The Application of Fuzzy Comprehensive Evaluation Method in The Evaluation of Customer Satisfaction in Logistics Enterprises

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Abstract: In recent years, with the development of social economy and the continuous improvement of living standards, competition in the logistics industry continues to increase. Logistics enterprises has recognized that it is more and more important to attract customers, retain customers, and then began to seek a variety of methods to evaluate customer satisfaction. Customer satisfaction is a multi-dimension concept which is influenced by many factors, and it needs to make an objective and comprehensive evaluation of customer satisfaction degree from many aspects. Therefore, chooses the fuzzy comprehensive evaluation method to study, by analyzing the factors influencing the treasure for the customer satisfaction of logistics, build customer satisfaction evaluation index system. Combined with the analytic hierarchy process (AHP) to establish judgment matrix, and get treasure for logistics customer service in the relative importance of each index, and calculate the customer satisfaction based on fuzzy membership degree matrix. For management decision-making and the further development of the enterprise, the rectification provides theoretical basis for further improving customer loyalty and improving corporate profits.

Keywords: Logistics service level; Customer satisfaction; The fuzzy comprehensive evaluation method

1. Introduction

Customer satisfaction is always one of the focuses of the logistics market competition. Especially in recent years, the gradually fierce competition in logistics market and Increasing customer demand for logistics makes customer satisfaction research particularly important. Customer satisfaction is the quantum statistical index of customer satisfaction. It describes the difference between customer's expectations of the product and actual experience value, and it is a series of comprehensive evaluation of satisfaction with specific experience [1]. It needs to improve the customer satisfaction constantly. Research shows that when the enterprise's service level is at the general level, customer reflects little. Once their service is increased or decreased to a certain extent, customer's praise or complaint will increase exponentially [2]. Therefore, how to evaluate and improve customer satisfaction has become the key issues to be addressed. Even though logistics customer satisfaction has been studied in theory and practice both at home and abroad in recent years, related research mostly focuses on key elements of logistics service quality [3]. So far, the research results on evaluation of third party logistics enterprise's customer satisfaction are not extensive. Study on third party logistics enterprise's customer satisfaction not only can

provide the impetus for sustainable development of enterprises, save costs; bring repeated consumption, advertising effectiveness, good reputation, maximum benefit, but also is imminent.

Integrating the related research at home and abroad we found that models and methods of customer satisfaction assessment has been studied a lot both at theoretical circle and business community. For example, Pan Lei [4] calculated to quantify customer satisfactionfor 5 companies and obtained evaluation results by using optimization methods. Zheng Bing [5] studied the third party logistics customers' satisfaction from the perspective of customer. He used a method named "direct measurement of expectation " to measure the quality of logistic service for the first time, and verified the antecedents of error processing quality and other reasons relative to seven logistics customer satisfaction, then found their influence weights for logistics customers. Feng Yan fang [6]constructed the satisfaction evaluation index system of logistics service through the analysis of factors affecting customer satisfaction. Tian Xue [7]studied the measures that improve customer satisfaction using hierarchy analysis process. Anna [8] analyzed logistics customer satisfaction based on grey system, and evaluated customer satisfaction and suggested improvements using grey correlation analysis method. Shi Wenli and Gao Tianbao

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[9]introduced the basic concepts of rough set theory, and tried to apply the rough set theory into customer satisfaction in order to identify several decision rules adapted to customer satisfaction. Li Hongliang[10]established the TPL customer satisfaction evaluation index system, evaluated the third-party logistics customer satisfaction using Integrated grey correlation and TOPSIS method, As a result, the results is more credible. Deng Yiwu [11]used AHP method and PCE to assess customer satisfaction. Xie Hongyan [12] built a mathematical model to study on the third party logistics enterprise's customer satisfaction byusing the set pair analysis theory and combining with the features of the third party logistics enterprise customer service. Zhao Yueping [13]used BP neural network model to enterprise customer satisfaction evaluation based on BP neural network model of training and generalization tests, and proved the effectiveness of BP Neural network model of customer satisfaction evaluation. Zhang Yanliang and Hu Linlin [14], built customer satisfaction neural networks ensemble model of third party logistics using neural network ensemble method, and tested the model with China resources logistics company customer satisfaction data. Xing Jie[15]studied the service level of Logistics Enterprises from the point of CMR. Based on this, it is of great importance to evaluate rich information to treasure for the customer satisfaction of logistics using fuzzy comprehensive evaluation method and analytic hierarchy process and expressed as a vector result.

This paper uses fuzzy comprehensive evaluation method and AHP analysis method to research the logistics third party logistics customer satisfaction. Firstly, we analyzed factors that affected Baogong logistics customer satisfaction, then setting up the evaluation factors set and construct the customer satisfaction evaluation index system. Then we use analytic hierarchy analysis method to determine the weight of primary and secondary indexes. After group discussion, evaluation set is established and the fuzzy membership matrix is evaluated. It has certain directive significance for the results for further improved planning and improve user satisfaction.

