

Retraction

Retracted: Cross-Border E-Commerce Supply Chain Risk Evaluation with FUZZY-ISM Model

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] Z. Fang and Q. Wang, "Cross-Border E-Commerce Supply Chain Risk Evaluation with FUZZY-ISM Model," *Security and Communication Networks*, vol. 2021, Article ID 5155524, 14 pages, 2021.

Research Article

Cross-Border E-Commerce Supply Chain Risk Evaluation with FUZZY-ISM Model

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As a main new business model of Internet plus foreign trade, cross-border e-commerce has become an important way and breakthrough for China creating new foreign trade requirements in Internet economy. Cross-border supply chain management is one of the most important supports for cross-border e-commerce. Compared with domestic e-commerce, the supply chain of cross-border e-commerce faces more risks. In order to effectively identify and avoid the operational risks in the cross-border e-commerce supply chain, this article firstly analyzes the cross-border e-commerce supply chain risks from the operation process of the cross-border e-commerce supply chain. The risks include product selection management risks, cross-border transaction risks, and customs clearance risks that exist in the operation of cross-border e-commerce. Secondly, the cross-border e-commerce supply chain risk evaluation index system is established based on the risk elements. Finally, the risk evaluation is carried out through the FUZZY-ISM evaluation method, and the internal connection of each risk factor and the risk generation mechanism are revealed through structural model analysis, which provides a theoretical reference for cross-border e-commerce enterprise supply chain risk management.

1. Introduction

With the rise of Internet economy, traditional international trade has begun to transform to cross-border e-commerce, and cross-border e-commerce business has a breakthrough development [1]. Cross-border e-commerce is a business process in which both transaction parties in different countries or regions use the Internet as the transaction media to transport goods out of the country with the help of postal logistics or express logistics to achieve the purpose of the transaction [2]. China's cross-border e-commerce exports totaled 1.12 trillion RMB in 2021, an increase of 40.1% year-on-year growth. Cross-border e-commerce has become an important form of international trade in China [3].

Cross-border e-commerce supply chain management plays a critical role in the process of cross-border e-commerce business transactions. It promotes the business progress of cross-border transactions through the integration of resource, collaborating operation, supply and

demand matching, and sharing business benefit [4]. Cross-border supply chain management can help e-commerce enterprises guarantee the normal production and sales effectively and reduce the cost of each sector in business transactions [5]. The cross-border e-commerce supply chain management has become the core competitiveness for the cross-border e-commerce enterprises.

In recent years, more and more black swans occur in international trading fields, such as Sino-US trade frictions, which have brought the risk of disruption to the cross-border e-commerce supply chain [6, 7]. At the same time, some unexpected irresistible force factors, such as the COVID-19 outbreak in early 2020 and the blockage of the Suez Canal, have also led to the interruption of the cross-border supply chain [8]. Therefore, more and more scholars have found that there are many problems and risks in the cross-border e-commerce supply chain under the current international trade environment. Such as unstable international transportation, tariff issues, trade barriers, and

other factors make cross-border e-commerce supply chains more complicated and unstable than traditional supply chains [9]. Secondly, risk factors such as the market environment (natural disasters, terrorist events, crisis events, etc.) [10] will also cause the paralysis and interruption of these cross-border supply chains, causing huge losses [11]. Therefore, how to effectively identify and evaluate the risks in the operation of the cross-border e-commerce supply chain and provide solutions to the risks has important theoretical and practical value for cross-border e-commerce. Presently, most former studies on cross-border e-commerce supply chain risks are based on qualitative analysis, such as Mensah et al.'s [12] qualitative methods to study the integration of cultural dimensions, such as power distance, collectivism, uncertainty avoidance, masculinity, and long-term orientation into UTAUT, and examined the comparative impact of cultural dimensions on the adoption of cross-border e-commerce by Chinese and Russian citizens. However, the quantitative analysis of the internal relationship between risk factors is still scarce, and most of the risks are ambiguous. To evaluate the supply chain risks for cross-border e-commerce enterprises under uncertain international business environment, this paper adopts Fuzzy Interpretative Structural Modeling (FUZZY-ISM) to construct an evaluation model for cross-border e-commerce supply chain risk management [13, 14]. The empirical analysis is carried out to explore the mechanism of the influencing factors of cross-border e-commerce supply chain risk as well as the mutual relationship between various factors, so as to provide theoretical guidance for cross-border e-commerce enterprises' supply chain risk management.

The paper is organized as follows. Section 2 summarizes the current research status of supply chain risk evaluation. Section 3 presents the method of the cross-border e-commerce supply chain risk evaluation process based on FUZZY-ISM. Section 4 presents the operation process of the cross-border e-commerce supply chain to provide a theoretical basis for subsequent risk identification. Section 5 identifies the risk factors of the cross-border e-commerce supply chain and establishes the risk evaluation index system. Section 6 conducts empirical analysis through calculation examples. Section 7 concludes.

2. Review of Literatures

As an important study issues in supply chain management, many valuable research results have been achieved in supply chain risk management fields. Christopher and Rutherford [15] provided that supply chain risk is "the risk from the original supplier to the final product delivery with product, material, and information flow." Ponomarov and Holcomb [16] presented that the goal of supply chain risk management is to develop adaptability, prepare for unexpected events, respond to supply chain interruptions, and recover from them. Fahimnia [17] put forward that supply chain risk management is the process of managing the risk of information, materials, and products flowing from suppliers to end users. Cucchiella and Gastaldi [18] used real options to

reduce corporate risk and studied risk management in the supply chain. In order to protect the company from risks caused by various uncertain factors, a personalized theoretical framework suitable for the company has been formulated so that it can choose feasible methods to reduce corporate risks. Um and Han [19] explored the relationships amongst global supply chain risks, supply chain resilience, and mitigating strategies through theoretically hypothesis and empirical study. The results provide practical implications for managing uncertain events and offering theoretical insight for future research in supply chain resilience. Ritchie and Brindley [20] studied supply chain risk performance and management and provided a reference framework for the future development of enterprises. The framework helps to provide a classification of risk drivers and integrates supply chain performance and risk dimensions. Giannakis and Louis [21] proposed a multiagent-based decision support system design framework in order to prevent and manage the risk interruption of the manufacturing supply chain. The framework focuses on the demand-driven supply chain, rather than the forecast-driven supply chain.

The evaluation methods of supply chain risk are also widely studied. Fazli et al. [22] identified the main risks and the crude oil supply chain through the decision-making trial and evaluation laboratory (DEMATEL) method to determine the correlation between risks and use the network analysis (ANP) method to assess the importance of each risk and determine the best response strategy. Rajesh [23] used a decision support model to incorporate an amalgamation of grey theory, and the layered analytic network process (ANP) has been employed for quantifying various resilient strategies for risk mitigation. The proposed model was also applied in a practical setting with the case study of an electronics manufacturing company. Song [24] evaluated the risk by text mining and fuzzy rule reasoning, which can assess the risk of cross-border e-commerce supply chain quantitatively and semi-automatically and also can evaluate the related risk factors. The output of the cross-border e-commerce supply chain is summarized to obtain the overall risk of the cross-border e-commerce supply chain, so as to improve the efficiency and accuracy of the risk assessment of the cross-border e-commerce supply chain. Soni et al. [25] established a supply chain elasticity measurement model based on graph theory and used the model to consider the main driving factors of elasticity and the relationship between them and measure elasticity through a single value. Similar to the above evaluation method, Tan et al. [26] proposed a conceptual model of the supply chain network to quantify the structural redundancy of supply chain risk management. Min [27] used block chain technology to enhance the resilience of the supply chain to avoid the supply chain risks. In addition, some research studies are more inclined to empirical research on supply chain risk management. For example, Donadoni et al. [28] used data from the sixth edition of the International Manufacturing Strategy Survey to study the relationship between product complexity, supply chain disruption, and performance. Research results show that product complexity increases the probability of supply chain disruption. Ceryno et al. [29] investigated the

performance of the automotive industry in three supply chains in Brazil, determined the main risks in the automotive supply chain, provided an initial risk profile for the Brazilian automotive industry, and by analyzing the real-life risks in different supply chains, determined the main risks that the supply chain may expose, as a way to help the supply chain start the supply chain risk management process.

