Using DEMATEL and AHP to Evaluate the Influencing Factors of Express Logistics Service Quality

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ABSTRACT
Express logistics is an important branch of logistics industry. In recent years, with the development of e-commerce and information technology, express logistics has developed rapidly. On the basis of literature review and literature review, this paper summarizes 17 factors that may affect the development of express logistics, which are divided into three parts: collection, delivery and information service. A DEMATEL questionnaire is designed and distributed to users to optimize the influencing factors. The influencing factors were divided into three categories: cost, time limitation and service, and then the analytic hierarchy process was adopted to determine the weight of the influencing factors. Based on the weight value, relevant suggestions were put forward for the development of express logistics.

Keywords: *Express logistics; The DEMATEL model; Analytic hierarchy process*

1. INTRODUCTION

1.1. Research Background and Significance

In recent years, China's express logistics industry has made great breakthroughs in the context of the rapid development of e-commerce and information technology. Coupled with strong national support policies, the express industry has entered a new era of development. The era of low-price competition has passed, and now express logistics enterprises focus on developing new target markets, but there are still problems such as delivery quality cannot be guaranteed, poor service of staff, and broken packages, which seriously restrict the development of express logistics industry. In order to solve the above problems and promote the rapid development of express logistics industry, it is necessary to have an objective understanding of the influencing factors of express logistics service quality and find out the key factors for analysis.

At present, different scholars have studied express logistics from different perspectives. Some scholars have evaluated the efficiency of a city's express logistics network by analyzing influencing factors such as the level of economic development, marketization degree, express logistics resource utilization rate, express logistics professionals and location advantages [7]. From the perspective of enterprise competitiveness, market share, network popularity, price level, service level, security level and network level have a great impact on express logistics service quality [5]. Modern express logistics enterprises have changed the traditional operation mode, and now focus on the overall optimization of the system, and provide personalized services and solutions on demand with customers as the core [3].

1.2. Research Methods

The research method of this paper is the combination of qualitative method and quantitative method. According to the process of express logistics, the influencing factors are divided into the link of collection, delivery and information service. Before the evaluation index system is analyzed by AHP, the DEMATEL method is firstly adopted to conduct correlation analysis on the listed influencing factors from the perspective of users, and the influential factors with higher centrality are selected to establish a scientific and reasonable evaluation index system, and carry out the next research on this basis.

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2. ESTABLISHMENT OF RESEARCH MODEL

2.1 Establishment of Evaluation Index System

There are many factors affecting express logistics service quality. However, there is no unified standard for express logistics service quality at present. As analyzed above in this paper, different scholars can construct different evaluation index systems from different perspectives. In the research of this paper, the evaluation index system is divided according to the express logistics process, which is divided into collection link, delivery link and information service link:

- collection link (Order form, door-to-door time limit, packaging quality, range receiver service, range receiver dress, express costs)
- delivery link (delivery quality, delivery speed, delivery scope, courier clothing, courier service, advanced distribution equipment, complaint handling service, loss compensation service)
- information service link (accurate degree of logistics information, logistics information update speed, personal information security protection)

2.2 Evaluation Methods

2.2.1 DEMATEL

DEMATEL method is a method to analyze system factors by using graph theory and matrix, which can calculate the degree of influence of each factor on other factors and the degree of influence by other factors, and then obtain the degrees of central role and the degrees of cause role, so as to further optimize the index system [2].

Step 1: Set up Direct-Relation matrix

Express logistics is essentially a service industry, so the collection of user data is very important for this study. A total of 215 questionnaires were collected online, of which 209 were valid, with an effective rate of 97.21%. Establishing the Direct-Relation matrix among the above factors. If factor I has a direct influence on factor J, row I and column J are denoted as 1; if there is no direct influence, the corresponding value is 0. Let's call this matrix X^d [4]

$$a_{ij} = \begin{cases} 0, & \text{I has no direct effect on J} \\ 1, & \text{I has a direct effect on J} \end{cases} \quad (1)$$

Step 2: Set up the generalized direct-relation matrix

The generalized direct-relation matrix can be obtained by normalizing the original relational matrix [1].

$$X = \frac{X^d}{\max\left(\sum_{j=1} a_{1j}, \sum_{j=1} a_{nj}\right)} \quad (2)$$

Step 3: Set up the total-relation matrix

The total-relation matrix is denoted as T. Calculate the positions and relations, as well as build cause and effect relationship diagram.

$$T = X(1 - X)^T \quad (3)$$

2.2.2 AHP

Analytic hierarchy process (AHP) is a decision method combining qualitative and quantitative analysis by decomposing the elements related to decision making into objective, criterion and scheme.

Step 1: Formation of a structural Hierarchy.

Step 2: Formation the judgment matrix of each level.