2. Establishment of Index System

2.1. Analysis of factors influencing customer satisfaction in logistics enterprises

To evaluate so many logistics companies, customer satisfaction is an important aspect. Logistics is a service, and the vast majority of logistics is the service provider, who is always willing to provide the highest value service providers purchase services. If an enterprise wants to increase market share, it is necessary to continuously improve customer satisfaction. According to the service of the third party logistics enterprise's own characteristics, there are several main factors affecting customer satisfaction.

(1) Logistics service quality. When a customer selects a logistics company, he or she firstly care the logistics service quality, specific including: fast reaction capacity; on time served capacity; goods security situation; and orders of track and feedback capacity. For customers, these aspects are particularly important.

(2) The reliability of logistics services. The third party logistics enterprise's logistics equipment advanced, professional staff quality and professional information system, is the embodiment of its logistics service and reliability. Customers in the choice of logistics enterprises to bear its logistics activities, will also have to consider its reliability. They are also more willing to choose advanced equipment, professional quality, professional information system of logistics enterprises, because they can provide professional and reliable logistics services.

(3) Ability to handle complaints. Improve customer satisfaction, is the core of customer relationship management. To resolve customer complaints through an effective management method is an effective mean of improving customer satisfaction.

(4) Service attitude. Service attitude is the foundation which reflects the quality of service. Good service can make guests have a sense of intimacy, a sense of passion, simple and sincere feeling. For service industries, service attitude was undoubtedly an important factor affecting customer satisfaction. Service attitude mainly includes the delivery of the third party logistics enterprise's attitude and service attitude.

2.2. Establishment of assessment factors set

Fuzzy comprehensive evaluation method is based on fuzzy mathematics. This comprehensive evaluation method based on fuzzy degree of attachment theory turned qualitative evaluation into quantitative evaluation, which can make an overall evaluation for a fuzzy math things or objects. It has the result clear, strong features of the system, and can be used to solve the non-deterministic problem of ambiguous and difficult to quantify.

General steps are: (1) Construction of fuzzy comprehensive evaluation. Fuzzy comprehensive evaluation index system is the base of the comprehensive evaluation. Selection of evaluation index of appropriateness will directly affect the accuracy of evaluation. (2) Building a weight vector through expert experience or AHP hierarchy analysis method of weight vector. (3) Building assessment matrix to establish the appropriate membership functions to build good evaluation matrix. (4) Synthesis of evaluation matrix and weight, using synthetic factor on the synthesis and to interpret the result vector.

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Fuzzy comprehensive evaluation of third-party logistics enterprises evaluate the customer satisfaction, according to the analysis of its influencing factors, first determine the evaluation factors set: U ={ Service quality, service reliability and ability to handle complaints, service attitude }, Establishing an evaluation assessment: V ={ Very satisfied, satisfied, satisfied, dissatisfied, very dissatisfied }, And its comprehensive evaluation target system as table1 shows.

3. Determine the Weight

The analytic hierarchy process (Analytic Hierarchy Process , Referred to AHP) Are elements that would be relevant to decision-making is always divided into objectives, guidelines and program levels, based on the qualitative and Quantitative analysis of Approach to decision making. Application of AHP method, there are three steps:

1. According to solve the problems relating to these factors, and to construct the model.

2. From the top down, starting from second on the same level in the 22 comparison of various factors, the judgment matrix is constructed, this upper tier than the corresponding factor is calculated the relative weight.

3. Calculating eigenvectors of matrix and consistency checking. According to the theory of matrix by solving the equation $AW = \lambda_{max}$, λ_{max} . For the largest eigenvalue of judgment matrix ,eigenvector W can be obtained. The maximum eigenvalue of judgment matrix $\lambda_{max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i}$ Indicators for measuring deviation from consistency of judgment matrix $CI = \frac{\lambda_{max} - n}{n - 1}$, n is the order of judgment matrix. When a conforming rate $CR = \frac{CI}{RI} < 0.1$ it shows that this meet compliance requirements, otherwise we will be the realignment of the judgment matrix. RI is stochastic indicator.

4. Calculate the bottom corresponds to the highest levels of synthetic weights, to serve as a basis for decision-making.

From the above analysis, the evaluation of customer satisfaction index is divided into two levels, figure evaluation index system as 2-1 shows.

Because of the customer satisfaction evaluation index structure is more complex, decision criteria and more difficult to quantify, the use of hierarchy analysis process to determine weight. The basic principle is: for this level of evaluation, using two phase comparison method, determine a matrix and judgment of the eigenvectors corresponding to the largest eigenvalue of the matrix component as an indicator of the relative weights, then the

basic matrix operations, each evaluation index weight value.

After calculation, the guidelines layer and target layer weights are summarized in Table1.