In summary, risk management, as an important part of supply chain management, plays a vital role in maintaining the sustainability of the supply chain [30]. The current market competition is a more direct competition between supply chains, especially the global supply chain competition has become a consensus [31]. However, the current supply chain risk evaluation and management are mainly concentrated in the manufacturing supply chain or the domestic supply chain field, and there are relatively few studies on the supply chain risk management issues of the cross-border e-commerce industry. Compared with domestic supply chains, cross-border e-commerce supply chains involve more risk factors, and the relationships among risk factors are complicated. Therefore, this paper adopts the fuzzy interpretation structure model to build the evaluation model of cross-border e-commerce supply chain risk management and conducts empirical analysis to explore the internal connection and mechanism of each risk factor of cross-border e-commerce supply chain risk, so as to provide advises for cross-border e-commerce enterprises to manage the supply chain risks.

3. Methodology

This section presents the methodology applied in this research. We provide the cross-border e-commerce supply chain risk evaluation method framework, which is shown in Figure 1.

The cross-border e-commerce supply chain risk evaluation method is based on ISM method, fuzzy sets theory, and FUZZY-ISM method. Firstly, the FUZZY-ISM method will be studied. Secondly, the operation process of the cross-border e-commerce supply chain is analyzed and summarized through field investigation and literature analysis. Thirdly, combined with the relevant literature of cross-border e-commerce supply chain risk management, the actual operation process of cross-border e-commerce is analyzed, and the questionnaire survey method and expert interview method are used to further screen out the key influencing factors of the cross-border e-commerce supply chain and establish the risk evaluation index system of cross-border e-commerce. Finally, through the example analysis, the risk factors of cross-border e-commerce are evaluated and ranked, and the results are analyzed and summarized.

In the rest of this section, we will present the Fuzzy-ISM model and its establishment process based on the induction of basic theory of ISM and fuzzy sets.

3.1. ISM. There are many risk factors in the cross-border e-commerce supply chain, and the relationship between the various influencing factors is intricate, and the explanatory

structure model, proposed by Warfeldt in 1973, is a static analysis method used to analyze the complex relationship between multiple factors. It uses an incidence matrix to analyze the overall structure of a project's complex risk system, uses a directed graph to describe the relationship between the elements in the system, extracts and analyzes the structural relationship of the elements by calculating the reachability matrix between the elements, and obtains the relationship between the elements. Through the transfer and hierarchical structure, a multilevel ladder model of the analysis object is finally constructed [13]. Lim et al. [32] used the ISM method to identify the driving forces and dependencies of sustainable supply chain management in the context of knowledge management, so as to improve the performance of textile enterprises in Vietnam. The research results show that learning organization, information, knowledge sharing, collaboration knowledge creation, information technology, and knowledge storage are the main driving and dependent forces. Dubey et al. [33] used the TISM model to identify the barriers of green supply chain management (GSCM). Wu et al. [34] used the Integrated Interpretive Structure Model (ISM) and Bayesian Network (BN) methods for risk assessment and used ISM to clearly specify the engineering risk factor relationships expressed in the causal relationship diagram and formed the structure of BN. The subjective judgment of experts is transformed into prior probability and conditional probability set and embedded in BN. The results show that the balance sheet can provide clear risk information for better project management.

3.2. Fuzzy Sets. However, it is not enough to only consider whether there are influences between systems. In the cross-border e-commerce supply chain risk, both the natural environment risk and the economic environment risk will have an impact on the risk of logistics interruption, but in contrast, the former will have greater influencing factors. And, in most business scenario, the influencing factors are inaccuracy and vague. The fuzzy theory was proposed by Zadeh to solve the inaccuracy and vague issue, and the fuzzy theory is widely used in quality management and risk management [35]. Presently, the fuzzy theory is widely extended to solve more complicated problems. Mahmood et al. [36] presented the concept of complex hesitant FSs (CHFSSs) and applied to pattern recognition and medical diagnosis. Chen et al. [37] used a fuzzy evaluation method based on life cycle assessment and cost-benefit analysis to achieve a comprehensive quantitative evaluation of the environmental and economic benefits of anaerobic digestion technology. In order to solve uncertain and unpredictable information in real-life problems, Mahmood et al. [38] proposed the complex dual hesitant fuzzy set (CDHFS) and applied to the environment of pattern recognition and medical diagnosis to assess the capability and feasibility of the interpreted measures.

3.3. FUZZY-ISM. In the FUZZY-ISM model, different values of α will generate different interpretation structure models, which are superior to the ISM model in terms of flexibility and

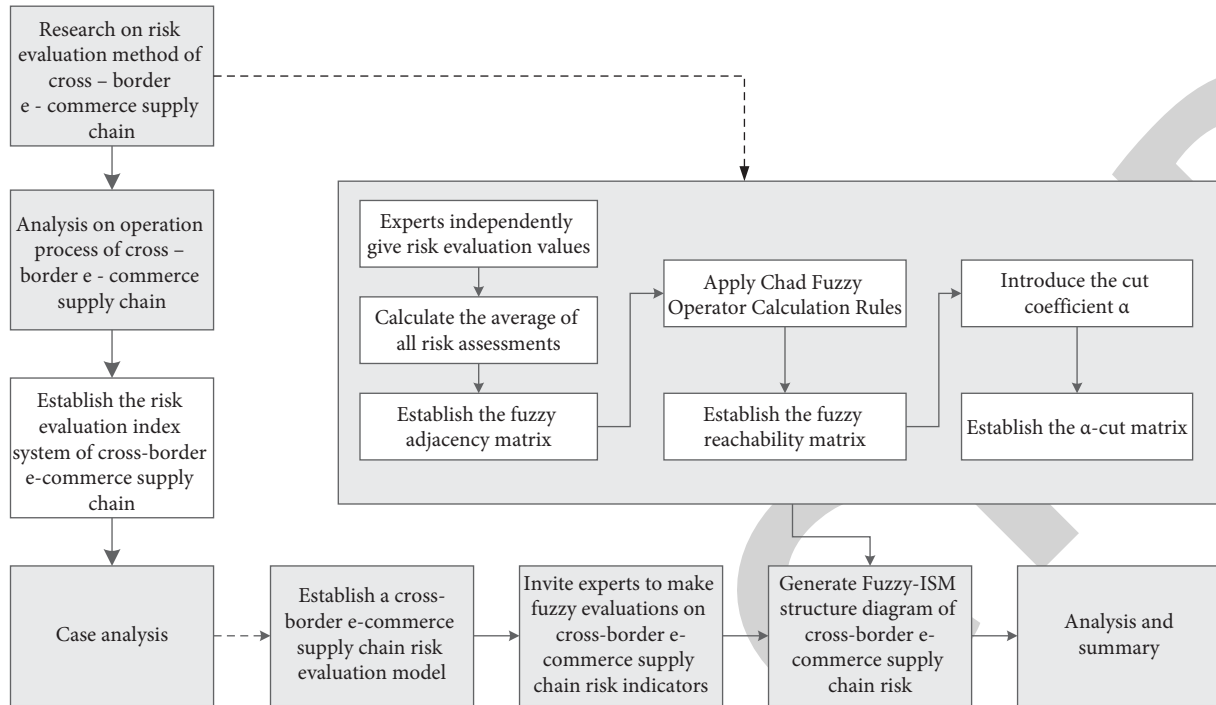


FIGURE 1: Cross-border e-commerce supply chain risk evaluation method framework based on the FUZZY-ISM model.

are more suitable for the diagnosis of complex system problems [14]. Therefore, this article introduces fuzzy theory to improve the ISM structure model and establishes the FUZZY-ISM model for risk factors of the cross-border e-commerce supply chain, which can conduct a more in-depth and intuitive analysis of risk factors and reveal the internal connections and risk generation of various risk factors and their mechanisms. At the same time, for the convenience of research, the weak influence relationship is weakened and omitted. The model establishment process is as follows:

- Step 1: establish the relationship between risk factors through expert data
- Step 2: establish a fuzzy adjacency matrix
- Step 3: use the Chad fuzzy operator in the fuzzy matrix [39] calculation rules to calculate the fuzzy reachability matrix from the fuzzy adjacency matrix
- Step 4: introduce the intercept coefficient α to transform it into a reachable matrix of 0 to 1, and obtain the α intercept matrix
- Step 5: generate the FUZZY-ISM structure diagram
- Step 6: analysis of risk assessment results

4. Operation Process of Cross-Border E-Commerce Supply Chain

The cross-border e-commerce enterprises sell the goods to abroad customers via the cross-border e-commerce platform, such as Amazon, eBay, and Wish. The cross-border supply chain is the core support for cross-border e-commerce transaction. The operation process of the cross-border e-commerce supply chain is shown in Figure 2.

