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Quantitative risk analysis method of information security-combining fuzzy comprehensive analysis with information entropy

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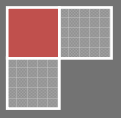
ABSTRACT

Quantitative risk assessment method based on information entropy: Because there was short effective assessment way for the risk level of the whole information system. I brought the information entropy into risk assessment of information security. The definition of risk degree was given first, which was the Likelihood estimate of probability and impact of risk, to scale risk degree of the whole information system. Since the evaluation on the probability and impact of risk were fuzzy, the risk factors were evaluated by means of fuzzy comprehensive evaluation method. For this method, the weight of each risk would be gained by entropy-weight coefficient; the subjective of expert assignment will be overcome. The risk degree will be gained by combining fuzzy comprehensive evaluation with information entropy, to measure off the risk degree of information system. In the paper I gave examples to show the application of this method.

KEYWORDS

Risk assessment; Quantitative method; Information security; Fuzzy comprehensive analysis; Information entropy.



INTRODUCTION

Risk analysis involves three basic elements: assets, threats, and vulnerability. Each element has its own attribute. Asset attributes are asset values. Threat attributes can be threat subject, threat object, frequency of occurrences, threat motivation, etc. The attributes of vulnerability is the severity of asset weaknesses. The main contents of the risk analysis are:

a) To identify assets, and to assign the value of the assets;
b) To identify threats; describe the attributes of the threat, and to assign the occurred frequencies of the threat;
c) To identify vulnerability, and to assign the severity of the asset vulnerability;
d) To judge the security incident probability according to the threat and the complexity of the vulnerability of the threat;
e) To calculate the incident that caused loss according to the severity of the vulnerability and the value of the assets when security events occur;

To calculate the risk value is to calculate the organization's effects according to the probability of the security incident occurring and the loss after the security incident appeared once the security incident happened.
Risk analysis principle as shown in Figure 1 below:

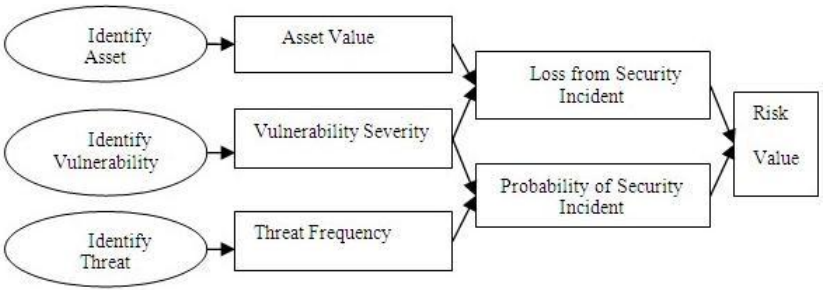


Figure 1 : Risk analysis's principle

FUZZY COMPREHENSIVE EVALUATION METHOD

The fuzzy comprehensive evaluation provides some assessment methods by using some of the concepts of fuzzy mathematics. To be specific, fuzzy comprehensive evaluation is the method which is based on fuzzy mathematics and applies the fuzzy synthetic relationship principle. The method can evaluate some not clear, not easily quantifying the boundary of factors and determine the membership grade on the evaluated object from multiple factors[1].

Fuzzy comprehensive evaluation method is first put forward by a Chinese scholar as a specific application method based on fuzzy mathematics. It is mainly divided into two steps: the first step is to evaluate every separated factor; the second step is to comprehensively evaluate all the factors. The advantages of the method are the following: the mathematical model is simple, and easy to master. It is better to evaluate the complex problems with many factors and it is multi-level, but it is difficult to be replaced by other branches of mathematics and other models. The characteristics of fuzzy comprehensive evaluation method are the following: judging by pairs, having the only value of evaluated object, and not being affected by the whole evaluated objects. This practical model is being used widely in many fields and also earns very nice economic benefit and social benefit. The fuzzy evaluation method also can be applied in the information security risk assessment[2].

