Choose the Reverse Logistics Mode on the Fuzzy Comprehensive Evaluation Method

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Abstract. Reverse logistics has different operation mode from forward logistics. This paper analyzed three kinds of operating mode of reverse logistics and the influence factors respectively. Through analyzing the influence factors, we constructed the evaluation index system of reverse logistics mode, and applied the fuzzy comprehensive evaluation method to choosing the enterprise reverse logistics operation mode. Finally, we analyzed the model through the practical application.

Introduction

Reverse logistics management as a new concept is accepted seriously by international academic in recent years. Reverse Logistics is proposed in a report to the Council of Logistics Management by Stock in 1992, who also pointed that reverse logistics has various important commercial and social meanings. From then on, reverse Logistics has been gradually researched deeply and widely in late 1990s. Spengler (1997) researched the process of slag waste reproduction of the German iron and steel industry, and used a piece-wise linear function to calculate the cost of transportation[1]. Rogers and Tibben Lembke (1999) introduced a wide range of commercial applications of reverse logistics[2]. Zhao Liming (2002) researched the reverse logistics in the e-commerce, and established e-business model to support reverse logistics activities, as well as the form of reverse logistics in e-commerce environment[3]. Yue Hui and Chen Yu (2004) used the analytic hierarchy process to evaluate the selection of alternative third-party logistics companies in the reverse logistics outsourcing[4]. Feng Yiqin (2009) considered reverse logistics mode selection and network design problems, using analytic hierarchy process and fuzzy comprehensive evaluation to analysis and select the mode of reverse logistics[5].

Comparative analysis of the reverse logistics operation mode

Reverse logistics operation mode

Reverse logistics has different modes of operations just like forward logistics, the enterprise can select the most appropriate mode of operation according to its specific situation.

(1) Reverse logistics self-operation mode

The reverse logistics self-operation mode means that enterprises establish reverse logistics system by itself, and independently undertake product recycling, treatment, reuse business.

Enterprise reverse logistics self-operation mode can improve the efficiency of the circulation of recyclables, enhance the functions of the logistics sector, and improve the efficiency of information processing and costing of reverse logistics. With the development of enterprise logistics technology and management, as well as improvement of social logistics service, some enterprises can manage themselves reverse logistics business in the range of service capabilities, so as to expand them profits.

(2) Reverse logistics associated operation mode

The reverse logistics associate operation mode means that companies that produce the same or similar products , selecting alliance, jointly establish associates or organizations to manage their reverse logistics operations, share recovery costs, responsibility and risk at the same time.

The higher the frequency of transactions between enterprises, the higher transaction costs are. Associates or organization, an organized market transaction between the cooperation of all parties in the logistics field, can not only save the various costs of market transactions, but also promote mutual learning between the partners, improving cognitive abilities of the market environment, to reduce transaction costs.

(3) Reverse logistics outsourcing operation mode

The reverse logistics outsourcing operation mode means that enterprises outsource part or all of the reverse logistics business to appropriate third-party reverse logistics service provider, and pay related costs according to signed the contract.

With the increasingly fierce competition, some enterprises begin to transfer their strategic focus to the supply chain superiority. Then enterprises will specialize in a particular area or business, which makes enterprises have to outsource other non-core businesses, such as reverse logistics business, according to its own characteristics.

Comparison of the different operation modes of the reverse logistics

An operation mode has different effects on any aspect of enterprise reverse logistics system, and three operation modes have different advantages and disadvantages, so enterprises need consider the impact factors according to their actual situation in decision-making. The comparison of three modes is shown in Table 1.

Table 1 comparison of reverse logistics mode

	Influencing factors	self-operation mode	associate operation mode	outsourcing operation mode
Economic factors	Logistics costs	higher	high	common
	Economic benefits	higher	common	common
Enterprise micro factors	Enterprise scale and strength	large and medium-sized enterprises	small and medium enterprises	small enterprises
	Service levels and customer satisfaction	common	good	better
	Personnel, equipment, information management capacity	better	good	common
	Anti-risks ability	strong	common	common
	logistics characteristics	less variety	different variety	many variety
Social macro factors	Environment protection	common	common	better
	Policy factors	big	common	common
	Social reverse logistics capabilities	simplification	strategic alliance	main trends

From table 1, we can get that different companies choose operation mode according to their own characteristics. For a certain production scale and strength enterprise, it can choose self-operation mode which is less variety but mass production batch, and it chooses associate or outsourcing mode which has many product categories but the yield is very few. The three reverse logistics operation mode is an ideal state, but the enterprise usually choose different mode according to reverse logistics activities needed in reality.

