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Study on the Selection of the Third Party Cold Chain Logistics Based on Fuzzy Comprehensive Evaluation Decision

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***Abstract*—Compared to general normal temperature logistics, the cost of cold chain logistics is very huge. Not all enterprises have the strength of the development of cold chain logistics. Therefore, these enterprises will focus on the choice of third party cold-chain logistics enterprises. In the process of selection, not only the price, but also consider the strength and influence of its enterprises. In this paper, the accuracy of service information, freight rate, punctuality rate, transportation cost, storage cost, emergency event processing time, timely delivery time, enterprise scale, logistics equipment, information technology level are comprehensively evaluated. Decider the method of fuzzy comprehensive evaluation. According to the membership theory of fuzzy mathematics, the qualitative evaluation indexes of the comprehensive ability of reaction enterprises, service time, service cost, and enterprise strength are converted into quantitative evaluation of specific data. Through the establishment of comprehensive evaluation model, the comprehensive evaluation of individual enterprises is obtained, and then the comprehensive ranking score of each enterprise is obtained. According to the score size, choose the cooperative third party cold-chain logistics enterprises, and select the comprehensive score higher enterprises.**

Keywords-Third party cold chain logistics ; Fuzzy comprehensive assessment method; Decision making

I. INTRODUCTION

China has about 400 million tons of fresh agricultural products enter the circulation market every year. Fruit and vegetable, meat, aquatic products cold chain flow rate reached 5 %, 15 %, 23 %; and Refrigerated transport rates reached 15%, 30% and 40% respectively. Per capita food consumption cash expenditure reached 6000 yuan, so the consumption demand of fresh agricultural products is very big and the agricultural cold chain logistics market is broad. Since 2005, the first fresh e-commerce company in China was founded; By 2012 is the outbreak of fresh e-commerce, originally life, sf-express, Amazon, Jingdong fresh, and Taobao ecological agriculture channel began to focus on the fresh field; by 2016, fresh e-commerce collective entry into obviously degrade phase. The important reason is the lack of professional standardization of the supply chain and distribution service providers. The vigorous development of fresh e-commerce objectively led to a large number of cold-chain logistics enterprises.

However, the cold chain logistics of agricultural products is still rather lag. Post-harvest loss of agricultural products is very serious. The cost of food logistics accounted for 70 % of the total cost of food, far higher than 50 % of international standards. And food safety problems occur frequently. According to statistics, the loss rate of agricultural products in developed countries has been controlled to 5 % or lower; In China, fruit and vegetable products, meat and aquatic products are still as high as 25 %, 12 % and 15 %, only fruit and vegetable loss reaches 100 billion yuan per year. Cold chain logistics not only needs special transport storage equipment, but also is very high technology level and talent requirements. This means huge cost inputs. In the selection of the third-party cold chain logistics enterprises, the general suppliers often consider multiple indicators of enterprises, and make a comprehensive evaluation. In order to help them choose, the following will discuss the use of fuzzy mathematics method make a comprehensive evaluation on the third party cold-chain logistics enterprises.

II. THE PRINCIPLE AND STEPS OF FUZZY COMPREHENSIVE EVALUATION DECISION

When choosing the cold-chain logistics enterprises of the third party, the supplier needs to consider many factors of the enterprise, and fuzzy comprehensive decision-making is a very effective multi-factor decision-making method for comprehensive evaluation of things affected by many factors.

A. The principle of fuzzy comprehensive evaluation

Suppose F = {f1, f_2... f_n}, F is a collection of n factors (or indicators), C = {c1, c_2… c_m}, C is a collection m results, the number and name of these elements can be determined by people according to the actual problem. Different factors are different in their position, and their roles are different, therefore different weight sizes are set according to specific needs, so different evaluation results may be obtained. Because the results of the m are not absolutely negative, not to be negative, the result of the final evaluation is the fuzzy subset B on C. B=（b_1,b_2,…,b_m）∈ ∮ (C), Among them, b_j (j = 1, 2, …, m) reflects the position of j in comprehensive evaluation (membership of v_j to fuzzy set B, B (v_j) = b_j). Comprehensive evaluation B depends on the weight of each factor, A=（a_1, a2…a_n）∈ ∮ (F), where $\sum_{i=1}^{n} a_i = 1$, Where a_i represents the weight of the Factor i. Therefore, as long as the weight A is determined, an evaluation result B is obtained accordingly.

