity Model has the Siemens KMMM, the Infosys KMMM, Paulzen and PERC's Knowledge Process Quality Model (KPQM), and Kulkarni and Freeze's Knowledge Management Capability Assessment Model (KMCA). Based on the specialty of individual knowledge management, by analysis of the existing maturity level, this research learn Paulzen and the Perc's knowledge process quality model, construct individual knowledge management maturity level, and the characteristics of each level is described in Table 1.

3. Building of Individual Knowledge Management Maturity Model

3.1. Determinate the Evaluation Index System

Combined with the sufficient analysis of previous research about knowledge management maturity, evaluation index and individual knowledge management, using existing indirect experience, get the based on the individual knowledge management maturity level above composed, and then invited five knowledge management expert filter the preselected indicators set using Delphi method, and get individual knowledge management maturity evaluation index system has three-level indicators and 10 secondary indicators (Han, 2013). As shown in Figure 1.

Level	Maturity Level	Level Features
1	Initial Level	Not focused on knowledge management activities, and hasn't managed individual knowledge consciously yet.
2	Repeatable Level	Has realized the importance of individual knowledge management, and understands the knowledge management and application, can improve the efficiency of acquiring knowledge; began to consciously pay attention to individual knowledge management activities.
3	Defined Level	Has developed a set of methods about individual knowledge management to manage individual knowledge systematics.
4	Management Level	Uses scientific management methods to manage individual knowledge and evaluate benefit of individual knowledge management.
5	Optimization Level	Gets feedback through individual knowledge management evaluation to improve the management methods, efficiency and circulation.

Table 1. Individual knowledge management maturity level and level features.

3.2. Determine the Index Weight

Due to the characteristics of individual knowledge management maturity evaluation, fuzzy analytic hierarchy process is used in this research to calculate the weights of the index system.

1. Construct fuzzy judgment matrix

First, construct fuzzy judgment matrix of factors in every level based on expert judgment.

The evaluation team consists of 10 knowledge management experts discussing and scoring to get fuzzy judgment matrix after in-depth knowledge of the meaning of every indicator. The fuzzy judgment matrixes against the evaluation criteria specified in Figure 1 are as follows:

