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Research on the integrated logistics supply chain management model of foreign trade processing products

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Abstract: There are some problems in the integrated logistics supply chain management model of foreign trade processing products, such as high management risk coefficient, large model effectiveness evaluation error, and low supply chain evaluation accuracy. Therefore, this paper designs a method to evaluate the integrated logistics supply chain management mode of foreign trade processing products. Firstly, the characteristics of integrated logistics supply chain management mode for different foreign trade processing products are determined. Then, with the help of the analytic hierarchy process to determine the management model evaluation indicators and weights. Finally, determine the maximum demand of each node in the integrated logistics supply chain, build the model effectiveness evaluation model, and realise the evaluation of the supply chain management model. Experiments show that the proposed method can effectively reduce the risk coefficient and improve the accuracy of the model effectiveness evaluation.

Keywords: foreign trade processing products; integrated supply chain; management mode; risk coefficient; analytic hierarchy process; judgement matrix.

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1 Introduction

With the rise of electronic information technology, China's foreign trade volume has been growing rapidly. The development trend of foreign trade with the internet as the key intermediary is becoming stronger and stronger (Narimissa et al., 2020). Among them, the supply of foreign trade processing products has also become a hot industry in cross-border transactions. The transportation of foreign trade processed products has become a key carrier in this economic trade, and the transportation mode led by cross-border logistics has also become an indispensable key in this field (Lawrence, 2021). In the comprehensive logistics management of foreign trade processing products, the management mode of supply chain not only affects the transportation of foreign trade technical products, but also relates to the cost and profit of the economic mode and other key issues. Therefore, the integrated logistics supply chain management model of foreign trade processing products is very important for the development of the industry (Mam et al., 2020). With the passage of time, the logistics transportation volume of foreign trade processing products is increasing, and the integrated logistics supply chain management mode of foreign trade processing products also needs some changes (Chaudhuri et al., 2020). For this reason, in order to improve the integrated logistics supply chain management mode of foreign trade processing products, researchers in this field have conducted more research on this issue and made some achievements.

Rathore et al. (2020) designed a supply chain risk assessment method based on failure mode effect analysis and fuzzy VIKOR. Use fuzzy VIKOR to prioritise FSC risk factors, rank FSC risk factors according to standards, and then analyse the sensitivity of the supply chain to check the robustness of the results, develop detailed risk mitigation strategies and risk mitigation classifications in the supply chain management model, so as to improve the resilience of FSC. However, the risk coefficient of supply chain mode management is still high, and there is no better response method, and the effectiveness of the management method needs to be improved. Dang et al. (2022) used blockchain technology and deep learning algorithm to evaluate the supply chain management model. Based on the relevant money inflow theory, this method analyses the potential risks of the supply chain financial market. The risk of supply chain financial market is predicted and managed through intelligent technology, and the financing mode of supply chain finance is analysed. The possible credit risks of supply chain finance are discussed, and a credit evaluation model of supply chain finance based on deep learning technology is constructed to predict potential credit risks. Then, the blockchain technology is used to control and optimise the credit evaluation model to establish a credit system with high

credit and reliability for supply chain enterprises and reduce potential supply chain financial risks. Although the method designed by the model can effectively predict the supply chain potential credit risk, for supply chain finance established a stable and reliable credit relationship network, but in practical application, the evaluation results and the actual risk between certain error, not to provide good help to supply chain management, may affect the actual management effect. Zou and Chen (2021) proposed a research on reverse supply chain management mode based on risk impact analysis. Starting from the interest chain formed by the continuous improvement of the supply chain, this paper analyses the risks that lead to supply chain interruption, considers the increase of the probability of supply chain interruption, analyses the modes and types of reverse supply chain interruption, and puts forward some linking strategies. However, the amount of data of this method in the research is relatively small, and there is still some room for the accuracy of supply chain evaluation, and there are some risks, which affects the effect of supply chain mode management.

Due to the traditional supply chain management mode management high risk coefficient, high model effectiveness assessment error, low precision, affect the overall effect of supply chain management, in order to solve this problem, this paper designs a new foreign trade processing products integrated logistics supply chain management mode evaluation of the new method.

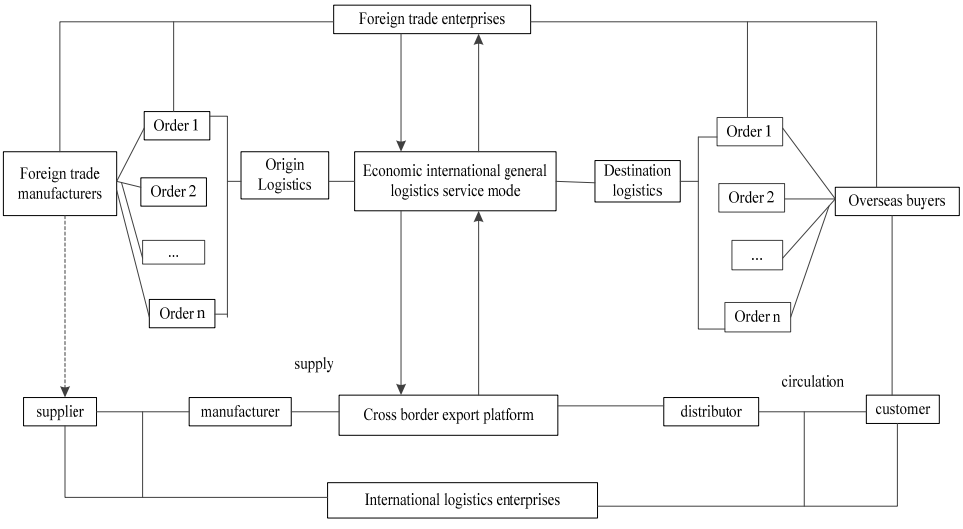
2 Analysis of logistics supply chain management mode of foreign trade processing products

