



## The evaluation on comprehensive risks for enterprises knowledge management by theory of matter-element model and extension set

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### ABSTRACT

*Knowledge management is the energy to get competitive advantage for enterprises, the cornerstone to get sustainable development. But knowledge management is one kind of actions with high risks, if the enterprises want to reduce and avoid loss, they must identify all types of risks in the process of knowledge management effectively, supply prior-warning signals for enterprises development to guarantee their safety by using scientific evaluating methods. The paper sets up multidimensional model of matter-element and extension set for evaluating comprehensive risks on knowledge management by theories of matter-element and extension set, offers extensive methods for evaluating comprehensive risks on knowledge management. The method can consider all risks in the process of knowledge management comprehensively, supply evidence for enterprises' business decision. Both theories and positive analysis fruits prove that the model is practicable and effective, it supplies a new road for evaluating knowledge management risks.*

**Keywords:** matter-element model, extension set, knowledge management risk, evaluation

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### INTRODUCTION

In the increasingly fierce market competition, knowledge has become the key elements of the enterprises obtain and maintain lasting competitive advantage. Knowledge management is the artificial center, on the basis of information, knowledge innovation and knowledge value as the goal, knowledge as a form of thought to the development of a resource management. Companies at the same time of using knowledge management improve the management level is also faced with uncertainty and risks. Experts estimate that knowledge management of project failure rate could be as high as 50%, even some people think that is 70% [1, 2]. Therefore, the research of knowledge management risk identification and evaluation is necessary. In recent years, domestic and foreign scholars study has been conducted for enterprise knowledge management risk, has made certain progress. Xu Xiangqin etc. (2007), uses of multi-level gray evaluation method for enterprise knowledge management risk from the risk in risk factors, knowledge, process, three aspects are analyzed [3]. Chen Zhen bin etc. (2008), think the fuzzy neural network method to evaluate the risk of enterprise knowledge management, and build the evaluation index system of enterprise knowledge management risk [4]. Zhang Xin guang etc. (2003), using LWD operator and LOWA operator gives a multi-index comprehensive evaluation method based on linguistic assessment information, and knowledge management of the enterprise risk condition is evaluated [5]. Hu Xiaoxiang etc. (2003), analyzes and summarizes the factors affecting the success or failure of the knowledge management, and using the method of interval number to evaluate knowledge management risk [6]. Huang Lijun (2002) proposed the enterprise knowledge management content and methods of risk identification, and the time risk factor analysis, risk estimate, risk range of frequency estimation, risk assessment and the estimated risks and losses of the five aspects has carried on the risk assessment [7]. In this paper, considering the causes of enterprise knowledge management risk complex are various, some factors to measure, some factors are hard to quantify, how to objectively measure of enterprise knowledge management comprehensive risk have yet to have a set of effective analysis method. From the existing research results, experts and scholars on knowledge management risk identification and evaluation, the objective judgment of

the risk factors in the majority, less subjective judgment involves risk factors, few from the perspective of subjective and objective factors in combination with the synthetically consideration. The author believes that only the organic combination of both, and starting from the situation of both influence each other, can more accurately to the enterprise knowledge management risk identification and evaluation.

Euthenics is an emerging discipline founded by Chinese scholars Cai Wen in 1976 [8], it uses formalized tools, from the viewpoints of both qualitative and quantitative research to solve the problem of the regularity of the comprehensive under the action of multiple factors, it is for people to know and analyze the complex and contradictory problems in the real world system provides a new methodology. This article in euthenics content and extension set theory, on the basis of enterprise knowledge management risk comprehensive evaluation of multidimensional extension matter-element model and extension evaluation method, this method can formally describe the state of all kinds of risk factors in enterprise knowledge management risk, not only can accurately evaluate the size of the enterprise knowledge management risk, and to be able to give enterprise knowledge management risk more clearly the objective risk and subjective risk qualitative and quantitative evaluation of the decision makers, and compared comprehensively reflect the comprehensive enterprise knowledge management level of risk.