Firstly, the cross-border e-commerce enterprises conduct product selection management through their own production or purchase from upstream suppliers or manufacturers. They can pick up the goods themselves or distribute them by manufacturers and publish and trade the company's product information on cross-border e-commerce platforms. After the cross-border e-commerce enterprise receives the goods, confirm whether the quality of the goods meets the receiving requirements and confirm the payment to the manufacturer or supplier after receiving the goods. After the goods are in warehouse, they will be sorted and packaged. After that, they will be transported to the exit customs through third-party logistics, and the procedures of application for customs declaration, customs inspection, tariff payment, release, export tax rebate, etc., are carried out. Then, the goods will be transported to the destination country by sea, air, land, or international multimodal transport. After arriving in the destination country, the consignee or the entrusted customs declaration company will apply to the customs of the destination country for customs clearance. After customs inspection, customs duties, value-added tax, and other taxes will be paid, and the goods will be shipped to overseas warehouses and put on shelves. And, cross-border e-commerce platform operators can provide cross-border e-commerce companies with corresponding cross-border service capabilities, such as installation and commissioning of products, technical guidance, data analysis, and related policy services. Overseas buyers can place orders online through cross-border e-commerce trading platforms such as Amazon and eBay. Domestic cross-border e-commerce companies received the orders and released them to the overseas warehouse. The overseas warehouse management system automatically

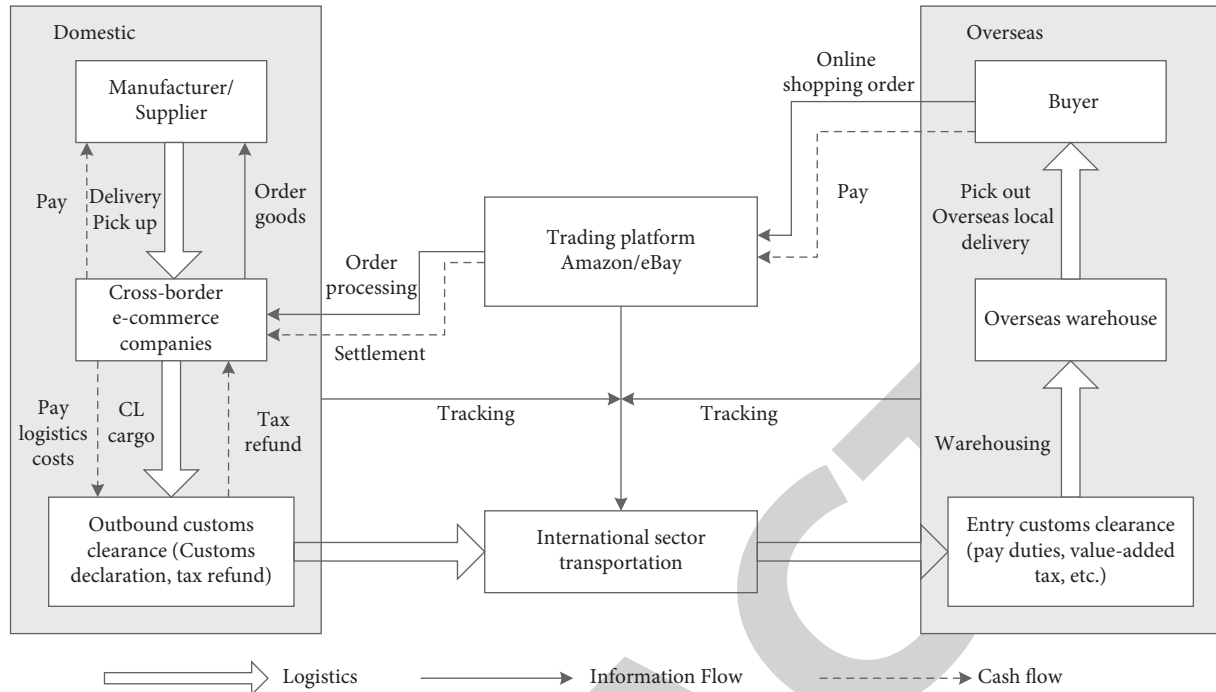


FIGURE 2: Operation process of the cross-border e-commerce supply chain.

obtains order information, and the goods will be sorted, packed, and then distributed to the customer via local postal or express delivery. In order to ensure the normal operation of the entire operation process of the cross-border e-commerce supply chain, the system will track the real-time information of logistics, information flow, and capital flow throughout the process.

Compared with traditional trade, cross-border e-commerce supply chains face different consumers. The consumers faced by traditional traders are mostly manufacturers, so the supply chain of traditional trade mainly plays a role in the transportation of goods from sellers to buyers, with relatively simple functions and simple structure. Cross-border e-commerce not only faces corporate customers but also faces consumers. The cross-border e-commerce supply chain is the way that cross-border e-commerce uses the cross-border supply chain to manage the entire cross-border e-commerce transaction activities, which means cross-border e-commerce is a special form of supply chain in the context of e-commerce. It is a modern form of supply chain under the background of cross-border e-commerce, advocating the concept of resource integration, coordinated operation, matching of supply and demand, and benefit sharing [4] including the entire online electronic transaction, online and offline cross-border payments, and cross-border logistics distribution and transportation.

Therefore, in the supply chain of cross-border e-commerce, multiple cross-border links such as cross-border payment and cross-border logistics are not only added but also laws and regulations, network information security, cultural backgrounds of different countries, and consumption must also be considered in the operation process. The risk factors faced by the cross-border e-commerce supply

chain are higher than that of the traditional trade supply chain.

5. Construction of Risk Evaluation Index System for Cross-Border E-Commerce Supply Chain

Gomez-Herrera et al. [40] examined consumer data in the EU market and analyzed the factors affecting the development of cross-border e-commerce, such as cost advantages, online payment, and logistics models, and recommended that the state should actively provide convenience for enterprises in terms of planning, supervision, and customs clearance. Van Heel et al. [41] studied cross-border e-commerce export trade and found that there are obstacles in customs clearance, logistics, and supervision. Shi et al. [42] conducted a data-driven analysis and research on Chinese fashion retailers and found that the risks affecting the cross-border e-commerce supply chain of enterprises include online marketing risks, cross-border e-payment risks, e-customs clearance risks, cross-border logistics risks, and credit risk. Nuruzzaman and Weber [43] have employed the qualitative research methods to identify some key issues such as supply chain facility, inventory management, and legal obstacles with today's supply chain performance of international e-commerce. To analyse the risks in the cross-border e-commerce supply chain under unexpected environment, this paper analyzes the relevant literature and the actual operation process of the cross-border e-commerce supply chain through the analysis of the operation process of the cross-border e-commerce supply chain and the literature analysis method, selects the risk factors of the cross-border

e-commerce supply chain from the literature, and then adopts the questionnaire survey method and expert interview method to provide the key influencing factors of the cross-border e-commerce supply chain. However, with the environmental issues such as the Sino-US trade conflict and the outbreak of the new crown epidemic, the logistics interruption caused by the supply chain failure and the failure of funds to return to the circulation also need to attract the attention of cross-border e-commerce companies. Therefore, this article finally classifies risk factors into 5 categories, including product selection management risk, cross-border transaction risk, customs clearance risk, logistics risk, and environmental risk. Finally, 5 first-level indicators and 16 second-level indicators are formed, and the risk evaluation index system is established. The results are shown in Table 1.