In order to effectively analyse the integrated logistics supply chain management mode of foreign trade processing products, this paper first analyses the logistics supply chain management mode of foreign trade processing products, and further determines the research system of the effectiveness of the integrated logistics supply chain management mode of foreign trade processing products according to the characteristics of these management modes. In this supply chain model analysis, on the basis of the existing third-party integrated logistics model, the offline logistics service model is analysed cooperatively (Boutkhoum et al., 2021), and the integrated logistics supply chain management model of foreign trade processing products is divided into economic international general logistics service model, high-end international logistics service model, and integrated international logistics storage and distribution service model.

2.1 Economic international general logistics service mode

At present, in the logistics supply chain of foreign trade processing products, the service function of logistics is relatively single, and there is a lack of integrated logistics mode in various forms. Because the logistics supply chain management mode of the foreign trade processing products industry is severely fragmented (Wang, 2022), under this management mode, the supplier management mode of foreign trade processing products is fragmented, which requires more capital costs before export, affecting the overall profits of foreign trade processing enterprises. In this supply chain model service, it is mainly aimed at the logistics affordability of the other enterprise, and it is used for low and medium consumption enterprises and customer groups (Yan and Zhang, 2022). The structure diagram of this mode is shown in Figure 1.

Figure 1 Structure of economic international general logistics service mode



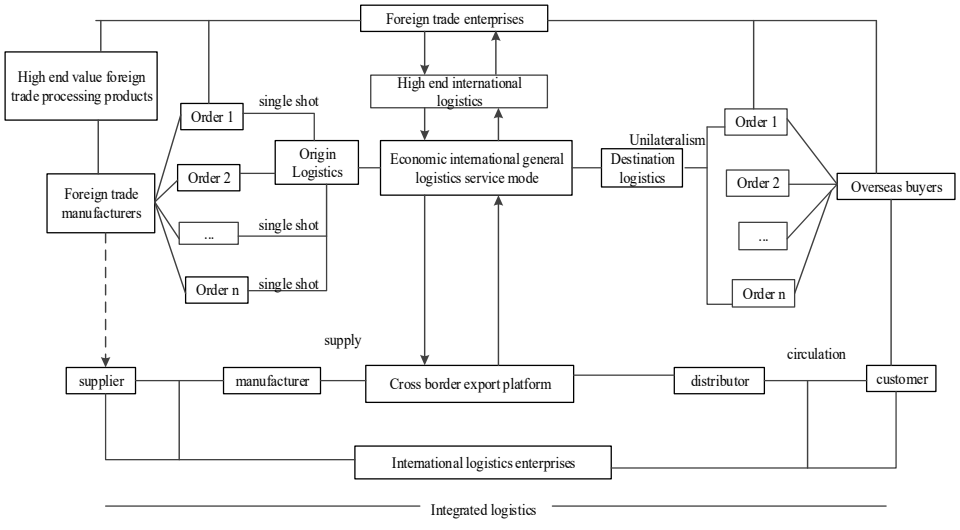
The economic international general logistics service mode fundamentally alleviates the problems such as weight limitation and package loss rate of foreign trade processing products in the comprehensive logistics transportation. At the origin of foreign trade processing products, through the effective integration of order transactions, the problems such as centralised integration in the traditional model have been changed. It is delivered at the destination, led by international logistics, and realises the service of this supply chain model, which has received extensive attention in the application of this model (Hou and Zhao, 2022).

2.2 High end international logistics service mode

For the above low-end foreign trade processing products, the recipients are more willing to provide higher prices to achieve integrated logistics supply chain services. This requires the export enterprises of foreign trade processing products to maintain high reliability and shorten the cycle of goods turnover. Under this service mode, consumers have a good ability to bear logistics costs, but they have high requirements on delivery time and safety reliability (Zhenlai et al., 2020). The structure diagram of this mode is shown in Figure 2.

This mode solves the problem of capital and distribution delay when foreign trade processing products enterprises sell to overseas markets, and solves the problem of imperfect operation under the general integrated logistics supply chain mode. This mode has been determined to send a single engine at the starting place, and needs to send a single engine after arriving at the destination. In this mode, the comprehensive logistics transformation is characterised by small batch size, high value of foreign trade processing products, and the need for timely logistics services. This mode is safe and can improve the speed of transportation.

