Hindawi
Mobile Information Systems
Volume 2022, Article ID 6318373, 9 pages
https://doi.org/10.1155/2022/6318373

Research Article

A Cross-Border e-Commerce Cold Chain Supply Inventory Planning Method Based on Risk Measurement Model

Yingjun Liu

School of International Business and Trade, Zhejiang Industry & Trade Vocational College, Wenzhou 325000, China

Correspondence should be addressed to Yingjun Liu; liuyingjun@zjitc.edu.cn

Received 24 August 2022; Accepted 17 September 2022; Published 27 September 2022

Academic Editor: Imran Khan

Inventory planning results are less reliable when the statistical problem of supply chain risk factors is not considered. In conjunction with the risk measurement model, a cross-border e-commerce cold chain supply inventory planning method is proposed to effectively address the aforementioned issues. This paper aims to define the fundamental elements of the supply chain network, determine the supply chain's imbalance range, and develop a risk measurement model and also to calculate the ordering cost and storage cost, the storage cost, the cross-border e-commerce imbalance index based on the risk measurement model, the node imbalance, the dynamic programming algorithm for the imbalance node, and the identification method for the cross-border e-commerce supply chain imbalance node. Taking inventory strategy into account, the optimization model of distribution node location and the node importance evaluation system are developed. The planning of cold chain supply inventory for cross-border e-commerce is studied based on an optimized management inventory. The experimental results indicate that the throughput of the research method is between 1000 and 2500 Mbps, that the overall fluctuation range and delay are small, and that the inventory turnover rate has been significantly increased, thereby satisfying the requirements of engineering materials inventory management.

1. Introduction

Due to the gradual improvement of people's living standards and the gradual penetration of electronic networks into everyday life, cross-border e-commerce has begun to rapidly dominate the retail industry. The expansion of international e-commerce has fueled the growth of the logistics industry. Therefore, the stable supply of cold chain goods in cross-border e-commerce has become a hot topic [1, 2]. The imbalance of the supply chain can be caused by large-scale ordering and distribution, imbalanced order quantity distribution, and large-scale price fluctuations. When such an incident occurs, the e-commerce network as a whole will fail. It is of utmost importance to study the supply inventory planning of cross-border e-commerce cold chain in order to ensure that the commodities can flow quickly and reliably along the entire supply chain and can respond quickly when the supply chain is unbalanced [3].

In this regard, numerous relevant studies have been published. On the basis of horizontal inventory share, reference [4] proposes a sustainable food supply network model for cross-border e-commerce of the Internet of Things. We investigated a business model based on a horizontal inventory sharing e-grocery network where online groceries are interconnected as a whole in an IoT environment. This paper aims to design a sustainable food supply chain network for cross-border e-commerce food companies by employing the horizontal inventory sharing strategy and accounting for the existence of strategic alliances between the organizations, reducing food waste and backlogs to create a network that is more sustainable. Reference [5] proposes an inventory sharing strategy design for a sustainable omnichannel cross-border e-commerce network. By pursuing an effective integration strategy for online and offline retailers, the entire supply network can reduce costs, lessen the environmental impact of shipments from the main warehouse, and improve its responsiveness. To reduce the negative impact of demand uncertainty and increase the network's profitability, the inventory share policy based on the strategic alliance concept is being studied. Through the inventory sharing policy, businesses share their current inventory with other businesses, thereby reducing transportation expenses and carbon dioxide emissions caused by the network's traffic density. The simulation modeling technique is utilized for modeling, and the strategy results based on the total network cost, the total number of shipments completed from the main warehouse, and the total sales loss cost are compared at the optimal level. The optimal strategy design is then proposed.

Although the preceding research has made some progress, risk assessment has received less attention. Therefore, it is proposed to conduct research on cross-border e-commerce cold chain inventory planning based on a risk measurement model. Risk evaluation is the foundation of risk management. Nonetheless, due to the inherent complexity of risk, research on risk measurement has always posed a challenge for the academic community. This paper examines the theoretical foundation for the measurement of cold chain supply inventory risk in cross-border e-commerce. The technical basis and applicability are examined, which provides a certain hint for the relevant research work on risk management, and the simulation experiment is used to draw an effectiveness conclusion.

2. Identification Method of Unbalanced Nodes in Cross-Border e-Commerce Supply Chain Based on the Risk Measurement Model

2.1. Establishment of the Risk Measurement Model. Before considering the overall model of a supply chain at a certain stage, it is necessary to first calculate the flow of information, logistics, and capital. There is a flow guide between raw materials and intermediate products, which can flow all raw materials from the place of production to the manufacturer. In the same way, there is a circulation guide between intermediate products and suppliers, which will flow all products from manufacturers to merchants. In the final stage from the merchant to the buyer, it is necessary to pass the products to the individual through the circulation of goods. Risk measurement is the evaluation and estimation of the impact and consequences of risks [6]. Risk measurement includes the evaluation and estimation of the probability or probability of project risks, which is called the risk measurement model. In this complex network, many scale-free data networks exist due to nodes. Due to self-organization and unrelated attraction strategies, many supply chain network nodes are unevenly distributed. Therefore, it is necessary to lead and connect core enterprises in the form of feature scale among the significant characteristics of network nodes.

