A Study on Risk Measurement of Logistics in International Trade: A Case Study of the RCEP Countries

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Abstract: International trade can be severely disrupted by failures in international logistics processes. Therefore, an understanding of international logistics risk is imperative for the smooth operation of international trade, systematically studying the causes, responsible parties, and possible consequences of international logistics risk. On this basis, international logistics risk is classified from the perspective of the consequences caused by logistics risk, combined with the influencing factors and types of risk, establishing the index system and evaluation model of international logistics risk; Fuzzy Comprehensive Evaluation (FCE) and Analytic Hierarchy Process (AHP) methods were used to evaluate international logistics risk, and the international logistics risk in the international trade of the Regional Comprehensive Economic Partnership (RCEP) is also discussed. The results show that generally, international logistics risks are mainly logistics loss risk, logistics cost risk, and logistics timeliness risk. The logistics risks in the transaction with RCEP mainly include logistics loss risk, logistics cost risk, logistics timeliness risk, environmental risk, and logistics information risk. The risk causes include five risks: general causes, accidents, bankruptcy or ultra vires of logistics companies, customs clearance problems, and cargo characteristics. By establishing the international logistics risk measurement index system, it can hopefully play a preventive and guiding role in the research of international logistics risk assessment and the international logistics risk management of RCEP enterprises.

Keywords: international logistics; RCEP; logistics risks; AHP

1. Introduction

Since 7 September 2013, China has had more trade exchanges with many countries than before. In 2013–2019, China has a total trade volume of over USD 7.8 trillion, with a direct investment of about USD 11 billion to countries along the Belt and Road. In particular, by the end of January 2021, 140 countries and 31 international organizations had signed 205 “Belt and Road Initiative” cooperation documents with China. On 15 November 2020, the signing of the Regional Comprehensive Economic Partnership (RCEP) marked the official launch of the free trade zone with the largest population, the largest economic and trade scale, and the most development potential in the world.

As an important support of international trade, international logistics also faces greater challenges. Moreover, compared with domestic logistics, international logistics business has long transportation time, long distance, many links, and complex environments along the way, which leads to a significant increase in logistics costs; the quality of logistics services cannot be guaranteed, the possibility of goods damage and loss increases [1], and it is also more vulnerable [2]. Due to the globalization of the supply chain, the change of product life cycle, multi-variety, and low-volume production, as well as the rapid change of market environment and technical level, the types and frequencies of risks faced by enterprises are increasing, resulting in more uncertainties and risks in international logistics [3]. In order to survive the fierce competition, it is difficult for enterprises to
maintain their competitiveness only by their own ability. Therefore, logistics outsourcing is booming. In particular, a logistics center or transportation equipment are difficult to maintain overseas, and the proportion of logistics outsourcing is larger, but due to the complex international logistics environment and many inevitable uncertainties, the international logistics risks increase. There were 139 cases of major losses in international trade caused by major logistics accidents collected, including 31 cases of total loss of goods. For example, on 4 August 2015, the goods of Rongfeng Company were all lost in an explosion accident, covering the loss value of USD 157,810 (Tianjin Maritime Court of PRC 2018). In August 2016, Shenzhen Longxing Agricultural Technology Co., Ltd. exported a batch of vegetables and fruits because of a serious overrun on the way of sea, with a loss of USD 32,092.50 (Guangzhou Maritime Court of PRC 2019). It is particularly important to correctly identify and accurately evaluate the logistics risks in international trade [3].

RCEP partner countries have relatively large space for international economic and trade cooperation [4], which also generates more demand for international logistics. There are many types of RCEP partner countries, including developed and developing countries, so there are great differences in logistics levels among them [5], but there are few studies on relevant international logistics of RCEP partner countries at present. There are many studies on international supply chain risk, and there are relatively few studies on international logistics risk [6]. Therefore, this study attempts to establish an international logistics risk evaluation index system and takes RCEP partner countries as a case study, hoping to make some contributions to the research of international logistics risk and play a preventive role in the international logistics risk management of enterprise international trade, especially in cooperation with RCEP partners.

The remainder of this study is as follows. In Section 2, the relevant previous literature is reviewed. Section 3 presents the methodology framework and data utilized in the study. Some analysis results about international logistics risk indicators, and a logistics risk assessment model in international trade is shown in Section 4. Section 5 proposes appropriate conclusions and policy recommendations.