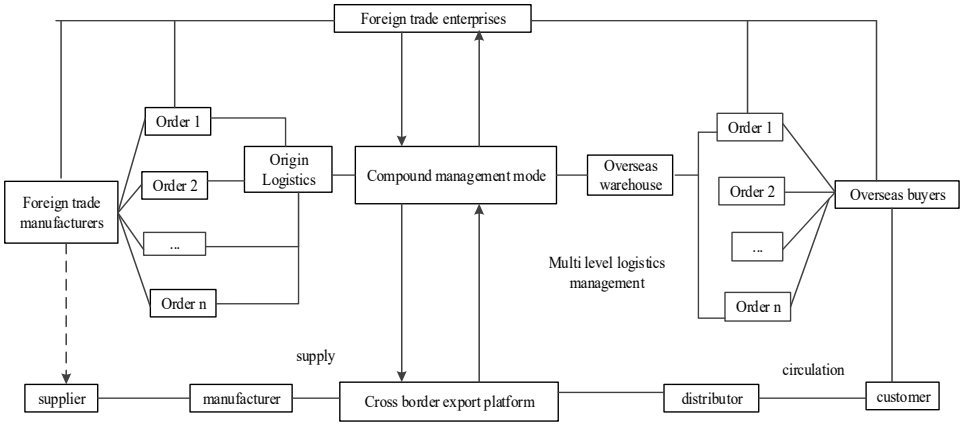
Figure 2 Schematic diagram of high-end international logistics service model



2.3 Integrated international logistics storage and distribution service mode

At present, foreign trade processing products have more necessities outside China, and the consumption is large. In international procurement, the bulk mode is often used, but in the existing supply chain service mode, due to differences in management and operation methods, the storage obtained in the export of foreign trade processed products (Ramadheena et al., 2020). Goods collection and other links cannot meet the demand. Therefore, the service pattern is generated. In this model, the third-party service integrated logistics model is dominated by overseas warehouses and international logistics companies. The structure diagram of this mode is shown in Figure 3.

Figure 3 Structure diagram of integrated international logistics storage and distribution service mode



The emergence of this mode has solved the problem of mode management in third-party logistics export, reduced the management cost in the storage and logistics of overseas warehouses, and reflected the mode of logistics integration in the leading mode of foreign trade processing. Its ability is obvious to all from the starting point to large-scale logistics services. It is suitable for the management of the composite supply chain model of most export enterprises.

Analyse the integrated logistics supply chain management mode of foreign trade processing products, divide it into economic international general logistics service mode, high-end international logistics service mode and integrated international logistics storage and distribution service mode, determine the characteristics of different integrated logistics supply chain management modes of foreign trade processing products, and lay the foundation for subsequent research.

3 Determination of evaluation index and weight of integrated logistics supply chain management mode for foreign trade processing products

On the basis of the above analysis of the integrated logistics supply chain management mode of foreign trade processing products, in order to achieve this research, this chapter determines the evaluation indicators and weight results of the integrated logistics supply chain management mode of foreign trade processing products, and provides indicator data for subsequent evaluation.

3.1 Determine the evaluation index

In this indicator determination, the indicators in the model management evaluation are determined by constructing a judgement matrix. First, determine the influencing factors in the evaluation through the analytic hierarchy process (Liu et al., 2021)]. In the setting hierarchy analysis method, there are n influencing factors in the evaluation indicators in the criterion layer. At this time, the corresponding judgement matrix affecting the quasize is $n \times n$ matrix, and the first-level index set of integrated logistics supply chain management mode evaluation of foreign trade processing products obtained in this matrix is set as:

$$A_i = \{A_1, A_2, ..., A_n\} \tag{1}$$

In formula (1), A_i represents the set of first-level indicators for management mode evaluation, A_1, A_2, …, A_n represents the composition factor of first-level indicators.

The set secondary indicator set is expressed as:

$$A_{im} = \{A_{i1}, A_{i2}, ..., A_{im}\} \tag{2}$$

In formula (2), A_{im} represents the set of second-level indicators evaluated, A_{i1}, A_{i2}, …, A_{im} represents the composition factor of second-level indicators.

The first and second level indicators determined mainly refer to the industry risk indicators in the integrated logistics supply chain management model of foreign trade processing products. The specific indicators are shown in Table 1.

The importance of indicators at different levels in the determined indicators needs to be further measured. For any primary and secondary indicators, the judgement matrix

(Zhao and Li, 2022) is constructed to make new judgements on each indicator under the indicators. The judgement matrix is:

$$p(x)=\begin{cases} p_{11},\ p_{12},\ ...,\ p_{1n} \\ p_{21},\ p_{22},\ ...,\ p_{2n} \\ \cdots \\ p_{m1},\ p_{m2},\ ...,\ p_{mn} \end{cases} \tag{3}$$

In formula (3), $p(x)$ represents the description of the constructed judgement matrix, and m represents the different attributes of the evaluation index of the comprehensive logistics supply chain management model of foreign trade processing products.