Basic principle

First, determine the evaluated object's factors (index) set and evaluation (grade) set; then respectively determine the weight of index and their membership vector to get the fuzzy judgment matrix; and finally fuzzy compute the fuzzy judgment matrix and the fuzzy factors' weight vector, and then normalize the result of fuzzy computing as the fuzzy comprehensive evaluation result[3].

Comprehensive evaluation purpose is to focus on selecting the best from evaluated objects set, so comprehensive evaluation results of all evaluated objects need to be sorted.

Model and steps

1. Determining the domain of evaluated object's factors $U=\{u_1,u_2,...,u_m\}$, that is to say there is "m" evaluation index showing from which respects to judge evaluated object, u_i means the ist primary index.

Comments set is the all evaluation results which are set up by evaluators to all kinds of evaluated object, with V said an evaluation index set:

$$V=\{v_1,v_2,...,v_n\}$$

In fact, the "V" is a division of the evaluated object's variation. Among them, v_i represents the ist evaluation result, n stands for the number of evaluation results.

Specific level can be described with the appropriate language basing on the evaluation content, for example evaluating the competitiveness of their products may use the V = {strong, medium, weak}, evaluating the development level of social area and economic area may use the V = {quite high, high, general, low, quite low}, evaluating economic benefits may use the V = {quite good, good, general, poor, quite poor}, etc.

EVALUATING SINGLE FACTOR, ESTABLISHING THE FUZZY RELATION MATRIX R

Evaluating one factor separately and determining the membership degree set "V" of the evaluated object's evaluation are called single-factor fuzzy evaluation. After establishing the structure of levels after fuzzy subsets, we will assess each factor $u_i(i=1,2,...m)$ of the evaluated object one by one, that is to say determining the membership of each level fuzzy subsets of single evaluated object's factor, and then getting the fuzzy relation matrix:

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

Among them, $r_{ij}(i=1,2,...m;\ j=1,2,...n)$ means the jst secondary index in the ist primary index or the membership of the factor u_i to the factor v_j. The performance of a evaluated object in some one factor u_i is described by fuzzy vector $r_i=(r_{i1},r_{i2},...,r_{im})$ (in other evaluation methods the performance is described with a index practical value, so from this point, fuzzy comprehensive evaluation needs more information), r_i is known as the single factor evaluation matrix, can be regarded as a relation between factor sets "U" and evaluation sets "V", the relation is also named "reasonable relationship" between influence factors and evaluated object.

When you determine the subordinate relationship, usually the experts or the expertise persons related to evaluation question give the scores of the evaluated objects based on evaluation grade, then statistic scoring results, and then obtain the r_{ij} by the method named "absolute value subtraction":

$$ri_j=\begin{cases} 1,(i=j) \\ 1-c\sum_{k=1}^{n}\left|x_{ik}-x_{jk}\right|,i\neq j \end{cases}$$

Among them, the "c" can be selected appropriately, make $0\le r_{ij}\le 1$。

DETERMINING THE FUZZY WEIGHT VECTORS OF EVALUATED FACTOR

In order to reflect the important degree of each factor, the weight $a_i(i=1,2,...,m)$ is given to the factors "U", usually requires a_i meets $a_i\ge 0;\sum a_i=1$, then a_i presents the ist factor weights, and then form the weight fuzzy set "A" consisted of each factor weights.

In the fuzzy comprehensive evaluation, the weight will have a great effect on the final results of the assessment. Different weights sometimes will produce completely different conclusions.

The right or not choice of the weight will directly relate to the success or failure of the model. The method of determining the weight has the following kinds: Analytic Hierarchy Process (AHP); Delphi method; the weighted average method; Experts estimating method, etc.

EVALUATING MULTI-FACTOR FUZZY

Using appropriate synthesis operator, we will combine A with the fuzzy relation matrix R to get the fuzzy comprehensive evaluation result vector B of each evaluated object.