2. Literature Review

In 1901, American scholar Willet first pointed out that risk is the objective manifestation of uncertainty about unwilling events [7]. Zhu S. Z. (2002) pointed out that risk refers to the losses and possible losses suffered by the subject due to the uncertainty of various events under certain conditions and periods [8]. Risk management has experienced three stages: traditional risk management, modern risk management, and comprehensive risk management. In particular, the comprehensive risk management framework of COSO (Committee of Sponsoring Organization) has a great impact on corporate risk management. It can be summarized as global risk management system, comprehensive risk management scope, whole staff risk management culture, whole process risk management flow, new risk management methods, and comprehensive risk measurement. In addition, it has three dimensions: the first is the objective dimension of risk management, the second is the element dimension of risk management, and the third is the organizational dimension of the enterprises. It is generally believed that risk management is the level of financial management and insurance management in enterprise operation management, focusing on the response and treatment after occurrence [3]. The general risk management includes eliminating the uncertainty of investment business and financing, implementing diversification to hedge investment risks, coping with the possible situations, etc., which constitute the content of risk management. However, once the international logistics risk occurs, it will lead to huge losses, therefore, the goal of international logistics risk management is to go beyond the prevention of unpredictable risks, grasp the unpredictable situation as far as possible in advance, minimize the damage when risks occur, and minimize the impact on commercial activities [9]. Its purpose is to predict and prevent the problems that occur or may occur in logistics activities, rather than management after they occur.
Since the 1990s, international logistics has been highly valued by researchers and practitioners. As the international logistics operational risks are involved in many regions and countries, the environment is complicated, the geographical area is large and the logistics has many links; therefore, compared with domestic logistics, the operation is more difficult and has more risks as well [10]. In order to efficiently deal with the changes of the market environment caused by the changes of international logistics environment, supply chain risk management has attracted the attention of many researchers [11]. Solving the uncertain logistics problems in the global network is very important to the success of the whole supply chain [12]. In the large and complex organization of supply chain, any part of the problem will lead to a “domino”-like chain reaction, and the consequences of the problems of transnational supply chain are even more disastrous [13]. Therefore, accurate risk assessment is the premise to ensure the stable and reliable development of international trade. The study found that at present, many international logistics enterprises lack theoretical basis and scientific evaluation methods in risk assessment. Managers simply analyze the risk factors faced by enterprises according to their previous experiences, rather than collect, count, or analyze specific data, and then adopt a single risk transfer way of insurance according to the limited insurable risk types provided by the insurance companies; it is hoped that certain economic compensation can be obtained after the risk occurs, but for other uncertain risks or uninsured risks, the probability and loss of these risks cannot be determined due to the lack of detailed quantitative analysis and estimation, so most companies can only retain these risks and bear their future losses [14]. Without adequate risk assessment, relevant proactive planning and mitigation strategies are based on a shaky foundation [13]. Although it is obvious that international logistics risks need to be assessed, the research on establishing risk assessment models that can be widely used is still limited, the current research usually focuses on the mitigation and response of international logistics risks, and there is a lack of risk assessment process to support active planning [15].

For risk assessment methods, there are mainly qualitative and quantitative methods [16]. Qualitative methods mainly include the questionnaire survey and expert evaluation method, Delphi method, and AHP. Quantitative methods mainly include Fuzzy Comprehensive Evaluation, rough set, maximum entropy, GRA risk assessment, weighted comprehensive evaluation, failure tree assessment, event tree evaluation, Markov method, Bayesian method, etc. The reason for describing international logistics risk is a difficult problem because it has a comprehensive risk source, it is more complex to describe the risk through a series of events in the modeling process, and the probability of various basic risk events is difficult to collect and estimate; in addition, the changeable international logistics environment and the specific risk preference of managers may lead to different evaluation standards [6], as some common methods are not suitable for the risk analysis of international logistics [17]. In this case, it is necessary to propose a risk analysis method that can deal with multi factors and fuzziness combined with quantitative analysis. In particular, it is more practical to quantify the experienced judges of decision-makers or solve the complicated structure under the situations that are lack of necessary data [6]. In the multi-criteria decision making (MCDM) problem, some data may be quantitative and can be determined objectively, decision makers can use the existing methods for comparison. However, there are also some data that need to be determined subjectively. Therefore, it is a great challenge for decision makers to include and evaluate these intangible parameters. In order to solve this problem, Saaty (1980) proposed the Analytic Hierarchy Process (AHP), which is an excellent tool to help people make decisions [3]; it is a practical decision-making method, which can deal with uncertain, imprecise, and subjective data, and has robustness in solving the actual ranking problem; thus, Fuzzy Comprehensive Evaluation (FCE) was frequently discussed in multi-discipline [18], and it is also a common method to analyze risk [19]. The combination method of FCE and AHP has also been used by scholars in risk analysis [20–22].
In addition, the exiting research generally has three main methods for the classification and index system of international logistics risk. The first is to classify risks according to their sources [3], the second is divided according to the logistics process, and the third is to divide it into customer credit risk, logistics company’s own responsibility risk, external property right risk, and maritime risk. However, few studies have classified international logistics risks from the perspective of the consequences of logistics risks and directly linked the risk categories and influencing factors. Yet, from the perspective of enterprises, the division of risk consequences will help enterprises make better risk decision-making and management, and the direct connection between influencing factors and international logistics risk types will help enterprises better prevent risks. Therefore, it is necessary and feasible to establish a set of appropriate index system and evaluation model of international logistics risk, and use FCE and AHP to evaluate international logistics risk, so as to improve the level of international logistics risk management.