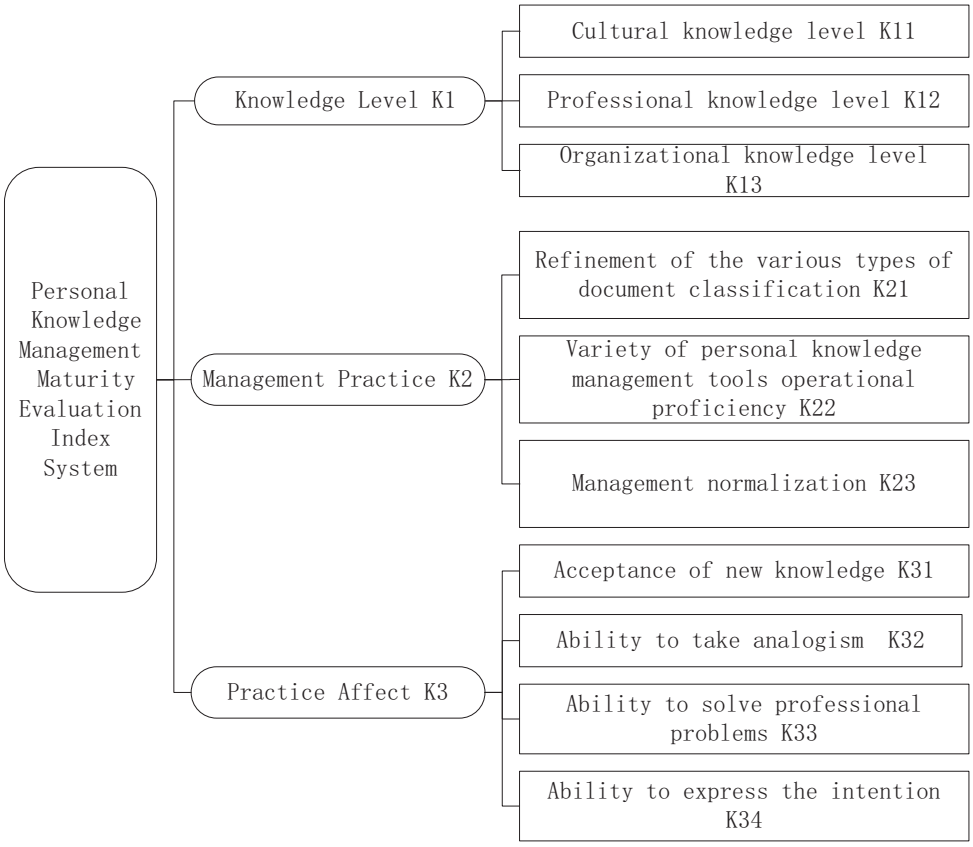

Figure 1. Individual knowledge management maturity evaluation index system.

The first level judge matrix is shown in Table 2.

Individual Knowledge Management Maturity Evaluation	K_1	K_2	K_3
Knowledge Level K_1	0.5	0.3	0.4
Management Practice K_2	0.7	0.5	0.7
Practice Affect K_3	0.6	0.3	0.5

Table 2. The first level judge matrix.

The second level judge matrix is shown in Table 3 to Table 5.

Knowledge level K_1	K_{11}	K_{12}	K_{13}
Cultural knowledge level K_{11}	0.5	0.3	0.3
Professional knowledge level K_{12}	0.7	0.5	0.55
Organizational knowledge level K_{13}	0.7	0.45	0.5

Table 3. Knowledge level sub judgment matrix.

Professional knowledge level K_2	K_{21}	K_{22}	K_{23}
Refinement of the various types of document classification K_{21}	0.5	0.4	0.4
Variety of individual knowledge management tools operational proficiency K_{22}	0.6	0.5	0.45
Management normalization K_{23}	0.6	0.55	0.5

Table 4. Management practice sub judgment matrix.

Practice affect K_3	K_{31}	K_{32}	K_{33}	K_{34}
Acceptance of new knowledge K_{31}	0.5	0.4	0.6	0.3
Ability to take analogism K_{32}	0.6	0.5	0.55	0.5
Ability to solve professional problems K_{33}	0.4	0.45	0.5	0.45
Ability to express the intention K_{34}	0.7	0.5	0.55	0.5

Table 5. Practice affect sub judgment matrix.

2. Determine the index weight

If the judgment matrix is fuzzy consistent, that is the elements of the matrix K and its weight match the formula (1),then formula (2) can be used to calculate the weight.

$$k_{ij} = 0.5 + a(w_i - w_j) \tag{1}$$

$$w_i = \frac{1}{n} - \frac{1}{2a} + \frac{1}{na}\sum_{k=1}^{n} k_{ik} \tag{2}$$

If the judgment matrix isn't fuzzy consistent, that is to say, the elements of the matrix K and its weight don't match the formula (1), then the weight vector $W = [w_1, w_2, w_3, \ldots w_n]^T$ can be get use least-squares method, that is to solve the constraint programming problem as shown in formula (3).

$$\begin{cases} \min z = \sum_{i=1}^{n}\sum_{j=1}^{n}[0.5 + a(w_i - w_j) - k_{ij}]^2 \\ \text{s. t.} \sum_{i=1}^{n} w_i = 1, \quad w_i \geq 0, \quad (1 \leq i \leq n) \end{cases} \tag{3}$$

By the method of Lagrange multipliers, substituted into the Lagrange multiplier λ, after the partial derivative transform, and substituted into the formula (4), we can get an equation set (5) which has $n+1$ equation and $n+1$ unknown quantity, and $a = \dfrac{n-1}{2}$.