In the supply chain network, there are several basic elements, the most important of which are nodes and edges. Nodes exist in the form of business entities in the main network of the supply chain, including raw material suppliers, commodity processors, sellers, and buyers. The above is the simplest single chain supply chain. If you increase the supply and demand side, you can also add business entities at any time. Although these business entities have the right to operate independently, there are certain limitations in the economic exchanges between each entity, showing an independent and limited structure. And the edge structure is mainly manifested as a kind of material flow, capital flow, information flow, and other circulation modes between the main bodies of the supply chain network. These edge structures can ensure that the different network nodes have business transactions, and make different structured networks have strong mobility. In addition to nodes and edges, there are other elements such as weight and direction, which can define and propagate the supply chain network. When an emergency occurs, it will directly lead to an imbalance between supply and demand in the market. At this time, the risk measurement model needs to be rebuilt. By setting the raw material supplier as A_a, the commodity manufacturer as B_b, the merchant and the buyer as C_c and D_d, respectively, and defining their logistics results, we can obtain the imbalance range of the supply chain:

$$\begin{cases} M_{AB} = \dfrac{N_i - N_1}{Z_X} \times A_a \\ M_{BC} = \dfrac{N_i - N_2}{Z_X} \times B_b \\ M_{CD} == \dfrac{N_i - N_3}{Z_X} \times C_c \\ M_{DA} == \dfrac{N_i - N_4}{Z_X} \times D_d \end{cases}. \quad (1)$$

In formula (1), M_{AB} represents the logistics imbalance amplitude from stage A to stage B, M_{BC} represents the logistics imbalance amplitude from stage B to stage C, M_{CD} represents the logistics imbalance amplitude from stage C to stage D, and M_{DA} represents the logistics imbalance amplitude from stage D to stage A, N_i represents the supply loss when there is no emergency, Z_X represents the label cost, N_1, N_2, N_3 and N_4 represent the supply and demand costs of products in the four supply chain structures when an emergency occurs. Through this formula, the risk measurement model can be obtained.

2.2. Risk Measurement Model Defines Cross-Border e-Commerce Imbalance Indicators. Through the edge structure of all network nodes, goods can flow from the factory to each distribution center in order to maintain warehouse inventory. To ensure that node indicators can be queried quickly, it is generally configured so that each seller can only transfer goods from a single warehouse. Thus, the location of the distribution center must be carefully considered during the initial stages of establishment. The primary objective of selecting and establishing a distribution center is to save money on logistics operations. Therefore, when measuring the indicators of cross-border e-commerce supply imbalance [7, 8], it is necessary to first calculate the inventory center's construction, inventory, and transfer costs [9, 10]. The initial construction cost of the inventory center is the highest among them, but it is a one-time expense that will not be repeated. The remaining two inventory costs and transshipment costs are continuous costs that necessitate the ongoing expenditures to maintain the inventory center's operation. Typically, inventory costs include both ordering and storage expenses. The ordering cost calculation formula is as follows:

$$E_{DH} = \frac{J_{12}}{T_{12}} + \sum_{i} \frac{k_O}{T_i}. \quad (2)$$

In formula (2), J_{12} and k_O, respectively, represent the overall ordering cost and the ordering cost of the O time, T_{12} represents the time of ordering in advance, and T_i represents the interval of inventory inspection. The ordering cost is generally proportional to the number of orders. In the distribution center, the lead time of inventory management is inversely proportional to the service level, so the overall replenishment times will not exceed the maximum inventory [11]. According to the operation mode of the distribution center, it is necessary to calculate the relationship between the goods in the inventory center and the goods of retailers in order to grasp the distribution level of the cross-border e-commerce supply chain in a timely manner. The calculation formula of storage cost is

$$J_{\alpha\beta} = J_\alpha + J_\beta. \quad (3)$$

In formula (3), J_α represents the maintenance cost that the inventory center can safely store goods, and J_β represents the storage cost when goods are transferred on the road. The transportation cost is quite different from the inventory cost. For example, when a large truck transports a box of fruit from city A to city B, the vehicle running loss on the road and the daily cost of the driver are all transportation costs. The cost of keeping the fruit in the truck without spoiling it is classified as storage cost. The calculation formula of transportation cost is

$$J_{\chi\varphi} = \sum_{i} \sum_{j} E_{ij} R_{ij}. \quad (4)$$

In formula (4), E_{ij} represents the transportation volume of goods j transported by the distribution center i, and R_{ij} represents the transportation cost per unit mass of goods j transported by the distribution center i during transportation. According to the above formula, the best inventory address of certain goods can be obtained through various costs. By integrating all goods and using buffer zone analysis, the best location can be obtained. Combined with the risk measurement model, the imbalance index of cross-border e-commerce supply chain nodes can be measured.