3. Methodology

Firstly, the literature related to international logistics risk was analyzed, and the logistics risk cases related to international trade were collected, then the classification and index system of logistics risk in international trade were obtained from these. Next, the logistics risk measurement index system in international trade was obtained by using Fuzzy Comprehensive Evaluation method, and the empirical analysis was carried out by taking RCEP countries as an example.

3.1. Classification of International Trade Logistics Risk

The logistics risk cases related to international trade were collected, and considering the authenticity of the cases and the availability of information, 127 of the 139 cases selected by the research group come from the 10 maritime courts and the Supreme People’s Court in China. Of course, these cases can only represent more controversial international logistics cases, not all international logistics risks. After sorting out these cases, the time of the accidents, causes, responsible party, and consequences of the cases were analyzed. Combined with the above literature analysis, from the perspective of the consequences caused by risk accidents, the classification index of logistics risk in international trade was obtained.

3.2. Establishment of Index System

The basic process of Fuzzy Comprehensive Evaluation method is as follows [18]:

(1) Establish evaluation objects vector \( U \cdot U = \{U_1, U_2, \ldots, U_m\} \), where \( U_i \) represents the index and \( m \) represents the number of evaluation indexes.

(2) Establish evaluation hierarchy theory vector \( V \cdot V = \{v_1, v_2, \ldots, v_n\} \), where \( v_j \) represents the outcome of the \( j^{th} \) evaluation, \( j = 1, 2, \ldots, n \).

(3) Determine comprehensive weight \( A \cdot A = \{a_1, a_2, \ldots, a_n\} \), where \( a_i \) represents the weight of the \( i^{th} \) index, which satisfies the normalization and non-negative conditions, that is, \( \sum_{i=1}^{m} a_i = 1, a_i \geq 0, i = 1, 2, \ldots, m \). The weight can be obtained by subjective judgment method or by the method of determining membership degree. We selected the AHP to obtain the weight.

(4) Establish the single factor fuzzy relation matrix \( R \).

\[
R = \begin{bmatrix}
    r_{11} & r_{12} & \cdots & r_{1n} \\
    r_{21} & r_{22} & \cdots & r_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    r_{m1} & r_{m2} & \cdots & r_{mn}
\end{bmatrix}
\]

where \( r_{ij} \) represents the membership degree of a evaluated object to the hierarchical fuzzy subset \( v_j \) from the point of view of the index \( u_i \), \( R_i \) represents the performance result of
the evaluated object on a certain \( u_i \) index, and can also be referred to as a single-factor evaluation index matrix, which is a representation of the fuzzy relationship between the factor set \( U \) and the evaluation set \( V \).

(5) The Fuzzy Comprehensive Evaluation vector \( B \) can be obtained by the following model:

\[
B = A \cdot R = (a_1, a_2, \ldots, a_m)
\begin{bmatrix}
  r_{11} & r_{12} & \cdots & r_{1n} \\
  r_{21} & r_{22} & \cdots & r_{2n} \\
  \vdots & \vdots & \ddots & \vdots \\
  r_{m1} & r_{m2} & \cdots & r_{mn}
\end{bmatrix}
= (b_1, b_2, \ldots, b_n)
\]  

where \( b_j \) represents the membership degree of the evaluated object to the fuzzy subset element \( v_j \) of the evaluation grade as a whole.

4. Construction of Logistics Risk Assessment Model in International Trade

4.1. Risk Classification Indicators of International Trade Logistics

Through the statistics of the collected cases, it was found that from the perspective of risk sources, the logistics risk in international trade mainly come from trade objects, logistics companies, freight forwarders, environment, the characteristics of the goods themselves, external causes, and marine perils. From the perspective of the consequences of logistics risks in international trade, the main consequences include timeliness, loss of goods, increase in costs and expenses, information security, timeliness, and environmental risk. So, we established the international logistics risk evaluation index system as shown in Table 1, and the first-level indicators were set up from the possible consequences angle to influence the risk size of the first-level indicators to the possible larger factor as the corresponding second-level indicators.