The different row in matrix R reflects the membership degree of each level fuzzy subset considering different factors of evaluated object. The combination of different rows in matrix R using the fuzzy weight vectors A will be the membership degree of each level fuzzy subset considering the entirety of evaluated object, named the fuzzy comprehensive evaluation result vector B.

Fuzzy comprehensive evaluation model is shown:

$$B=A\bullet R^T=(a_1,a_2,...,a_m)\begin{bmatrix} r_{11} & r_{21} & \cdots & r_{n1} \\ r_{12} & r_{22} & \cdots & r_{n2} \\ \cdots & \cdots & \cdots & \cdots \\ r_{1m} & r_{2m} & \cdots & r_{nm} \end{bmatrix}=(b_1,b_2,...,b_n)$$

Among them, $b_j(j=1,2,...,n)$ is the result of A and jst column in matrix V operation, represents the membership degree of v_j level fuzzy subsets to the whole of evaluated object.

BASIC THEORY OF INFORMATION ENTROPY

Entropy is recognized as one of the important concepts of the contemporary physics frontier. With the development of research, the concept of entropy gradually walked out of physics range and won new vitality. At present, the entropy concept has been applied to mathematics, biology, information theory, control theory, economics, sociology and all kinds of engineering sciences[4]. Usually the statistical entropy in physics theory is called physics entropy, and the theory in information entropy is called information entropy.

In 1948, the Boltzmann entropy concept is introduced into the information theory by Shannon[5]. Set the system will be in the following n different kinds of state: $S_1, S_2, ..., S_n$, the following formula represents the probability P_i is system is in the state S_i.

$$p(s-s_i)=p_i, i=1,2,...,n$$

The number of the system's uncertainty H:

$$H=-C\sum_{i=1}^{n} p_i \ln p_i$$

C is a positive integer, generally take C = 1, p_i meets: $0 \le p_i \le 1; \sum_{i=1}^{n} p_i = 1$

It may be proved that the above two types can be mutually conversed by using the equal probability principle, H is information entropy. The information entropy is the expansion of physics entropy. In this expansion, entropy does not have to connect to the thermodynamics process; the "system" and "status" have a broader meaning[6]. In natural science and social science of every field, there are all kinds of random events. Each kind of random event set has corresponding uncertainty. All these uncertainties can be described by the concept of information entropy. For this reason, there is a point of view that the generalized entropy is also called information entropy. The concept used in this paper is called information entropy. Its abbreviation is entropy.

COMBINING FUZZY ANALYSIS WITH ENTROPY WEIGHT COEFFICIENT

The probability of risk and risk event occurrence connects with the effect of risk events. We use the system risk degree to assess the level of the system risk, so the risk degree is the function for the probability P of a risk occurrence and the effect C of risk events. The probability P of a risk occurrence and the effect C of risk events own some of the fuzziness, the fuzzy comprehensive evaluation method will be applied. In the fuzzy comprehensive evaluation method, the weight of each risk events is obtained by entropy weight coefficient method in order to overcome subjectivity of direct assignment of the experts[7].

The concepts of risk degree

The risk is a function not only for the probability P of risk occurrence, but also for the effect of risk events. The range of P, C is the interval [0, 1], using subscript f represents risk events that did not happen, and using subscript s represents risk events that happened. There is clearly:

$$p_f = 1-p_s$$

$$C_f = 1-C_s$$

Defining the risk degree R is the likelihood estimation of risk events that happened and the consequences of risk events[8].

$$\begin{aligned} R &= f(Risk\,\mathrm{Pr}obability, RiskEffect) \\ &= 1-p_f C_f \\ &= 1-(1-p_s)(1-C_s) \\ &= P_s + C_s - p_s C_s \end{aligned}$$

Therefore, if we work out the probability P of risk occurrence and the effect of risk events, we will get the risk degrees of system.