$$B(x, y) = \sum_{j} \left[E_{DH} + \sum_{i} \left(J_{\alpha\beta} \times b_{ij} \times V_e \right) \right] + J_{\chi\varphi}. \quad (5)$$

In formula (5), $B(x, y)$ represents the value of the objective function to measure the imbalance of cross-border e-commerce supply, b_{ij} represents the function value of retailers in the distribution center to minimize the objective function, and V_e represents the individual adaptability of the distribution center in the original location. When it is greater than 0, $B(x, y)$ indicates that the supply of the cross-border e-commerce supply chain node is unbalanced, and it is difficult for the node to effectively provide logistics services. When $B(x, y)$ is less than or equal to 0, it indicates that the supply of the node is good. Through this formula, it can be effectively determined whether there is a supply chain imbalance in the cross-border e-commerce transport entity nodes in the risk measurement model.

2.3. Dynamic Programming Algorithm for Designing Unbalanced Nodes. In combination with the risk measurement model and cross-border e-commerce imbalance indicators in the above, a corresponding dynamic planning algorithm is designed to quickly query the imbalance nodes in the cross-border e-commerce supply chain. The flow of the dynamic planning algorithm is shown in Figure 1.

As shown in Figure 1, after obtaining the supply chain imbalance index, the dynamic planning algorithm needs to send a query command to ensure the integrity of all supply nodes. All inventory decisions are traversed one by one to obtain the effective value of supply chain nodes. Search for tags and determine whether the tags respond to the unbalanced node. If there is no response, it is necessary to traverse other nodes again. If there is a response, it is further determined whether the tags collide. When the labels do collide, it indicates that there is an imbalance in the supply chain of cross-border e-commerce, and this node is the imbalance node. If there is no collision, check whether there is a continuous collision. And according to the continuity or not, the quadtree query is carried out to determine the classification of inventory location, and the connection mechanism of all supply chains needs to be updated. Use the constrained evaluation function to determine whether all the tags are recognized. The evaluation function $H(x, y)$ is

$$G(m, n) = \begin{cases} g(m, n), f \geq 0 \\ g(m, n) + k(m, n), f < 0 \end{cases}. \quad (6)$$

In formula (6), $g(m, n)$ represents the function value of the evaluation index for judging the supply chain imbalance; $k(m, n)$ represents the penalty function of code repair; f represents the satisfaction condition of the individual constraint. When f is greater than or equal to 0, it indicates that the individual meets the constraint conditions; when f is less than 0, it indicates that the individual does not meet the constraint conditions. If the results of the tags in the evaluation function are all identified, all the unbalanced nodes are successfully planned. However, when the results in the evaluation function are not all identified, it is necessary to resend the query command and replan. Through the above algorithm, the planning results of cross-border e-commerce supply chain imbalance nodes can be obtained.

3. Research on Cross-Border e-Commerce Cold Chain Supply Inventory Planning

3.1. An Optimization Model of Distribution Node Location considering Inventory Strategy. At this time, considering the inventory strategy and designing the location optimization model of distribution nodes, it is necessary to describe the model, set all network vertices, and connect them. At this time, the connection between the vertices becomes the vertex path, select some demand nodes, and design the subset distribution cost at the nodes to ensure that the distribution can start from the parent distribution center and return to the distribution center through the circulation of child nodes. At this time, it is assumed that the distribution path set of a parent distribution center k is $P_k = \{p_1, p_2, p_3, \ldots, p_K\}$, the model is assumed, and the demand points are set as discrete points. At this time, the demand of the demand nodes in the cycle is constant. Grid planning is carried out for the international logistics transportation route of cross-border e-commerce, and a uniform rectangular grid is obtained, as shown in Figure 2.

When a demand point is selected as a sublevel distribution node, it provides services by itself. If it is not selected as a sublevel node, there is only one adjacent sublevel distribution node to serve it. Finally, the circular distribution adopts a uniform model, that is, the vehicle load limit in the distribution path is consistent, and the capacity of each sublevel distribution node is consistent. At this time, the distribution cost formula from node i to node j is shown in

$$L_{ij} = Z \times O_{vb}. \tag{7}$$

In formula (7), Z represents the node distance and O_{vb} represents the distribution cost. At this time, the cycle distribution cost can be designed according to the distribution route, and the calculation formula of distribution times is shown in

$$M_E = L_{ij} \times J_K \times R_T \times F_D \tag{8}$$

In formula (8), J_K represents the number of circular distribution, R_T represents the service cost of the node, and F_D represents the distribution demand. At this time, the distribution cost is in a fixed state. Therefore, in order to keep the node cost always in the optimal state, it is necessary to calculate the service cost of the node at this time, and build a distribution node location optimization model as shown in

$$R_{WE} = M_E \times U_{\alpha\beta} \times B_{ZX} \times G_{HJ}. \tag{9}$$

In formula (9), $U_{\alpha\beta}$ represents the average service times of coverage demand, B_{ZX} represents the service times of node i, and G_{HJ} represents the fixed cost of sequential distribution. At this time, the fixed operating costs can be listed using the distribution times and service costs calculated above, and then according to the inventory strategy.

