Research on the Performance Evaluation of Cold Chain Logistics Enterprises of Fresh Products E-commerce

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Abstract: In the era of the upgrading of domestic consumption level, fresh products e-commerce has become a rising star. However, it's limited in its characteristics, which make it difficult to develop. Therefore, this paper mainly conducts a research on its performance, firstly constructing the performance evaluation index system of the cold chain logistics enterprise, secondly carrying on the empirical research to the enterprise by means of Analytic Hierarchy Process and Fuzzy Comprehensive Evaluation, and finally putting forward some optimized suggestions regarding the existing problems.

1. Introduction

With the development of the economy and the improvement of people's living standard, people are increasingly pursuing high-quality products. Driven by this demand, many e-commerce enterprises and traditional enterprises have been involved in the field of fresh products e-commerce, and the fresh products e-commerce is coming to a flourishing era. However, according to a report from the China Electronic Commerce Center, only 1% of fresh products e-commerce vendors achieved profitability in the country, 4% were flat, 88% were lost, and the remaining 7% were huge losses [1]. The main reason is the restriction of cold chain logistics. Therefore, the research on the performance of cold chain logistics enterprises of fresh products e-commerce has important practical significance to promote the healthy and rapid development of fresh products e-commerce.

2. Construction of performance evaluation indication system of cold chain logistics enterprises of fresh products e-commerce

2.1 Construction of indication system

Under the background of e-commerce, the cold chain logistics of fresh products is a special logistics form, which requires products to be in a corresponding low temperature environment from beginning to the end [2]. Therefore, based on the characteristics of fresh products e-commerce, cold chain logistics of fresh products and the literature on performance evaluation, this paper established the performance evaluation indication system of cold chain logistics enterprises of fresh products e-commerce, as shown in Table 1.

2.2 Selection of performance evaluation methods

There are many uncertainties and ambiguities in the performance evaluation of cold chain logistics enterprises of fresh products e-commerce, and characteristics of the subjective factors are obvious [3]. Therefore, based on the indicators weight that were given by the expert questionnaire method and the AHP, this paper decided to adopt the fuzzy comprehensive evaluation to evaluate the overall performance of cold chain logistics enterprises of fresh products e-commerce.

2.2.1 Analytic Hierarchy Process.

Analytic Hierarchy Process (AHP) was proposed by T. L. Satty et al., a famous American

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operational researcher in the 1970s. This is a multi-criteria decision making method that combines qualitative and quantitative analysis [4]. The method aims at the stratification of complex issues, and mathematization of thinking process with certain scale, and finally provides a simple decision method which will deal with complex problems [5].

AHP can be roughly divided into six steps: clearing questions; establishing an analytic hierarchy structure; constructing judgment matrix; ranking singly of layer and checking consistency; ranking totally of layers; making appropriate decisions.

Table 1. The performance evaluation indication system of cold chain logistics enterprises of fresh products e-commerce

Target layer	First-grade indicator	Second-grade indicator
The performance evaluation indication system of cold chain logistics enterprises of fresh products e-commerce A	Financial level B_1	Return On Total Assets C_{11}
		Increase rate of main business revenue C_{12}
		Current ratio C_{13}
	Cold supply chain level B_2	Refrigerated trucks utilization C_{21}
		Refrigerating cabinets utilization C_{22}
		Refrigerating cabinets turnover rate C_{23}
		Cold chain storage and transportation loss rate C_{24}
		Tightness of process linkage C_{25}
		Product quality safety C_{26}
	Customer service level B_3	Customer complaint rate C_{31}
		Cold chain distribution punctuality rate C_{32}
		Logistics service integration C_{33}
		Product freshness C_{34}
	Business development level B_4	Employee training rate C_{41}
		Information coverage rate C_{42}
		Cold chain facility equipment investment rate C_{43}

2.2.2 Fuzzy Comprehensive Evaluation.

As a specific method of fuzzy mathematics, Fuzzy Comprehensive Evaluation was proposed by Chinese scholar Wang Peizhuang. Based on fuzzy mathematics, Fuzzy Comprehensive Evaluation is a method that quantifies some unclear and not easily quantified factors by using the principle of synthetic fuzzy relation, and it comprehensively evaluates membership degree of evaluated objects from multiple factors. Its characteristic is that the evaluated object is not affected by its collection and has its own unique evaluation value. The purpose of comprehensive evaluation is to sort the evaluation results of all objects and select the winner from them [6].

Fuzzy Comprehensive Evaluation can be roughly divided into three steps: determining evaluation factors and ratings; constructing the judgment matrix and determining the weight; making fuzzy synthesis and decisions [7]. There will be a detailed explanation in the empirical section.