5.1. Product Selection Management Risk Including Product Quality Risk, Product Delivery Risk, and Intellectual Property Disputes Risk. When cross-border e-commerce companies purchase goods, they will buy shoddy goods, which will cause the risk of not being able to continue to sell. In addition, if the product is not communicated or tracked in time after the product is purchased, the product cannot be delivered and there is a risk. However, companies do not have a strong awareness of intellectual property rights and do not know much about overseas laws. Infringements occur from time to time. Infringed persons use e-commerce platforms to carry out phishing law enforcement and freeze the accounts of companies or clear their accounts.

5.2. Cross-Border Transaction Risks Including Credit Risk, Information Risk, and Capital Settlement Risk. Selling goods online is prone to dishonesty. The credit risk is particularly prominent in cross-border transactions. The subjects that cause the risk include domestic sellers, overseas buyers, and third-party payment platforms. In the online world, there are also information security issues, and its own security risks are prone to information and data leakage issues, such as seller data and buyer information. The settlement of funds is entirely dependent on third-party payment platforms. If cross-border payment channels are not smooth and cross-border e-commerce foreign exchange settlement problems occur, corporate funds will not be able to withdraw, resulting in cross-border e-commerce companies operating difficulties.

5.3. Customs Clearance Risk Including Customs Clearance Risk, Declaration Risk, and Taxation Risk. In the process of cross-border e-commerce transactions, all commodities entering and leaving the country need to be supervised by the customs. After the basic steps of declaration, inspection, taxation, and release are completed, customs clearance is completed. However, goods at different customs locations may have slow customs clearance efficiency or noncustoms clearance. In addition, some cross-border e-commerce companies have special circumstances such as high market value of goods. In order to reduce the tariffs, cross-border e-

commerce enterprise uses the fictitious information, such as fictitious weights of goods and fictitious prices. After the customs finds it, the goods will be intercepted and returned, and the logistics timeliness will not be guaranteed. In the tax collection process, risks mainly come from tax system risks, tax source supervision risks, and tax law enforcement risks.

5.4. Logistics Risk Including Logistics Timeliness Risk, Logistics Information Risk, Logistics Damage Risk, and Logistics Interruption Risk. At present, cross-border e-commerce logistics includes five modes, including traditional transnational logistics, postal parcel, special line express, overseas warehouse, and multimodal transport. Cross-border logistics transportation takes a long time and long distances, increasing the links of customs clearance, commodity inspection, tax refund and foreign exchange settlement, overseas warehousing, etc., which greatly increases the risks of cross-border logistics and also puts forward high requirements for its efficiency and service quality. The risk of cross-border statute of limitations lies in the low cross-border efficiency and the increasing differences in the national conditions of countries in cross-border transactions, which make cross-border logistics work impossible to carry out efficiently. In addition, errors in logistics information, difficulty in real-time tracking, and damage to goods during transportation may also occur. And, with the Sino-US trade conflict and the outbreak of the new crown epidemic, it will lead to the supply chain breakage and logistics interrupted.

5.5. Environmental Risks Including Natural Environmental Risks, Economic Environmental Risks, and Industrial Policy Environmental Risks. The environmental risk of the cross-border e-commerce supply chain refers to the risk of cross-border e-commerce enterprises caused by the uncertainty of the external environment. Natural disasters, environmental issues, disease outbreaks, and other risks may suddenly occur in the natural environment, such as the outbreak of the COVID-19 outbreak in early 2020 and the earthquake in Japan. Economic environment risks will have large fluctuations in the market economy and real-time changes in exchange rates and interest rates, such as the Sino-US trade war. The cross-border e-commerce industry has changed greatly, and national economic policies are constantly changing. Fluctuations in market demand and changes in the market scale will affect the economic benefits of enterprises. The faster the development, the fiercer of the competition in the cross-border trade fields, there will be certain risks for cross-border e-commerce companies.

6. Case Analysis

The COVID-19 epidemic has caused a huge impact on the cross-border e-commerce supply chain. Due to lack of awareness of supply chain risk management, many cross-border e-commerce enterprises have experienced supply chain disruptions or even business failures. In order to effectively identify the risk factors of the COVID-19 epidemic

TABLE 1: Risk evaluation index system of the cross-border e-commerce supply chain.

First-level indicator	Second-level indicator	Description of risk indicator
Product selection management risk [4, 5, 12, 40, 42–44]	Product quality risk C1	During the product selection process, the actual product cannot be seen, and the product can only be understood through the pictures, evaluations, introductions, and videos on the website; some speculative merchants who only pursue short-term benefits pretend to be shoddy and display high-quality products online; the products are actually fake and inferior, and the actual goods are completely different from the description
	Product delivery risk C2	After the products are purchased, the materials or products provided by the supplier may not be delivered on time, which may cause the delay or interruption of the domestic logistics of the supply chain
	Intellectual property disputes risk C3	Sometimes, the companies do not have a strong awareness of intellectual property rights and do not know much about overseas laws; infringed persons use e-commerce platforms to carry out phishing law enforcement, freeze the accounts of companies or clear their accounts, and put companies in a difficult position
Cross-border transaction risk [1, 5, 40, 42–44]	Credit risk C4	Transaction credit risk refers to the fact that cross-border e-commerce companies do not understand foreign consumers in the online transaction process, and it is difficult to grasp the transaction motives of foreign consumers, and transactions that violate the principle of good faith are likely to occur; dishonest behaviors cause “abortion” of transactions and bring losses to cross-border e-commerce companies
	Information risk C5	Information risk includes domestic supplier information risk and cyber security information risk
	Capital settlement risk C6	In the field of cross-border e-commerce, international payments are basically monopolized by international credit organizations and international payment companies, and their payment procedures are relatively expensive; most payment tools in China are not recognized by overseas users; cross-border payment channels are not smooth, cross-border e-commerce foreign exchange settlement is prone to problems, and corporate funds cannot be withdrawn, resulting in cross-border e-commerce companies operating difficulties
Customs clearance risk [9, 40–42, 44, 45]	Customs clearance risk C7	Includes customs clearance efficiency and cargo clearance rate; different customs locations have different customs clearance requirements, and goods may have slow customs clearance efficiency or noncustoms clearance
	Customs declaration risk C8	Some cross-border e-commerce companies have special circumstances such as high market value of goods; in order to reduce tariffs, false declarations of goods and goods weight, virtual logistics prices, virtual consignees and consignees, or split declarations
	Taxation risk C9	Taxation risks include tax system risks, tax source supervision risks, and tax enforcement risks
Logistics risk [1, 4, 8, 9, 12, 40–45]	Logistics timeliness risk C10	Cross-border logistics transportation takes a long time and long distances; due to transportation delays, customs clearance delays, delivery delays, etc., the logistics timeliness will be affected, and customers will not be able to sign for a long time, affecting corporate reputation and payment
	Logistics information risk C11	In the process of cross-border logistics information transmission, information errors may occur or it is difficult to achieve real-time tracking
	Logistics damage risk C12	In the process of cross-border transportation of cross-border goods, the goods are damaged or lost, which prevents the goods from reaching overseas consumers in a timely and safe manner
	Logistics interruption risk C13	Due to force majeure and other reasons, such as wars and epidemics, there is a risk of interruption of cross-border logistics and transportation

TABLE 1: Continued.