$$w_1 + w_2 + \ldots + w_n = 1 \tag{4}$$

$$\begin{cases} 2a^2(n-1)w_1 - 2a^2w_2 - 2a^2w_3 - \ldots \\ \quad -2a^2w_n + \lambda = a\sum_{j=1}^{n}(k_{1j} - k_{j1}) \\ -2a^2w_1 + 2a^2(n-1)w_2 - 2a^2w_3 - \ldots \\ \quad -2a^2w_n + \lambda = a\sum_{j=1}^{n}(k_{2j} - k_{j2}) \\ \qquad \vdots \\ -2a^2w_1 - 2a^2w_2 - 2a^2w_3 - \ldots \\ \quad +2a^2(n-1)w_n + \lambda = a\sum_{j=1}^{n}(k_{nj} - k_{jn}) \\ w_1 + w_2 + \ldots + w_n = 1 \end{cases} \tag{5}$$

By solving this equation, we can get the weight vector $W = [w_1, w_2, w_3, \ldots, w_n]^T$.

Finally, through weighted average, we can get weight of each index relative to the overall goal of the weights.

The first level judge matrix is not fuzzy matrix, by using least-squares method we get weight vector. Take $a = \dfrac{3-1}{2} = 1$.

Substitute corresponding elements of the first level judge matrix and the value of a into the equations (5), we can get equations (6):

$$\begin{cases} 4w_1 - 2w_2 - 2w_3 + \lambda = -0.6 \\ -2w_1 + 4w_2 - 2w_3 + \lambda = 0.8 \\ -2w_1 - 2w_2 + 4w_3 + \lambda = -0.2 \\ w_1 + w_2 + w_3 = 1 \end{cases} \tag{6}$$

Solving the equations above, we have:

$$\begin{cases} w_1 = 0.233 \\ w_2 = 0.467 \\ w_3 = 0.3 \end{cases} \tag{7}$$

The weight vector of knowledge level, professional knowledge level and practice affect is $W = [0.233, 0.467, 0.3]^T$.

Similarly, the index system of weights can be calculated, and the result is shown in Table 6.

3.3. Evaluate Using Gray Comprehensive Evaluation Method

1. Determine the evaluation standard and sample matrix

The evaluation criteria are divided into five levels: "optimization level", "management level", "defined level", "repeatable level" and "initial level", according to former discussion of maturity level. These five evaluation criteria were assigned values 9, 7, 5, 3, 1, and scoring takes ten-point system. The scores of indicator level higher than the highest level, between two adjacent levels and below the lowest level, are 10, 8, 6, 4, 2, 0. Grading is shown in Table 7.

Assume that number of experts in the expert evaluation team is P, the k^{th} $(k = 1, 2, \ldots, p)$ experts scorecard of indicators K_{ij} is d_{ijk}, we can get individual knowledge management maturity evaluation sample matrix D after experts scoring.

2. Determine gray class assessment

Assume evaluation gray class is e, the evaluation gray class has 5 classes according to evaluation level, that is $e = 1, 2, 3, 4, 5$, the corresponding gray number is $\otimes = (\otimes_1, \otimes_2, \otimes_3, \otimes_4, \otimes_5) = (9, 7, 5, 3, 1)$ (Dong, Xiao, Liu, et al., 2010), and the corresponding whitenization weight functions as below [9]:

Evaluation objectives	The first level index	Weight coefficient of index	The second level index	Weight coefficient of index
Individual management maturity evaluation knowledge	Knowledge level K_1	0.233	Cultural knowledge level K_{11}	0.2
	Professional knowledge level K_2	0.467	Professional knowledge level K_{12}	0.417
			Organizational knowledge level K_{13}	0.383
			Refinement of the various types of document classification K_{21}	0.267
			Variety of individual knowledge management tools operational proficiency K_{22}	0.35
			Management normalization K_{23}	0.383
	Practice affect K_3	0.3	Acceptance of new knowledge K_{31}	0.2278
			Ability to take analogism K_{32}	0.2666
			Ability to solve professional problems K_{33}	0.2278
			Ability to express the intention K_{34}	0.2778

Table 6. Individual knowledge management maturity evaluation index system of weights.