Establishing the membership degree matrix R

According to some of the fuzziness of the probability of risk occurrence and the effect of risk events that happened, we will use the fuzzy comprehensive evaluation method[9].

First structure risk factors set, let $U=\{u_1,u_2,...,u_n\}$.Then construct the evaluation set, for the probability and risk effect, we can set up different evaluation sets. Let evaluation sets $V=\{V_1,V_2,...,V_m\}$.

According to each factor's judgment of the judgment set V to factor set V, the comments will be given by experts. Structure fuzzy mapping $f:U\to F(V)$, $F(V)$ is the fuzzy set of all V, $u_i\to f(u_i)=(r_{i1},r_{i2},...,r_{im})\in F(V)$, mapping f represents the support degree of the risk factor u_i to each comments of the judgment set. The membership vector of the risk factor u_i to the judgment set V is $R_i=(r_{i1},r_{i2},...,r_{im}),i=1,2,..n$. So we get the membership matrix R shown as the following:

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}$$

Risk factors relative to the probability and risk influence will produce the different membership matrix, respectively is R_p and R_c.

Calculating the R_p **and** R_c

When calculating the probability of risk events occurrence, the weight vector of each factor will be:

$$A_p=(a_1,a_2,...,a_n)$$

The index weight of judgment V will be given, and the index weight vector:

$$B_p=(b_1,b_2,...,b_m)$$

So, the probability of risk events occurrence is:

$$p_S=A_pR_pB_p^T$$

When calculating the effect of risk events that happened, the weight vector of each factor will be:

$$A_i=(a_1,a_2,...,a_n)$$

The index weight of judgment V will be given, and the index weight vector:

$$B_i=(b_1,b_2,...,b_m)$$

So, the effect of risk events that happened is:

$$C_S=A_iR_iB_i^T$$

Calculating the weight vector of A_p and A_i usually use experts estimation method. A_p and A_i also can be obtained by AHP method based on the pair wise comparisons judgment matrix given by experts and is obtained. No matter which kind of method will be applied, both have the obvious subjectivity[10]. In this paper, the entropy weight coefficient method will be adopted to quantify the weight vector A_p and A_i.

Determining the entropy weight coefficient of each risk factor

For some factor U_i in the judgment membership matrix given by experts, the longer the distance of its support degree r_{ij} to the evaluation index in the judgment set, the more the effect in the comprehensive evaluation is. If the support degrees of some factor U_i are all equal, that is, the results of expert evaluation are scattered and the expert's cohesion is poor,

there will be little effect of the factor U_i in comprehensive evaluation. The information entropy $H = -\sum_{i=1}^{n} P_i LnP_i$ represents the orderly level of system. From the extremism property of entropy, it is known that the more close to equal the P_i, the bigger value the entropy and the bigger the uncertainty of the risk factors of the system in risk assessment. Therefore, the weight vectors of various factors can be calculated by the information entropy according to the support degree to the evaluation index in the judgment set.

Specific methods are as follows:

The relative importance of risk factors U_i can be measured by the following entropy:

$$H_i = -\sum_{j=1}^{m} r_{ij} Lnr_{ij}$$

In the formula, the more close to equal the $r_{ij}(j=1,2,...,m)$, the bigger value the entropy and the bigger the uncertainty of the risk factor U_i of the system in risk assessment. If all $r_{ij}(j=1,2,...,m)$ are equal, the value of entropy will be the maximum: $H_{\max} = Lnm$, if $H = -\sum_{i=1}^{n} P_i LnP_i$ is normalized with $H_{\max}$, the relative importance e_i of entropy to measure the risk factor U_i will be obtained:

$$e_i = -\frac{1}{Lnm}\sum_{j=1}^{m} r_{ij} Lnr_{ij}$$

If all $r_{ij}(j=1,2,...,m)$ are equal, the entropy will arrive the maximum value: 1. So, e_i meets: $0 \le e_i \le 1$。When the entropy arrive the maximum value, the factor will affect the system risk assessment at the least level. So, $1-e_i$ will be used to determine the weight of the risk factor U_i.