## THE ENTERPRISE KNOWLEDGE MANAGEMENT COMPREHENSIVE RISK ASSESSMENT OF MULTIDIMENSIONAL EXTENSION MATTER-ELEMENT MODEL

### 1. Matter-element and matter-element transformation theory

Matter-element transformation is according to the characteristics of extensibility and extensibility of transformation, matter-element transformation matter-element theory is the basic method to solve the problem of contradiction. On the basis of matter-element transformation is the matter-element extension, the possibility of things change called the extensibility of things. Extensibility is the basic character of the matter-element; it describes the internal structure and external relationships, to provide people with creative thinking and the way of. Matter-element extensibility, therefore, become the basis to solve the problem of contradiction, so people can accord certain procedures to innovate, design the scheme to solve the problem [9].

Given the name of the M things, its n characteristics of  $c_1, c_2, \dots, c_n$  and the corresponding measure  $x_1, x_2, \dots, x_n$  expressed in an orderly array as follows:

$$R = \begin{bmatrix} R_1 \\ R_2 \\ \vdots \\ R_n \end{bmatrix} = \begin{bmatrix} M & c_1 & x_1 \\ & c_2 & x_2 \\ & \vdots & \vdots \\ & c_n & x_n \end{bmatrix} \quad (1)$$

R called describing things n matter-element, shorthand for

$$R = (M, C, X) \quad (2)$$

Including:

$$C = \begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_n \end{bmatrix}, \quad X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} \quad (3)$$

And the name, character and value in things called the three elements of matter-element.

### 2. Extension set theory

In the real world, things are variable, have a degree of some kind is variable. Under certain conditions, things can change in the nature of some don't have the nature of things; don't have the nature of things can change with the nature of things. To solve the problem of conflict, it is necessary to consider "yes" and "not" reciprocal transformation. Therefore must establish concepts of extension set, so to make the discussion object does not belong to classical subsets and can convert to the subset of the elements. For each element  $u \in U$ , if a proposition: (1) u has properties P; (2) u does not have property P; (3) can make u do have the properties of P elements into had the properties of P; (4) u have or property P, nor has the properties of P. As long as the above four propositions have one established, is it set up a collection of U is the extension set. Extension set is used to solve the problem of conflict process quantitative and formal mathematical tools. And use extended to  $(-\infty, +\infty)$  the size of the correlation

function values of the measured element and set, the relationship between the classic collection "belong to" and "does not belong to" set the qualitative description of extended to quantitative description [10-12].

2.1 The domain object matter-element matrix.

According to the type (1), (2), (3), the joint domain object matter-element matrix can be expressed as:

$$R = \begin{bmatrix} M_p & c_1 & [a_{p1}, b_{p1}] \\ & c_2 & [a_{p2}, b_{p2}] \\ & \vdots & \vdots \\ & c_n & [a_{pn}, b_{pn}] \end{bmatrix} \tag{4}$$

In this type,  $M_p$  said things by things and can be converted into standard section of the domain objects;  $x_{pi} = [a_{pi}, b_{pi}]$  said the domain object about the characteristics of the value of the range.

2.2 The classical matter-element matrix domain object.

Classic domain object matter-element matrix can be expressed as:

$$R = \begin{bmatrix} M_B & c_1 & [a_{B1}, b_{B1}] \\ & c_2 & [a_{B2}, b_{B2}] \\ & \vdots & \vdots \\ & c_n & [a_{Bn}, b_{Bn}] \end{bmatrix} \tag{5}$$

In this type,  $M_B$  as standard objects;  $x_{Bi} = [a_{Bi}, b_{Bi}]$  for the value of the range of the characteristics of standard object of  $M_B$  about  $c_i$ . There are clearly  $x_m \in x_{pi}(i = 1, 2, \dots, n)$ .