First-level indicator	Second-level indicator	Description of risk indicator
Environmental risk [1, 4, 6–8, 10–12, 41, 44, 46]	Natural environment risk C14	Natural disasters, environmental issues, disease outbreaks, and other risks may suddenly occur in the natural environment, such as the outbreak of the COVID-19 outbreak in early 2020 and the earthquake in Japan
	Economic environment risk C15	Economic environment risks will have large fluctuations in the market economy and real-time changes in exchange rates and interest rates, such as the Sino-US trade conflict
	Industry policy environmental risks C16	The cross-border e-commerce industry has changed greatly, and national economic policies are constantly changing; fluctuations in market demand and changes in the market scale will affect the economic benefits of enterprises; the faster the development, the fiercer the competition in the industry and unpredictable the development prospects of the industry, and there will be certain risks for cross-border e-commerce companies

on the cross-border e-commerce supply chain and conduct an objective evaluation, this article takes Ningbo cross-border comprehensive zone e-commerce enterprises as an example. Since Ningbo was approved as the second batch of comprehensive pilot zone for cross-border e-commerce by the state in January 2016, cross-border e-commerce has achieved rapid development. In 2019, the scale of cross-border e-commerce transactions in the city reached 128.2 billion RMB, accounting for 13.98% of the city's total foreign trade import and export, upto 374.4% compared with 2016, and 328.9 percentage points higher than the growth rate of foreign trade in the same period.

Based on the risk evaluation indicators and methods in the previous section, this section will take the e-commerce enterprise in the Ningbo comprehensive pilot zone as an example. Based on the establishment of a cross-border e-commerce supply chain risk factor index system, the risk factor evaluation research method based on the FUZZY-ISM model is used for quantitative evaluation.

Step 1: Establish the Fuzzy Adjacency Matrix.

Through the design of questionnaires and via online and offline surveys, a 16×16 matrix was set up to confirm and score the interrelationships of cross-border e-commerce supply chain risk factors and take the average value as the final degree of influence between the two factors. The fuzzy relationship between various risk factors is analyzed, and the fuzzy adjacency matrix A of cross-border e-commerce supply chain risk factors is generated (see in Figure 3).

In this matrix, the cross-border e-commerce supply chain risk is regarded as a system, which includes 16 components such as $C_i (i=1, 2, \dots, 16)$ and builds a 16×16 adjacency matrix on this basis $A = [C_{ij}]_{16 \times 16}$. When constructing this adjacency matrix, the logical relationship between the two influencing factors is represented by C_{ij} , $0 \leq C_{ij} \leq 1$. In addition, the direct relationship between factor i and factor j , that is, the cell on the diagonal is recorded as 0.

Step 2: Calculate the Reachable Matrix.

After obtaining the fuzzy adjacency matrix, calculate the sum $A + I$ of A and the identity matrix I and use the Chad fuzzy operator calculation rules in the fuzzy matrix to perform matrix $A + I$ power operation on a certain integer n until the following formula holds:

$$M = (A + I)^{n+1} = (A + I)^n \neq (A + I)^{n-1} \neq \dots \neq (A + I)^2 \neq (A + I). \quad (1)$$

Use MATLAB to calculate the order of matrix convergence. When $n=6$, the matrix converges, and the reachable matrix M is obtained (see in Figure 4).

Step 3: α -Cut Matrix.

Since the fuzzy reachable matrix cannot be decomposed into domains and interstages, the cut-off coefficient α is introduced to transform it into a reachable matrix of 0~1. Because the value of α is different, different 0~1 reachable matrices will be generated. For the convenience of research, the intermediate threshold $\alpha = 0.5$ is adopted, and the horizontal intercept matrix $M_{\alpha=0.5}$ can be obtained as (see in Figure 5):

$$\alpha_{xij} = \begin{cases} 1, & x_{ij} \geq 0.5 = \alpha, \\ 0, & x_{ij} \leq 0.5 = \alpha. \end{cases} \quad (2)$$

Step 4: Divide the Hierarchical Relationship of Each Factor.

- (1) According to the reachability matrix, the reachability set $R(C_i)$ and the antecedent set $A(C_i)$ of each influencing factor can be determined first. The reachable set $R(C_i)$ refers to the set of all reachable factors starting from C_i , that is, the set of all the column factors with a score of 1 in the row of the factor C_i in the reachable matrix; the antecedent set $A(C_i)$ refers to all possible reach. The set of factors of C_i can be the set of all the row factors with a score of 1 in the column of factor C_i in the matrix [47].
- (2) According to the obtained reachable set $R(C_i)$ and antecedent set $A(C_i)$ of each influencing factor, find

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_1	0	0.3	0.8	0	0	0.5	0.5	0.5	0	0	0	0	0	0	0	0
C_2	0	0	0	0	0	0.5	0	0	0	0.5	0	0	0	0	0	0
C_3	0	0	0	0	0	0.9	0.7	0.4	0	0.5	0	0	0	0	0	0.6
C_4	0	0	0	0	0	0.9	0.5	0	0	0	0	0	0	0	0	0.5
C_5	0	0.1	0	0.1	0	0.7	0	0	0	0	0.7	0	0	0	0	0.1
C_6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.3
C_7	0	0	0.5	0	0	0.5	0	0	0	0.5	0	0	0.2	0	0	0
C_8	0.5	0	0.5	0	0	0.5	0.5	0	0	0.2	0	0	0	0	0	0
C_9	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0.5
C_{10}	0	0.5	0	0.1	0	0.7	0	0	0	0	0	0	0	0	0	0
C_{11}	0	0	0	0.5	0	0.5	0	0	0	0	0	0	0	0	0	0
C_{12}	0.5	0.2	0	0	0	0.5	0	0	0	0.5	0	0	0	0	0	0
C_{13}	0	0.5	0	0.5	0	0.8	0	0	0	0.9	0	0	0	0	0	0
C_{14}	0	0.2	0	0	0	0.5	0	0	0.2	0.5	0	0.5	0.8	0	0.3	0.5
C_{15}	0	0	0	0	0	0.5	0	0	0	0	0	0	0.6	0	0	0.1
C_{16}	0	0	0.5	0	0	0.5	0	0	0.3	0	0	0	0	0	0	0

FIGURE 3: Adjacency matrix of the FISM model for cross-border e-commerce supply chain risk.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_1	1	0.5	0.8	0.2	0	0.8	0.7	0.5	0.3	0.5	0	0	0.2	0	0	0.6
C_2	0.3	1	0.3	0.2	0	0.5	0.3	0.3	0.3	0.5	0	0	0.2	0	0	0.3
C_3	0.4	0.5	1	0.2	0	0.9	0.7	0.4	0.3	0.5	0	0	0.2	0	0	0.6
C_4	0.4	0.5	0.5	1	0	0.9	0.5	0.4	0.3	0.5	0	0	0.2	0	0	0.5
C_5	0.4	0.5	0.5	0.5	1	0.7	0.5	0.4	0.3	0.5	0.7	0	0.2	0	0	0.5
C_6	0.3	0.3	0.3	0.2	0	1	0.3	0.3	0.3	0.3	0	0	0.2	0	0	0.3
C_7	0.4	0.5	0.5	0.2	0	0.5	1	0.4	0.3	0.5	0	0	0.2	0	0	0.5
C_8	0.5	0.5	0.5	0.2	0	0.5	0.5	1	0.3	0.5	0	0	0.2	0	0	0.5
C_9	0.4	0.5	0.4	0.2	0	0.5	0.4	0.4	1	0.5	0	0	0.2	0	0	0.5
C_{10}	0.3	0.5	0.3	0.2	0	0.7	0.3	0.3	0.3	1	0	0	0.2	0	0	0.3
C_{11}	0.4	0.5	0.5	0.5	0	0.5	0.5	0.4	0.3	0.5	1	0	0.2	0	0	0.5
C_{12}	0.5	0.5	0.5	0.2	0	0.5	0.5	0.5	0.3	0.5	0	1	0.2	0	0	0.5
C_{13}	0.4	0.5	0.5	0.5	0	0.8	0.5	0.4	0.3	0.9	0	0	1	0	0	0.5
C_{14}	0.5	0.5	0.5	0.5	0	0.8	0.5	0.5	0.3	0.8	0	0.5	0.8	1	0.3	0.5
C_{15}	0.4	0.5	0.5	0.5	0	0.6	0.5	0.4	0.3	0.6	0	0	0.6	0	1	0.5
C_{16}	0.4	0.4	0.5	0.2	0	0.5	0.5	0.4	0.3	0.4	0	0	0.2	0	0	1

FIGURE 4: Reachability matrix of the FISM model for cross-border e-commerce supply chain risk.