Normalize $1-e_i$ to get the weight ϕ_i of the risk factor U_i :

$$\phi_i = \frac{1}{n-E}(1-e_i)$$

In the formula: $E = \sum_{i=1}^{n} e_i$

ϕ_i meets : $0 \le \phi_i \le 1; \sum_{i=1}^{n} \phi_i = 1$

If there are subjective judgment weights of each risk factor given by experts with their experience, set to be W_i, we can combine the subjective evaluation and objective judgment, to get comprehensive weight σ_i :

$$\sigma_i = \frac{\phi_i w_i}{\sum_{i=1}^{n} \phi_i w_i}$$

If there is no subjective judgment, we can directly take ϕ_i as the weight of factors.

Assessing the risk of system

Work out A_p and A_i using the methods mentioned in part 4.3, work out P_s and C_s according to $p_s = A_p R_p B_p^T$ and $C_s = A_i R_i B_i^T$,work out the risk degree R according to $R = P_s + C_s - p_s C_s$

APPLICATION IN RISK ASSESSMENT OF INFORMATION SECURITY

According to the risk assessment the risk factors have to be identified. First, structure the fuzzy set $U = \{C_1, C_2, ..., C_6\}$, of which $C_1, C_2, ..., C_6$ are risk factors: "operating error", "divulging data", "malicious code", "denying service", "software and

hardware failure", and "cheating password". And then build the evaluation set. Build different evaluation set to the different criteria.

For the criterion: B_{1}_ "risk probability", the meaning of the judgment set $V=\{V_1,V_2,...,V_7\}$ of the risk factor set U is shown in TABLE 1.

TABLE 1 : Definition of risk probability level

Risk Probability Level	Description
V_1 Ignore	Might never occur.
V_2 Very Low	Might occur 2 or 3 times every 5 years.
V_3 Low	Might occur only 1 time every year or less than one year.
V_4 Medium	Might occur only 1 time every 6 months or less than 6 months.
V_5 High	Might occur 1 time every month or less than one month.
V_6 Very High	Might occur many times every month.
V_7Extremely High	Might occur many times every day.

The experts will evaluate the probability of the risk factor U according to TABLE 1. Each risk probability given by the experts should be one kind of the judgment set $V_1,V_2,...,V_7$. Experts' assessment form is shown in TABLE 2:

TABLE 2 : Experts' Assessment Form of Risk Probability

Risk Factors		Fuzzy Assessment Level							Weight
		V_1	V_2	V_3	V_4	V_5	V_6	V_7	
Risk Probability B_1	C1	0	0	10%	10%	20%	40%	20%	0.333
	C2	20%	30%	20%	10%	10%	10%	0	0.333
	C3	10%	20%	20%	20%	20%	10%	0	0.333
	C4	0	0	10%	10%	30%	30%	20%	0.333
	C5	0	10%	0	0	30%	30%	30%	0.333
	C6	10%	10%	10%	0	30%	30%	10%	0.333

Remarks: The meaning of V_1 to V_7 is shown in TABLE 1 which should be attached below in the actual operation. C1:Operating Error, C2:Divulging Data, C3:Malicious Code, C4:Denying Service, C5:Software and Hardware Failure, C6:Cheating Password.