3.2. Construction of the Node Importance Evaluation System.

In the process of cross-border e-commerce cold chain supply inventory planning, the cross-border e-commerce cold chain enterprises are taken as the core of the whole supply chain, and the internal personnel of the core enterprises are controlled and guided. Among them, the cross-border e-commerce enterprises focus on the control of information flow, logistics, and capital flow [12, 13]. The cross-border e-commerce supply chain structure chart shown in Figure 3 is established by combining the most advanced technologies and equipment at the present stage.

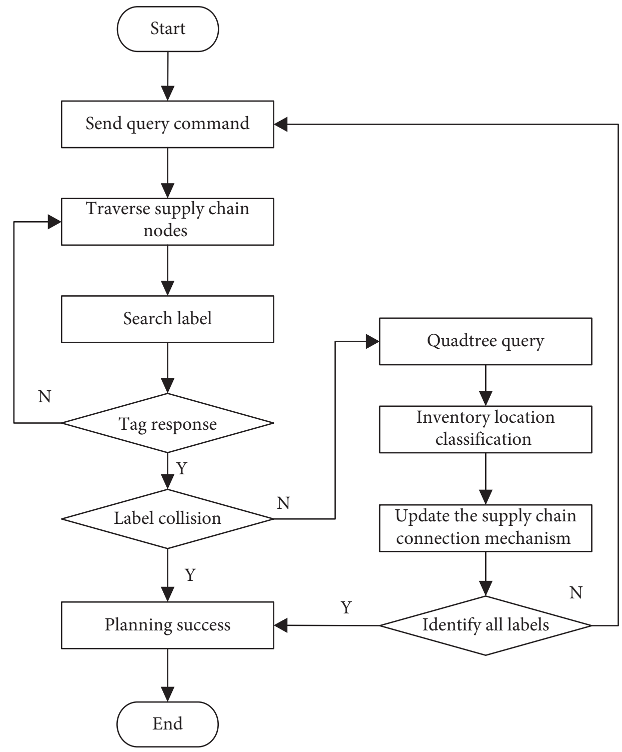

Figure 1: Flowchart of dynamic programming algorithm.

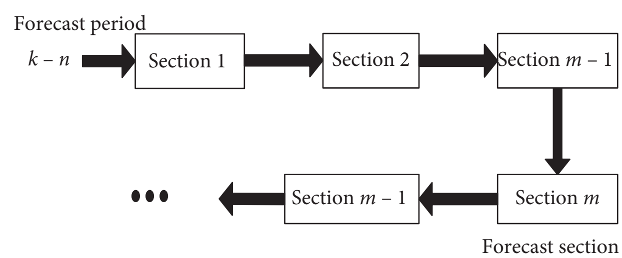

Figure 2: Cross-border e-commerce cold chain supply and transportation path grid planning.

Figure 3 demonstrates that the supply chain of cross-border e-commerce companies is a mesh structure, allowing for the elimination of inefficient operation processes and losses. Suppliers can view the detailed inventory information of e-commerce businesses in real time and make purchase and sales calculations without needing to obtain specific demand information in conjunction with the orders of businesses. In addition, businesses can comprehend consumer demand information in a timely manner and formulate corresponding purchase plans. Not only can the formulation of purchase plans effectively prevent losses caused by calculation errors, but it can also improve the overall operational efficiency of the method.

Cooperation is indispensable to the development of all businesses. All businesses are involved in the supply chain. When a supply chain risk occurs, all businesses will incur

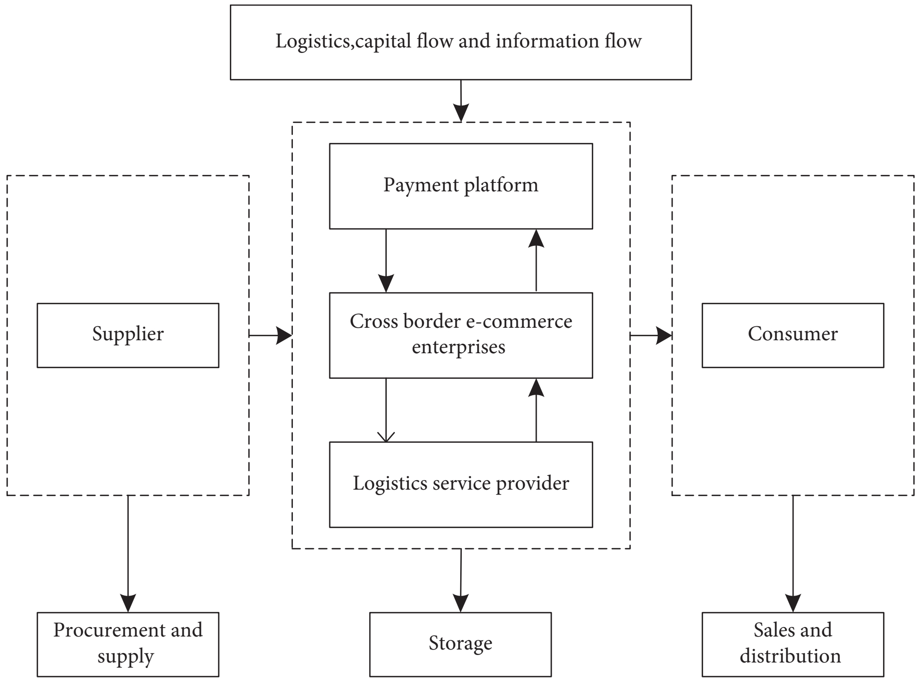

Figure 3: Supply chain structure of cross-border e-commerce enterprises.