Table 1 Details of industry risk indicators

Index name	*Macro and industrial risks*	
Level I indicators	Macro environmental indicators	Development stage of foreign trade processing products industry
	Industrial policy for foreign trade processing products	Competition intensity of foreign trade processing products industry
Secondary indicators	Supply chain relationship risk indicators	
	Close relationship with the industry	Enterprise status of foreign trade processing products
	Supply chain transaction frequency	Product substitutability

3.2 Weight determination

According to the evaluation indicators and levels of the integrated logistics supply chain management model of foreign trade processing products determined above, the criticality of the indicators is determined by calculating the relative weight (Arabshahi and Fazlollahtabar, 2020). By calculating the product of each index in the judgement matrix, the result is:

$$y_m=\prod_{m=1}^{n} p_{mn}(n=1, 2, ..., n) \tag{4}$$

In formula (4), y_m represents the product result of different indicators.

The results determined above are normalised by vectors, and the results are as follows:

$$w_i=u\frac{\sqrt[m]{\prod_{m=1}^{n} p_{mn}(n=1, 2, ..., n)}}{\sum_{i=1}^{n}\sqrt[m]{\prod_{m=1}^{n} p_{mn}(n=1, 2, ..., n)}} \tag{5}$$

In formula (5), w_i represents the vector normalisation treatment and u represents the normalisation factor proportion coefficient.

After the above vector normalisation results, the weight of the evaluation index of the integrated logistics supply chain management model of foreign trade processing products is determined as follows:

$$q(i) = \frac{1}{n}\sum_{i=1}^{n} w_i / v_i \tag{6}$$

In formula (6), $q(i)$ represents the weight results of the evaluation index, and v_i represents the actual critical degree value of the index.

In order to further determine the weight results of the evaluation indicators for the integrated logistics supply chain management model of foreign trade processing products and improve the effectiveness of the follow-up research, the composite weight calculation is further carried out for the indicator weight calculation, and the results are more accurate. The results are as follows:

$$q(i)' = \frac{1}{n} t_i \left(\sum_{i=1}^{n} w_i / v_i \right) \tag{7}$$

In formula (7), $q(i)'$ represents the synthetic weight result, and t_i represents the weight criterion.

In the process of determining the evaluation index and weight of the integrated logistics supply chain management mode of foreign trade processing products, the first level index and the second level index of the evaluation of the integrated logistics supply chain management mode of foreign trade processing products are determined with the help of the analytic hierarchy process, the key degree of the check index of the judgement matrix is constructed, and the weight results of the indicators at all levels are calculated to achieve the determination of the evaluation index and weight of the management mode.

4 Effectiveness evaluation model of integrated logistics supply chain management model of foreign trade processing products

After determining the evaluation index and weights of management mode, in order to verify the effectiveness of the integrated logistics supply chain management mode of foreign trade processing products, this paper designs the effectiveness evaluation model of the integrated logistics supply chain management mode of foreign trade processing products. In the integrated logistics supply chain of foreign trade processing products, the transaction quantity and price between decision-makers at different levels are the key to this model (Tundys and Wisniewski, 2020). Therefore, firstly, the effectiveness of the management mode is determined by analysing the balance state of the integrated logistics supply chain of foreign trade processing products. The balance state description formula of the integrated logistics supply chain of foreign trade processing products is:

$$\left(E_1, E_2, \beta^i, L_1, L_2\right) \in R_+^{M+X+C+K} \tag{8}$$

In formula (8), R_+^M represents m dimensional European space description, M represents the foreign trade processing product supplier, X represents the logistics provider, C represents the product buyer, K represents the supply between the supplier and agent, E_1 product order sales volume, E_2 represents the trading volume matrix, β^i represents the supplier intermediate volume. L_1, L_2 represent Lagrangian factors with different constraints, respectively.

In order to make each node in the integrated logistics supply chain of foreign trade processing products meet the needs of different decision-makers to the greatest extent (Mitropoulos et al., 2021), the balance state can be described as follows:

$$MAX\left(E_1, E_2, \beta^i, L_1, L_2\right) R_+^{M+X+C+K} \tag{9}$$

In order to keep the equilibrium state in formula (8) and formula (9) unchanged, it is necessary to transform them into inequalities, and the result is:

$$\delta_i(x) = \sum\nolimits_{i=1}^{n} \frac{\partial \beta^i}{\partial M} + \frac{E_2}{L_2}\left(L_1 \times E_1\right) \tag{10}$$

In formula (10), $\delta_i(x)$ represents the result of the equilibrium state inequality transformation.

After determining the equilibrium state of the integrated logistics supply chain of foreign trade processing products, in order to make the integrated logistics supply chain management mode of foreign trade processing products more effective, it is necessary to analyse the production logistics behaviour and optimal goal of foreign trade processing product suppliers, the transportation behaviour and optimal goal of foreign trade processing product logistics providers, and the customer behaviour and optimal goal of foreign trade processing products (Yldz et al., 2020). Based on the analysis of the above contents, the comprehensive logistics supply chain management mode of foreign trade processing products should be appropriately adjusted, the model effectiveness evaluation model should be constructed, and the effectiveness of the comprehensive logistics supply chain of foreign trade processing products should be improved.

The foreign trade processing product enterprise is the supplier in the logistics supply chain. The behaviour of the object and the effectiveness of the optimal target influence mode. For this object, considering the fixed cost, the relationship between the cost of foreign trade processing products and logistics is mainly reflected in the quantity ordered by the buyer, namely:

$$Z_i = \sum\nolimits_{n=1}^{n} b_i \in R_+^M \tag{11}$$

In formula (11), Z_i represents the quantity of purchased goods, and b_i represents the unit price of foreign trade processed products.