B. Steps of fuzzy comprehensive evaluation

The mathematical model of fuzzy comprehensive evaluation consists of three important factors, the process is divided into six steps.

First, the index factors of the evaluation object constitute a collection, namely factor set F= {f_1, f2,…,f_n};

Second, set the evaluation set C composed of m evaluation results. C=（c_1, c2,…,c_m）;

Third, the weight set of each factor assignment, A=（a_1,a_2,⋯,a_n）($\sum a_i = 1$);

Fourth, the fuzzy evaluation of the i factor is Ri=(r_{i1},r_{i2},⋯,r_{im})（i=1,2,⋯,n）;

Fifth, the fuzzy evaluation matrix R is constituted, R=

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

Sixth, the fuzzy comprehensive evaluation of the evaluation object is B = A°R = (a_1,a_2,…,a_n) ° $\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}$ =(b_1,b_2,…,b_m); Comprehensive evaluation results of single object can be obtained through the single treatment of B.

III. FUZZY COMPREHENSIVE EVALUATION PROCESS OF THIRD PARTY COLD CHAIN LOGISTICS ENTERPRISES

A. Selection of comprehensive evaluation index of cold chain logistics enterprises

In this paper, through the relevant literature, combined with Country lengmeng (China warehouse and distribution association, China animal husbandry association, national Federation of industry and commerce industry chamber of China, China fruit circulation association, China vegetable circulation association) group standard "cold chain operation management standard ", build the following index system:

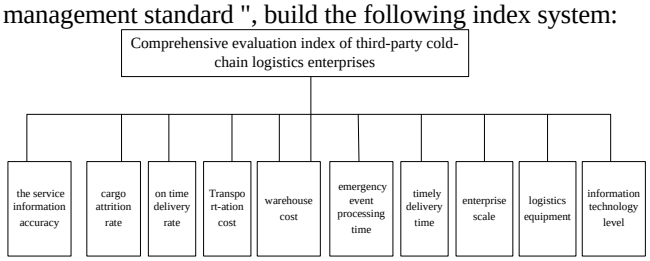

Figure 1. Comprehensive evaluation index of third party cold chain logistics enterprise

B. Fuzzy Comprehensive Evaluation Process of Cold Chain Logistics Enterprises

This paper selects 5 cold-chain logistics enterprises, respectively, company 1, company 2, company 3, company 4, company 5; 10 experts in the logistics industry were invited to evaluate each index of each enterprise.

First, according to the evaluation index of the third party cold-chain logistics, the service information accuracy f1, cargo attrition rate f_2, on time delivery rate f_3， transportation cost f_4, warehouse cost f_5, emergency event processing time f_6, timely delivery time f_7, enterprise scale f_8, logistics equipment f_9, information technology level f_{10},so factor set F={f_1,f_2,…,f_{10}};

Second, the evaluation results are divided into very good c_1, good c_2, general c_3, difference c_4, very poor c_5, and get comment set C={c_1,c_2,c_3,c_4,c_5};

Third, according to the relevant experts, the cold-chain logistics enterprises and technical personnel comprehensive judgment, mainly consider reducing cost, technical control problem, the weight of each factor is A=（a_1,a_2,⋯,a_{10}）,and A=(0.06,0.09,0.05,0.16,0.15,0.08,0.12,0.1,0.08,0.12);

Fourth, the company 1, four experts' evaluation is very good, two experts' evaluation is good, two experts' evaluation is general, one expert evaluation is poor, 1 expert evaluation is very poor, according to the index service information rate f_1 factor evaluation, R_1=(0.4,0.2,0.2,0.1,0.1); According to the scoring of 10 indicators by experts, the comprehensive evaluation matrix R, like table 1:

TABLE I. COMPREHENSIVE EVALUATION MATRIX OF COMPANY 1

index	very good c_1	good c_2	general c_3	poor c_4	very poor c_5
the service information accuracy f_1	0.4	0.2	0.2	0.1	0.1
cargo attrition rate f_2	0.2	0.3	0.3	0.2	0
on time delivery rate f_3	0.3	0.4	0.1	0	0.2
e delivery rate f3，f_4	0	0.3	0.5	0.1	0.1
warehouse cost f_5	0.1	0.4	0.2	0.1	0.2
emergency event processing time f_6	0.5	0.5	0	0	0
timely delivery time f_7	0.2	0.6	0.2	0	0
enterprise scale f_8	0	0	0.9	0.1	0
logistics equipment f_9	0.5	0.4	0.1	0	0
information technology level f_{10}	0.2	0.1	0.5	0.2	0