3. Empirical Research

As one of the representative enterprises in fresh cold chain logistics enterprises of fresh products e-commerce, T enterprise is committed to provide customers with high-quality fresh products and personalized fresh services. T enterprise selects fresh food from the global, and builds refrigerating cabinets and cold chain logistics meanwhile building a direct supply platform from production area to consumers. Nowadays, T enterprise has grown into a large cold-chain logistics enterprise which can deliver 100,000 pure cold chain services every day.

Table 2. T enterprise's fuzzy comprehensive evaluation collection of comments

Target layer	First-grade indicator	Second-grade indicator	Evaluation Set				
			Excellent	Good	Medium	Poor	Very Poor
The performance evaluation indication system of cold chain logistics enterprises of fresh products e-commerce A	Financial level B_1 (0.360)	Return on total assets C_{11} (0.296)	0.000	0.163	0.488	0.233	0.116
		Increase rate of main business revenue C_{12} (0.539)	0.047	0.372	0.302	0.279	0.000
		Current ratio C_{13} (0.163)	0.000	0.186	0.256	0.512	0.047
	Cold supply chain level B_2 (0.274)	Refrigerated trucks utilization C_{12} (0.057)	0.023	0.465	0.488	0.023	0.000
		Refrigerating cabinets utilization C_{22} (0.057)	0.070	0.349	0.419	0.163	0.000
		Refrigerating cabinets turnover rate C_{23} (0.218)	0.000	0.233	0.581	0.186	0.000
		Cold chain storage and transportation loss rate C_{24} (0.218)	0.000	0.023	0.233	0.674	0.070
		Tightness of process linkage C_{25} (0.314)	0.023	0.093	0.442	0.395	0.047
		Product quality safety C_{26} (0.137)	0.047	0.791	0.163	0.000	0.000
	Customer service level B_3 (0.112)	Customer complaint rate C_{31} (0.119)	0.000	0.093	0.140	0.698	0.070
		Cold chain distribution punctuality rate C_{32} (0.348)	0.116	0.581	0.256	0.047	0.000
		Logistics service integration C_{33} (0.157)	0.163	0.256	0.349	0.209	0.023
		Product freshness C_{34} (0.374)	0.674	0.186	0.140	0.000	0.000
	Business development level B_4 (0.254)	Employee training rate C_{41} (0.163)	0.070	0.814	0.093	0.023	0.000
		Information coverage rate C_{42} (0.296)	0.465	0.535	0.000	0.000	0.000
		Cold chain facility equipment investment rate C_{43} (0.539)	0.047	0.442	0.395	0.116	0.000

3.1 Determination of performance evaluation indicator weight

To ensure the validity of the data, this paper made a questionnaire survey on the experts in the field of cold chain logistics and the managers of the related cold chain logistics enterprises. In this survey, a total of 45 valid questionnaires were recovered. According to the results of the questionnaire survey and AHP, the calculated results are as follows:

The weight vector of the judgment matrix of the first grade indicator:

$W = \{0.360,0.274,0.112,0.254\}$

The weight vector of the judgment matrix of the second grade indicator:

$W_1 = \{0.296,0.539,0.163\}$

$W_2 = \{0.057,0.057,0.218,0.218,0.314,0.137\}$

$W_3 = \{0.119,0.348,0.157,0.374\}$

$W_4 = \{0.163,0.296,0.539\}$

3.2 Comprehensive performance evaluation and analysis of results

We made second questionnaire survey, which issued a paper questionnaire to 50 professionals from T enterprise and let them score the evaluation indicators. After that we counted all the evaluation results to obtain the corresponding membership degree.

Calculation method of membership degree r_{ij}: it is assumed that the frequency of the indicator u_i is N at evaluation level, that is, $r_{ij} = N/50$, then we use EXCEL to calculate the frequency of each grade, as shown in Table 2.

3.2.1 Performance evaluation of second grade indicator.

The fuzzy judgment matrix of indicator can be obtained from the above Table. So the single factor evaluation of financial level B_1 in the first grade indicator is:

$$B_1 = W_1 \cdot R_1 = [0.296 \quad 0.539 \quad 0.163] \cdot \begin{bmatrix} 0.000 & 0.163 & 0.488 & 0.233 & 0.116 \\ 0.047 & 0.372 & 0.302 & 0.279 & 0.000 \\ 0.000 & 0.186 & 0.256 & 0.512 & 0.047 \end{bmatrix}$$

That is, $B_1 = [0.0253 \quad 0.2790 \quad 0.3489 \quad 0.3028 \quad 0.0419]$

In the same way, the single factor evaluation of cold supply chain level B_2 in the first grade indicator is:

$$B_2 = W_2 \cdot R_2 = [0.0189 \quad 0.2397 \quad 0.3902 \quad 0.3221 \quad 0.0300]$$

The single factor evaluation of customer service level B_3 in the first grade indicator is:

$$B_3 = W_3 \cdot R_3 = [0.3180 \quad 0.3230 \quad 0.2129 \quad 0.1322 \quad 0.0119]$$

