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RS-markov Chain Model of Logistics Service Supply Chain based on Exploration Diagram

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Abstract: In order to achieve the forecast evaluation of logistics service supply chain, a tool of system-thinking in complex scientific management-Exploration diagram, is used to establish the index system for the forecast evaluation of logistics service supply chain. And according to the significant Markov chain property in the operation of logistics service supply chain, the predictability of the Markov chain is used to put forward a dynamic evaluation model, example analysis demonstrates the validity and application value of the model.

Key words: Logistics service supply chain, exploration diagram, markov chain

INTRODUCTION

For the rapid response to market demand changes, supply chain must be efficient to maintain overall agility, it's need to evaluate and manage the risk state in the chain and replace the improper node enterprise, make the supply chain structure always maintained a dynamic process. Therefore, the risk evaluation of the supply chain is a very important tache in supply chain management, which not only affects the profit of the supply chain but also affects the stability of the supply chain.

At present, many scholars in the research of supply chain risk forecast problems and puts forward the evaluation index and evaluation method of supply chain risk forecast. Spekman and Davis (2004) pointed out that the interest of many scholars focus on the risks of logistics and its impact on timely delivery of goods. Tang (2006) believes that the risk of supply chain can be reduced through effective cooperation and coordination between supply chain partners. Liu and Bai (2006) analysis studies the supply chain risk and early warning mechanism, puts forward the comprehensive evaluation of supply chain risk early warning methods. On the basis of the introduction of supply chain risk, Ma and Zhang (2008) used the fuzzy comprehensive evaluation method to calculate the risk of supply chain risk early warning level. Supply chain risk issues own studies have advanced but the service supply chain risk problem has not caused enough atten-tion.

There is no unified framework of logistics service supply chain index system in the present study. Up to now, domestic and foreign researchers have proposed a variety of evaluation methods but evaluation are often focused on the current situation, unable to evaluate the future continuous development of logistics service supply chain, unable to provide data support about establishing long-term cooperative partnership with logistics service. So, exploration diagram tool is put forward in this paper, it use the complex scientific management system thinking mode (Xu and Zheng, 2010a) to apply logistics service supply chain forecast evaluation, absorb its systematic, modular and visual thinking ways of thinking. Through the questionnaire survey, logistics service supply chain evaluation of influence factors are found and the evaluation index system is established. Then Markov chain method is introduced to construct a dynamic evaluation prediction logistics service supply chain model. It provides a new method to forecast logistics service supply chain.

INDEX SYSTEM BASED ON EXPLORATION DIAGRAM

Exploration diagram (Xu and Zheng, 2010b) is the system thinking tool, which mainly helps to solve the problem of how to conduct visual thinking. Exploration diagram can help us to solve such kind of decision making problems: Advance unknown, such as new product development decision-making, investment project evaluation and decision-making, through the creation of Exploration diagram to find all the factors that affects or may affect the research topic, helping to make decision.

Exploration diagram use ellipse to represent factors, elliptic bidirectional arrow indicates interactive

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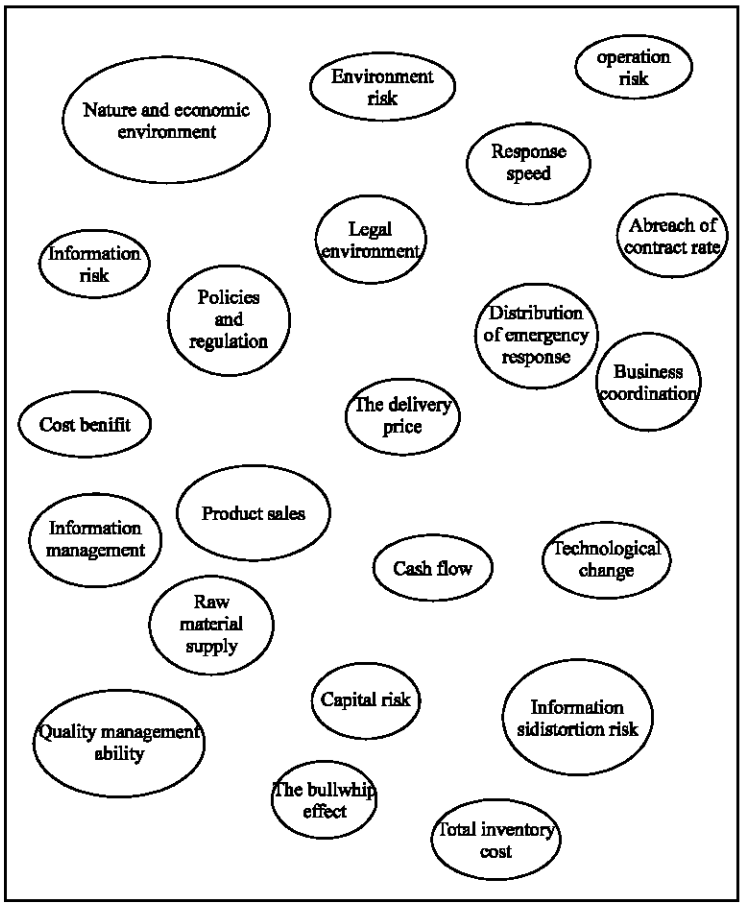

