The Choice of Reverse Logistics Management Mode for Garment Enterprises

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Abstract. This paper systematically evaluates three operating modes of apparel reverse logistics: self-support mode, joint operation mode and outsourcing mode. Taking a garment enterprise as an example, the evaluation index is selected according to the actual situation, and the TOPSIS method of fuzzy evaluation theory is used to quantify the evaluation index. Using the data envelopment analysis method to analyze the quantitative evaluation index, so as to get the evaluation of the clothing reverse logistics business model. The conclusion shows that outsourcing mode is the best choice for reverse logistics.

Keyword: Reverse logistics · Fuzzy evaluation theory · DEA

1 Introduction

With the development of society and economy and the continuous improvement of our overall national strength, people's living standards are also improving day by day. As an indispensable part of daily life, clothing is no longer satisfied with simple basic functions. Instead, it becomes more of a medium for people to show their individuality, and consumers have more diversified demands for clothing. With the rise of e-commerce and livestreaming, clothing orders have surged, followed by an increase in returns. How to control the cost of garment reverse logistics has become a problem that garment enterprises need to solve. Clothing reverse logistics operation mode is divided into self-operation mode, joint operation mode and outsourcing mode. In this paper, three reverse logistics management modes will be evaluated based on the existing data of garment enterprises.

2 Evaluation Index Selection

In order to improve the scientific evaluation and selection of the operation mode of clothing reverse logistics, it is the basic guarantee to establish a rational, operable and targeted evaluation index system of the operation mode of clothing reverse logistics. Based on the research results of Zuqing Huang [1] et al., Lili Xie [2] et al., Weibin Lin [3] et al. and Kejia Chen [4], considering the possible investment cost and value of recovery under different operation modes, the environmental behavior of different

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Table 1. Evaluation index system of clothing reverse logistics business mode selection

First-order index	Secondary index
Economic factor	Total investment cost
	Unit operating cost
	Risk cost
	Value Recovery
Social factor	Customer Satisfaction
	Strategic alliances
	Professional talent ratio
	Environmental protection benefit
Technical factor	Information feedback
	Recovery rate
	Inventory control
	Internet penetration
	Transport capability

operation modes, and the professional requirements of clothing reverse logistics in terms of recovery processing rate and information feedback, Construct the evaluation index system for the operation mode selection of clothing reverse logistics, as shown in Table 1.

3 The TOPSIS Method Based on Fuzzy Evaluation Theory to Obtain Relevant Index Evaluation Information

According to the evaluation indicators in Table 1, the evaluation value of each indicator is obtained. Data for the relevant quantitative indicators (total cost of investment, unit operating cost, value regained) are derived from simulations based on data from related statements of similar enterprises. For relevant qualitative indicators, TOPSIS method [5] based on fuzzy evaluation theory is adopted to quantify qualitative indicators. The specific steps are as follows:

Step 1: Establish the expert voting matrix. The evaluation information of experts on 10 qualitative evaluation indicators of three reverse logistics operation modes was obtained through questionnaires and summarized. Among them, 20 questionnaires were sent out, 15 were collected and 10 were valid, with an effective rate of 66.7%.

Step 2: Quantification of voting levels. Percentile grading method was used to quantify the voting level. There are five grades in total. If the highest grade is 100 points, the highest grade "excellent" should be 100 points, "good" should be 100–100/5 = 80 points, "average" should be 80–100/5 = 60 points, and "poor" should be 60–100/5 = 40 points. The "difference" should be 40–100/5 = 20 points.

Step 3: Determine the positive and negative ideal voting scheme. The evaluation index is divided into two categories: positive index w^+ and negative index w^-. Positive index w^+ means that the larger the value of the index, the better the index is. Negative index w^- means that the smaller the value of the indicator, the better the index is.

Step 4: Calculate Euclidean distance and balance the Euclidean distance of the positive ideal solution and the negative ideal solution of each index are calculated by the quantized voting matrix and the positive and negative ideal voting schemes through formula 1 and 2. The balance degree of voting scheme is calculated by formula 3.

$$D_i^+ = \sqrt{\sum\nolimits_{j=1}^{n}\left(w_{ij} - A_j^+\right)^2} \tag{1}$$

$$D_i^- = \sqrt{\sum\nolimits_{j=1}^{n}\left(w_{ij} - A_j^-\right)^2} \tag{2}$$

$$G_i = 1 - \frac{S_i}{\overline{x_i}} \tag{3}$$

Step 5: The approximate degree of each scheme to the ideal voting scheme is calculated by formula 4. By multiplying the equilibrium degree G_i and proximity degree C_i obtained in step 4 by formula 5, the final evaluation result is the final quantized value F_i of the index in each scheme.