On this basis, taking into account the competitive relationship between foreign trade processing enterprises, the order quantity with other customers is also closely related. Therefore, the production cost function of foreign trade processing products is set as f_m, which is specifically expressed as follows:

$$f_m = f_m\left(Z_i\right) \forall \omega \tag{12}$$

In formula (12), ω represents the intensity of competition in the same industry.

The related costs incurred in the transaction between the foreign trade processing enterprise and the logistics provider can be seen as the transaction volume function in the supply chain, expressed as:

$$h_m = d_m\left(f_m\left(Z_i\right) \forall \omega\right) \tag{13}$$

In formula (13), h_m represents the transaction volume function and d_m represents the constraints in the logistics supply chain.

At this time, the foreign trade processing product enterprises need to achieve the maximum profit in the supply chain in the logistics transaction, and get:

$$\max L_i = \sum_{i=1}^{n} d_m - f_m(Z_i) - \sum_{i=1}^{n} h_m \tag{14}$$

In formula (14), maxL_i represents the maximum profit value of foreign trade processing products and logistics providers.

Set the target function of the foreign trade processing product enterprise as, calculate the corresponding optimal target at this time, and get:

$$\aleph_x = \left[f_m / d_m \right] + \sum_{x=1}^{n} \frac{\partial L_i}{\rho_m} \tag{15}$$

In formula (15), ρ_m represents the Lagrange multiplier produced by the constraint.

After ensuring the optimal goal of foreign trade processing product enterprises in the logistics supply chain, it is necessary to further maintain the balance between other logistics providers (Wang et al., 2020), namely:

$$B_i(x) = \frac{\partial \vartheta_x}{\partial \rho_m} + \frac{\partial c_i}{\partial \tau_i} - \sum_{i=1}^{n} h_m \tag{16}$$

In formula (16), $B_i(X)$ represents the description of the balance state between the logistics supplier, ϑ_x represents the balance matrix, c_i represents the profit of the logistics provider, and τ_i represents the balance factor.

The behaviour and optimal goal of logistics providers in the logistics supply chain of foreign trade processing products are also crucial. For this object, when it trades in the supply chain, it needs to pay relevant fees and consider the competition relationship with other peers. At this time, the transaction volume function of this object is expressed as:

$$s_i = \sigma_i(v_m) \forall^{\circ} F \tag{17}$$

In formula (17), s_i represents the transaction function of the logistics provider in the supply chain, σ_i represents a non-convex function, $^{\circ}F$ represents the constraint condition in the transaction, and v_m represents the interference factor in the trading volume.

At this time, calculate the maximum profit target of the logistics provider in the supply chain, which is expressed as:

$$\max Q_i = r_n \sum s_i - \sum_{i=1}^{n} \sigma_i(v_m) \tag{18}$$

In formula (18), maxQ_i represents the maximum profit target of the logistics provider in the supply chain, and r_n represents the target function.

The integrated logistics supply chain of foreign trade processing products also includes an answer object, that is, the buyer of foreign trade processing products, which is at a key position in the supply chain. Therefore, it is necessary to further determine the behaviour and optimal conditions of the object. The total cost paid by the buyer in the integrated supply chain is not only the cost of foreign trade processing products, but also other related costs, such as logistics transportation, related import tariffs and other costs. The transaction volume function of these fees paid by the object is expressed as:

$$r_m^n = e_i\left(x_i\right) + \begin{cases} \gamma_k > 0 \\ \gamma_k = 0 \end{cases} \tag{19}$$

In formula (19), r_m^n represents the trading volume function, e_i (x_i) represents the relevant handling fee function, and γ_k represents whether the transaction relationship is expressed in this supply chain.

In this integrated supply chain, there is also fierce competition between the object and its same industry, so it is also necessary to calculate its profit maximisation. The result is:

$$\max V_i = r_m^n \int \gamma_k \sum e_i\left(x_i\right) \tag{20}$$

In formula (20), $\max V_i$ represents the maximum target result of the buyer in this supply chain.

At this time, buyers, like foreign trade processing product enterprises, need to maintain their balance in the integrated logistics supply chain. The set balance conditions are shown as follows:

$$d_k = \begin{cases} \sum_{k=1}^{n} V_i > 0 \\ \sum_{k=1}^{n} V_i = 0 \end{cases} \tag{21}$$

In formula (21), d_k represents the set equilibrium condition.

On the basis of the above analysis of the transaction behaviour and profit maximisation goal of foreign trade processing product enterprises, logistics providers and buyers, in order to achieve the evaluation of the effectiveness of the integrated logistics supply chain management model of foreign trade processing products, the final evaluation model is constructed. The above determined behaviours of foreign trade processing product enterprises, logistics providers and buyers in the supply chain are input into the model to determine the profit maximisation results of different objects, To achieve effective evaluation, the set evaluation model is:

$$\varphi_i(x) = \sum_{i=1}^{n} \frac{1}{n} p^t \sum_{t=1}^{n} \left[\varepsilon^i / d_k\right]\left[\varepsilon^i / \gamma_k\right]\left[\varepsilon^i / r_n\right] \tag{22}$$

In formula (22), $\varphi_i(x)$ represents the validity model description, p^t represents the balance solution of different objects in the logistics integrated supply chain, and ε^i represents the supply and demand relationship of the logistics integrated supply chain.