- the intersection of them to get the intersection set $I(C_i)$. The results are shown in Table 2.
- (3) Calculate the top factor set: when the reachable set is equal to the intersection, the factor in the reachable set is the top-most set of factors, and the top-most set of factors is thus determined $L_1 = \{C_6\}$.
 - (4) The same influencing factors at the intersection set $C(C_i)$ and reachable set $R(C_i)$ are classified as the same influencing factor level. Then, remove the crossed-out factors to get a new matrix, and then, follow step 2 to determine the second-level factor set of the new matrix. The 16 cross-border

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	C_9	C_{10}	C_{11}	C_{12}	C_{13}	C_{14}	C_{15}	C_{16}
C_1	1	1	1	0	0	1	1	1	0	1	0	0	0	0	0	1
C_2	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
C_3	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	1
C_4	0	1	1	1	0	1	1	0	0	1	0	0	0	0	0	1
C_5	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	1
C_6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
C_7	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	1
C_8	1	1	1	0	0	1	1	1	0	1	0	0	0	0	0	1
C_9	0	1	0	0	0	1	0	0	1	1	0	0	0	0	0	1
C_{10}	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0
C_{11}	0	1	1	1	0	1	1	0	0	0	1	0	0	0	0	1
C_{12}	1	1	1	0	0	1	1	1	0	1	0	1	0	0	0	1
C_{13}	0	1	1	1	0	1	1	0	0	1	0	0	1	0	0	1
C_{14}	1	1	1	1	0	1	1	1	0	1	0	1	1	1	0	1
C_{15}	0	1	1	1	0	1	1	0	0	1	0	0	1	0	1	1
C_{16}	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	1

FIGURE 5: α -cut matrix of the FISM model for cross-border e-commerce supply chain risk.

TABLE 2: Reachable set, antecedent set, and intersection set.

Element C_i	Reachable set $R(C_i)$	Antecedent set $A(C_i)$	Intersection set $I(C_i)$
1	1, 2, 3, 6, 7, 8, 10, 16	1, 8, 12, 14	1, 8
2	2, 6, 10	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15	2, 10
3	2, 3, 6, 7, 10, 16	1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16	3, 7, 16
4	2, 3, 4, 6, 7, 10, 16	4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16	4, 7, 16
5	2, 3, 4, 5, 6, 7, 10, 11, 16	5	5
6	6	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	6
7	2, 3, 6, 7, 10, 16	1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16	3, 7, 16
8	1, 2, 3, 6, 7, 8, 10, 16	1, 8, 12, 14	1, 8
9	2, 6, 9, 10, 16	9	9
10	2, 6, 10	1, 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15	2, 10
11	2, 3, 4, 6, 7, 11, 16	5, 11	11
12	1, 2, 3, 6, 7, 8, 10, 12, 16	12	12
13	2, 3, 4, 6, 7, 10, 13, 16	13, 14, 15	13
14	1, 2, 3, 4, 6, 7, 8, 10, 12, 13, 14, 16	14	14
15	2, 3, 4, 6, 7, 10, 13, 15, 16	15	15
16	3, 6, 7, 16	1, 3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16	3, 7, 16

e-commerce supply chain risk factors are divided into 6 levels in turn, namely, $L = \{L_1, L_2, L_3, L_4, L_5, L_6\}$, and the results are shown in Table 3.

- (5) Drawing of the structural model: according to the above calculation and analysis, the reachable matrix M is divided into 5 levels, and the first-level node $L_1 = \{C_6\}$ of cross-border e-commerce supply chain risk factors, the second-level node $L_2 = \{C_2, C_{10}, C_{16}\}$, the third-level node $L_3 = \{C_3, C_7, C_9\}$, the fourth-level node $L_4 = \{C_1, C_4, C_8\}$, the fifth-level node $L_5 = \{C_{11}, C_{12}, C_{13}\}$, and the sixth-level node $L_6 = \{C_5, C_{14}, C_{15}\}$. Sort the risk factors according to the hierarchical results, and draw a multilayer

hierarchical structure diagram (see Figure 6), which intuitively reflects the logical relationship, transmission path, and interaction mechanism between the risk factors of the cross-border e-commerce supply chain.

Step 5: Analysis of Risk Factors' Results.

According to Figure 6, the risk factors of the cross-border e-commerce supply chain are a 6-level hierarchical structure.

- (1) The first-level factor is the risk of capital settlement. As a surface risk factor, the inability of funds to settle foreign exchange is the most direct risk factor

TABLE 3: Results of the hierarchical structure of risk factors in cross-border e-commerce supply chains.

Level	1	2	3	4	5	6
Node C_i	6	2, 10, 16	3, 7, 9	1, 4, 8	11, 12, 13	5, 14, 15

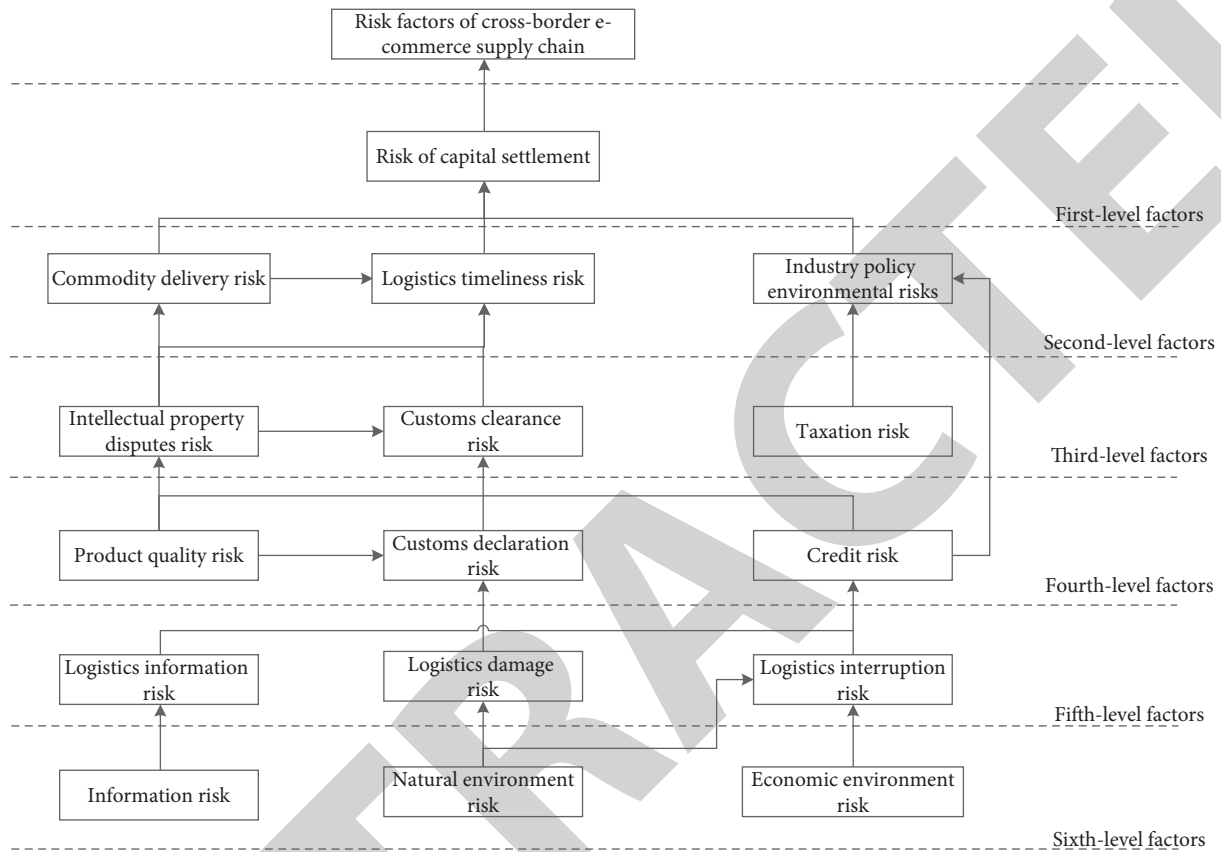


FIGURE 6: Cross-border e-commerce supply chain risk factors' FUZZY-ISM multilevel hierarchical diagram.

affecting the operation of cross-border logistics enterprises. The risk of capital settlement is also affected by the second-level factors of commodity delivery risk, logistics timeliness risk, and industry environment risk. The reason is that whether the goods are in domestic logistics or international logistics, if they cannot be delivered and the logistics timeliness cannot be guaranteed, buyers cannot sign for them, and cross-border e-commerce sellers cannot receive payment back. And, if the development of cross-border industries and policies are not controlled in time, it will also pose risks to foreign exchange settlement. In cross-border e-commerce foreign exchange settlement transactions, international payments are basically monopolized by foreign payment companies such as PayPal, which is unstable and affects cross-border e-commerce companies.