<table>
<thead>
<tr>
<th>First-Level Indicators</th>
<th>Second-Level Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics Information Risk (( U_1 ))</td>
<td>Availability of Logistics Information (( U_{11} ))</td>
</tr>
<tr>
<td></td>
<td>Logistics Information Security (( U_{12} ))</td>
</tr>
<tr>
<td>Logistics Timeliness Risk (( U_2 ))</td>
<td>Order Processing Efficiency (( U_{21} ))</td>
</tr>
<tr>
<td></td>
<td>Transportation Efficiency (( U_{22} ))</td>
</tr>
<tr>
<td></td>
<td>Customs Clearance Efficiency (( U_{23} ))</td>
</tr>
<tr>
<td></td>
<td>Transfer Efficiency (( U_{24} ))</td>
</tr>
<tr>
<td></td>
<td>Trading Partners’ Credit (( U_{25} ))</td>
</tr>
<tr>
<td>Logistics Risk of International Capacity Cooperation (( U ))</td>
<td>Logistics Loss Risk (( U_3 ))</td>
</tr>
<tr>
<td></td>
<td>Characteristics of Goods (( U_{31} ))</td>
</tr>
<tr>
<td></td>
<td>Logistics Operation (( U_{32} ))</td>
</tr>
<tr>
<td></td>
<td>Natural Environment along the Way (( U_{33} ))</td>
</tr>
<tr>
<td></td>
<td>Social Environment along the Way (( U_{34} ))</td>
</tr>
<tr>
<td>Logistics Cost Risk (( U_4 ))</td>
<td>Economic Conditions (( U_{41} ))</td>
</tr>
<tr>
<td></td>
<td>Characteristics of Goods (( U_{42} ))</td>
</tr>
<tr>
<td></td>
<td>Complexity of Logistics Lines (( U_{43} ))</td>
</tr>
<tr>
<td></td>
<td>Trading Partners’ Credit (( U_{44} ))</td>
</tr>
<tr>
<td></td>
<td>Logistics Company Reliability (( U_{45} ))</td>
</tr>
<tr>
<td></td>
<td>Freight Forwarder Reliability (( U_{46} ))</td>
</tr>
<tr>
<td>Environmental Risk (( U_5 ))</td>
<td>Characteristics of Goods (( U_{51} ))</td>
</tr>
<tr>
<td></td>
<td>Trading Partners’ Credit (( U_{52} ))</td>
</tr>
<tr>
<td></td>
<td>Natural Environment along the Way (( U_{53} ))</td>
</tr>
<tr>
<td></td>
<td>Logistics Operation (( U_{54} ))</td>
</tr>
</tbody>
</table>

Here, logistics information risk refers to the inaccuracy, lag, and other adverse consequences of information caused by information asymmetry and serious information pollution in the process of international logistics. Logistics timelines risk refers to the risk
of transportation delay caused by customs clearance, distribution, transportation, partner credit, and other reasons. Logistics loss risk refers to the risk of goods damage and shortage due to characteristics of goods, logistics operation, natural environment along the way, social environment along the way, and other reasons. Logistics cost risk refers to the risk of rising logistics costs and other costs caused by economic conditions, characteristics of goods, complexity of logistics lines, trading partners’ credit, logistics company reliability, freight forwarder reliability, and other reasons. Environmental risk refers to the risk of environmental pollution caused by characteristics of goods, trading partners’ credit, natural environment along the way, logistics operation, and other reasons.

4.2. The Construction of Logistics Risk Evaluation Model Based on Fuzzy Comprehensive Evaluation

Aiming at the logistics risk classification index in international trade, Fuzzy Comprehensive Evaluation method was used to established the logistics risk assessment model in international trade.

(1) Establish evaluation objects vector \( U \).

\( U \), \( U_i \) and \( U_{ij} \) were set as shown in Table 1.

(2) Establish evaluation hierarchy theory vector \( V \).

\( V = \{v_1, v_2, v_3, v_4, v_5\} = \{\text{the risk is very small}, \text{the risk is small}, \text{the risk is general}, \text{the risk is big}, \text{the risk is very big}\} \).

(3) Determine comprehensive weight vector \( A \).

The evaluation matrix was obtained by expert scoring method, the weight was determined by AHP, and the results are shown in Table 2.

Table 2. Weight coefficient.