Score	9≤d<10	7≤d<9	5≤d<7	3≤d<5	0≤d<3
Level	Optimization Level	Management Level	Defined Level	Repeatable Level	Initial Level

Table 7. Grading criterion.

(1) The first gray class is optimization level, $e = l$, gray number is $\otimes_1 \in [0, 9, 10]$, whitenization weight function $f_1(d_{ijk})$ is shown in formula (8):

$$f_1(d_{ijk}) = \begin{cases} \frac{1}{9}d_{ijk} & d_{ijk} \in [0, 9] \\ 1 & d_{ijk} \in [9, 10] \\ 0 & d_{ijk} \notin [0, 10] \end{cases} \quad (8)$$

(2) The second gray class is management level, $e = 2$, gray number is $\otimes_2 \in [0, 7, 10]$, whitenization weight function $f_2(d_{ijk})$ is shown in formula (9):

$$f_2(d_{ijk}) = \begin{cases} \frac{1}{7}d_{ijk} & d_{ijk} \in [0, 7] \\ \frac{1}{3}(10-d_{ijk}) & d_{ijk} \in (7, 10] \\ 0 & d_{ijk} \notin [0, 10] \end{cases} \quad (9)$$

(3) The third gray class is defined level, $e = 3$, gray number is $\otimes_3 \in [0, 5, 10]$, whitenization weight function $f_3(d_{ijk})$ is shown in formula (10):

$$f_3(d_{ijk}) = \begin{cases} \frac{1}{5}d_{ijk} & d_{ijk} \in [0, 5] \\ \frac{1}{5}(10-d_{ijk}) & d_{ijk} \in (5, 10] \\ 0 & d_{ijk} \notin [0, 10] \end{cases} \quad (10)$$

(4) The fourth gray class is repeatable level, $e = 4$, gray number is $\otimes_4 \in [0, 3, 6]$, whitenization weight function $f_4(d_{ijk})$ is shown in formula (11):

$$f_4(d_{ijk}) = \begin{cases} \frac{1}{3}d_{ijk} & d_{ijk} \in [0, 3] \\ \frac{1}{3}(6-d_{ijk}) & d_{ijk} \in (3, 6] \\ 0 & d_{ijk} \notin [0, 6] \end{cases} \quad (11)$$

(5) The fifth gray class is initial level, $e = 5$ gray number is $\otimes_5 \in [0, 1, 2]$, whitenization weight function $f_5(d_{ijk})$ is shown in formula (12):

$$f_5(d_{ijk}) = \begin{cases} d_{ijk} & d_{ijk} \in [0, 1] \\ 2 - d_{ijk} & d_{ijk} \in (1, 2] \\ 0 & d_{ijk} \notin [0, 2] \end{cases} \quad (12)$$

3. Calculate the gray evaluation coefficient

For evaluation index K_{ij}, in all expert scores, $f_e(d_{ij1})$, $f_e(d_{ij2})$,...,$f_e(d_{ijp})$ is the whitening weight of gray class which belongs to the e^{th} $(e = 1, 2, \ldots, 5)$. The gray evaluation coefficient of the index K_{ij} which belongs to the e^{th} evaluation gray class X_{ije} can be calculated using formula (13).

$$X_{ije} = \sum_{k=1}^{p} f_e(d_{ijk}) \quad (13)$$

For evaluation index K_{ij}, the gray evaluation coefficient belonging to every evaluation gray class X_{ij} can be calculated using formula (14).

$$X_{ij} = \sum_{e=1}^{g} X_{ijk} \quad (g = 5) \quad (14)$$

4. Calculate the evaluation weight vector and weight matrix

If all experts claim that the gray evaluation coefficient of the e^{th} evaluation gray class is r_{ije} for evaluation index K_{ij}, then:

$$r_{ije} = \frac{X_{ije}}{X_j} \quad (e = 1, 2, \ldots, 5) \quad (15)$$

Evaluation index K_{ij} of all gray-evaluation weight vectors $r_{ij} = (r_{j1}, r_{j2}, \ldots, r_{j5})$.