The single factor evaluation of business development level B_4 in the first grade indicator is:

$$B_4 = W_4 \cdot R_4 = [0.1743 \quad 0.5292 \quad 0.2280 \quad 0.0662 \quad 0.0001]$$

3.2.2 Performance evaluation of first grade indicator.

By summarizing the results of single factor evaluation, the results of fuzzy comprehensive evaluation of the first grade indicator were shown in the following Table 3:

Table 3. Fuzzy comprehensive evaluation of first grade indicator

First grade indicator	Evaluation Set				
	Excellent	Good	Medium	Poor	Very Poor
Financial level B_1	0.0253	0.279	0.3489	0.3028	0.0419
Cold supply chain level B_2	0.0189	0.2397	0.3902	0.3221	0.0300
Customer service level B_3	0.3180	0.3230	0.2129	0.1322	0.0119
Business development level B_4	0.1743	0.5292	0.2280	0.0662	0.0001

From the Table above, the fuzzy judgment matrix R of first grade indicator can be obtained, we could get the comprehensive evaluation result of T enterprise by multiplying the weight W of first grade indicator and R.

$$A = W \cdot R = \begin{bmatrix} 0.0942 & 0.3367 & 0.3143 & 0.2289 & 0.0246 \end{bmatrix}$$

4. Analysis of results

According to the principle of maximum membership degree, we conclude that the overall performance level of T enterprise is at “good”, but there is still much improvement space in achieving “excellent”. Then by analyzing the main aspects, we can conclude that the performance level of financial of T enterprise is at “medium”, mainly due to the large amount of capital invested in the cold chain logistics construction and the long payback period; although the cold supply chain ability is an important aspect of cold chain logistics enterprises of fresh products e-commerce, its performance level is at “medium”, which severely restricts the development of enterprises; the performance level of customer service is at “good”, this reflects that the enterprise attach importance to customer service, but because of some irresistible factors, it will still cause consumers' dissatisfaction and reduce customer consumption stickiness; the performance level of business development is at “good”, which indicates that although there are many problems at present, there is still great potential for development.

5. Suggestions for improvement

On the one hand, evaluating the performance of cold chain logistics enterprises of fresh products e-commerce can provide important and useful basis for the economic decision which was made by enterprise management authorities and related evaluation entities; on the other hand, it can serve the management goals which to comprehensively enhance the overall performance level of cold chain logistics enterprises of fresh products [8]. Therefore, this paper puts forward several targeted suggestions for the problems and shortcomings what fresh products e-commerce enterprises encountered in their actual operations.

(1) Improving enterprise's operating innovation ability. Enterprises should use their own facilities to provide socialized cold-chain logistics services. In addition, they can try their best to carry out innovations in business model, such as common delivery of cold-chain logistics, “fresh e-commerce + cold chain delivery”, “central kitchen + cold chain distribution of raw materials” and so on. What’s more, they should make full use of the advantages of integrating resources on own network platform to cooperate with small enterprises and agricultural cooperatives, so as to create conditions for the further development of small-scale markets.

(2) To perfect cold chain logistics system of fresh products. Enterprises should strengthen cooperation with other domestic fresh e-commerce enterprises and build a system of cold-chain logistics of fresh products. In this way, enterprise will not only improve the utilization of refrigerating cabinets and refrigerated trucks, but also save amounts of costs of transportation and cold-chain construction. In addition, they can supplement cold chain logistics system with the help of the third party cold chain logistics.

(3) To accelerate the cultivation of talents who adapt to the intelligent development of cold chain logistics of fresh products e-commerce. Enterprises can increase the intensity of the introduction and cultivation of professional talents in cold-chain logistics, by establishing a talent introduction mechanism and formulating incentive policies, and encouraging internal promotion of enterprises to introduce or cultivate the cold-chain logistics intelligent specialized talents who urgently needed by the market. It is also possible for enterprises to establish school-enterprise cooperation. In this way, enterprise will hire outstanding graduates who are good at cold chain logistics theory, refrigeration technology, temperature control technology and so on, so as to meet the cold chain logistics enterprises' demand for intelligent professional talents of cold chain logistics.

(4) Using large data to achieve accurate marketing. Enterprises should be apt at using cloud computing to analyze the big data information of what customers purchase, search and browse in the near future. Through the analysis of large data, the customers’ preference and demand can be mastered, then the enterprise can gradually recommend personalized and intelligent products and

categories for customers, and achieve accurate marketing finally.

6. Conclusion

This paper carried on the performance evaluation research on the cold chain logistics enterprise of fresh products e-commerce. After research we found that its research results and suggestions have important reference value to our country cold chain logistics enterprise of fresh products e-commerce. However, when the performance evaluation indicator system is specifically applied, we should combine characteristics of evaluated objects to further perfect the construction of the indication system, and put forward a more appropriate comprehensive evaluation method, in order to propose the targeted development countermeasures for enterprises.

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