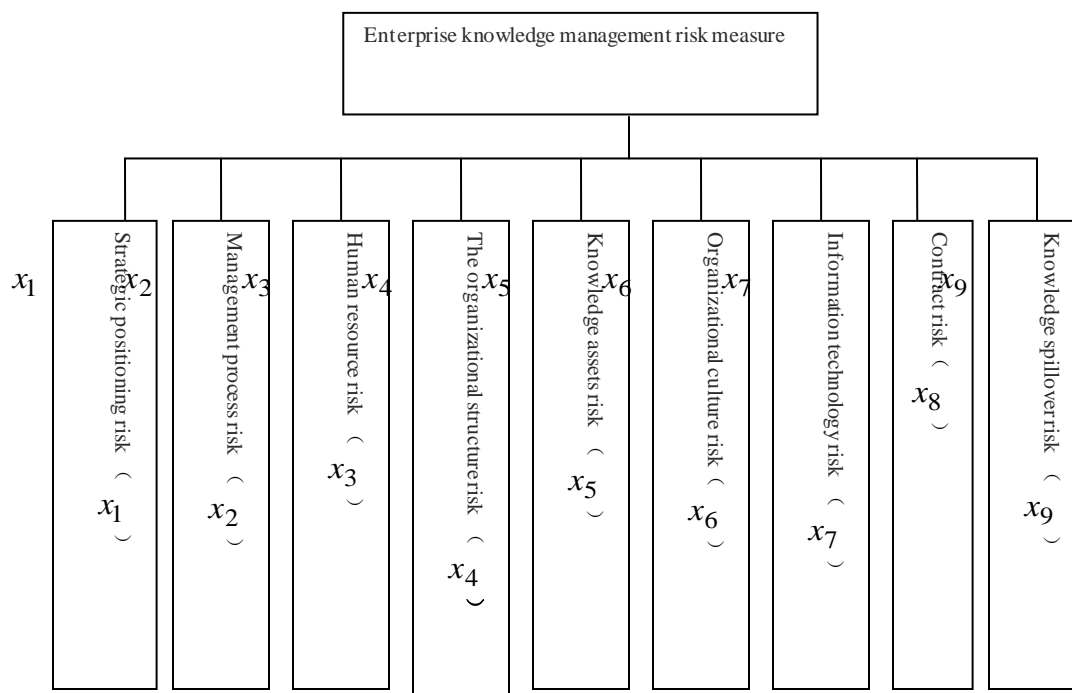


Figure 1: the model of enterprise knowledge management risk measure

3. Establish the factors associated with the risk of enterprise knowledge management

Enterprise knowledge management risk can be divided into two aspects of subjective factors and objective factors. Subjective risk refers to the because of limited knowledge level managers and organizational barriers such as the subjective causes of risk; Objective risk refers to because of the uncertainty of the external environment, the complexity and the difficulty of the project itself, as well as their own objective conditions the limit of objective reasons such as risk [13]. Therefore, considering the enterprise knowledge management risk factors in the process of

the establishment of the indexes, the risk of subjective and objective two aspects must be taken into account comprehensively. In this paper, combining the reality of our country enterprise, compliance to global, measurability, the principle of complementarily, sensitivity, will affect the enterprise knowledge management risk factors of strategic orientation risk, risk management process, human resources, organizational structure risk, knowledge assets risk, organization culture, information technology risk, contract risk, knowledge spillover nine indexes such as risk, particular case is shown in figure 1:

#### 4. Model is established in this paper

For enterprise knowledge management comprehensive risk factor index  $n$ , is the ( $n = 9$ ) in this paper, on the basis of this part of the index, cluster analysis, according to expert judgment enterprise knowledge management into comprehensive risk quantitatively  $m$  level, described them as the following comprehensive qualitative and quantitative risk measure the matter-element model (called "classical field matter-element matrix") :

$$R_{oh} = \begin{bmatrix} N_{oh} & x_1 & V_{oh1} \\ & x_2 & V_{oh2} \\ & \vdots & \vdots \\ & x_n & V_{ohn} \end{bmatrix} = \begin{bmatrix} N_{oh} & x_1 & [a_{oh1}, b_{oh1}] \\ & x_2 & [a_{oh2}, b_{oh2}] \\ & \vdots & \vdots \\ & x_n & [a_{ohn}, b_{ohn}] \end{bmatrix} \quad (6)$$

Among them,  $R_{oh}$  said enterprise knowledge management in the first class  $h$  risk of matter-element model;  $N_{oh}$  said the first class  $h$  risk;  $V_{ohk} = [a_{ohk}, b_{ohk}]$  said the first  $k$  enterprise knowledge management risk factors in the first class  $h$  risk scope;  $h = 1, 2, \dots, m; k = 1, 2, \dots, n$  .