Each risk probability given by the experts should be one kind of the judgment set $V_1,V_2,...,V_7$. Combined with the evaluation opinion of each expert, calculate the probability of risk factors belonging to each index, then get membership matrix R_p.

$$R_p=\begin{bmatrix} 0.0 & 0.0 & 0.1 & 0.1 & 0.2 & 0.4 & 0.2 \\ 0.2 & 0.3 & 0.2 & 0.1 & 0.1 & 0.1 & 0.0 \\ 0.1 & 0.2 & 0.2 & 0.1 & 0.1 & 0.1 & 0.0 \\ 0.0 & 0.0 & 0.1 & 0.1 & 0.3 & 0.3 & 0.2 \\ 0.0 & 0.1 & 0.0 & 0.0 & 0.3 & 0.3 & 0.3 \\ 0.1 & 0.1 & 0.1 & 0.0 & 0.3 & 0.3 & 0.0 \end{bmatrix}$$

Then calculate the entropy weight coefficient of each risk factors。 According to the formula $e_i=-\frac{1}{Lnm}\sum_{j=1}^{m} r_{ij}Lnr_{ij}$, calculate the vector e_i: (0.756,0.871,0.898,0.773,0.675,0.845), According to the formula $\phi_i=\frac{1}{n-E}(1-e_i)$ calculate the weight vector of each risk factors $A_p=(\phi_1,\phi_2,...,\phi_6)=(0.207,0.109,0.086,0.192,0.275,0.132)$。

Then calculate each index weight of the judgment set: B_p. Determine the weights standard $V_1,V_2,...,V_7$ of the B_1_C membership matrix is: 1/28, 2/28, 3/28, 4/28, 5/2, 6/28, 7/28,which is the index vector: $B_p=(1/28,2/28,3/28,4/28,5/28,6/28,7/28)$。

According to the formula: $p_s=A_pR_pB_p^T$, calculate the probability of the risk accident:

$$P_S = (0.207, 0.109, 0.086, 0.192, 0.275, 0.132) \times \begin{bmatrix} 0.0 & 0.0 & 0.1 & 0.1 & 0.2 & 0.4 & 0.2 \\ 0.2 & 0.3 & 0.2 & 0.1 & 0.1 & 0.1 & 0.0 \\ 0.1 & 0.2 & 0.2 & 0.1 & 0.1 & 0.1 & 0.0 \\ 0.0 & 0.0 & 0.1 & 0.1 & 0.3 & 0.3 & 0.2 \\ 0.0 & 0.1 & 0.0 & 0.0 & 0.3 & 0.3 & 0.3 \\ 0.1 & 0.1 & 0.1 & 0.0 & 0.3 & 0.3 & 0.0 \end{bmatrix} \times \begin{bmatrix} 1/28 \\ 2/28 \\ 3/28 \\ 4/28 \\ 5/28 \\ 6/28 \\ 7/28 \end{bmatrix} = 0.176$$

For the "risk effect", the judgment set $V = \{V_1, V_2, ..., V_5\}$ of risk effect U, its meaning has been mentioned in TABLE 3.

TABLE 3 : Definition of risk effect level

Risk Effect Level	Description
V_1 Ignored	There is almost no effect to the system when risk accident occurs.
V_2 Slight Effect	There is some slight effect to the system which can be restored by slight efforts.
V_3 General Effect	Cause damage to the reputation of system, or reduce the trust of the system's resources or the system's trust. It needs to pay the maintenance costs of the important resource.
V_4 Serious Effect	Cause disruption of important system, loss of the connection to customers or loss commercial trust.
V_5 Ruinous Effect	Cause interrupter or permanent closure of the system. Can cause great loss of agency information or services.

The experts will evaluate the probability of the risk factor U according to TABLE 3. Each risk probability given by the experts should be one kind of the judgment set $V_1, V_2, ..., V_5$. Experts' assessment form is shown in TABLE 4:

TABLE 4 : Experts' assessment form of risk effect

Risk Factors		Fuzzy Assessment Level					Weight
		V_1	V_2	V_3	V_4	V_5	
Risk Effect B_2	C1	10%	10%	30%	40%	10%	0.592
	C2	0	10%	20%	40%	30%	0.592
	C3	0	10%	30%	30%	30%	0.592
	C4	10%	10%	30%	40%	20%	0.592
	C5	0	10%	10%	40%	40%	0.592
	C6	20%	20%	30%	20%	10%	0.592

Remarks: The meaning of V_1 to V_5 is shown in TABLE 3 which should be attached below in the actual operation. C1:Operating Error, C2:Divulging Data, C3:Malicious Code, C4:Denying Service, C5:Software and Hardware Failure, C6:Cheating Password.