In the effectiveness evaluation of the integrated logistics supply chain management model for foreign trade processing products, by analysing the balance state of the integrated logistics supply chain for foreign trade processing products, and determining the maximum demand of each node in the integrated logistics supply chain, on this basis, analyse the behaviours and optimal goals of suppliers, logistics providers, and buyers in the integrated logistics supply chain for foreign trade processing products, set balance conditions, and build the model effectiveness evaluation model, realise the final research.

5 Experimental analysis

5.1 Experiment scheme design

To verify the effectiveness of the supply chain management model provided in this article, comparative experiments were designed. The supply chain risk assessment method based on fuzzy VIKOR and failure mode effect analysis, as well as the supply chain risk assessment method based on blockchain technology and deep learning models, will be used as a comparative method, and will participate in experimental testing together with the method in this paper.

A foreign trade processing enterprise in a certain place is selected as the research object. Its foreign trade processing products are plush toys. Its customers are stable, and the monthly quantity of processing orders is fixed. Logistics is mainly realised through ship transportation. The logistics costs vary according to international prices, and the range of changes is relatively fixed. Specific experimental parameters are shown in Table 2.

Table 2 Experimental parameter design

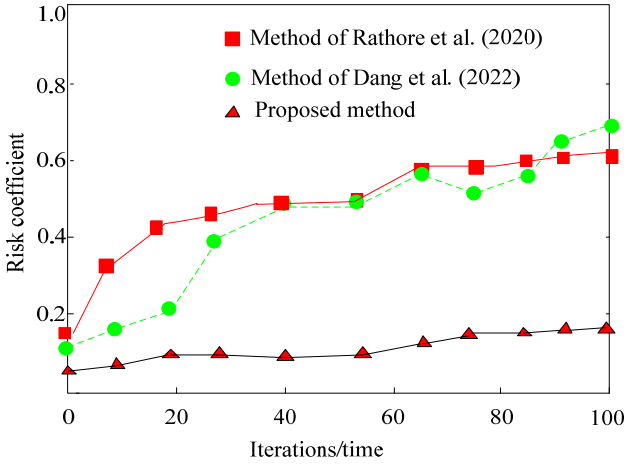
Parameter	*Content*
Size of foreign trade processing enterprises/person	>500
Processing capacity/day/piece	1,000,000
Monthly output/piece	10,000,000
Foreign trade processing order quantity/month/piece	10,000,000
Shipping cost/container/10,000 yuan	5–6
Change range of transportation price%	<5
Supply chain effectiveness evaluation error%	<1
Iterations/time	100

Taking the management risk coefficient, model effectiveness evaluation error and supply chain evaluation accuracy in the integrated logistics supply chain management model of foreign trade processing products as the indicators of the experimental test, the lower the management risk coefficient, the lower the model effectiveness evaluation error and the higher the supply chain evaluation accuracy, the better the effectiveness of the management model.

5.2 Analysis of experimental results

In the test, the proposed method, Rathore et al. (2020) method and Dang et al. (2022) method were first tested, and the management risk coefficient in the sample foreign trade processing integrated logistics supply chain management model was analysed. The analysis of this index can determine the risk in the management under this model. The lower the coefficient is, the lower the risk in the integrated logistics supply chain management model is, which can be used as the management model of this type of enterprise. The test results are shown in Figure 4.

Figure 4 Risk coefficient results of integrated logistics supply chain management mode for foreign trade processing (see online version for colours)



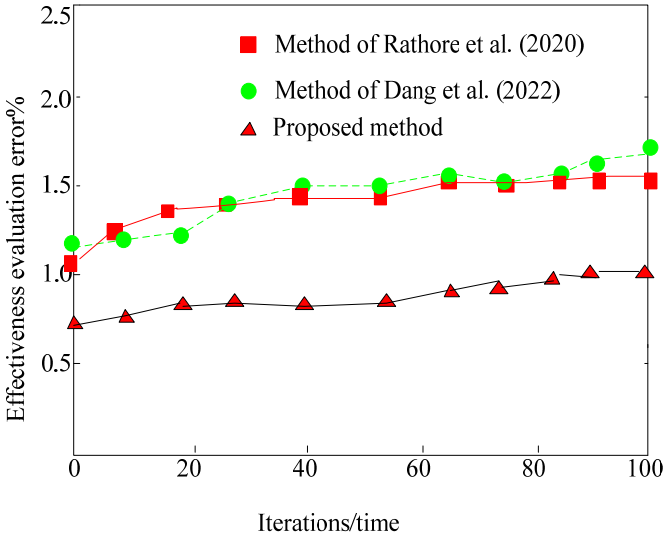
By analysing the experimental results in Figure 4, we can see that there are some differences in the management risk coefficients in the sample foreign trade processing integrated logistics supply chain management model using the proposed method, Rathore et al. (2020) method and Dang et al. (2022) method. Among them, the proposed method aims at the low management risk coefficient in the sample foreign trade processing integrated logistics supply chain management model, followed by the Dang et al. (2022) method and Rathore et al. (2020) method. The risk coefficient of the three methods of management fluctuates slightly, while the other two methods fluctuate greatly. The risk coefficient of this method is always lower than 0.2, so it can be seen that the risk coefficient of the management mode of the proposed method is well controlled and has certain feasibility.