Fig. 1: Initial exploration diagram

relationship, ruleless circles represent the same factors and ligature used to connect factors of the same class, a tail on the ellipse indicates deleting factors. The process of drawing Exploration diagram for Evaluation of logistics service supply chain is as follows:

Step 1: According to the needs of the research theme or decision-making problems, the relevant experts convened to discuss the research topic or decision-making problems

Step 2: Moderator or the responsible raise questions in accordance with the research topic or the question of the decision-making, allowing you to think.This article mainly discusses how to evaluate logistics service supply chain

Step 3: Each member give full play to their imagination and express their views, Moderator depicts many factors that will affect the theme on paper according to each person and represent these factors via oval. Initial Exploration diagram is showed in Fig. 1

Step 4: After they have fully express their views, everybody are guided to conduct the visual think about all the proposed factors aimed at these oval, starting from the overall, integrated the same, Eliminate redundant, connect the factors of the same class with ligature, use the rule less circles to enclose the same type factors, plus a tail in the oval for the deleted factors. According to figure 1, the classified exploration diagram is shown in Fig. 2

Step 5: To further the visual thinking, named each irregular circle, Such as commodity prices, types of goods, commodities performance and Brand and commodity picture information can be classified as commodity information. The naming of this category is only an initial name, can eventually named after the analysis of the causal association

Step 6: Analysis of the causal relationship between the factors and describe it with arrows. Exploration diagram is created and it is a collective creation.