Table 1. Weight table

Criterion weights	Index weight
Quality of service 0.9486	Rapid response 0.4331
	Even if served 0.8821
	Safety of goods 0.1670
	Order tracking and feedback 0.0802
Service reliability 0.2759	Advanced Logistics equipment 0.9055
	Professional accomplishments 0.4096
	Professional information systems 0.1112
Ability to handle complaints 0.1097	Complaint response time 0.8180
	Resolution of complaints 0.5551
	Resolution satisfaction 0.1507
Service attitude 0.1097	Delivery approach 0.7500
	After sale customer service attitude 0.2500

4. Build Comment Set

Starting from factors, reference to the relevant citation information, according to the judge, make comments looks like this:{Very satisfied, satisfied, satisfied, dissatisfied, very dissatisfied}

5. The Fuzzy Membership Matrix

5.1. Determines the set of evaluation index weight

The above results, the evaluation criterion weight determined

$$A = [0.6570, 0.1911, 0.0760, 0.0760]^T$$
$$A_1 = [0.2772, 0.5646, 0.1069, 0.0513]^T$$
$$A_2 = [0.6349, 0.2872, 0.0780]^T$$
$$A_3 = [0.5368, 0.3643, 0.0989]^T$$
$$A_4 = [0.7500, 0.2500]^T$$

5.2. Implementation of expert evaluation and an evaluation matrix

Customer service quality, service reliability and ability to handle complaints, service evaluation, determine the membership matrix. Is the process of determining the membership function of the objective, but there is still not a completely objective standard. In many cases, is often a preliminary rough membership function, and then through the "learning" and time tested and gradually modified and improved, while the actual effect is the basis of membership function inspection and adjustment. Fuzzy statistical method used is a main method to determine the membership function.

The membership matrix is as follows

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$$R_1 = \begin{bmatrix} 0.3 & 0.5 & 0.2 & 0 & 0 \\ 0.4 & 0.4 & 0.2 & 0 & 0 \\ 0 & 0.2 & 0.4 & 0.3 & 0.1 \\ 0.5 & 0.5 & 0 & 0 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0 & 0.5 & 0.1 & 0.4 & 0 \\ 0.3 & 0.2 & 0.4 & 0 & 0.1 \\ 0.1 & 0.4 & 0.5 & 0 & 0 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.4 & 0.4 & 0.1 & 0.1 & 0 \\ 0.8 & 0.1 & 0 & 0.1 & 0 \\ 0 & 0.5 & 0 & 0.5 & 0 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 0.2 & 0.2 & 0.2 & 0.2 & 0.2 \\ 0 & 0.5 & 0.5 & 0 & 0 \end{bmatrix}$$

6. A Comprehensive Evaluation

Will be evaluated on a set of factors of a fuzzy set A After blur transform to comment on the set of a fuzzy set B . Fuzzy synthetic evaluation model, matrix multiplication represents a complex relationship.

$B_1 = A_1 \Box R_1 = [0.33465 \quad 0.41147 \quad 0.21112 \quad 0.03207 \quad 0.01069]$

$B_2 = A_2 \Box R_2 = [0.309396 \quad 0.40409 \quad 0.21737 \quad 0.25396 \quad 0.02872]$

$B_3 = A_3 \Box R_3 = [0.50616 \quad 0.3006 \quad 0.05368 \quad 0.13956 \quad 0]$

$B_4 = A_4 \Box R_4 = [0.15 \quad 0.275 \quad 0.275 \quad 0.15 \quad 0.15]$

For normalization, the final comprehensive evaluation of customer satisfaction:

$B = A \Box R = [0.6570 \quad 0.1911 \quad 0.0760 \, 0.0760]^T$

$= [0.287689 \quad 0.391685 \quad 0.205225 \quad 0.091608 \quad 0.023912]$

7. Conclusion

There are two fundamental principles in fuzzy comprehensive evaluation. One is the principle of maximum membership degree. That is, to take maximum value of the corresponding elements between V and b_j as the evaluation results. That is to say, in the evaluation of Baogong logistics customers' satisfaction, 39.17% of most customers think Baogong logistics the quality of service, service reliability and ability to handle complaints and service attitude fit their satisfaction. The other principle is the fuzzy distribution principle, which is directly used b_j as the evaluation result, and each evaluation index reflects the distribution state of the evaluation object in the characteristic aspect. From calculation of the above results, we can see that customers satisfied with the membership degree is 0.2876. It can be further illustrated that 28.76% grasp of Baogong logistics service satisfying customers. Similarly logistics services to customer satisfaction, there are 39.17% sure that. And 20.52% certainty that

Baogong logistics customer satisfaction is a basic satisfaction, grasp of 9.16% think Baogong logistics customer satisfaction degree is not satisfied, 2.39% certainty that Baogong logistics customer satisfaction is very dissatisfied.

Through the above analysis, Baogong logistics do well in customer satisfaction, because it makes the vast majority of people satisfied, even very satisfied. But there are still one tenth of the people do not satisfy with it. Logistics enterprise is a service enterprise. Customer satisfaction is the power source of enterprise development. Therefore, we suggest that the company make efforts to find out the cause of dissatisfaction of customers, and actively correct it.

In short, fuzzy comprehensive evaluation applied to the third party logistics enterprise's customer satisfaction can help TPL enterprise make a comprehensive and nature interpretation and judgment on customer satisfaction,and then increase the accuracy of assessment.

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