- (2) The second-level factors are middle-level factors, including commodity delivery risks, logistics timeliness risks, and industry policy environmental risks. Industry policy environmental risks are

affected by intellectual property disputes, taxation risks, credit risks, and economic environment risks. Cross-border e-commerce companies do not have a strong sense of intellectual property rights, and infringements occur from time to time. Once intellectual property disputes arise, corporate payment accounts such as PayPal will be frozen, cleared, and even their stores will be closed. International taxation policies, domestic and foreign trade policies, language barriers, and other political, geographic, and cultural constraints, as well as seller credit constraints, will all have a certain impact on industry development and policies. Commodity delivery risk is affected by commodity quality risk. The risk of logistics timeliness will be directly affected by the risk of customs clearance. If there is a problem in the customs clearance of the goods, the logistics efficiency will not be guaranteed, and the goods will take a long time to transport.

- (3) The third-level factors are the risk of property rights' disputes, customs clearance risks, and

taxation risks. The risk of customs clearance will be affected by the risk of commodity declaration and property rights' disputes. When the commodity is cleared, if the commodity declaration is not consistent, the goods and the weight of the goods are falsely reported, fictitious goods information and fictitious consignee or consignor. After the customs finds it, the goods will be intercepted and returned, and if the goods are infringing, they will be directly detained, which will have a great impact on customs clearance. The risk of property rights' disputes will also be affected by product quality risks. If a product has quality or infringement, property rights' disputes will occur, which will bring a heavy blow to cross-border e-commerce companies.

- (4) The fourth-level factors are product quality risk, declaration risk, and credit risk. Credit risk will be affected by the risk of logistics interruption, and credit risk plays an important role in the process of risk, directly affecting the upper-level customs clearance risk. At the same time, credit risk is bound to restrict the industry policy environment, which means that credit risk is directly affected by logistics disruption. Credit risks include controllable and uncontrollable risks. The controllable part includes the credit of cross-border e-commerce companies, such as guaranteeing not to sell infringing goods and counterfeit and shoddy goods, and uncontrollable risks include foreign buyer credit and third-party payment platforms.
- (5) The fifth-level factors are logistics information risk, logistics loss risk, and logistics interruption risk. The risk of logistics loss and logistics interruption will be affected by natural environmental risks. Such as the Sino-US trade conflict, the outbreak of the new crown epidemic, earthquakes, and tsunamis, there are situations such as logistics interruption, damage to the transportation process of goods, and depressed economic environment. The logistics information risk will also be affected by the information risk. Security issues arising from online transactions and untimely supervision will lead to errors in logistics information or failure to track in real time, which will affect cross-border e-commerce companies.
- (6) The sixth-level factors are information risk, natural environment risk, and economic environment risk. This risk is at the bottom of the model, is an input element of the risk system, has an impact on other risk factors, and is the fundamental cause of cross-border e-commerce supply chain risks. We need to make adequate preparations in the face of different natural environments and timely maintain and supervise the systems and software used by the company to ensure that corporate information, data, and buyer information are not leaked. When faced with different situations, make corresponding strategy.

7. Conclusions

The unexpected events, such as COVID-19 and the Suez Canal blockage, caused the cross-border supply chains disrupted and made the cross-border e-commerce companies face many risks in business operation. How to evaluate the supply chain risks and take measures to avoid the cross-border e-commerce supply chain risks becomes an important issue for the cross-border e-commerce enterprises. Based on studying the operation process of the cross-border e-commerce supply chain, this article pointed out that the cross-border supply chain risk factors involved were divided into five aspects and creatively added the product selection management risk analysis, and more in the past studies focused on the risk of cross-border transaction risk, customs clearance risk, logistics risk, and environmental risk, and these four aspects rarely consider the enterprise when picking product management which will also produce risk. Secondly, this paper provided the relationship between risk factors, through the FUZZY-ISM model, while the ISM model only considers whether there is influence between risks, it cannot determine the degree of influence between risk factors and provides a theoretical basis for further study of the logical level. Finally, the FUZZY-ISM model is used to rank the 16 risk factors. However, most of the previous studies focus on the relationship between risk factors and supply chain risk management and rarely consider the mechanism of action between risk factors. In this paper, the FUZZY-ISM model revealed the mechanism of action among risk factors, revealed the relationship between risk factors, and provided theoretical support for the supply chain risk management of cross-border e-commerce enterprises.

For future research, according to different types and cross-border e-commerce enterprise operation patterns, we will establish a more comprehensive supply chain risk index system and provide corresponding suggestions.

Data Availability

The data used to support the findings of the study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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References