losses. Consequently, the majority of businesses pay greater attention to enterprise supply chain management and strive to implement the most recent supply chain risk management strategy. Predicting supply chain risk is a vital component of supply chain management. Good risk prediction can effectively improve supply chain management efficiency [14, 15].

External environmental factors that contribute to the risk of the supply chain are the primary focus of the external risk of the supply chain. These external factors primarily consist of the natural and social environments. At the same time, these risk factors are unavoidable and cannot be controlled by the enterprise, but it can take preventative measures to reduce the losses effectively. Analyze the impact of a single enterprise on the network from the perspective of complex network and node importance, and tally the supply chain risk factors exhaustively from the perspective of supply chain risk.

In the framework of a model node importance evaluation system, the model's solution must be encoded to facilitate local search and the generation of domain solutions. This model utilizes three-segment natural number coding. They consist of the site code, the coverage point code, and the coverage relationship code. Assuming there are N demand points and P regular circular distribution paths, the location point code specifies the distribution node locations and the order of circular distribution. The code contains a total of $N+P+1$ digits. 0 represents the distribution center's parent and separates the various distribution paths. The remaining natural numbers indicate the number of demand points chosen as child distribution nodes. The coding sequence is the circular distribution sequence. The current coding diagram is depicted in Figure 4.

As can be seen from Figure 4, the coverage point code and the coverage relationship code jointly represent the corresponding relationship between the coverage point and the location point. Coverage point coding and coverage relation coding are both n-k bit coding. The coverage point code represents the number of the covered demand node, and the coverage relationship code of the corresponding digits represents the child distribution node covering the demand point. The demand point 10 is selected as the No. 2 node of the child distribution node to cover the service, and the range of the shared logistics distribution center can be divided according to the specific coding status.

3.3. Optimizing Inventory Management. In order to realize the optimization of engineering materials and materials inventory, we need to adopt the economic ordering mode and realize the safety inventory through inventory control. Therefore, this paper estimates the optimal interval of various materials and materials inventory and then determines the order batch. The specific formula for calculating the annual storage cost per unit storage is

$$R_1 = \frac{1}{r_i} \times \frac{v_i}{\sum v_i} \times H_0. \tag{10}$$

In formula (10), r_i represents the annual demand of inventory, v_i represents the annual inventory value, H_0 represents the annual storage cost, in which the individual storage cost accounts for a small proportion of the total expenditure. Therefore, considering the comprehensive storage cost, the cost is defined to be proportional to the inventory, and the risk coefficient is introduced in combination with the historical experience data.

Optimizing inventory management necessitates a streamlined information channel, a rapid response to market changes, a transformation of the inventory management

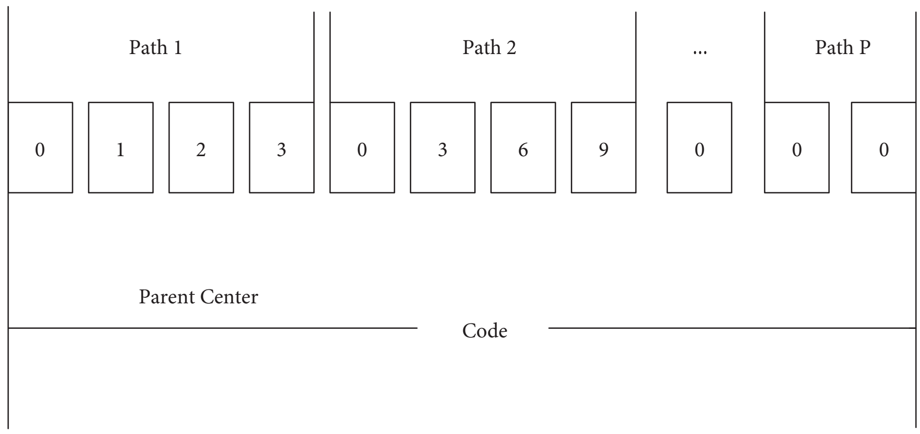

Figure 4: Coding diagram.