Record R_i is the gray evaluation weight matrix of index K_{ij}, then:

$$R_i = \begin{pmatrix} r_{i1} \\ r_{i2} \\ \cdots \\ r_{hi} \end{pmatrix} = \begin{pmatrix} r_{i11} & r_{i12} & \cdots & r_{i15} \\ r_{i21} & r_{i22} & \cdots & r_{i25} \\ \cdots & \cdots & \cdots & \cdots \\ r_{h_i1} & r_{h_i2} & \cdots & r_{h_i5} \end{pmatrix} \quad (16)$$

5. Comprehensive evaluation of the first and second level indicators

Record the comprehensive evaluation result of evaluation index K_i is B_i, then $B_i = W_i \cdot R_i = (b_{i1}, b_{i2}, \ldots, b_{i5})$ Gray evaluation weight matrix of evaluation object K for all evaluation gray classes is:

$$R = \begin{pmatrix} B_1 \\ B_2 \\ B_3 \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{15} \\ b_{21} & b_{22} & \cdots & b_{25} \\ b_{31} & b_{32} & \cdots & b_{35} \end{pmatrix} \quad (17)$$

Record the comprehensive evaluation result of the final evaluation index K is B, then $B = W \cdot R = (b_1, b_2, b_3, b_4, b_5)$.

6. Calculate comprehensive evaluation value

Assign values for every evaluation gray class level by their gray level, that is, the value of the first level gray class "optimization level" is 9, the value of the second level gray class "management level" is 7, the value of the third level gray class "defined level" is 5, the value of the fourth level gray class "repeatable level" is 3, the value of the fifth level gray class "initial level" is 1. Then the value vector of every evaluation gray class level $A = (9, 7, 5, 3, 1)$, the comprehensive evaluation value Q of evaluation object can be calculated by formula (18).

$$Q = B \cdot A^T \tag{18}$$

The higher the final calculated score, the better the knowledge management practices of evaluated object, and the higher management maturity. On the contrary, at the same time, the individual knowledge management maturity is lower.

4. Examples of the Application of the Model

To verify the validity of individual knowledge management maturity evaluation model, we took a graduate student in a research center for example, using the model built in this research to evaluate the student's individual knowledge management ability, and to determine the student's individual knowledge management maturity, then give suggestions in accordance with the analysis results.

1. Obtain the sample matrix D

We invited 10 experts evaluation team to score the secondary index K_{ij} of individual knowledge management maturity evaluation index system, in accordance with the previously evaluation criteria. The evaluation sample matrix D can be obtained according to the scoring results of the expert team.

$$D = \begin{pmatrix} 8 & 7 & 6 & 9 & 7 & 8 & 7 & 5 & 4 & 7 \\ 6 & 9 & 8 & 8 & 7 & 6 & 8 & 4 & 7 & 5 \\ 7 & 4 & 3 & 6 & 5 & 4 & 6 & 2 & 5 & 6 \\ 8 & 6 & 7 & 7 & 6 & 5 & 6 & 5 & 4 & 3 \\ 3 & 1 & 2 & 3 & 2 & 0 & 5 & 4 & 4 & 1 \\ 2 & 0 & 3 & 2 & 1 & 2 & 3 & 3 & 4 & 3 \\ 8 & 8 & 7 & 8 & 6 & 7 & 7 & 5 & 7 & 6 \\ 7 & 8 & 7 & 5 & 6 & 7 & 6 & 7 & 5 & 4 \\ 9 & 8 & 9 & 7 & 8 & 6 & 8 & 7 & 8 & 8 \\ 4 & 5 & 6 & 8 & 5 & 7 & 7 & 5 & 6 & 6 \end{pmatrix} \tag{19}$$

2. Calculate the gray class evaluation weight matrix R_i

The evaluation weight matrix of every gray class R_i $(i = 1, 2, 3)$ that the secondary index K_{ij} relative to the first level index K_i can get using the whitening weight function and its gray evaluation coefficient formula.