The proposed method, Rathore et al. (2020) method and Dang et al. (2022) method were tested in the experiment, and the results of the model effectiveness evaluation error in the sample foreign trade processing integrated logistics supply chain management model are shown in Figure 5.

Analysis of the experimental results in Figure 5 shows that there are some differences in the results of the effectiveness evaluation error of the sample foreign trade processing integrated logistics supply chain management model based on the analysis of the proposed method, Rathore et al. (2020) method and Dang et al. (2022) method. Among them, the error result curve of Rathore et al. (2020) method and Dang et al. (2022) method in evaluating the effectiveness of the sample foreign trade processing integrated logistics supply chain management model is relatively close, and the error is greater than 1.0%. It is observed that the evaluation error of the proposed method on the effectiveness of the sample foreign trade processing integrated logistics supply chain management model is low, and is always less than 1%. In contrast, the effectiveness evaluation error of the proposed method is lower, which verifies the feasibility of the proposed method. This is due to this paper proposed the integrated logistics supply chain management mode evaluation method in the process of evaluation, set the balance conditions, and build the mode effectiveness evaluation model, analyse the production of logistics behaviour and

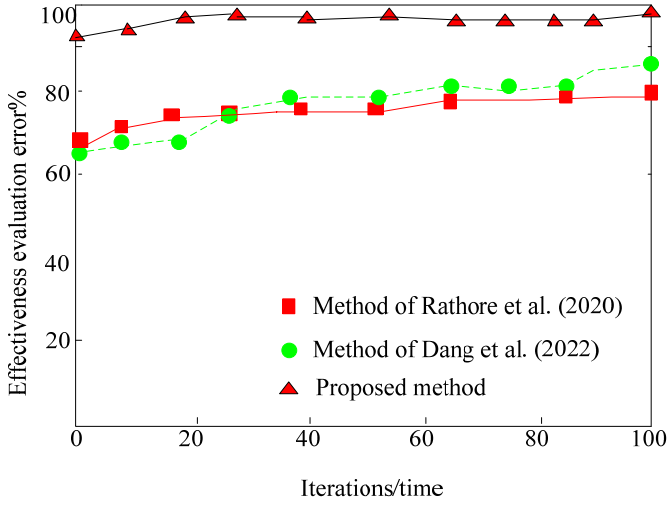
optimal target, foreign trade processing products logistics transportation behaviour and optimal target and foreign trade processing products customer behaviour and optimal goal, can better reduce the evaluation error, improve the accuracy of evaluation.

Figure 5 Effectiveness evaluation error of the comprehensive logistics supply chain management mode of foreign trade processing (see online version for colours)



At the end of the test, the proposed method, Rathore et al. (2020) method and Dang et al. (2022) method are analysed to evaluate the precision index of the integrated logistics supply chain, and the results are shown in Figure 6.

Figure 6 Analysis on the precision results of integrated logistics supply chain assessment (see online version for colours)



It can be seen from the analysis of the experimental results in Figure 6 that, with the constant change of the number of experimental iterations, the proposed method, the Rathore et al. (2020) method and the Dang et al. (2022) method have certain differences in the evaluation accuracy of the integrated logistics supply chain. Among them, the evaluation accuracy of the proposed method for the integrated logistics supply chain is always above 95%, and can be close to 100% at the highest, while the evaluation accuracy of the other two methods is lower than the proposed method, which verifies the feasibility of the proposed method. This is due to the foreign trade processing products integrated logistics supply chain management mode evaluation method to determine the influencing factors in the evaluation, build the key degree of judgement matrix calibration index, and calculate the index weight results at all levels, improve the comprehensive logistics supply chain evaluation accuracy, is advantageous to the auxiliary foreign trade processing products integrated logistics supply chain management work.

6 Conclusions

There are some problems in the integrated logistics supply chain management model of foreign trade processing products. Therefore, this paper designs a new method to evaluate the integrated logistics supply chain management model of foreign trade processing products.

1 Analyse the integrated logistics supply chain management mode of foreign trade processing products, and determine the characteristics of different integrated logistics supply chain management modes of foreign trade processing products. With the help of AHP, the first level and second level indicators of management model evaluation are determined, and the weight of indicators at all levels is calculated. Evaluate the effectiveness of the integrated logistics supply chain management mode of foreign trade processing products, set balance conditions, build the model effectiveness evaluation model, and complete the design of the integrated logistics supply chain management mode of foreign trade processing products.

2 Through experiments, it is verified that the management risk coefficient of the proposed method for the integrated logistics supply chain management model of foreign trade processing products fluctuates less, less than 0.2, and the effectiveness evaluation error is good, which is kept below 1%, and the highest accuracy can reach 100%, which shows that the proposed method has certain feasibility and effectiveness.