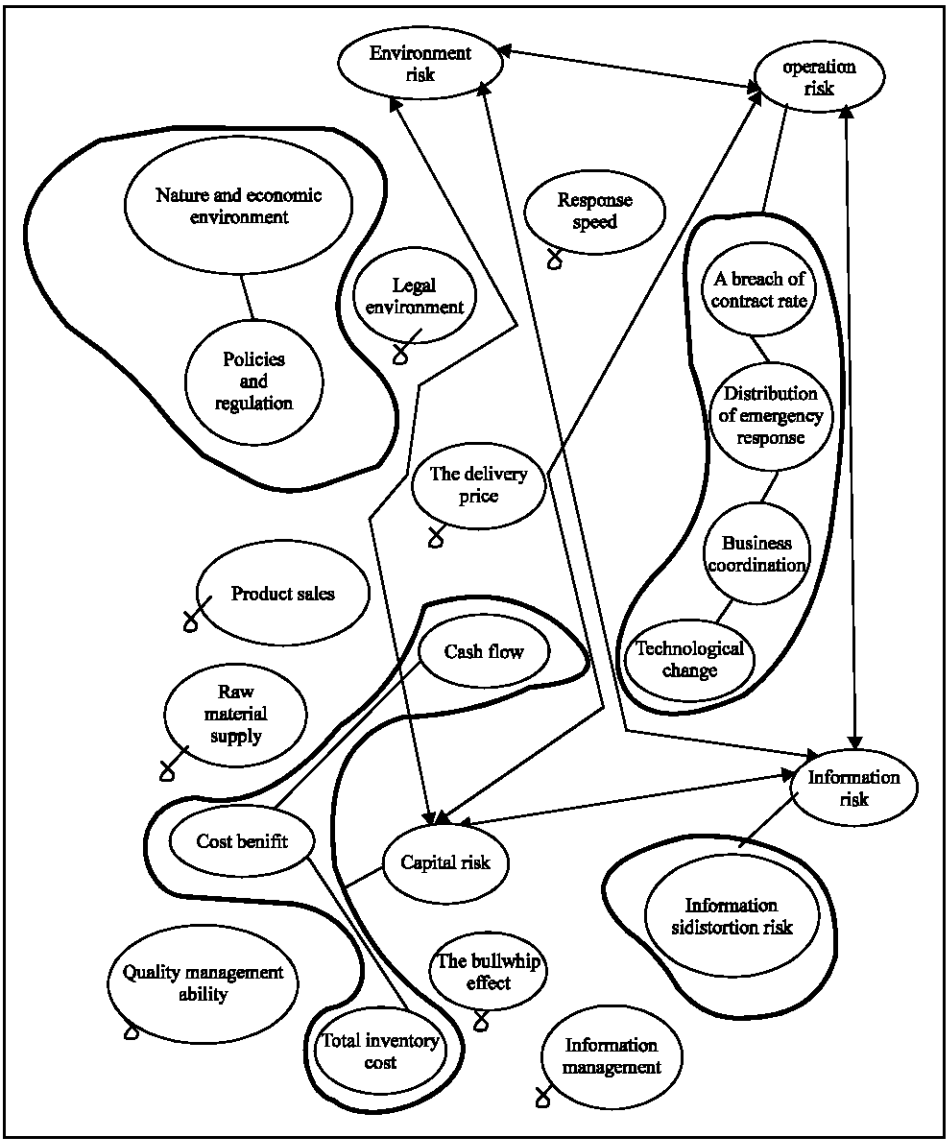

Fig. 2: Classified exploration diagram

The creation process is a combination of logical thinking and thinking in images to form the formation of innovative thinking, Exploration diagram of logistics service supply chain evaluation is formed in Fig. 3

Based on above, logistics service supply chain forecast evaluation index system is obtained and shown in Fig. 4.

DETERMINE THE WEIGHTS OF INDEX SYSTEM

The rough set theory is a new mathematical tool to deal with imprecise, incomplete and inconsistent data. It can effectively analyze each kind of incomplete information such as imprecise, inconsistent, not integrity and so on but also discovers the concealed knowledge and promulgates the latent rule according to analyzing and reasoning data. In the rough set theory, computation of approximations and edge and attributes reduction of decision table is import part of them:

Step 1: Foundation data processing. In this step, we need input S = (U, A, V, F), A is the attribute set, A = CUD. C, is the condition attribute, D is the policy-making attribute. Then, according to given classification method, data are standardized

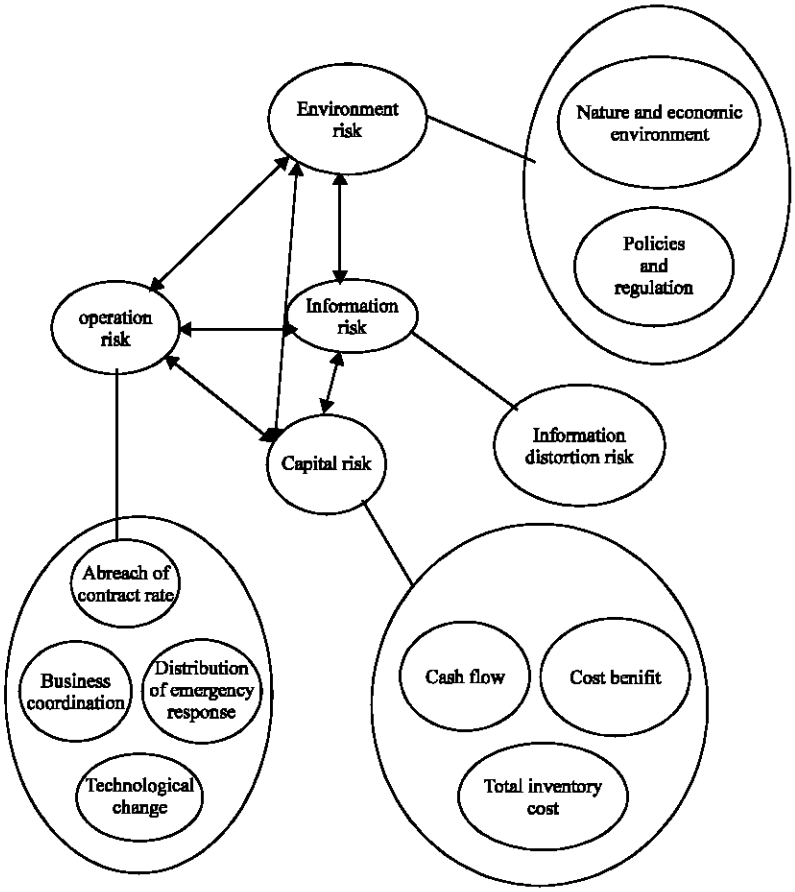

Fig. 3: Exploration diagram of logistics service supply chain forecast evaluation