Various risk factors of enterprise knowledge management indicators allow scope, namely each risk factor index is at level 1 to level the first  $m$  risk value range of the formation of the matter-element model (referred to as "joint domain matter-element matrix") as follows:

$$R_q = \begin{bmatrix} N_q & x_1 & V_{q1} \\ & x_2 & V_{q2} \\ & \vdots & \vdots \\ & x_n & V_{qn} \end{bmatrix} = \begin{bmatrix} N_q & x_1 & [a_{q1}, b_{q1}] \\ & x_2 & [a_{q2}, b_{q2}] \\ & \vdots & \vdots \\ & x_n & [a_{qn}, b_{qn}] \end{bmatrix} \quad (7)$$

Among them,  $R_q$  said enterprise knowledge management comprehensive risk assessment matter-element model of section area;  $N_q$  said the all risk of enterprise knowledge management level;  $V_{qk} = [a_{qk}, b_{qk}]$  said among  $N_q$  the target value of the risk factors  $x_k$  in allowed range;  $V_{ohk} \subset V_{qk}, h = 1, 2, \dots, m; k = 1, 2, \dots, n$  .

#### 5. The establishment of the evaluation of enterprises knowledge management risk matter-element matrix

The various risk factors in the process of enterprise knowledge management index measured data can be used by the following matter element matrix, said:

$$R = \begin{bmatrix} N & x_1 & v_1 \\ & x_2 & v_2 \\ & \vdots & \vdots \\ & x_n & v_n \end{bmatrix} \quad (8)$$

Where  $N$  is said to be risk evaluation of enterprises knowledge management;  $v_k$  said to be the first  $k$  risk evaluation of enterprises knowledge management factors  $x_k$  index value ( $k = 1, 2, \dots, n$ ) .

#### THE EXTENSION EVALUATION METHOD OF ENTERPRISE KNOWLEDGE MANAGEMENT RISK

In establishing the multidimensional enterprise knowledge management risk assessment after the extension matter-element model, to evaluate how to treat the risk evaluation of enterprises knowledge management level? Available for this purpose, the relevant theories and methods of extension set, so first of all, the concept of perimeter billion real variables function widely the concept of "degree", as the basis of qualitative description to expand for quantitative description; According to the correlation function is established for evaluation of enterprise knowledge management risk level size.

### 1. Degree concept definition

Districts  $V_{qk} = [a_{qk}, b_{qk}]$  for enterprise knowledge management between the first k risk factors index  $x_k$  at level 1 to level the first h risk value of the allowed range; The first k range  $V_{ohk} = [a_{ohk}, b_{ohk}]$  for knowledge management risk factors index  $x_k$  in the first class h risk scope; District  $V_{ohk} \subset V_{qk}, h = 1, 2, \dots, m; k = 1, 2, \dots, n$ ; Point  $v_k$  said to be the first k risk evaluation of enterprises knowledge management risk factors index evaluation value of  $x_k$ , so call them

$$l(v_k, V_{ohk}) = \left| v_k - \frac{a_{ohk} + b_{ohk}}{2} \right| - \frac{b_{ohk} - a_{ohk}}{2} \quad (k = 1, 2, \dots, n; h = 1, 2, \dots, m) \quad (9)$$

$$l(v_k, V_{qk}) = \left| v_k - \frac{a_{qk} + b_{qk}}{2} \right| - \frac{b_{qk} - a_{qk}}{2} \quad (k = 1, 2, \dots, n; h = 1, 2, \dots, m) \quad (10)$$

"degree" between point  $v_k$  (value) and interval  $V_{ohk}, V_{qk}$ .

By introducing the concept of closeness, we implemented in the form of a quantitative relationship between the position of the point and interval and heart accurate positioning, and can according to the different description of the "degree" points within the range of different position, make us accurate to "also has different degree of difference between" within the class description.

### 2. Risk correlation concept definition

$V_{qk} = [a_{qk}, b_{qk}]$  for enterprise knowledge management between districts the first k risk factors index  $x_k$  allowed range of values; The first k range  $V_{ohk} = [a_{ohk}, b_{ohk}]$  for knowledge management risk factors index  $x_k$  in the first class h risk scope; Point  $v_k$  said to be the first k risk evaluation of enterprises knowledge management risk factors index value of  $x_k$ ;  $l(v_k, V_{ohk}), l(v_k, V_{qk})$  respectively the "degree" between point  $v_k$  (value) and interval  $V_{ohk}, V_{qk}$ . Interval

$V_{ohk} \subset V_{qk}$ , and there is no public endpoint, so we call  $G_h(v_k) = \frac{l(v_k, V_{ohk})}{l(v_k, V_{qk}) - l(v_k, V_{ohk})} \quad (h = 1, 2, \dots, m; k = 1, 2, \dots, n)$

(11) The first k for risk evaluation of enterprises knowledge management risk factors about  $x_k$  first class h the correlation of risk.