$$R_1 = \begin{pmatrix} r_1 \\ r_2 \\ r_3 \end{pmatrix} = \begin{pmatrix} 0.3378 & 0.3492 & 0.2683 & 0.0447 & 0 \\ 0.3452 & 0.3350 & 0.2741 & 0.0457 & 0 \\ 0.2274 & 0.2923 & 0.3240 & 0.1563 & 0 \end{pmatrix} \tag{20}$$

$$R_2 = \begin{pmatrix} r_{21} \\ r_{22} \\ r_{23} \end{pmatrix} = \begin{pmatrix} 0.2669 & 0.3230 & 0.3118 & 0.0983 & 0 \\ 0.1461 & 0.1878 & 0.2629 & 0.2980 & 0.1052 \\ 0.1386 & 0.1782 & 0.2494 & 0.3796 & 0.0542 \end{pmatrix} \tag{21}$$

$$R_3 = \begin{pmatrix} r_{31} \\ r_{32} \\ r_{33} \end{pmatrix} = \begin{pmatrix} 0.3388 & 0.3725 & 0.2740 & 0.0147 & 0 \\ 0.2957 & 0.3597 & 0.3017 & 0.0429 & 0 \\ 0.4350 & 0.3442 & 0.2208 & 0 & 0 \\ 0.2734 & 0.3317 & 0.3253 & 0.0695 & 0 \end{pmatrix} \tag{22}$$

3. Comprehensive evaluation

Comprehensive evaluate the second index K_{ij}, record the second index weight vector is W_i $(i = 1, 2, 3)$, and the evaluation results is B_i $(i = 1, 2, 3)$, then:

$$B_1 = W_1 \cdot R_1 = (0.2986\ 0.3215\ 0.2921\ 0.0879\ 0) \quad (23)$$

$$B_2 = W_2 \cdot R_2 = (0.1755\ 0.2202\ 0.2707\ 0.2759\ 0.0576) \quad (24)$$

$$B_3 = W_3 \cdot R_3 = (0.3311\ 0.3513\ 0.2835\ 0.0341\ 0) \quad (25)$$

Hence the gray evaluation weight matrix R of individual knowledge management maturity evaluation is:

$$R = \begin{pmatrix} B_1 \\ B_2 \\ B_3 \end{pmatrix} = \begin{pmatrix} 0.2986 & 0.3215 & 0.2921 & 0.0879 & 0 \\ 0.1755 & 0.2202 & 0.2707 & 0.2759 & 0.0576 \\ 0.3311 & 0.3513 & 0.2835 & 0.0341 & 0 \end{pmatrix} \quad (26)$$

Comprehensive evaluate the first level index K_i, record the comprehensive evaluate result is B, and then have:

$$B = W \cdot R = (0.2508\ 0.2831\ 0.2795\ 0.1596\ 0.0269) \quad (27)$$

Finally, the comprehensive evaluation value of this student's individual knowledge management maturity is:

$$Q = B \cdot A^T = \begin{pmatrix} 0.2508 \\ 0.2831 \\ 0.2795 \\ 0.1596 \\ 0.0269 \end{pmatrix}^T \begin{pmatrix} 9 \\ 7 \\ 5 \\ 3 \\ 1 \end{pmatrix} = 6.1429 \quad (28)$$

4. Analysis of the results and suggestions for improvement

We can see from the analysis of sample matrix D and gray-class evaluation weight matrix R_i that, practice results R_3 has the best expert evaluation results, the knowledge level R_1 is followed, and the management practices R_2 has the worst evaluate result. The ultimate comprehensive evaluate score of this graduate is 6.1429.

According to the grading criterion, this student's individual knowledge management maturity level is "defined level", that means that this student has realized the importance of individual knowledge management, and begin to consciously focus on individual knowledge management activities. And he has also developed a set of methods of individual knowledge management to manage individual knowledge systematically in practice, but still lacks of scientific management means and methods.

This student knowledge acquisition process should pay more attention to detailed classification of documents, and strengthen the use of variety of individual knowledge management tools in future, in order to improve the standardization of management, so that the effect of individual knowledge management is more significant.