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{4}$$

$$F_i = G_i * C_i \tag{5}$$

Through the above calculation, quantitative index data and qualitative index data are integrated to form a complete collection table of evaluation index Table 2 shows the integration results.

4 Using Data Envelopment Analysis Method to Evaluate Reverse Logistics Management Model

DEA (Data Envelopment Analysis), this method is a comprehensive evaluation method based on the relative efficiency theory proposed by Charness, Cooper and Rhodes in 1978. Based on the concept of relative efficiency, this method is a method to evaluate the relative effectiveness or benefit of similar units or departments (decision units) according to multiple index inputs and multiple index outputs, which can effectively solve the sequential problems. Methods Based on the relative efficiency, the mathematical programming model is used to calculate the efficiency of decision making unit.

In DEA model, the evaluated unit is called DMU, DMU_n represents the NTH evaluated unit. Suppose that the output index set of DMU_j is Y and the input index set is X. Then the DEA model is shown in Formula 6. Where, the set of input and output indicators is known quantity; The weight set of input and output indexes is unknown.

$$\max \frac{u^T Y}{v^T X} \quad \text{s.t.}\begin{cases} \frac{u^T Y}{v^T X} \le 1 \\ u \ge 0, v \ge 0 \end{cases} \tag{6}$$

Table 2. Summary of evaluation index data of clothing reverse logistics business model

Evaluation index	Self-operating model	Pool model	Outsourcing model
Risk cost	0.29	0.51	0.61
Customer Satisfaction	0.44	0.43	0.51
Strategic alliances	0.33	0.51	0.49
Professional talent ratio	0.37	0.49	0.56
Environmental protection benefit	0.54	0.58	0.44
Information feedback	0.55	0.55	0.46
Recovery rate	0.42	0.54	0.49
Inventory control	0.33	0.41	0.52
Internet penetration	0.37	0.51	0.55
Transport capability	0.45	0.51	0.65

Table 3. Efficiency of reverse logistics operation mode

Business model	Combined efficiency	technical efficiency	Scale efficiency
Self-operating model	0.667	1.000	0.667
Pool model	0.879	1.000	0.879
Outsourcing model	1.000	1.000	1.000

Since formula 6 cannot be solved directly, CCR model or BCC model is usually used to convert it into a linear programming problem, among which CCR model is the most widely used. CCR model is also known as Charnes-Cooper [6] transform. The specific method is as follows: Let $t = 1/(v^T X)$, $w = tv$, $\mu = tu$ convert formula 6 to formula 7

$$\max \mu^T Y \quad \text{s.t.} \begin{cases} w^T X - \mu^T Y \geq 0 \\ w^T X = 1 \\ w \geq 0,\ \mu \geq 0 \end{cases} \tag{7}$$

The efficiency value $\mu^T Y$ of each evaluated unit can be obtained by using formula 7, and sorted and selected according to the efficiency value. The calculation results of the three reverse logistics operation modes are shown in Table 3:

5 Conclusions

5.1 DEA Effectiveness Analysis

As shown in Table 3, when a garment enterprise chooses the third-party outsourcing mode, its comprehensive efficiency, technical efficiency and scale efficiency are all 1. The technical efficiency is 1, while the comprehensive efficiency and scale efficiency are both less than 1. This suggests that DMUs with only a third-party outsourcing model are effective. In the third party outsourcing reverse logistics business model, the input and output level of clothing enterprises is optimized, and the level of technology investment and scale is reasonable.

5.2 Efficiency Analysis

The comprehensive efficiency value is the optimal output that can be achieved by the actual input in the operation process of the enterprise when the DEA model is used for analysis and calculation. When the comprehensive efficiency value is 1, it represents the optimal output under the current technical conditions and resource supply of the company. When the comprehensive efficiency value is less than 1, it means that the company has not achieved the optimal output under the input of technical conditions and resources, resulting in insufficient output. The smaller the comprehensive efficiency value, the worse the utilization effect of invalid DMU on the input resources. As shown in Table 3, DMU is effective only when a garment enterprise chooses the third-party outsourcing mode, while DMU is ineffective when it chooses the self-operated mode or the joint operation mode. Moreover, when it chooses the self-operated mode, the performance level of the enterprise is the worst.

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