Reverse logistics mode selection with fuzzy comprehensive evaluation method

Index selection

Based on the analysis of influencing factors of the reverse logistics mode in last section, the evaluation index is summarized as follows in figure 1.

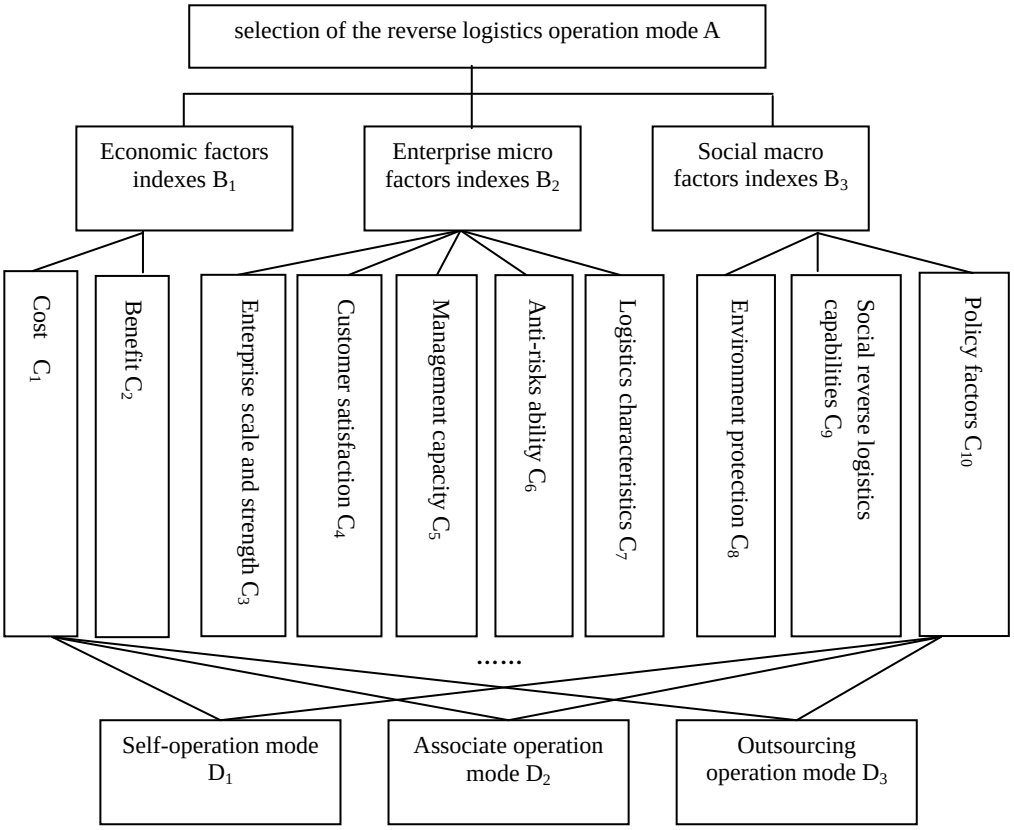

Fig. 1 Reverse Logistics Mode Selection Evaluation Index System

Method application

In order to introduce the application of fuzzy comprehensive evaluation method, we select a medium-sized telecommunication enterprise to illustrate the method's steps.

Step 1: Determine the enterprise evaluation object, given the evaluation object set X = {x1, x2, x3} = {self, associates, outsourcing}.

Step 2: Establish evaluation index set U = {u1, u2, u3}, B layer indexes and C layer indexes of sub-set of U according to influencing factors.

Step 3: Determine the reviews set V = {v1, v2, v3, v4, v5} = {better, good, common, bad, worse} and scores set F = {1, 0.8, 0.6, 0.4, 0.2}.

Step 4: layers of evaluation weights are assigned as follows.