5. Conclusion

For the time being, research about knowledge management maturity model has been relatively mature, while the individual knowledge management maturity model research is very limited. This research tries to build a scientific and effective individual knowledge management maturity evaluation index system by taking into account all aspects that have impact on individual knowledge management maturity, and to determine the index weights using mathematical method in order to establish a scientific and operational individual knowledge management maturity evaluation model, to evaluate knowledge management maturity of individuals in organizations. But individual knowledge management maturity evaluation is a complex problem that requires more theoretical and empirical research to improve. Hopefully, this paper can contribute to future research as a preliminary attempt.

Acknowledgements

This research is supported by Beijing Municipal Science and Technology Commission project: Research and development for top-level design decision support the system of industrialization and informatization integration (Project No. Z121100000312093).

References

[1] F. Y. DONG, M. D. XIAO, B. LIU, Y. HAN, Construction method of whitenization weight function in grey system teaching. *Journal of North China Institute of Water Conservancy and Hydroelectric Power*, **31**(3) (2010), 97–99.

[2] C. L. FENG, T. P. LI, Y. T. YAN, Research on the Influence Factors of Knowledge Sharing in Supply Chain – Based on the Perspective of Knowledge Characteristics. *Journal of System and Management Sciences*, **1**(3) (2011), 21–30.

[3] Y. LIU, G. L. LI, W. HU, Construction of industrial clusters knowledge management maturity model (KMMM) based on the method of grey comprehensive. *Manufacturing Automation*, **35**(2) (2013), 4–10.

[4] W. C. MA, Y. L. JIANG, Z. KANG, A fuzzy evaluation method of individual knowledge capability in knowledge management. *Journal of Northeastern university (Natural science)*, **25**(7) (2004), 711–714.

[5] M. C. PAULK, M. B. CHRISSIS, C. V. WEBER, *Capability Maturity Model for Software*, Version 1.1. Software Engineering Institute, Pittsburgh, 1993.

[6] H. S. ROBINSON, C. J. ANUMBA, P. M. CARRILLO, Steps: a knowledge management maturity roadmap for corporate sustainability. *Business Process Management Journal*, **12**(6) (2006), 793–808.

[7] N. SYED, X. Y. LIN, The linkage between knowledge management practices and company performance: Empirical evidence. *Journal of Industrial Engineering and Management*, **6**(1) (2013), 1–6.

[8] R. H. ZHANG, Study on performance evaluation model and evaluation method of enterprise knowledge management based on balanced score card. *Science and Technology Management Research*, **23** (2011), 159–162.

[9] X. M. ZHU, The Individual knowledge management performance evaluation system and method of university teachers. *Higher Education Development and Evaluation*, **25**(1) (2009), 100–105.

[10] X. Y. HAN, Building and Application of Personal Knowledge Management Maturity Comprehensive Evaluation Model. *Proceedings of 3rd International Conference on Logistics, Informatics and Service Science*, (2013) Beijing, China, pp. 529–537.

Received: November, 2013
Revised: March, 2014
Accepted: July, 2014

Contact address:
Dan Chang
School of Economics and Management
Beijing Jiaotong University
Beijing, China, 100044
e-mail: dchang@bjtu.edu.cn

Xiaoying Han
School of Economics and Management
Beijing Jiaotong University
Beijing, China, 100044
e-mail: 12120653@bjtu.edu.cn

Baowei Chen
Junior College of Zhejiang Wanli University
Ningbo, China, 315101
e-mail: Chenbaowei-gryx@163.com

DAN CHANG is an associate professor in the School of Economics and Management of Beijing Jiaotong University. She has received her PhD in information management from Beijing Jiaotong University in 2013. Her research interests are economic mathematical modeling and mobile e-commerce.

XIAOYING HAN has received her master's is degree in information management from Beijing Jiaotong University in 2014. Her research interest is economic mathematical modeling.

BAOWEI CHEN is an associate professor in the Junior College of Zhejiang Wanli University. Her research interest is mathematical statistics.