- [1] Y. Wang, F. Jia, T. Schoenherr, Y. Gong, and L. Chen, "Cross-border e-commerce firms as supply chain integrators: the management of three flows," *Industrial Marketing Management*, vol. 89, pp. 72–88, 2020.
- [2] W. Xue, D. Li, and Y. Pei, "The development and current of cross-border E-commerce," in *Proceedings of the WHICEB 2016 Proceedings*, vol. 53, pp. 131–138, Wuhan, China, June 2016.
- [3] Penny, *Cross-border E-Commerce Industry Data Analysis: In 2020, China's Total Import and export Volume of Cross-Border E-Commerce Reached 1.69 Trillion Yuan*, <https://www.iimedia.cn/c1061/78795.html>, 2021.
- [4] X. Liu, Z. Dou, and W. Yang, "Research on influencing factors of cross border E-commerce supply chain resilience based on integrated fuzzy DEMATEL-ISM," *IEEE Access*, vol. 9, pp. 36140–36153, 2021.
- [5] Z. Liu and Z. Li, "A blockchain-based framework of cross-border e-commerce supply chain," *International Journal of Information Management*, vol. 52, pp. 1–18, 2020.
- [6] A. Lukin, "The US-China trade war and China's strategic future," *Survival*, vol. 61, no. 1, pp. 23–50, 2019.
- [7] T. P. Velavan and C. G. Meyer, "The COVID-19 epidemic," *Tropical Medicine and International Health*, vol. 25, no. 3, pp. 278–280, 2020.
- [8] K. Lawrence, *When "Just-In-Time" Falls Short: Examining the Effects of the Suez Canal Blockage*, SAGE Business Cases Originals, London, UK, 2021.
- [9] G. H. Gessner and C. R. Snodgrass, "Designing e-commerce cross-border distribution networks for small and medium-size enterprises incorporating Canadian and U.S. trade incentive programs," *Research in Transportation Business & Management*, vol. 16, pp. 84–94, 2015.
- [10] B. Rabta, C. Wankmüller, and G. Reiner, "A drone fleet model for last-mile distribution in disaster relief operations," *International Journal of Disaster Risk Reduction*, vol. 28, pp. 107–112, 2018.
- [11] G. A. Lopez, "Terrorism in Latin America," *The Politics of Terrorism*, CRC Press, Boca Raton, FL, USA, pp. 497–524, 2020.
- [12] I. K. Mensah, G. Zeng, and C. Luo, "The impact of national culture dimensions on the adoption of cross-border E-commerce," *International Journal of Information Systems in the Service Sector*, vol. 12, no. 4, pp. 91–112, 2020.
- [13] A. P. Sage, *Interpretive Structural Modelling: Methodology for Large Scale Systems*, pp. 91–164, McGraw-Hill, New York, NY, USA, 1977.
- [14] R. K. Ragade, "Fuzzy sets in communication systems and in consensus formation systems," *Cybernetics and Systems*, vol. 6, no. 1-2, pp. 21–38, 1976.
- [15] M. Christopher and C. Rutherford, "Creating supply chain resilience through agile six sigma," *Critical Eye*, vol. 7, no. 1, pp. 24–28, 2004.
- [16] S. Y. Ponomarov and M. C. Holcomb, "Understanding the concept of supply chain resilience," *International Journal of Logistics Management*, vol. 20, no. 1, pp. 124–143, 2009.
- [17] B. Fahimnia, C. S. Tang, H. Davarzani, and J. Sarkis, "Quantitative models for managing supply chain risks: a review," *European Journal of Operational Research*, vol. 247, no. 1, pp. 1–15, 2015.
- [18] F. Cucchiella and M. Gastaldi, "Risk management in supply chain: a real option approach," *Journal of Manufacturing Technology Management*, vol. 17, no. 6, pp. 700–720, 2006.
- [19] J. Um and N. Han, "Understanding the relationships between global supply chain risk and supply chain resilience: the role of mitigating strategies," *Supply Chain Management: International Journal*, vol. 26, no. 2, pp. 240–255, 2020.
- [20] B. Ritchie and C. Brindley, "Supply chain risk management and performance," *International Journal of Operations and Production Management*, vol. 27, no. 3, pp. 303–322, 2007.
- [21] M. Giannakis and M. Louis, "A multi-agent based framework for supply chain risk management," *Journal of Purchasing and Supply Management*, vol. 17, no. 1, pp. 23–31, 2011.
- [22] S. Fazli, R. Kiani Mavi, and M. Vosooghizajji, "Crude oil supply chain risk management with DEMATEL-ANP," *Operational Research*, vol. 15, no. 3, pp. 453–480, 2015.
- [23] R. Rajesh, "A grey-layered ANP based decision support model for analyzing strategies of resilience in electronic supply chains," *Engineering Applications of Artificial Intelligence*, vol. 87, pp. 1–18, 2020.
- [24] B. Song, W. Yan, and T. Zhang, "Cross-border e-commerce commodity risk assessment using text mining and fuzzy rule-based reasoning," *Advanced Engineering Informatics*, vol. 40, pp. 69–80, 2019.
- [25] U. Soni, V. Jain, and S. Kumar, "Measuring supply chain resilience using a deterministic modeling approach," *Computers and Industrial Engineering*, vol. 74, pp. 11–25, 2014.
- [26] W. J. Tan, A. N. Zhang, and W. Cai, "A graph-based model to measure structural redundancy for supply chain resilience," *International Journal of Production Research*, vol. 57, no. 20, pp. 6385–6404, 2019.
- [27] H. Min, "Blockchain technology for enhancing supply chain resilience," *Business Horizons*, vol. 62, no. 1, pp. 35–45, 2019.
- [28] M. Donadoni, F. Caniato, and R. Cagliano, "Linking product complexity, disruption and performance: the moderating role of supply chain resilience," *Supply Chain Forum: International Journal*, vol. 19, no. 4, pp. 300–310, 2018.
- [29] P. S. Ceryno, L. F. Scavarda, and K. Klingebiel, "Supply chain risk: empirical research in the automotive industry," *Journal of Risk Research*, vol. 18, no. 9, pp. 1145–1164, 2015.
- [30] R. Rostamzadeh, M. K. Ghorabae, K. Govindan, A. Esmaeili, and H. B. K. Nobar, "Evaluation of sustainable supply chain risk management using an integrated fuzzy TOPSIS- CRITIC approach," *Journal of Cleaner Production*, vol. 175, pp. 651–669, 2018.
- [31] C. Y. Chu, K. Park, and G. E. Kremer, "A global supply chain risk management framework: an application of text-mining to identify region-specific supply chain risks," *Advanced Engineering Informatics*, vol. 45, pp. 1–17, 2020.
- [32] M. K. Lim, M.-L. Tseng, K. H. Tan, and T. D. Bui, "Knowledge management in sustainable supply chain management: improving performance through an interpretive structural modelling approach," *Journal of Cleaner Production*, vol. 162, pp. 806–816, 2017.
- [33] R. Dubey, A. Gunasekaran, S. F. Wamba, and S. Bag, "Building theory of green supply chain management using total interpretive structural modeling (TISM)," *IFAC-PapersOnLine*, vol. 48, no. 3, pp. 1688–1694, 2015.
- [34] W.-S. Wu, C.-F. Yang, J.-C. Chang, P.-A. Château, and Y.-C. Chang, "Risk assessment by integrating interpretive structural modeling and Bayesian network, case of offshore pipeline project," *Reliability Engineering & System Safety*, vol. 142, pp. 515–524, 2015.
- [35] L. A. Zadeh, "Fuzzy sets," *Information and Control*, vol. 8, no. 3, pp. 338–353, 1965.
- [36] T. Mahmood, U. Ur Rehman, Z. Ali, and T. Mahmood, "Hybrid vector similarity measures based on complex hesitant

- fuzzy sets and their applications to pattern recognition and medical diagnosis,” *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 1, pp. 625–646, 2021.
- [37] T. Chen, D. Shen, Y. Jin et al., “Comprehensive evaluation of environ-economic benefits of anaerobic digestion technology in an integrated food waste-based methane plant using a fuzzy mathematical model,” *Applied Energy*, vol. 208, pp. 666–677, 2017.
- [38] T. Mahmood, U. Ur Rehman, Z. Ali, and R. Chinram, “Jaccard and dice similarity measures based on novel complex dual hesitant fuzzy sets and their applications,” *Mathematical Problems in Engineering*, vol. 2020, Article ID 5920432, 25 pages, 2020.
- [39] J. Močkoř and D. Hýnar, “On unification of methods in theories of fuzzy sets, hesitant fuzzy set, fuzzy soft sets and intuitionistic fuzzy sets,” *Mathematics*, vol. 9, no. 4, 2021.
- [40] E. Gomez-Herrera, B. Martens, and G. Turlea, “The drivers and impediments for cross-border e-commerce in the EU,” *Information Economics and Policy*, vol. 28, pp. 83–96, 2014.
- [41] B. Van Heel, V. Lukic, and E. Leeuwis, *Cross-Border E-Commerce Makes the World Flatter*, The Boston Consulting Group, Boston, MA, USA, 2014.
- [42] Y. Shi, T. Wang, and L. C. Alwan, “Analytics for cross-border e-commerce: inventory risk management of an online fashion retailer,” *Decision Sciences*, vol. 51, no. 6, pp. 1347–1376, 2020.
- [43] M. Nuruzzaman and A. N. Weber, “Supply chain in cross-border E-commerce,” *Cross-Border E-Commerce Marketing and Management*, IGI Global, Hershey, PA, USA, 2021.
- [44] W. Yu, W. Yi, and L. Soo Hee, “The effect of cross-border e-commerce on China’s international trade: an empirical study based on transaction cost analysis,” *Sustainability*, vol. 9, no. 11, pp. 1–13, 2016.
- [45] R. Shuyun, C. Tsan-Ming, L. Ka-Man, and L. Lin, “Intelligent service capacity allocation for cross-border-E-commerce related third-party-forwarding logistics operations: a deep learning approach,” *Transportation Research Part E*, vol. 134, pp. 1–19, 2020.
- [46] M. Shuzhong, C. Yuxi, and Z. Hongsheng, “Rise of cross-border E-commerce exports in China,” *China and World Economy*, vol. 26, no. 3, pp. 63–87, 2018.
- [47] H. Bux, Z. Zhang, and N. Ahmad, “Promoting sustainability through corporate social responsibility implementation in the manufacturing industry: an empirical analysis of barriers using the ISM-MICMAC approach,” *Corporate Social Responsibility and Environmental Management*, vol. 27, no. 4, pp. 1729–1748, 2020.