To obtain the maximum characteristic roots and weight vectors of each matrix [8].

$$v_i = \sqrt[n]{\prod_{j=1}^{n} a_{ij}} \quad (4)$$

To get a normalized result,

$$w_i = \frac{v_i}{\sum v_i}, \quad i = 1, \cdots, \quad n \quad (5)$$

Step 3: Consistency test is performed on the judgment matrix.

a) Deviation consistency index:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (6)$$

And,

$$\lambda_{max} = \frac{1}{n} \sum_i \frac{(Aw)_i}{w_i} \quad (7)$$

b) The average consistency index:

RI corresponds to different values under different number of factors.

c) Proportion of random consistency:

$$CR = \frac{CI}{RI} \quad (8)$$

If CR<0.1, the consistency of judgment matrix is considered to be good and the test is passed; otherwise, the importance of factors needs to be re-evaluated.

3. DATA STATISTICS AND ANALYSIS

3.1 Optimization of Evaluation Index System

Through calculation, we can conclude that the reasons factors, from large to small, are express cost, advanced distribution equipment, delivery scope, order form,

courier service, packaging quality, range receiver service, range receiver dress, courier dress.

The result factors, from large to small, are complaint handling service, loss compensation service, delivery quality, logistics information accuracy, personal information security protection, door-to-door time limit, delivery speed, logistics information update speed.

The degrees of central role from large to small is: express costs, complaint handling service, loss compensation service, delivery speed, advanced distribution equipment, courier service, logistics information update speed, packaging quality, door to door time limit, delivery quality, logistics information accuracy, range receiver service, delivery scope, order form, range receiver dress, courier dress, personal information security protection.

Table 1: Total-relation index results

Index	X1	X2	X3	X4	X5	X6	X7	X8
Sum of rows	0.4827	0.2859	0.5365	0.3774	0.1893	1.3551	0.1667	0.5503
Sum of columns	0.0000	0.4675	0.3034	0.1981	0.1125	0.4629	0.5123	0.6018
Degrees of cause role	0.4827	-0.1815	0.2330	0.1793	0.0768	0.8921	-0.3456	-0.0515
Degrees of central role	0.4827	0.7534	0.8399	0.5755	0.3018	1.8180	0.6789	1.1521

Index	X9	X10	X11	X12	X13	X14	X15	X16	X17
Sum of rows	0.5503	0.1295	0.6835	0.8980	0.0833	0.0833	0.1667	0.4654	0.0000
Sum of columns	0.0000	0.1125	0.2837	0.1125	1.4072	1.3135	0.4278	0.4970	0.1909
Degrees of cause role	0.5503	0.0170	0.3998	0.7854	-1.3238	-1.2302	-0.2612	-0.0316	-0.1909
Degrees of central role	0.5503	0.2420	0.9672	1.0105	1.4905	1.3969	0.5945	0.9624	0.1909

3.2 Index Weight Calculation

Based on the above analysis of influencing relationships among factors, the top 7 degrees of central role were selected in this study [6].That is, express cost (X6), complaint handling service (X13), loss compensation service (X14), delivery speed (X8), advanced distribu7tion equipment (X12), courier service (X11), logistics information update speed (X16) are taken as the new level three indicators, and the secondary indicators are renamed according to cost B1, timeliness B2 and service B3.The evaluation index system of express logistics service quality is re-established. The hierarchical structure model is shown in Figure 1. According to the steps introduced in evaluation method, the results are shown in Table 2. The proportion of consistency test is less than 0.1, indicating that the consistency test has been passed.