3 Due to time constraints, in the following research, the proposed method needs to be constantly improved, multiple industry supply chains are selected for testing, and the amount of data for experimental testing is increased, in order to effectively predict the financial market risk of China's foreign processing trade enterprises' supply chain, and provide certain technical support for the rapid development of enterprises.

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References

Arabshahi, H. and Fazlollahtabar, H. (2020) 'Supply chain innovation performance evaluation based on cross efficiency concept: case study of supply chain innovation awards winners, runner-ups and finalists', *International Journal of Logistics Systems and Management*, Vol. 35, No. 1, pp.1–5.

Boutkhoum, O., Hanine, M., Nabil, M. et al. (2021) 'Analysis and evaluation of barriers influencing blockchain implementation in Moroccan sustainable supply chain management: an integrated IFAHP-DEMATEL framework', *Mathematics*, Vol. 12, No. 1, pp.36–41.

Chaudhuri, A., Ghadge, A., Gaudenzi, B. et al. (2020) 'A conceptual framework for improving effectiveness of risk management in supply networks', *The International Journal of Logistics Management*, Vol. 36, No. 1, p.31.

Dang, C., Wang, F., Yang, Z. et al. (2022) 'Evaluating and forecasting the risks of small to medium-sized enterprises in the supply chain finance market using blockchain technology and deep learning model', *Operations Management Research*, Vol. 1, No. 14, pp.662–675.

Hou, J. and Zhao, X. (2020) 'Toward a supply chain risk identification and filtering framework using systems theory', *Asia Pacific Journal of Marketing and Logistics*, Vol. 15, No. 7, pp.964–973.

Lawrence, M. (2021) 'An evaluation of selected supply chain management elements in department of community safety and transport management in Mahikeng', *HOLISTICA – Journal of Business and Public Administration*, Vol. 12, No. 3, pp.13–38.

Liu, S.P., Sun, Q. and Li, S.H. (2021) 'Risk assessment for supply chain risk management based on cloud model', *Journal of Intelligent and Fuzzy Systems*, Vol. 44, No. 5, pp.1–18.

Mam, A., Ad, B., Nsk, A. et al. (2020) 'Analysis of risk factors in sustainable supply chain management in an emerging economy of leather industry – ScienceDirect', *Journal of Cleaner Production*, Vol. 33, No. 15, pp.74–82.

Mitropoulos, S., Giannakos, K., Achlioptas, J. et al. (2021) 'A prototype workflow MIS for supply chain management: architecture, implementation and business evaluation', *International Journal of Business Information Systems*, Vol. 15, No. 11, pp.1123–1129.

Narimissa, O., Arahani, A.K. and Avardehi, S.M.L. (2020) 'Evaluation of sustainable supply chain management performance: dimensions and aspects', *Sustainable Development*, Vol. 28, No. 3, pp.654–660.

Ramadheena, F.A., Zhafari, M. and Aini, Q. (2020) 'Evaluation of supply chain management performance at MSMEs using the SCOR method', *INTENSIF Jurnal Ilmiah Penelitian dan Penerapan Teknologi Sistem Informasi*, Vol. 4, No. 2, pp.159–172.

Rathore, R., Thakkar, J.J. and Jha, J.K. (2020) 'Evaluation of risks in food grains supply chain using failure mode effect analysis and fuzzy VIKOR', *International Journal of Quality & Reliability Management*, Vol. 3, No. 4, pp.425–430.

Tundys, B. and Wisniewski, T.T. (2020) 'Green supply chain management evaluation for organic products: theoretical and empirical point of view', *Operations and Supply Chain Management An International Journal*, Vol. 14, No. 1, pp.412–417.

Wang, K., Yan, F., Zhang, Y. et al. (2020) 'Supply chain financial risk evaluation of small- and medium-sized enterprises under smart city', *Journal of Advanced Transportation*, Vol. 12, No. 1, pp.124–131.

Wang, Z. (2022) 'Interventionism, decoupling, and reshuffle: new developments in global supply chain management', *China Quarterly of International Strategic Studies*, Vol. 8, No. 1, pp.1–19.

Yan, Y. and Zhang, L. (2022) 'Evaluation method of enterprise economic management model effectiveness based on deep data mining', Vol. 142, No. 2, pp.354–364, Springer, Cham.

Yldz, B., Idem, E. and Seyhan, M. (2020) 'The route of supply chain literature: the evolution of graduate studies', *Kafkas Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Vol. 11, No. 21, pp.21–47.

Zhao, J. and Li, Y. (2022) 'Supply chain security evaluation model and index system based on a 5G information system', *Neural Computing and Applications*, Vol. 34, No. 15, pp.12271–12281.

Zhenlai, X., Ruyi, Z., Guanxiang, Z. et al. (2020) 'The evaluation index system of electric power industry supply chain management based on FAHP', Vol. 13, No. 2, pp.365–371, Springer, Cham.

Zou, J. and Chen, Y. (2021) 'Research on computer simulation evaluation based on risk impact analysis and mitigation strategy of waste disposal reverse supply chain disruption', *Journal of Physics: Conference Series*, Vol. 1992, No. 3, p.3207.