mode of thought, and the use of a multidimensional mode of thought to circumvent obstacles to departmental cooperation. Consequently, it is crucial to optimize the inventory of engineering materials and enhance the inventory management procedure. Reorganize the material procurement decision-making process so that it forms an internal organic whole, and give priority to the application of the project material auxiliary management system to facilitate the reorganization. The central challenge of optimizing inventory management is the precise forecasting of material demand. According to market forecasts, the handover time with suppliers can be minimized to the greatest extent possible in order to reduce the inventory costs. The greater the accuracy of the inventory forecast, the shorter the forecast period. If there is a significant difference between the actual demand for project materials and the planned quantity, there will be an inventory backlog or shortage. Consequently, from the four dimensions of external resource management, order-driven procurement, external collaboration, and internal collaboration of the project, optimize the management of inventory, set the forecast period of material inventory reasonably, and maintain and update inventory data in a timely manner. Establish an internal information system among the various project departments, query the inventory of materials and materials based on the shared demand and inventory information, and make adjustments to the actual project production plan and delivery activities based on the queried information, so as to achieve the optimization objective of minimizing the inventory based on the premise of meeting demand and supply. Master the project node information, examine the quality of materials and materials, manage the suppliers of materials and materials at various levels, terminate the cooperative relationship with the suppliers of unqualified materials and materials, avoid unnecessary costs, and optimize the inventory.

4. Simulation Experiment Analysis

In order to verify the effect and feasibility of cross-border e-commerce cold chain supply inventory planning based on the risk measurement model, a simulation experiment is designed to obtain the whole supply chain through cross-border e-commerce. The blockchain network needs to be obtained from the configured server. The specific server hardware and software configuration table is shown in Table 1.

In combination with the server configuration in Table 1, the unbalanced nodes in the cross-border e-commerce supply chain are identified. For different types of nodes, the identified parameters are slightly different. In the virtual server, multiple image systems can be formed through the function of dynamic logical partition, and the application requirements of the system can be obtained from all component resources. Cluster management is carried out by dynamically allocating the capacity as needed. If the configuration in the system is mostly reliable and secure, it can directly connect to the relational database, call, and create middleware applications.

In the experiment, the unbalanced nodes are tested and identified through the throughput. When the throughput has a large prominent range, the supply chain imbalance at the node can be judged. The calculation formula of throughput is

$$Y_t = \frac{T_t}{\Delta t} \times 100\%. \tag{11}$$

In formula (11), Y_t represents the throughput of a cross-border e-commerce supply chain node, T_t represents the number of commodities circulated in a period of time, and Δt represents the elapsed time of the experiment. Through this formula, the throughput of multiple nodes is calculated, as shown in Figure 5.

As shown in Figure 5, the throughput of most nodes in nodes 1–25 is between 1000 and 2500 Mbps. Although there is a certain fluctuation in the movement of each node, the overall fluctuation range is small. It can be seen that the supply environment in these nodes is stable and there is no imbalance. Only at node 16, the throughput has been greatly increased, from 1100 Mbps to 2500 Mbps. It can be seen that there is a supply chain imbalance at this node.

The supply chain channel from the origin of raw materials supplied by the cross-border e-commerce cold chain to the product production plant is taken as stage 1, the

Table 1: Server hardware and software configuration.

Serial number	Name	Parameter configuration
1	Server CPU	Intel (R) Core (TM)i3-8100 CPU @ 3.60 GHz 3.60 GHz
2	Operating system	Windows 1064 bit home edition
3	Memory capacity	24 GB
4	Develop and write programs	Java JDK 2.0 installation package
5	Development tool software	Net beans IDE 7.8
6	Solid state drive	40 GB
7	Bandwidth	1 G bit/s

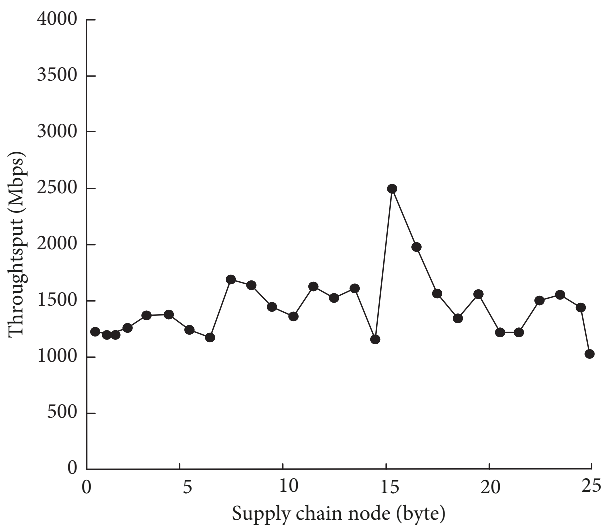

Figure 5: Throughput results of different supply chain nodes.