<table>
<thead>
<tr>
<th>First-Level Indicators</th>
<th>Weight A</th>
<th>Second-Level Indicators</th>
<th>Weight A_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logistics Information Risk</td>
<td>0.0533</td>
<td>Availability of Logistics Information (( U_{11} ))</td>
<td>0.2500</td>
</tr>
<tr>
<td>( (U_1) )</td>
<td></td>
<td>Logistics Information Security (( U_{12} ))</td>
<td>0.7500</td>
</tr>
<tr>
<td>Logistics Timeliness Risk</td>
<td>0.1161</td>
<td>Order Processing Efficiency (( U_{21} ))</td>
<td>0.0646</td>
</tr>
<tr>
<td>( (U_2) )</td>
<td></td>
<td>Transportation Efficiency (( U_{22} ))</td>
<td>0.2974</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Customs Clearance Efficiency (( U_{23} ))</td>
<td>0.1621</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transfer Efficiency (( U_{24} ))</td>
<td>0.1512</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trading Partners’ Credit (( U_{25} ))</td>
<td>0.3247</td>
</tr>
<tr>
<td>Logistics Loss Risk</td>
<td>0.3213</td>
<td>Characteristics of Goods (( U_{31} ))</td>
<td>0.1357</td>
</tr>
<tr>
<td>( (U_3) )</td>
<td></td>
<td>Logistics Operation (( U_{32} ))</td>
<td>0.4215</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natural Environment along the Way (( U_{33} ))</td>
<td>0.3468</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Social Environment along the Way (( U_{34} ))</td>
<td>0.0960</td>
</tr>
<tr>
<td>Logistics Cost Risk</td>
<td>0.1880</td>
<td>Economic conditions (( U_{41} ))</td>
<td>0.0486</td>
</tr>
<tr>
<td>( (U_4) )</td>
<td></td>
<td>Characteristics of Goods (( U_{42} ))</td>
<td>0.1345</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complexity of Logistics Lines (( U_{43} ))</td>
<td>0.1231</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trading Partners’ Credit (( U_{44} ))</td>
<td>0.3111</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Logistics Company Reliability (( U_{45} ))</td>
<td>0.3111</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Freight Forwarder Reliability (( U_{46} ))</td>
<td>0.0716</td>
</tr>
<tr>
<td>Environmental Risk</td>
<td>0.3213</td>
<td>Characteristics of Goods (( U_{51} ))</td>
<td>0.3636</td>
</tr>
<tr>
<td>( (U_5) )</td>
<td></td>
<td>Trading Partners’ Credit (( U_{52} ))</td>
<td>0.0909</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Natural Environment along the Way (( U_{53} ))</td>
<td>0.1818</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Logistics Operation (( U_{54} ))</td>
<td>0.3636</td>
</tr>
</tbody>
</table>

That is,

\[
A_1 = [0.25, 0.75],
A_2 = [0.0646, 0.2974, 0.1621, 0.1512, 0.3247],
A_3 = [0.1357, 0.4215, 0.3468, 0.0960],
A_4 = [0.0486, 0.1345, 0.1231, 0.3111, 0.3111, 0.0716],
A_5 = [0.3636, 0.0909, 0.1818, 0.3636],
A = [0.0533, 0.1161, 0.3213, 0.1880, 0.3213].
\]
(4) Establish fuzzy relation matrix $R$.
Thirteen experts were invited to fill in a questionnaire on the international logistics risk in international trade.

The score status of the questionnaire was counted, and $r_{ij}$, the ratio of the number of $u_{ij}$ subordinated to the evaluation set $V$ to the total number of effective questionnaires was obtained, using the Fuzzy Comprehensive Evaluation method to obtain the evaluation matrices of each indicator.

$$R_1 = \begin{bmatrix} 0.0769 & 0.3077 & 0.4615 & 0.1538 & 0 \\ 0 & 0.3077 & 0.3077 & 0.3846 & 0 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.2308 & 0.2308 & 0.3077 & 0.2308 & 0 \\ 0 & 0.1538 & 0.0769 & 0.7692 & 0 \\ 0.0769 & 0.1538 & 0.4615 & 0.3077 & 0 \\ 0 & 0.0769 & 0.3846 & 0.5385 & 0 \\ 0 & 0.0769 & 0.1538 & 0.6932 & 0.0769 \end{bmatrix}$$

