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Evaluation model of cross-border e-commerce Fourth Party logistics capability based on improved FAHP

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Abstract: *In order to improve the accuracy of cross-border e-commerce fourth party logistics capability evaluation, an evaluation method based on improved analytic hierarchy process and fuzzy comprehensive evaluation method is proposed. Through the analysis of the evaluation index of the fourth party logistics capability of cross-border e-commerce, the evaluation model is constructed and the empirical analysis is carried out. The improved FAHP method is a feasible and effective evaluation method, and has a certain value of popularization and application.*

Keywords: *Improved fuzzy analytic hierarchy process; Cross-border e-commerce fourth Party logistics; Logistics capability evaluation*

1. Introduction

With the rapid development of international trade, China's transnational e-commerce is developing rapidly. In 2018, the transaction scale of China's cross-border e-commerce reached 9 trillion [1]. But at the same time, logistics bottleneck is increasingly prominent. At present, domestic cross-border logistics service projects are difficult to effectively meet the requirements of the rapid development of cross-border e-commerce logistics. Cross-border e-commerce Fourth party logistics service providers integrate all kinds of resources in the cross-border e-commerce supply chain, make an effective breakthrough from the three dimensions of logistics complexity, information technology and value-added services, and overcome the problems of customs clearance, logistics costs and standards existing in traditional cross-border e-commerce logistics.

Cross-border e-commerce fourth party logistics capability evaluation is a comprehensive evaluation problem involving many factors. Existing studies mainly focus on the evaluation of the fourth party logistics and cross-border e-commerce logistics capability evaluation. Representative studies on cross-border e-commerce logistics capability evaluation are as follows: From the perspective of sellers, Libin Xie constructed a satisfaction evaluation model of third-party cross-border e-commerce platform based on cross-border e-commerce process, providing scientific basis for small and medium-sized companies to choose cross-border e-commerce system [2]; According to the characteristics of cross-border e-commerce of agricultural products, Feng Zuo conducted an empirical analysis on the impact degree of cross-border e-commerce of agricultural products through analytic hierarchy process, and pointed out that among the factors affecting the development of cross-border e-commerce of agricultural products, the supply chain of cross-border e-commerce of agricultural products has the most significant impact [3].Lei Song studied the current situation and development of cross-border e-commerce logistics by using fuzzy comprehensive evaluation method, analytic hierarchy process (AHP), literature analysis method and empirical analysis method, proposed cross-border e-commerce logistics model and put forward corresponding countermeasures for the problems [4].Junhui Di used the generalized utility function method to conduct a corresponding comprehensive evaluation of e-commerce logistics modes, and compared various logistics modes with reference to the size of function values [5].Guie Sun used analytic hierarchy Process (AHP) to construct the service quality evaluation system of cross-border e-commerce logistics enterprises, and proposed to improve the quality of commodity transportation and distribution, improve the flexibility of distribution service, improve the attitude of service personnel, and establish a return and exchange logistics system [6]. Research on 4PL evaluation: Ying Xu and Rui Li put forward the competitiveness evaluation index system of 4PL enterprises and established the competitiveness evaluation model of 4PL enterprises based on network analysis method [7]. Ling Wang, Hui Li and Jou Jiang took an auto parts enterprise as

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an example to construct an evaluation index system of supply chain coordination degree based on 4PL from four dimensions, and then used the improved evaluation formula of coordination degree to discuss the changes of supply chain coordination degree based on 4PL during 2010-2012 [8]. Chuntao Yang proposed a multi-attribute group decision making method, which was effectively combined with 3PL supplier matching in the fourth party logistics [9]. On the basis of summarizing and analyzing the relevant researches on cross-border e-commerce and 4PL, Yun Seng constructed the 4PL capability evaluation index system of cross-border e-commerce. Taking Zhejiang Province as an example, FAHP was used to conduct empirical analysis on 4PL capability of Cross-border e-commerce in Zhejiang Province [10].

2. Improved fuzzy analytic hierarchy process

In order to solve the accuracy problem of convergence, the improvement process of fuzzy analytic hierarchy process is as follows.

(1) Building evaluation Matrix: $F = (f_{ij})_{n\times n}$

$$f_{ij} = \begin{cases} 0, & C(i) < C(j) \\ 0.5, & C(i) = C(j) \\ 1.0, & C(i) > C(j) \end{cases}$$

Among them, $F = (f_{ij})_{n\times n}$ is the fuzzy complementary matrix.

(2)The sum of the F rows is $r_i = \sum_{j=1}^{n} f_{ij}$, Using the formula $r_{ij} = (r_i - r_j)/(2n) + 0.5$, Transforming to fuzzy consistency judgment matrix: $R_{ij} = (r_{ij})_{n\times n}$.