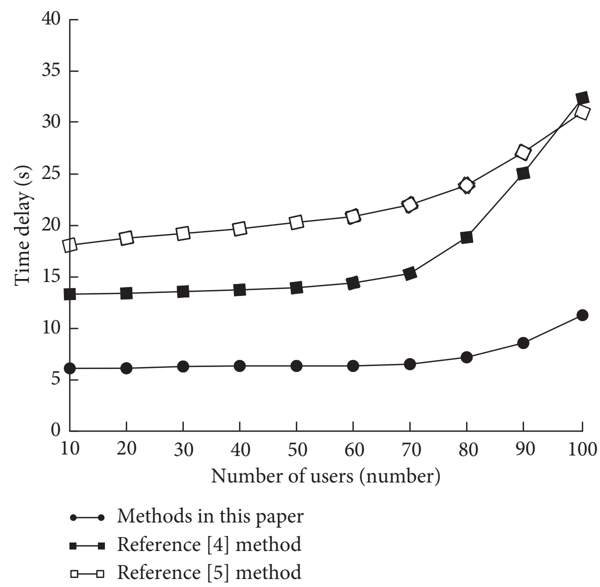

Figure 6: Test results of node planning time.

supply chain channel between the cross-border e-commerce cold chain product production plant and the seller is taken as stage 2, and the channel from the seller to the buyer is taken as stage 3. The operation delay of the cross-border e-commerce supply chain in the three stages in Figure 3 can directly indicate the efficiency of the algorithm. Therefore, the greater the operation delay, the worse the efficiency of the algorithm. And the delay will change according to the number of users. The calculation formula is

$$T_a = T_b - T_c. \quad (12)$$

In formula (12), T_a represents the response time of inventory planning under different throughput; T_b and T_c, respectively, represent the arrival time and departure time of the goods. The comparison experiment is conducted by using the method of reference [4], the method of reference [5], and the method of this paper. The test results of different supply chain segment planning times under the three methods are shown in Figure 6.

As shown in Figure 6, as the number of users increases, the delay of each planning method increases to a certain extent. In phase 1, when the number of users reaches 70, the delay starts to change. When the number of users reaches 100, the delay is 11S, which is 5S longer than the 6S delay when the number of users is 10. The delay of the method in reference [4] increases from 13s to 33S, and the delay of the method in reference [5] increases from 18s to 31s. In this stage, the time delay of this method is much less than the other two methods.

Then, the optimization results of cross-border e-commerce cold chain supply inventory turnover based on the risk measurement model from May 2021 to December 2021 are displayed, as shown in Figure 7.

Figure 7 clearly shows the trend of the optimized inventory turnover rate. With the continuous reduction of the inventory cost, the inventory turnover rate has been significantly improved. In May 2021, the inventory turnover rate was only 13% when this method was not applied for optimization. After this method was optimized, the inventory turnover rate reached 62% in December 2021, which proves that the operation level of the entire cross-border e-commerce cold chain supply chain for inventory materials has been significantly improved.

Compare the delivery rates of suppliers in four categories before and after the application of this method: frozen processing, frozen storage, refrigerated transportation and distribution, and frozen sales, as shown in Table 2.

It can be seen from Table 2 that before the application of this method, the delivery rate of frozen processing, frozen storage, refrigerated transportation and distribution, and frozen sales could not respond to the project demand in time, and it was difficult to guarantee the construction progress of the project. After the application of this method, the delivery rate of frozen processing, frozen storage, refrigerated transportation and distribution, and frozen sales

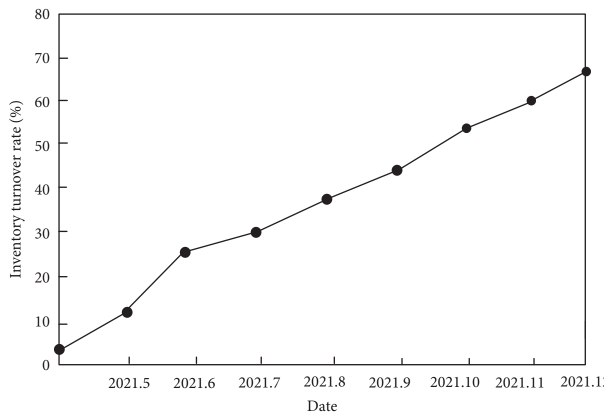

Figure 7: Inventory turnover rate.

Table 2: Comparison of delivery rate before and after optimization.

Category	Before and after application	Engineering procurement requirements (%)	Actual delivery by the supplier (%)
Freeze processing	Before application	93	80
	After application	93	93
Freeze storage	Before application	87	73
	After application	87	87
Refrigerated transportation and distribution	Before application	84	69
	After application	84	84
Frozen sales	Before application	90	89
	After application	90	90

were consistent with the project procurement requirements and gradually realized the synchronization with the project demand. Through the application of the above aspects, it can be seen that this method has a good inventory planning effect and can meet the requirements of engineering materials inventory management.

In conclusion, the research on cross-border e-commerce cold chain supply inventory planning based on the risk measurement model has good performance.

5. Conclusion and Prospect

5.1. Conclusion. Through the above research, the following conclusions are obtained:

(1) The throughput of the cross-border e-commerce cold chain supply inventory planning method based on the risk measurement model is between 1000 and 2500 Mbps, and the overall fluctuation is small. It can be seen that the supply environment in these nodes is relatively stable and there is no imbalance.

(2) With the increase in the number of users, the time delay of each planning method increases to a certain extent. The time delay of this method for identifying unbalanced nodes is much smaller than that of the other two methods.