$$R_3 = \begin{bmatrix} 0.0769 & 0.3077 & 0.4615 & 0.1538 & 0 \\ 0 & 0.2038 & 0.5385 & 0.2308 & 0 \\ 0 & 0.1538 & 0.3846 & 0.3846 & 0.0769 \\ 0 & 0 & 0.3077 & 0.6154 & 0 \\ 0 & 0 & 0 & 0.3077 & 0.6154 \end{bmatrix}$$

$$R_4 = \begin{bmatrix} 0.0769 & 0.3077 & 0.4615 & 0.1538 & 0 \\ 0.0769 & 0.2308 & 0.1538 & 0.5385 & 0 \\ 0 & 0.0769 & 0.1538 & 0.6923 & 0.0769 \\ 0.0769 & 0.1538 & 0.2308 & 0.5385 & 0 \\ 0.0769 & 0.1538 & 0.2308 & 0.5385 & 0 \end{bmatrix}$$

$$R_5 = \begin{bmatrix} 0.0769 & 0.3077 & 0.4615 & 0.1538 & 0 \\ 0 & 0.0769 & 0.1538 & 0.6932 & 0.0769 \\ 0 & 0.1538 & 0.3846 & 0.3846 & 0.0769 \\ 0 & 0.2308 & 0.5385 & 0.2308 & 0 \end{bmatrix}$$

Then the evaluation results of the second-level indicators were obtained.

$$B_1 = A_1 \cdot R_1 = [0.0192, 0.3077, 0.3462, 0.3269, 0.0000]$$

$$B_2 = A_2 \cdot R_2 = [0.0274, 0.1222, 0.2257, 0.5998, 0.0250]$$

$$B_3 = A_3 \cdot R_3 = [0.0104, 0.1924, 0.4525, 0.3106, 0.0341]$$

$$B_4 = A_4 \cdot R_4 = [0.0253, 0.1526, 0.2598, 0.5383, 0.0239]$$

$$B_5 = A_5 \cdot R_5 = [0.0280, 0.2308, 0.4476, 0.2727, 0.0210]$$

Therefore, the evaluation matrix of the second-level indicators is:

$$R = [B_1, B_2, B_3, B_4, B_5]^T = \begin{bmatrix} 0.0192 & 0.3077 & 0.3462 & 0.3269 & 0 \\ 0.0274 & 0.1222 & 0.2257 & 0.5998 & 0.0250 \\ 0.0104 & 0.1924 & 0.4525 & 0.3106 & 0.0341 \\ 0.0253 & 0.1526 & 0.2598 & 0.5383 & 0.0239 \\ 0.0280 & 0.2308 & 0.4476 & 0.2727 & 0.0210 \end{bmatrix}$$

(5) Evaluation matrix of first-level indicators.
The evaluation matrix of the first-level indicators is as follows:

$$A \cdot R = [0.0213, 0.1952, 0.3827, 0.3757, 0.0251]$$

(6) Determine the Fuzzy Comprehensive Evaluation vector $B$.

$$B = A \cdot R = [0.0213, 0.1952, 0.3827, 0.3757, 0.0251]$$
The international logistics risks faced by enterprises in international trade are in turn: logistics loss risk, logistics cost risk, logistics timeliness risk, environmental risk, and logistics information risk.

4.3. Empirical Analysis

According to the logistics dispute cases that were collected, the proportion of import and export is 65:74, close to 1:1. The stage of the accident, mainly in transit and destination, accounted for nearly 90%. The main consequences caused by the accident are the loss of logistics, the loss of expenses, and the increase in logistics cost, accounting for 93.5%; the total loss of goods accident reached more than 1/5, and the rest is mainly the impact on the timeliness of logistics (see Figure 1). This is also in line with the above, in international trade, the main risks are logistics loss risk, logistics cost risk, and logistics timeliness risk.

![Figure 1. The consequences caused by accidents.](image)

As can be seen from Figure 1, there are 69 cases involving total loss and partial loss, 61 cases involving cost loss, and 9 cases involving timeliness; they are sorted according to the order of the number of events, which is in line with the above research results; among the international logistics risks, the top three risks are logistics loss risk, logistics cost risk, and logistics timeliness risk, of course, this is not to say that the cases of environmental risk and logistics information risk have not occurred; in fact, we can often see some cases of environmental pollution caused by goods leakage and cases of damage to one party due to credit problems, but the cases in our study are cases involving large amounts of money, and the parties cannot reach a preliminary settlement, which are solved through various maritime courts. However, this also proves that these three types of risks are the risks that need to be paid attention to in international logistics.

The main causes of these accidents are: general causes and accidents (accounting for 43.2%), logistics company fails or exceeds its authority (nearly accounting for 1/3), credit problems of trading partners (accounting for 13.7%), and other causes, including...
natural calamities, customs clearance problems, and characteristics of the goods themselves, accounting for 8.6% (see Figure 2).