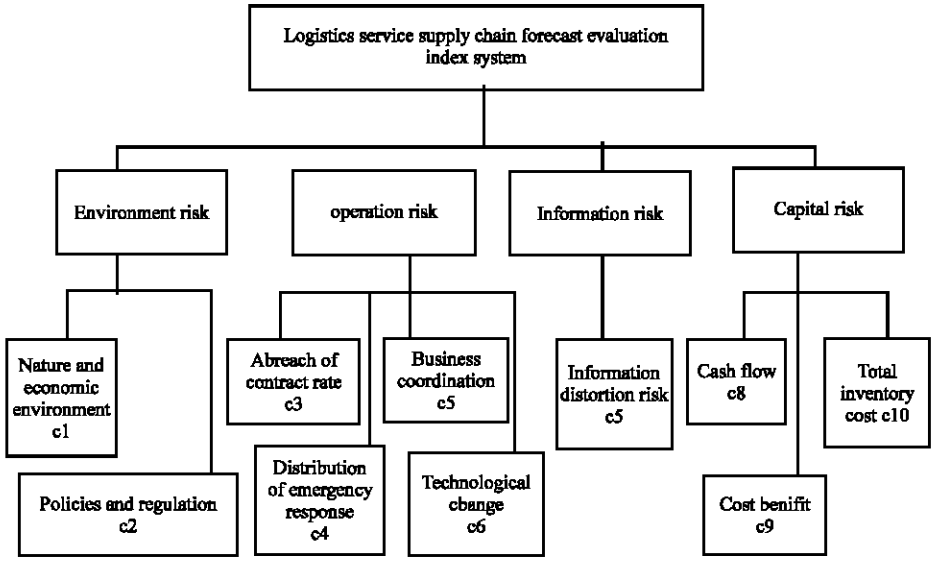

Fig. 4: Logistics service supply chain forecast evaluation index system

Table 1: Weights of index system

Indicator	C1	C2	C3	C4	C5
W	0.09	35	0.08	28	0.09
	98	0.08	17	0.12	21
Indicator	**C6**	**C7**	**C8**	**C9**	**C10**
W	0.11	82	0.12	81	0.13
	10	0.05	86	0.08	42

Step 2: Calculate the importance of attribute $sig_x(x_i)$ to attribute x_i in $C = \{x_1, x_2, \ldots, x_n\}$. Definition of importance of attribute is:

$$sig_x(x) = 1 - \frac{|X \cup \{x\}|}{|X|}$$

Step 3: Processing importance of attribute $sig_x(x_i)$ in step 2 according under eqaution:

$$p_i = \frac{sigx_i(x_i)}{\sum_{i=1}^{n} sigx_i(x_i)}$$

p_I is the objective weight of x_i

Step 4: Experts give subjective weight of each attribute, namely:

$$Q_i (i = 1, 2, .., n), \sum_{i=1}^{n} Q_i = 1$$

Step 5: Choose appropriate experience factor α. Then, comprehensive weight w_I of each attribute x_I is obtained by $w_i = \alpha Q_i + (1-\alpha)p_i (1 \le i \le n)$

Based on questionnaire survey result, using Rough set method to calculate weights (Shi and Dong, 2012) and results is shown in Table 1.

DYNAMIC EVALUATION OF LOGISTICS SERVICE SUPPLY CHAIN

Relevant principles: Fuzzy comprehensive evaluation method: The fuzzy comprehensive evaluation method is a kind of systems analysis method which uses the principle of fuzzy mathematics to analyze and evaluate "fuzzy" things. It has been widely applied to many subject areas in recent years (Tang *et al*., 2012).