Each risk probability given by the experts should be one kind of the judgment set $V_1, V_2, ..., V_5$. Combined with the evaluation opinion of each expert, calculate the probability of risk factors belonging to each index, then get membership matrix R_c.

$$R_C = \begin{bmatrix} 0.1 & 0.1 & 0.3 & 0.4 & 0.1 \\ 0.0 & 0.1 & 0.2 & 0.4 & 0.3 \\ 0.0 & 0.1 & 0.3 & 0.3 & 0.3 \\ 0.1 & 0.1 & 0.3 & 0.4 & 0.1 \\ 0.0 & 0.1 & 0.1 & 0.4 & 0.4 \\ 0.2 & 0.2 & 0.3 & 0.2 & 0.1 \end{bmatrix}$$

Then calculate the entropy weight coefficient of each risk factors。 According to the formula $e_i = -\frac{1}{Lnm}\sum_{j=1}^{m} r_{ij} Lnr_{ij}$, calculate the vector e_i: (0.881,0.795,0.816,0.881,0.742,0.967),According to the formula $\phi_i = \frac{1}{n-E}(1-e_i)$ calculate the weight vector of each risk factors $A_1 = (\phi_1, \phi_2, ..., \phi_6) = (0.129, 0.223, 0.200, 0.129, 0.282, 0.035)$。

Then calculate each index weight of the judgment set: B_i. Determine the weights standard $V_1, V_2, ..., V_5$ of the B_1_C membership matrix is: 1/25、3/25、5/25、7/25、9/25, which is the index vector: $B_i = (1/25, 3/25, 5/25, 7/25, 9/25)$。According to the formula: $C_s = A_i R_i B_i^T$, calculate the effect after the risk accident occurred.

$$C_S = (0.129, 0.223, 0.200, 0.129, 0.282, 0.035) \times \begin{bmatrix} 0.1 & 0.1 & 0.3 & 0.4 & 0.1 \\ 0.0 & 0.1 & 0.2 & 0.4 & 0.3 \\ 0.0 & 0.1 & 0.3 & 0.3 & 0.3 \\ 0.1 & 0.1 & 0.3 & 0.4 & 0.1 \\ 0.0 & 0.1 & 0.1 & 0.4 & 0.4 \\ 0.2 & 0.2 & 0.3 & 0.2 & 0.1 \end{bmatrix} \times \begin{bmatrix} 1/25 \\ 3/25 \\ 5/25 \\ 7/25 \\ 9/25 \end{bmatrix} = 0.259$$

According to the formula: $R = P_s + C_s - p_s C_s$ get the security risk level of the whole OA system: $R = 0.176 + 0.259 - 0.176 \times 0.259 = 0.389$。

The system risk degree is between 0.3 and 0.4 which belongs to the risk level 4. After investigation, analysis and comparison to the assessment result, the risk level is in accord with the actual situation.

SUMMARY

Put forward Fuzzy Information Entropy method of the information system risk assessment in order to measure the whole information system risk level.

First, defining the risk degree is likely an estimation of risk probability and risk influence, measuring the whole information system risk level through the risk degree. According to the fuzziness which the probability of risk incident and the effect of estimates own, we can use the fuzzy comprehensive evaluation method. Use the information entropy to determine the weights of risk factors and to calculate the uncertainty of the risk factors, thereby obtaining the weight vectors of risk factors, and overcoming the direct assignment of subjectivity. Giving information system risk levels by working out the risk degree through the application of the fuzzy comprehensive evaluation method and the information entropy combined method could also be put forward.

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