Figure 2. The main causes of accidents.

Among them, the main consequences of general causes and accidents, which are the first ranking factors, include goods loss, cost increase, and timeliness, that is, corresponding to the above-mentioned top three logistics loss risk, logistics cost risk, and logistics timeliness risk; a logistics company that fails or exceeds its authority will also lead to an increase in these three risks. Credit problems of trading partners usually lead to timeliness problems, increased costs and environmental risks. Natural calamities mainly cause goods losses and environmental problems. The characteristics of goods mainly bring goods losses, increased costs, and environmental problems. Customs clearance efficiency mainly affects timeliness.

In addition, through the observation of the cases, it was found that the main causes of logistics cost risk accidents are delivery without bills of lading and credit problems of trading partners, accounting for 83.78%. This also conforms to the above index system. In the second-level indicators ranking of logistics cost risk, the top three are trading partners' credit, economic conditions, and logistics company reliability. The cost increase caused by economic conditions usually does not cause legal disputes. The main causes of logistics loss risk accidents are external causes and maritime risks, accounting for 76.92%. This is also in line with the above index system. In the second-level index system of logistics loss risk, the top three are social environment along the way, natural environment along the way and logistics operation. The main causes of logistics timeliness risk accidents are the credit problems of logistics companies, external causes, and maritime perils, as well as the trading partners’ credit problems. This is also in line with the aforementioned index system. In the ranking of logistics loss risk’s second-level index system, the top three are trading partners’ credit, transportation efficiency, and transfer efficiency. Of course, since the number of cases in this part is relatively small, accounting for only 9% of the total number of cases, the ranking of risk causes is not necessarily consistent with the actual situation.

In addition, there are few cases of environmental risk accidents that cause legal disputes. However, once it happens, the impact is still relatively large. For example, on
On August 14, 2013, the “TRANS SUMMER” ship was loaded with more than 50,000 tons of nickel ore from Indonesia to the port of Yangjiang, Guangdong, and sank during the anti-typhoon process in the south water area of the Pearl River Estuary. The oil spilled from the ship into the sea, resulting in the nearby port pool of Dawanshan Island, the coastline of surrounding islands, Nansha Bay Beach, surrounding fishing and breeding facilities, and peripheral waters being affected by different degrees of pollution; the direct economic loss of the accident was estimated to be more than RMB 140 million (Guangzhou Maritime Court of PRC 2017).

The same is true for logistics information risk, which may even result in scrapping the goods. For example, in 2016, during the shipment process of the goods of DLS Shenzhen Branch, it was found that the container box of the goods was damaged. According to a preliminary investigation, the damage may have been caused by the operation equipment. As the goods were bonded goods for processing trade, they need to be scrapped out of the country according to the regulations of the customs; as the goods involve the confidentiality of the company’s customers, they must be smashed and scrapped (Guangzhou Maritime Court of PRC 2018).

4.4. Logistics Risk in International Trade with RCEP Countries

Among the cases, there are 38 risk cases related to RCEP countries, accounting for 27.3% of the total cases, involving 10 countries of RCEP partners, namely Australia, Philippines, Korea, Malaysia, Japan, Thailand, Singapore, New Zealand, Indonesia, and Vietnam. The number of cases involved, venture enterprises, and risk consequences are shown in Table 3.

<table>
<thead>
<tr>
<th>RCEP Countries</th>
<th>Numbers</th>
<th>The Main Causes of Accidents</th>
<th>The Consequences Caused by Accidents</th>
<th>Trade Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Zealand</td>
<td>1</td>
<td>general causes</td>
<td>total loss</td>
<td>import</td>
</tr>
<tr>
<td>Singapore</td>
<td>1</td>
<td>characteristics of the goods themselves</td>
<td>cost loss</td>
<td>import</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1</td>
<td>logistics company fails or exceeds its authority</td>
<td>cost loss</td>
<td>import</td>
</tr>
<tr>
<td>Australia</td>
<td>2</td>
<td>customs clearance problems, logistics company fails or exceeds its authority</td>
<td>cost loss</td>
<td>import, export</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2</td>
<td>logistics company fails or exceeds its authority, accidents</td>
<td>total loss, cost loss</td>
<td>import, export</td>
</tr>
<tr>
<td>Philippines</td>
<td>3</td>
<td>general causes, logistics company fails or exceeds its authority, characteristics of the goods themselves</td>
<td>partial loss, timeliness, cost loss</td>
<td>import</td>
</tr>
<tr>
<td>Thailand</td>
<td>3</td>
<td>general causes, accidents, logistics company fails or exceeds its authority</td>
<td>partial loss</td>
<td>import, export</td>
</tr>
<tr>
<td>Japan</td>
<td>4</td>
<td>general causes, accidents, logistics company fails or exceeds its authority</td>
<td>total loss, partial loss</td>
<td>import, export</td>
</tr>
<tr>
<td>Korea</td>
<td>7</td>
<td>general causes, accidents, logistics company fails or exceeds its authority</td>
<td>total loss, partial loss, cost loss</td>
<td>import, export</td>
</tr>
<tr>
<td>Indonesia</td>
<td>14</td>
<td>general causes, accidents, logistics company fails or exceeds its authority, customs clearance problems</td>
<td>total loss, increase in logistics cost, timeliness, partial loss</td>
<td>import, export</td>
</tr>
</tbody>
</table>