General steps of fuzzy comprehensive evaluation:

- First, determine the factor set $U = (U_1, \ldots, U_n)$ and evaluation set $V = (V_1, \ldots, V_n)$, Among them, the U represent all of the evaluation factors set; V represent all the comments level set
- Second step, to determine the fuzzy evaluation matrix

$$R = \begin{pmatrix} R1 \\ R2 \\ M \\ Rn \end{pmatrix} = \begin{pmatrix} r_{11} & r_{12} & \ldots & r_{1m} \\ r_{21} & r_{22} & \ldots & r_{2m} \\ M & M & M & M \\ r_{n1} & r_{n2} & \ldots & r_{nm} \end{pmatrix}$$

Make a judgment $f(u_i)$, $(i = 1, 2, \ldots, n)$ for each factor u_i, then we can get a fuzzy mapping from U to V. Namely, $f: U \to F(U)$, $u_i \to f(u_i) = (r_{i1}, r_{i2}, \ldots, r_{in}) \in F(V)$. After that, we can induce the fuzzy relation $R_f \in F(UHV)$ by he fuzzy mapping f, namely, $R_f(u_i, v_i) = f(u_i)(v_i) = r_{ij}$ $(i = 1, 2, \ldots, n; j = 1, 2, \ldots, m)$. Thus, we can determine the fuzzy judgment matrix $R = (r_{ij})_{nHm}$, (U, V, R) is known as the fuzzy comprehensive evaluation model and U, V, R are the three elements of the model.

- Third step is to make comprehensive evaluation. If the Weight distribution for each evaluation factors is $A = \{a_1, \ldots, a_m\}$, $0 \le a_i \le 1$, then, applying of fuzzy transformation synthesis operation, we can get a fuzzy subset in domain of discourse V, namely, the comprehensive evaluation results:

$$B = ABR = (b_1, b_2, \ldots, b_n)$$

Markov procedure definition: set $\{x_n, n> = 0\}$ to a discrete time Markov chain. For any I, $j \in S$, $P\{X_{n+1} = J | X_n = i\}$ is known as Markov chain step transition probability, remember be $p^{n, n+1}_{ij}$. When the probability and n irrelevant, says the Markov chain has a smooth transition probability and notes for p_{ij}.

Usually the transition probability in a (infinite dimensional) square, namely:

$$P = \begin{bmatrix} p_{00} & p_{01} & \cdots & p_{0j} & \cdots \\ p_{10} & p_{11} & \cdots & p_{1j} & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ p_{i0} & p_{i1} & \cdots & p_{ij} & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \end{bmatrix}$$

It is transition probability matrix of the Markov chain (Shen, 2012).

Through several steps transfer, it will eventually make the system to reach a stable state, that is, followed a transfer, secondary,..., the result is no longer change, namely:

$$P(n) = p(n-1)p = p(n-2)\,pp = \ldots = p(0)p^n$$

Dynamic evaluation model based on fuzzy evaluation and Markov chain:

- Invite five relevant experts to form an evaluation team

- Determining factor set $U = (U_1, \ldots, U_n)$ and evaluation set $V = (v_1, \ldots, v_m)$, where V = [excellent, good, moderate, average, poor]
- The probability of the factor which transfers from evaluation grade i to evaluation grade j is called the transition probability p_{ij} of this factor

After one month, the change of the state is called the first level transition, statistics five experts' index evaluation for the past two months and the evaluation grade transfer situation of the indicators can be concluded. Suppose n_{ij} means the transfer numbers from the state i to the state j of an indicator, according to the theory of the Markov chain, this transfer is shown by the one-step transition probability matrix p_{ij} (Zhang *et al*., 2012):

$$P = \begin{bmatrix} \frac{n_{11}}{n} & \frac{n_{12}}{n} & \cdots & \cdots & \frac{n_{15}}{n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{n_{51}}{n} & \cdots & \cdots & \cdots & \frac{n_{55}}{n} \end{bmatrix} \quad \text{and} \sum_{j=1} \frac{n_{ij}}{n} = 1$$

This probability is called the Markov chain's first step transition probability, transferred through a number of steps that will ultimately enable the system reaches a stable state, then transfer once or twice ..., the result does not change, use the steady state vector Z to represent it, after that, we can obtain the membership matrix R.

- Set $W = (w_1, \ldots, w_n)$, so the result is: $B = W \circ R = [b_1, b_2, \ldots, b_n]$

According to the above model, the forecast evaluation result of logistics service supply chain is obtained.

ANALYSIS OF EXAMPLE

In this section, an example in logistics service supply chain forecast evaluation is introduced to confirm the algorithm's validity. Let five experts give score to the logistics service supply chain according to indexes rank, two months of data are shown in Table 2 and 3.