A ={0.64, 0.28, 0.08};A_1={0.33, 0.67};A_2={0.44, 0.11, 0.28, 0.05, 0.12};A_3={0.65, 0.12, 0.23}

Step 5: Arranging 13 experts carried out a single factor evaluation, given evaluation set value, derived transformation matrix $R_i=(r_{ij})_{m*n}$. Experts evaluate each factor according to the review set V, conclude the evaluation matrix R_i. R_i in each row number is divided by the number of experts, then we can derive the fuzzy relationship matrix.

For the self-operation mode of the enterprise, economic factors set = {cost, benefit}, it is assumed that the expert assessment results are as follows:

$$R_1=\begin{bmatrix} 0 & 3 & 10 & 0 & 0 \\ 0 & 9 & 4 & 0 & 0 \end{bmatrix}$$

According to the first line of matrix R1, from the cost point of view, 3 experts think the mode is good, 10 experts think the mode is common. The meaning of other numbers are similar to them. Each element divided by the number of experts, we can derive the fuzzy relationship matrix R1:

$$R_1=\begin{bmatrix} 0 & 0.23 & 0.77 & 0 & 0 \\ 0 & 0.69 & 0.31 & 0 & 0 \end{bmatrix}$$

Similarly, we can derive the fuzzy relationship matrix R2 and R3 as follows:

$$R_2=\begin{bmatrix} 0 & 0.15 & 0.70 & 0.15 & 0 \\ 0 & 0.31 & 0.54 & 0.15 & 0 \\ 0 & 0.22 & 0.62 & 0.08 & 0.08 \\ 0 & 0 & 0.31 & 0.63 & 0.06 \\ 0.46 & 0.31 & 0.23 & 0 & 0 \end{bmatrix} \qquad R_3=\begin{bmatrix} 0 & 0.15 & 0.54 & 0.23 & 0.08 \\ 0 & 0 & 0.62 & 0.31 & 0.07 \\ 0 & 0 & 0.31 & 0.46 & 0.23 \end{bmatrix}$$

Step 6: The secondary fuzzy evaluation of u_i.

$$B_1= A_1 R_1= \begin{bmatrix} 0 & 0.5382 & 0.4618 & 0 & 0 \end{bmatrix}$$

$$B_2= A_2 R_2= \begin{bmatrix} 0.0552 & 0.1989 & 0.5841 & 0.1364 & 0.0254 \end{bmatrix}$$

$$B_3= A_3 R_3= \begin{bmatrix} 0 & 0.0975 & 0.4967 & 0.2925 & 0.1133 \end{bmatrix}$$

Step 7: Implement the comprehensive evaluation, we can obtain the final comprehensive evaluation results.

$$Z=A\times B= \begin{bmatrix} 0.03 & 0.44 & 0.48 & 0.04 & 0.01 \end{bmatrix}$$

$$D=F\times Z^T= \begin{bmatrix} 1 & 0.8 & 0.6 & 0.4 & 0.2 \end{bmatrix}\times\begin{bmatrix} 0.03 & 0.44 & 0.48 & 0.04 & 0.01 \end{bmatrix}^T=0.688$$

In the same way, we can derive the D of associate operation mode is 0.502, outsourcing operation mode is 0.428. By applying the fuzzy comprehensive evaluation method, we know that the enterprise is more suitable for the self-operation mode of reverse logistics.

Analysis of Results

Economic index are the main factors in the three indexes from the results of the above calculations. Enterprises consider the most important thing is the cost and benefit in choosing reverse logistics mode. If the cost is too high or benefit is too low will not help the enterprises to carry out the reverse logistics. The weight of scale and strength of the enterprise micro factors is large in sub-set. In selection mode, enterprise strength is also the focus.

Summary

Of course, it is not enough to select the reverse logistics mode according to the evaluation influencing factors, and it also need depend on the actual situation of the enterprise, including other more factors. In the actual decision-making choice, the index and evaluation process will be more diverse and complex, while the general idea is the same. To quantify the qualitative indexes, to get the results of an actual value, is conducive to enterprises decision-making. Adopting experts evaluate various factors in the fuzzy comprehensive evaluation method is full of subjectivity. It is also the further research direction.

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