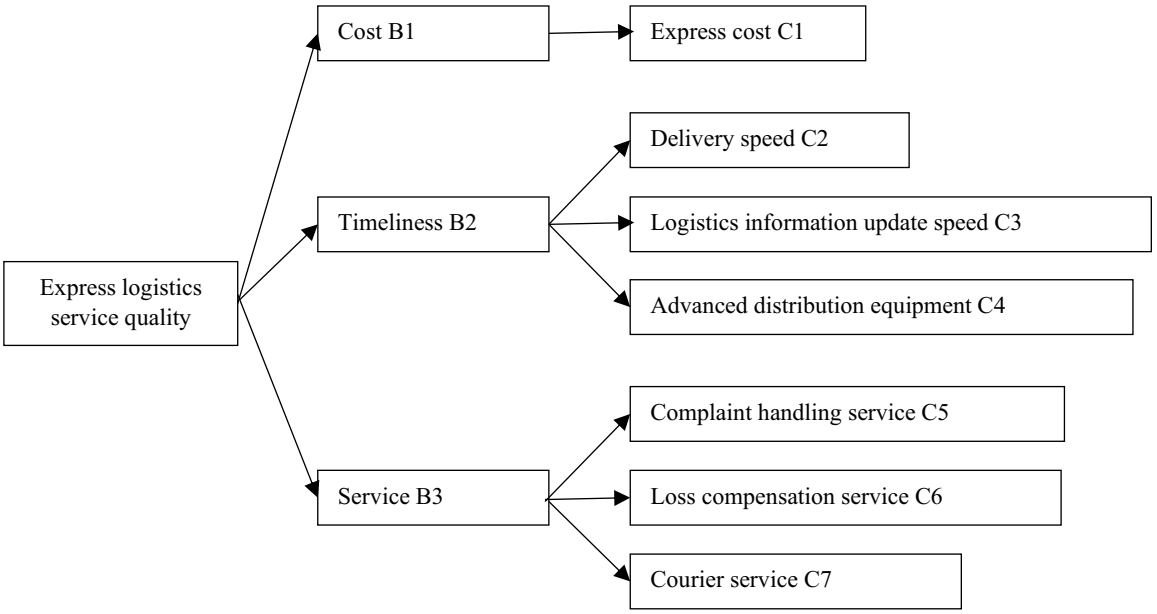

Figure1: The hierarchical structure model

Table 2: AHP calculated weight and consistency test results

First level indicator	Secondary indicators	Weights	Level three indicators	Weights	λ_{max}	CI	CR
Express logistics service quality	Cost B1	0.4286	express costs C1	0.4286	1	0	0
	Timeliness B2	0.4286	service speed C2	0.5278	3.0536	0.0268	0.0516
			logistics information update speed C3	0.3325			
			advanced distribution equipment C4	0.1396			
	Service B3	0.1429	complaint handling service C5	0.3874	3.0183	0.0091	0.0176
			loss compensation service C6	0.4434			
			courier service C7	0.1692			

According to the results, it can be seen that the weight of cost and timeliness is the same in the criterion layer, while the weight of service is relatively low. Cost and timeliness are also what users consider most in the practical application process. The meaning of logistics management itself is to provide users with satisfactory logistics services at the lowest cost, that is, to send the right goods to the right place at the right time at the right time. On the basis of traditional logistics, express logistics strengthens the concept of time and emphasizes timeliness, so the management of express logistics emphasizes to provide users with satisfactory and efficient logistics services at the lowest cost. Although the weight value of service is low, there is no denying that service is also an important factor affecting the quality of express logistics service.

It can be seen from the data that express delivery cost is the most direct factor that affects users, which is also the reason for the scale economy of express logistics. In addition, in the process of enjoying services, users are more concerned about whether their own interests are damaged.

4. RESULTS & DISCUSSION

4.1 Step-up Infrastructure Construction and Upgrade Equipment

To speed up the delivery infrastructure, improve e-commerce Posting and delivering services, through the integration of existing resources, to provide one-stop warehousing, processing, distribution management, promote enterprise production operation to a great extent saving energy and reducing consumption, reduce costs, improve the efficiency of delivery, service ability, better for the masses to provide more quality services. To promote high-quality and diversified upgrading of urban express services to improve people's livelihood, focus on building a diversified, intelligent and intensive terminal delivery service system, and promote the construction of intelligent receiving and delivery terminals and terminal public service platforms.

4.2 Strengthen Customer Relationship Management

The implementation of customer relationship management is not to use a few software can be achieved, need to work with express enterprises related resources to play a role. As a kind of service industry, express delivery and logistics industry should pay more attention to establishing a good relationship with customers. We should set up corresponding posts and propose corresponding responsibilities according to express business process. In addition to adjusting the organizational structure, we should also promote the participation of all staff and deal with the links of dealing with "people" well, such as complaint handling, compensation handling, information consulting and other businesses.

4.3 Strengthen Information Construction

Information of all links and departments should be open and transparent to realize information sharing, real-time tracking, effective control and management of all links of express services, and form an integrated express logistics platform. Users pay more and more attention to the security of their personal information, and a strong and perfect logistics information network can greatly avoid the leakage of customer information. In addition to helping information transfer between departments more effectively, information construction can also realize automatic sorting of express. This can not only greatly reduce the cost of error, improve work efficiency, but also avoid artificial violence sorting behavior, but also to ensure the quality of goods.

5. CONCLUSIONS

Many factors affecting the quality of express logistics service, using DEMATEL method for correlation analysis, the influencing factors on the quality of the express logistics service factors, the influence of the relationship between multiple factors to identify the main factors influencing the express logistics service quality, to help build a more scientific evaluation index system, finally concludes the cost, time and serve the three main factors. This method can simplify the system, reduce the time of index data collection, improve work efficiency and make the whole model more objective. It also lays the foundation for the next application of analytic hierarchy process.

However, the factors listed in this paper are limited, so the evaluation index system of express logistics service quality needs to be further improved. In addition, in the further study, subjective evaluation and objective evaluation methods can be combined to make the index weight more scientific.

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