Original state of index C1 is: $p^{(0)} = [3/5\ 1/5\ 1/5\ 0\ 0]$

First step transition probability Matrix p is:

$$p = \begin{bmatrix} 2/3 & 1/3 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Table 2: Evaluation data of the first month

Index	Expert1	Expert2	Expert3	Expert4	Expert5
C1	Excellent	Medium	Excellent	Excellent	Good
C2	Medium	Excellent	Excellent	Good	Good
C3	Excellent	Excellent	Good	Good	Excellent
C4	Good	Medium	Medium	Good	General
C5	Good	Good	Medium	Good	Excellent
C6	Medium	Good	Medium	Medium	General
C7	Medium	Good	Medium	General	General
C8	Good	Medium	Good	Medium	General
C9	Excellent	Good	Medium	Excellent	Good
C10	Good	Good	Medium	Excellent	Medium

Table 3: Evaluation data of the second month

Index	Expert1	Expert2	Expert3	Expert4	Expert5
C1	Excellent	Good	Excellent	Good	Excellent
C2	Good	Good	Good	Medium	Medium
C3	Excellent	Good	Medium	Excellent	Good
C4	Medium	Good	Good	Good	Medium
C5	Good	Excellent	Good	Medium	Good
C6	Good	Good	Medium	Medium	Medium
C7	Good	Medium	General	Medium	General
C8	General	General	Medium	Medium	General
C9	Excellent	Medium	Good	Good	Medium
C10	Good	Medium	Excellent	Good	Good

Stable state vector gram is $Z = [0.75\ 0.25\ 0\ 0\ 0]^T$

Similarly, the steady state vector of other indicators is calculated and membership degree matrix R is:

$$R = \begin{bmatrix} 0.75 & 0 & 0.4 & 0 & 0.2 & 0 & 0 & 0 & 0.2 & 0.14 \\ 0.25 & 0.5 & 0.4 & 0.67 & 0.6 & 0.4 & 0.2 & 0 & 0.4 & 0.57 \\ 0 & 0.5 & 0.2 & 0.33 & 0.2 & 0.6 & 0.2 & 0.4 & 0.4 & 0.29 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.4 & 0.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}^T$$

The overall evaluation of S1 is:

$$E_{s1} = [0.1580\ 0.3770\ 0.3352\ 0.1298\ 0]$$

So, the logistics service supply chain forecast evaluation rating as a "good".

CONCLUSION

In this study, the tool which uses complex scientific management system-thinking-Exploration diagram, established the index system for the logistics service supply chain forecast evaluation. Using the method of rough set to determine index weights and combining Markov chain and fuzzy comprehensive evaluation method, to puts forward a forecast evaluation model. It could assess the future capacity of the logistics service supply chain and could provide data information. An example analysis demonstrates the validity of the model and its application value.

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REFERENCES

Liu, Y.S. and X.J. Bai, 2006. On early warning index system of supply chain risk. Logistics Technol., 10: 55-57.

Ma, L. and G.M. Zhang, 2008. Study on the risk early-warning management in the supply Chain. Value Eng., 2: 69-72.

Shen, X., 2012. Application of vector markov chain to reliability evaluation of agricultural products cold chain. Adv. Inform. Sci. Serv. Sci., 4: 554-560.

Shi, L. and H.B. Dong, 2012. Selecting IT-outsourcing suppliers based on combination weighting: Double base points model. Int. J. Digital Content Technol. Appl., 6: 112-119.

Spekman, R.E. and E.W. Davis, 2004. Risky business: Expanding the discussion on risk and the extended enterprise. Int. J. Physical Distribution Logistics Manage., 34: 414-433.

Tang, C.S., 2006. Perspectives in supply chain risk management. Int. J. Prod. Econ., 103: 451-488.

Tang, G.F., B. Dan, H. Song and X.M. Zhang, 2012. Research on incentive mechanism of application services outsourcing under asymmetric information. Int. J. Inform. Process. Manage., 3: 39-47.

Xu, X.S. and X.J. Zheng, 2010. Analysis framework for combination of qualitative and quantitative. Technol. Econ., 29: 1-6.

Xu, X.S. and X.J. Zheng, 2010. Qualitative analysis tools: Probe graph, cycle graph and structure graph. Technol. Econ., 29: 1-6.

Zhang, X., Q. Zhao and G. Xia, 2012. Research on integrated optimization problem in a multi-product supply chain based on Markov decision processes. J. Converg. Inform. Technol., 1: 45-53.