By introducing the risk correlation function  $G_h(v_k) \in (-\infty, +\infty)$ , property is making "P" things from qualitative description to quantitative description of a "has the nature of the P".

### 3. The determination of evaluation of enterprise knowledge management level of risk

By type (11) to calculate the correlation matrix of risk evaluation of enterprises knowledge management

$$G = [G_h(v_k)]_{n \times m} \quad (12)$$

According to the type (12) available for evaluation of enterprise knowledge management the first k risk factors  $x_k$  in the  $d_0$  level risk for:

$$\max_{1 \leq h \leq m} G_h(v_k) = G_{d_0}(v_k) = G^*(v_k) \quad (13)$$

If  $z_k (\sum_{k=1}^n z_k = 1)$  for enterprise knowledge management risk factors index weight coefficient  $x_k$ , and the first class h for risk evaluation of enterprises knowledge management risk correlation is as follows:

$$G_h(R) = \sum_{k=1}^n z_k G_h(v_k) \quad (14)$$

Type (14) fully consider the enterprise knowledge management various risk factors for the success or failure of the enterprise knowledge management influence degree is different, the actual situation of enterprise knowledge management various risk factors of risk weighting correlation comprehensive risk evaluation of enterprise knowledge management system, strong scientific nature and operability.

Calculated by the type (14), available:

$$G_{h_0}(R) = \max_{1 \leq h \leq m} G_h(R) \quad (15)$$

By type (15) the comprehensive risk evaluation of enterprises knowledge management level for the first grade  $h_0$ .

### THE EMPIRICAL RESEARCH

Using the above theory and method, and using the matter-element and extension set theory to the practical enterprise knowledge management risk evaluation. This article selects a case study of shanxi Zhongyuan pharmaceutical co., LTD., the company production of pt made capsules at the joint of text in the drug has a high profile, select the company "Portuguese set capsule" products to implement knowledge management risk evaluation.

This article will risk of the enterprise knowledge management according to the discretion of the degree of risk is divided into high, higher, medium, lower, low five grades, at the same time invited to the enterprise knowledge management and medical field familiar 10 experts to rate. If a experts think the index  $x_k$  low risk, with the index score value of  $y_1(y_1 \in [0,1])$ ; If think index  $x_k$  lower risk, the index score value of  $y_2(y_2 \in (1,2])$ ; If think indicators  $x_k$  in a medium risk, the index score value is  $y_3(y_3 \in (2,3])$ ; If think index  $x_k$  at a higher risk, the index score value of  $y_4(y_4 \in (3,4])$ ; If think indicators  $x_k$  are at increased risk for the index score value of  $y_5(y_5 \in (4,5])$ .

#### 1. The enterprise knowledge management comprehensive risk assessment

1.1 Enterprise knowledge management classical field matter-element matrix and joint domain matter-element matrix According to the enterprise knowledge management risk factors index  $x_k$  ( $k = 1, 2, \dots, 9$ ) is in the scope of different risk levels, can get comprehensive risk evaluation of enterprises knowledge management classical field matter-element matrix of the:

$$R_{o1} = \begin{bmatrix} N_{o1} & x_1 & [0,1] \\ & x_2 & [0,1] \\ & \vdots & \vdots \\ & x_9 & [0,1] \end{bmatrix} \quad R_{o2} = \begin{bmatrix} N_{o2} & x_1 & [1,2] \\ & x_2 & [1,2] \\ & \vdots & \vdots \\ & x_9 & [1,2] \end{bmatrix} \quad R_{o3} = \begin{bmatrix} N_{o3} & x_1 & [2,3] \\ & x_2 & [2,3] \\ & \vdots & \vdots \\ & x_9 & [2,3] \end{bmatrix} \quad R_{o4} = \begin{bmatrix} N_{o4} & x_1 & [3,4] \\ & x_2 & [3,4] \\ & \vdots & \vdots \\ & x_9 & [3,4] \end{bmatrix}$$

$$R_{o5} = \begin{bmatrix} N_{o5} & x_1 & [4,5] \\ & x_2 & [4,5] \\ & \vdots & \vdots \\ & x_9 & [4,5] \end{bmatrix}$$