(3)Obtained by the sum and row normalization method $W_{(0)} = (\omega_1, \omega_2 \cdots \omega_n)^T = \left[\sum_{j=1}^{n} e_{1j} / \sum_{i=1}^{n}\sum_{j=1}^{n} e_{ij}, \sum_{j=1}^{n} e_{2j} / \sum_{i=1}^{n}\sum_{j=1}^{n} e_{ij}, \cdots, \sum_{j=1}^{n} e_{nj} / \sum_{i=1}^{n}\sum_{j=1}^{n} e_{ij} \right]^T$

(4)Applying the transformation formula: $e_{ij} = r_{ij} / r_{ji}$ $R_{ij} = (r_{ij})_{n\times n}$ is reciprocal matrix $E = (e_{ij})_{n\times n}$.

(5)Taking the sorting vector $W_{(0)}$ as the initial value of iteration V_0 , The sorting vector with higher accuracy is further solved as W_K .Through $V_{k+1} = EV_k$, Finding eigenvectors V_{k+1} , and finding the infinite norm $\|V_{k+1}\|_\infty$ of V_{k+1} .If $\left| \|V_{k+1}\|_\infty - \|V_k\|_\infty \right| < \varepsilon$,then $\|V_{k+1}\|_\infty$ is the maximum eigenvalue λ_{max} , after V_{k+1} normalized,

$V_{k+1} = \left[V_{k+1,1} / \sum_{i=1}^{n} V_{k+1,i}, V_{k+1,2} / \sum_{i=1}^{n} V_{k+1,i}, \cdots, V_{k+1,n} / \sum_{i=1}^{n} V_{k+1,i} \right]^T$ The resulting vector $W_K = V_{k+1}$ is the sorting vector, end of the iteration.Otherwise, taking $V_k = V_{k+1} / \|V_{k+1}\|_\infty = \left[V_{k+1,1} / \|V_{k+1}\|_\infty, V_{k+1,2} / \|V_{k+1}\|_\infty, \cdots, V_{k+1,n} / \|V_{k+1}\|_\infty \right]^T$ as our initial data, re-iteration.

3. Cross-border e-commerce fourth Party logistics capability evaluation model

3.1 Establish the fourth party logistics capability evaluation index system of cross-border e-commerce enterprises

The fourth Party logistics itself is characterized by service demand, corporate culture and supply chain management globalization. Therefore, based on the above characteristics and the achievements of

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relevant domestic scholars, this paper takes the indicators of technology integration capability, service integration capability and resource integration capability as the secondary indicators of the evaluation and evaluation of the fourth party logistics capability of cross-border e-commerce enterprises.

Table 1: Evaluation index system of cross-border e-commerce fourth Party logistics capability

A layer of target	The target on the second floor	Three layers of target
Cross-border e-commerce fourth Party logistics capacity index system(A)	Technical integration capability indicator(B_1)	Level of Customs Clearance informatization (C_1) Information sharing capability (C_2) Cargo tracking capability (C_3)
	Service integration capability indicator (B_2)	Transportation capacity (C_4) Transportation cost (C_5) Logistics infrastructure automation (C_6) International logistics coverage (C_7)
	Resource integration capability indicators (B_3)	Internal resource integration (C_8) Partner development (C_9) Financing ability (C_{10}) Customer resource integration (C_{11})

Table 1 shows the evaluation index system of cross-border e-commerce fourth Party logistics capability constructed in this paper. Among them, strong technology integration ability is the key to effectively solve the problem of cross-border e-commerce supply chain; Service integration capability is embodied in helping supply chain participants reduce unnecessary input, effectively reduce all kinds of costs in the process of supply chain integration, and improve the overall benefit. The resource integration capability is reflected in the effective integration of the supply side, the demand side and the 3PL of the cross-border e-commerce, so as to coordinate logistics resources and meet logistics needs.

3.2 Determine the fourth party logistics capability evaluation level of cross-border e-commerce enterprises

According to the characteristics of the cross-border e-commerce fourth party logistics capability, this paper divides the capability level into five levels: very high, high, medium, low and very low. See Table 2. On this basis, logistics experts and all parties in the supply chain evaluate the evaluation value of sub-logistics capability according to the actual situation of the fourth party logistics capability of cross-border e-commerce enterprises (F_i).

Table 2: Logistics capability grade table

Ability level	Very high(V_5)	High (V_4)	Medium (V_3)	Low (V_2)	Very low (V_1)
Judge value	80-100	60-80	40-60	20-40	0-20

3.3 Cross-border e-commerce fourth Party logistics capability evaluation comprehensive evaluation

According to the formula: $Q = \sum_{i=1}^{n} F_i N_i$ thereinto： Q is the evaluation value of the total logistics capacity; N_i is the evaluation value of each sub-logistics capability, F_i is the index weight of each sub-logistics capability; The fourth party logistics capacity of cross-border e-commerce is used to determine its comprehensive capacity level.

4. The empirical analysis

This paper takes the fourth party logistics of cross-border e-commerce in a port city as the evaluation object, and evaluates its logistics capability by relevant supply chain expert group.

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4.1 Determine the fourth party logistics capability level of cross-border e-commerce enterprises

According to the technical integration, service integration and resource integration of the fourth party logistics of the cross-border e-commerce enterprise, the evaluation scores of each sub-logistics ability were determined to the experts in the logistics supply chain through questionnaire survey. See Table 3.