As can be seen from Table 3, in general, the main types of logistics risks in the process of trading with RCEP involve logistics loss risk (24), logistics cost risk (11), logistics timeliness risk (3), and the risk causes also include the five risks mentioned above: general causes, accidents, logistics company fails or exceeds its authority, customs clearance problems, and characteristics of the goods. Among them, accidents accounted for 36.8%, followed by the responsibility of logistics companies, accounting for 31.5%. As far as losses are concerned, there were as many as 14 times of total losses, accounting for 36.8% of all accidents, followed by partial losses, accounting for 11 times (28.96%). Accidents were mainly concentrated in the transportation and the port of destination, accounting for 52.5%
and 44.7%, respectively. As far as a specific country was concerned, Indonesia had the most logistics risks in its trade with China. The main causes of the risks were general reasons, accidents, logistics companies’ failing to perform their duties or exceeding their authority, and customs clearance problems. The second was Korea, where the main reasons for the risk were general reasons, accidents, and logistics companies’ failing to perform their duties or exceeding their authority.

5. Conclusions and Discussion

This paper classifies and evaluates international logistics risks from the perspective of international logistics risk consequences, analyzes the influencing factors of various risks, makes enterprises have a clear understanding of international logistics risks more intuitively, helps those international logistics operations that often lose tens of millions of dollars to recover some losses, and ranks international logistics risks through FCE and AHP methods, it was found that the international logistics risks faced by enterprises in international trade include logistics loss risk, logistics cost risk, logistics timeliness risk, environmental risk and logistics information risk. Among them, the factors affecting the logistics loss risk include the social environment along the way, the natural environment along the way, the logistics operation and the characteristics of goods. The factors affecting logistics cost risk include the credit of trading partners, economic conditions, reliability of logistics companies, reliability of freight forwarders, complexity of logistics lines, and characteristics of goods. The factors affecting logistics timeliness risk include trading partners’ credit, transportation efficiency, transfer efficiency, customs clearance efficiency, and order processing efficiency. The factors affecting environmental risk include the credit of trading partners, the natural environment along the way, logistics operation and the characteristics of goods. The factors affecting logistics information risk are logistics information security, and logistics information availability. Therefore, in order to prevent international logistics risks, enterprises should also pay attention to these factors and take corresponding preventive measures, such as increasing the investigation of trading partners, logistics companies and freight forwarding companies, risk transfer through insurance, etc. At the same time, enterprises also need to establish a comprehensive risk management system. From the perspective of comprehensive risk management framework, it is necessary to establish a global risk management system, carry out comprehensive risk management, have the awareness of risk management of all staff, implement risk management in the whole process, and use new risk management methods to measure risks in full.

In terms of international logistics risks in trading with RCEP countries, first of all, the enterprises should pay attention to establishing reasonable risk management objectives, such as reducing losses or logistics costs. Secondly, the enterprises should pay attention to the elements of risk management, and focus on the factors that affect this kind of risk according to different objectives of logistics risk management. Third, they should set up a reasonable enterprise organization to manage the risk, as different levels have different risk management authority. For example, the corresponding risk management scheme is designed from the management level and the business level respectively. In particular, the companies should pay attention to the risks from accidents and cooperative logistics companies, and reduce the risks by buying insurance and cooperating with reputable international logistics companies.

The advantage of using FCE and AHP in international logistics risk assessment is that when it is difficult to obtain direct and objective data, it helps to find the weak links of international logistics and helps international logistics risk managers make decisions. When the limited resources are put into the place where they are most needed, the cost will be greatly reduced. However, although the method adopted in this paper adopts expert opinions as much as possible, it will also be affected by subjective factors, which will be the next step in this research work.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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