Considering the scope of enterprise knowledge management risk factors indicators, it is concluded that the enterprise knowledge management risk assessment matter-element matrix of the section of the domain:

$$R_q = \begin{bmatrix} N_q & x_1 & [0,5] \\ & x_2 & [0,5] \\ & \vdots & \vdots \\ & x_9 & [0,5] \end{bmatrix}$$

1.2 To comprehensive risk evaluation of enterprises knowledge management classical field matter-element matrix Set the first  $t$  ( $t = 1, 2, \dots, 10$ ) expert knowledge management of the enterprise risk index  $x_k$  score value of  $y_t$ , the risk index  $x_k$  value for:

$$v_k = \frac{1}{10} \sum_{t=1}^{10} y_t \quad (16)$$

On the basis of the above methods, 10 experts score results summary as shown as follows:

$$R = \begin{bmatrix} N & x_1 & 0.81 \\ & x_2 & 1.53 \\ & x_3 & 2.01 \\ & x_4 & 0.92 \\ & x_5 & 2.46 \\ & x_6 & 1.15 \\ & x_7 & 0.94 \\ & x_8 & 1.26 \\ & x_9 & 2.18 \end{bmatrix}$$

1.3 To comprehensive risk evaluation of enterprises knowledge management evaluation:

Calculate the risk correlation matrix

According to the type (12) for evaluation of enterprise knowledge management risk correlation matrix of the:

$$G = G_h(v_k)_{9 \times 5} = \begin{bmatrix} 1.36 & 0.21 & 1.32 & 0.18 & -0.85 \\ -0.15 & -0.14 & -0.45 & -0.32 & -0.71 \\ 0.23 & -0.21 & -0.36 & -0.42 & -0.75 \\ -0.47 & 0.24 & -0.45 & -0.56 & -0.35 \\ -0.23 & -0.34 & -0.32 & 0.13 & -0.65 \\ -0.32 & 0.07 & -0.21 & -0.33 & -0.52 \\ -0.12 & 0.14 & 0.16 & -0.63 & -0.71 \\ -0.38 & -0.13 & 0.14 & -0.24 & -0.42 \\ -0.51 & -0.32 & -0.23 & -0.21 & -0.34 \end{bmatrix} \quad \text{Comprehensive risk correlation calculation}$$

According to the expert investigation and AHP method, the enterprise knowledge management risk factors can be determined the weight coefficient of index  $x_k, Z=(z_1, z_2, \dots, z_9) = (0.132, 0.142, 0.083, 0.114, 0.083, 0.125, 0.126, 0.084, 0.111)$

By type (14), for evaluation of enterprise knowledge management risks with the first class h points correlation of risks are as follows:

$$G_h(R) = \sum_{k=1}^9 z_k G_h(v_k) \quad (h = 1, 2, 3, 4, 5) \quad (17)$$

The enterprise knowledge management index weight coefficient of each risk factor and the correlation matrix of the data bring type (17), computing available:

$$G_1(R) = -0.0354, \quad G_2(R) = -0.3254, \quad G_3(R) = -0.0254, \quad G_4(R) = -0.2354, \quad G_5(R) = -0.3354$$

By (15) available:

$$G_{h_0}(R) = \max_{1 \leq h \leq m} G_h(R) = G_3(R) = -0.0254$$

Thus can judge Zhongyuan pharmaceutical industry company (Shanxi) for evaluation of enterprise knowledge management level of risk to low risk. Which coincide with the actual risk of enterprise knowledge management, the enterprise pt capsule has always been in good market prospects, and products curative effect is remarkable.

## CONCLUSION

① Through the comprehensive risk evaluation of enterprises knowledge management, enterprise can understand their own knowledge management status quo, take targeted measures to effectively reduce the risk. This method can evaluate the condition of multiple enterprise knowledge management risk, can also be used for a different, more is implementing the knowledge management project risk evaluation, help enterprise risk value sorting based on knowledge management, strengthen the consciousness of enterprise early warning and to protect the healthy development of the enterprise.

② In knowledge management risk evaluation method, matter-element and extension set evaluation method of knowledge management risk of the subjective factors and objective factors into account, and the qualitative problem is transformed into quantitative problem solved, it is advantageous to the enterprise comprehensive understanding the risk situation of knowledge management, and take the corresponding measure to control. The method established the matter-element model is simple and effective and don't need a lot of state evaluation samples, the evaluation results intuitive, see knowledge management for the enterprise risk early warning and decision-making provides a new way, have very strong practicability.

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