Table 3: Evaluation value of the fourth party logistics capability of cross-border e-commerce enterprises

The evaluation index	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}
Judge value	30	50	70	40	60	50	60	80	40	50	20

4.2 Determine the priority judgment matrix

According to the experts of the fourth party logistics capability evaluation indicator system of cross-border e-commerce enterprises, they judge the relative importance of the evaluation indicators and obtain the following four priority evaluation matrices.

$$A\text{-}B\begin{bmatrix}0.5 & 1 & 1\\ 0 & 0.5 & 0\\ 0 & 1 & 0.5\end{bmatrix} \qquad B_1\text{-}C\begin{bmatrix}0.5 & 1 & 1\\ 0 & 0.5 & 1\\ 0 & 0 & 0.5\end{bmatrix}$$

$$B_2\text{-}C\begin{bmatrix}0.5 & 1 & 1 & 1\\ 0 & 0.5 & 0.5 & 1\\ 0 & 0.5 & 0.5 & 1\\ 0 & 0 & 0 & 0.5\end{bmatrix} \qquad B_3\text{-}C\begin{bmatrix}0.5 & 1 & 1 & 1\\ 0 & 0.5 & 0 & 1\\ 0 & 1 & 0.5 & 1\\ 0 & 0 & 0 & 0.5\end{bmatrix}$$

4.3 The weight of the fourth party logistics capability evaluation index was calculated based on **the** *improved fuzzy analytic hierarchy process (AHP)*

(1) The fuzzy consistency judgment matrix R is obtained from the priority matrix

$$\begin{matrix}\\ R=\end{matrix}\begin{matrix}A\text{-}B\\ \begin{bmatrix}0.5000 & 0.8333 & 0.6667\\ 0.1667 & 0.5000 & 0.3333\\ 0.3333 & 0.6667 & 0.5000\end{bmatrix}\end{matrix}$$

(2) Getting it by the sum and row normalization $W_{(0)}$

$$W_{(0)}=(0.4444,0.2222,0.3333)^T$$

(3) The reciprocal matrix E is obtained

$$E=\begin{bmatrix}1 & 5 & 2\\ 0.2 & 1 & 0.5\\ 0.5 & 2 & 1\end{bmatrix}$$

(4) Getting the sorting vector W_K

The precision $\varepsilon = 0.0001$ is calculated in power method The maximum number of iterations is 100.The sorting vector $W_{(0)}$ is taken as the initial value of iteration $V_{(0)}$, and $W_K=(0.5954,0.1283,0.2764)^T$ is obtained after five iterations.

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Similarly, the weight of the fourth party logistics capability evaluation index system of cross-border e-commerce is obtained. See Table 4.

Table 4: Index weight of cross-border e-commerce fourth Party logistics capability evaluation

Priority judgment matrix	Ordering vector			
	W_1	W_2	W_3	W_4
A-B	0.5954	0.1283	0.2764	
B_1-C	0.5954	0.2764	0.1283	
B_2-C	0.5008	0.2066	0.2066	0.0860
B_3-C	0.4952	0.1541	0.2670	0.0837

4.4 Comprehensive evaluation

The weight table can be used to calculate the weight of the evaluation index combination (), and then carry out the comprehensive evaluation of the fourth party logistics capability of cross-border e-commerce enterprises. See Table 5.

Table 5: Comprehensive evaluation results

The evaluation index	F_i	N_i	F_iN_i
C_1	30	0.3545	10.635
C_2	50	0.1645	8.225
C_3	70	0.0764	5.348
C_4	40	0.0642	2.568
C_5	60	0.0265	1.59
C_6	50	0.0265	1.325
C_7	60	0.0110	0.66
C_8	80	0.1369	10.952
C_9	40	0.0426	1.704
C_{10}	50	0.0738	3.69
C_{11}	20	0.0231	0.462

The final result is $Q = \sum_{i=1}^{n} F_i N_i$ =47.159, then the final evaluation score of the fourth party logistics capability of the cross-border e-commerce enterprise is 47.159, Comparing with the logistics capability level in Table 2, it can be seen that the evaluation result of the fourth party logistics capability of the cross-border e-commerce enterprise is medium. As can be seen from Table 5, in the evaluation index system of the fourth party logistics capability of cross-border e-commerce, the internal resource integration index has the greatest influence, followed by the level of customs clearance informatization.

5. Conclusion

In this paper, an improved fuzzy analytic hierarchy process is adopted to evaluate the fourth party logistics capability of cross-border e-commerce enterprises. In cross-border electricity technology is put forward on the evaluation of the fourth party logistics capability integration, service integration, resource integration index as evaluation index level 2, build the more perfect cross-border electricity fourth party logistics capability evaluation index system, and then on the basis of the improved fuzzy analytic hierarchy process (ahp), cross-border electricity fourth party logistics capability evaluation. Finally, the fourth party logistics capability of cross-border e-commerce enterprises in a port city is evaluated, and the evaluation result is medium. In the evaluation index system of the fourth party logistics capability of cross-border e-commerce, the internal resource integration index has the greatest influence, followed by the level of customs clearance informatization. This evaluation method opens up a new method and approach for evaluating the fourth party logistics capability of cross-border e-commerce.

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