(3) With the continuous reduction of inventory cost, the inventory turnover rate has been significantly improved, and the supply chain operation level of the whole cross-border e-commerce cold chain to supply inventory materials has been significantly improved.

(4) After the application of this method, the delivery rate of frozen processing, frozen storage, refrigerated transportation and distribution, and frozen sales are consistent with the requirements of engineering procurement, which has a good inventory planning effect and can meet the requirements of engineering material inventory management.

5.2. Prospect. Although this paper analyzes the cross-border e-commerce cold chain supply inventory planning, the actual cross-border e-commerce business is becoming more and more complex, which will be further discussed in the follow-up work.

(1) The cross-border e-commerce enterprises vary greatly, and the product types are also various. In reality, the calculation of models is different due to different products, which needs further research in the future

(2) The objective of inventory management is to reduce the inventory cost on the premise of meeting the market demand. On the basis of this objective, the logistics cost of each link of the cross-border e-commerce cold chain supply chain is analyzed, and the inventory cost calculation model is established.

When the demand and lead time are random, the safety inventory, purchase point, and purchase volume are calculated, so as to reduce the cross-border e-commerce cost and promote the cross-border e-commerce business development of enterprises.

(3) Cross-border e-commerce has diversity and complexity. The sales of products are affected by many factors, such as seasonal factors, product promotion factors, and price factors; all affect the sales and inventory of products. The next step is to further explore the characteristics of cross-border e-commerce cold chain supply inventory cost, so as to make a better inventory planning plan.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] M. Giuffrida, H. Jiang, and R. Mangiaracina, "Investigating the relationships between uncertainty types and risk management strategies in cross-border e-commerce logistics," *International Journal of Logistics Management*, vol. 32, no. 4, pp. 1406–1433, 2021.

[2] H. Zhang, F. Jia, and J. X. You, "Striking a balance between supply chain resilience and supply chain vulnerability in the cross-border e-commerce supply chain," *International Journal of Logistics Research and Applications*, vol. 7, no. 6, pp. 1–25, 2021.

[3] C. Liu and R. Liu, "Application of bp neural network in cross-border e-commerce web pages quality evaluation," *Journal of Physics: Conference Series*, vol. 1774, no. 1, pp. 012015-012016, 2021.

[4] B. Y. Ekren, S. K. Mangla, E. E. Turhanlar, Y. Kazancoglu, and G. Li, "Lateral inventory share-based models for iot-enabled e-commerce sustainable food supply networks," *Computers & 2 Operations Research*, vol. 130, no. 6, pp. 105237–106137, 2021.

[5] D. İzmirli, B. Y. Ekren, and V. Kumar, "Inventory share policy designs for a sustainable omni-chanel e-commerce network," *Sustainability*, vol. 12, no. 23, pp. 10022–10122, 2020.

[6] M. M. Kithinji, P. N. Mwita, and A. O. Kube, "Adjusted extreme conditional quantile autoregression with application to risk measurement," *Journal of Probability and Statistics*, vol. 2021, no. 1, pp. 1–10, 2021.

[7] C. Liu and R. Liu, "Application of BP neural network in cross-border e-commerce web pages quality evaluation," *Journal of Physics: Conference Series*, vol. 1774, no. 1, pp. 012015–012025, 2021.

[8] Q. Zhou, "Research on the basic situation of import and export mode of cross-border e-commerce in sichuan province," *Advances in Social Sciences*, vol. 10, no. 03, pp. 479–485, 2021.

[9] T. Sharma, "Evaluation of inventory cost in supply chain using case based reasoning," *International Journal of Emerging Trends & Technology in Computer Science*, vol. 4, no. 1, pp. 198–204, 2021.

[10] A. Yang, R. Wang, Y. Sun, K. Chen, and Z. Chen, "Coastal shuttle tanker scheduling model considering inventory cost and system reliability," *IEEE Access*, vol. 8, no. 10, pp. 193935–193954, 2020.

[11] Y. Li, Y. Lin, and J. Shu, "Location and two-echelon inventory network design with economies and diseconomies of scale in facility operating costs," *Computers & Operations Research*, vol. 133, no. 1, pp. 105347–106117, 2021.

[12] Z. Zhang, "An optimization model for logistics distribution network of cross-border e-commerce based on personalized recommendation algorithm," *Security and Communication Networks*, vol. 2021, no. 4, pp. 1–11, 2021.

[13] B. B. Hazarika and R. Mousavi, "Review of cross-border e-commerce and directions for future research," *Journal of Global Information Management*, vol. 30, no. 2, pp. 1–18, 2021.

[14] W. Wang, R. Chi, and C. Liu, "Modeling on disruption risk prediction of manufacturing supply chain based on C4.5 algorithm," *International Journal of Circuits, Systems and Signal Processing*, vol. 15, pp. 578–585, 2021.

[15] M. R. Fayyaz, M. R. Rasouli, and B. Amiri, "A data-driven and network-aware approach for credit risk prediction in supply chain finance," *Industrial Management & Data Systems*, vol. 6, no. 7, pp. 1–10, 2020.