Fifth, according to the principle of matrix multiplication, the fuzzy comprehensive evaluation of company1 is B_1, B_1=(0.06,0.09,0.05,0.16,0.15,0.08,0.12,0.1,0.08,0.12)×

$$\begin{bmatrix} 0.4 & 0.2 & 0.2 & 0.1 & 0.1 \\ 0.2 & 0.3 & 0.3 & 0.2 & 0 \\ 0.3 & 0.4 & 0.1 & 0 & 0.2 \\ 0 & 0.3 & 0.5 & 0.1 & 0.1 \\ 0.1 & 0.4 & 0.2 & 0.1 & 0.2 \\ 0.5 & 0.5 & 0 & 0 & 0 \\ 0.2 & 0.6 & 0.2 & 0 & 0 \\ 0 & 0 & 0.9 & 0.1 & 0 \\ 0.5 & 0.4 & 0.1 & 0 & 0 \\ 0.2 & 0.1 & 0.5 & 0.2 & 0 \end{bmatrix} = (0.245, 0.315, 0.211, 0.143, 0.086)$$

Similarly, according to the above calculation process, the fuzzy comprehensive evaluation matrix of four other companies are calculated.

$$B_2 = (0.245, 0.315, 0.211, 0.143, 0.086);$$

$$B_3 = (0.03, 0.413, 0.256, 0.226, 0.075);$$

$$B_4 = (0.358, 0.162, 0.221, 0.105, 0.154);$$

$$B_5 = (0.105, 0.233, 0.332, 0.298, 0.032);$$

Sixth, give the score of the result set, score vector $v=(v_1,v_2,v_3,v_4,v_5)$, and c_1 is 5, c_2 is 4, c_3 is 2, c_4 is 1, c_5 is 0;so V=(5,4,2,1,0), Table 2 for each company's score matrix:

TABLE II. COMPANY COMPREHENSIVE SCORING MATRIX

name	v_1	v_2	v_3	v_4	v_5
	5	**4**	**2**	**1**	**0**
Company 1	0.2	0.323	0.336	0.089	0.052
Company 2	0.245	0.315	0.211	0.143	0.086
Company 3	0.03	0.413	0.256	0.226	0.075
Company 4	0.358	0.162	0.221	0.105	0.154
Company 5	0.105	0.233	0.332	0.298,	0.032

Using fuzzy comprehensive evaluation method again, get score vector of five companies, D= (d_1, d2, d3, d4, d5);

$$D=V \times B = (5, 4, 2, 1, 0) \times \begin{bmatrix} 0.2 & 0.323 & 0.336 & 0.089 & 0.052 \\ 0.245 & 0.315 & 0.211 & 0.143 & 0.086 \\ 0.03 & 0.413 & 0.256 & 0.226 & 0.075 \\ 0.358 & 0.162 & 0.221 & 0.105 & 0.154 \\ 0.105 & 0.233 & 0.332 & 0.298 & 0.032 \end{bmatrix} = (3.503, 3.05, 2.54, 2.985, 2.419);$$

From D, we can see $d_1>d_2>d_4>d_3>d_5$. The comprehensive performance of company 1 and company 2 is higher, so the selection can be appropriately selected on the choice.

IV. CONCLUSIONS

In the selection of the third party cold chain logistics enterprises, the fuzzy comprehensive evaluation method takes into account the fuzziness and actual situation of human thinking, and skillfully turns qualitative factors into quantitative factors. In practical problems, due to the complexity of objective objects, uncertainty and the fuzziness of human thinking, it is difficult to give precise numbers as evaluation values. Therefore, in the process of the comprehensive evaluation of the third party cold chain logistics enterprises, the purpose of this paper is to explain how to use this evaluation method. Of course, this process also has some problems, need further investigation and analysis. First is the selection of indicators and the determination of the weight of these indicators. The indicators are not comprehensive, and such indicators as information cost, financial stability, development potential, service scope corporate culture are not involved. The weight of the indicators is also very important. The choice of preference is different, the weight of the establishment is also different. It can be established according to the FAHP method. Furthermore, in the process of ranking the enterprise score, it is more reasonable to set the score as the interval.

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