International Aviation Logistics Risk Identification and Assessment from Perspective of Consolidator Based on AHP

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Abstract. Given the effect of uncertainty, international aviation logistics faced many risks. How to identify and evaluate the risk degree of each link becomes the main problem in the international aviation logistics management. Based on the analysis of the causes of international aviation logistics risks, this paper constructs an international aviation logistics risk evaluation index system from the perspective of consolidators, and evaluates the risk degree of each link by using AHP. The effectiveness of the method is verified by typical cases. The research shows that this method has certain application value to the risk identification and evaluation of international aviation logistics.

Introduction

International aviation logistics is to meet the needs of customers, starting from the organization of the source of goods, through ground transportation, temporary storage, customs clearance and air transport and other operational links, and finally send the goods to the consignees. This process is a whole composed of freight forwarding enterprises, airport cargo station operators, air carriers and customers. From a broad perspective, international air logistics also involves the supervision of relevant government departments (customs, inspection, etc.).

Because international aviation logistics is a complex process involving many links, many objects and many contents, involving the connection and coordination of many subjects, the uncertainty or error of any link will bring risks to the whole logistics process. In addition, compared with domestic logistics, international aviation logistics has great differences in logistics environment, logistics system, information and standardization requirements. At the same time, due to the limitation of the technical and economic characteristics of air transport, it has many different influences on the carrying capacity, cargo collection and transportation, cargo packaging and safety standards in the logistics process. The uncertainty caused by the above reasons can lead to logistics risks under certain circumstances. Therefore, it is necessary to evaluate and identify the degree of risks faced by each link of international aviation logistics.

Up to now, the research on the risk of international aviation logistics mainly includes the risk research based on the macro environment [1]. Based on the accompanying international logistics risks from the perspective of international trade [2]; Research on risks brought by the nature of goods (special goods) to the logistics process [3-5]; It focuses on theoretical analysis, and there are few qualitative and quantitative studies. In addition, there is no study on the risk of international aviation logistics from the perspective of freight forwarder.

Risk Identification Based on AHP

Analytic hierarchy process (AHP), proposed by American operations research scientist T.L. Saaty in the 1970s, is a kind of multi-criteria decision-making method that transforms qualitative problems into quantitative analysis, and has been widely applied in many industries and fields [6]. The idea of analytic hierarchy process (AHP) is from decompose to synthesize, integrate the
subjective judgment of interviewees, organically combine the qualitative analysis with the quantitative analysis, and realize the quantitative decision. The core idea of this method is to put the problems need to be solved in the complex system that can be solved in the (target layer) is divided into several aspects (rule layer), and then put the rule layer of each problem is decomposed into each can get quantitative factors (index layer), a variety of complex problems associated factors to separate several levels and index, form the target hierarchy diagram; By comparing two ways to determine the relative importance of factors in the hierarchy, the judge on the comprehensive analysis of the experience, and give the relative importance of each evaluation factor, between each level of each index calculation, comparison, judgment, construct the judgment matrix, the weight of the resulting risk levels, and to judge the level of risk.

First, a judgment matrix is established to express the comparison of relative importance between the elements at this level and the relevant elements at the previous level. Judgment matrix is the basis of AHP method and also the basis for calculation of relative importance[7]. By pairwise comparison, the relative importance of an element at a higher level to related elements at a lower level can be obtained [7,8]. The result can be expressed as the judgment matrix $A = (a_{ij})_{n \times n}$.

| Level of scale | relative importance       |
|---------------|--------------------------|
| 1             | $A_i$ is as important as $A_j$ |
| 3             | $A_i$ is slightly more important than $A_j$ |
| 5             | $A_i$ is more important than $A_j$ |
| 7             | $A_i$ is obviously more important than $A_j$ |
| 9             | $A_i$ is extremely more important than $A_j$ |
| 2, 4, 6, 8    | Between adjacent odd Numbers |
| reciprocal    | $a_{ij} = 1, \ a_{ji} = \frac{1}{a_{ij}}, i, j = 1, 2 \cdots n$ |

Secondly, the maximum eigenvalue $\lambda_{\text{max}}$ of the judgment matrix and the corresponding eigenvector, namely weight vector $\omega$, are calculated.

The weight vector $\omega$ is calculated from the arithmetic mean of all the vectors

$$\omega_i = \frac{1}{n} \sum_{j=1}^{n} a_{ij}, i = 1, 2 \cdots n$$

Maximum eigenvalue:

$$\lambda_{\text{max}} = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{\omega_i} \sum_{j=1}^{n} a_{ij}\omega_j$$

Where, $\omega_i$ is the weight of index; $a_{ij}$ is a member of the judgment matrix; $\lambda_{\text{max}}$ is the largest
eigenvalue of the judgment matrix, \( \omega_j \) is the weight of the index \( j \).

Calculated consistency index \( CI \):

\[
CI = \frac{\lambda_{\text{max}} - n}{n - 1} \quad (n \text{ is the order of the judgment matrix})
\]

After the above process is completed, the random consistency index \( RI \) corresponding to the \( n \) order judgment matrix is searched in table 2.

| Order | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| \( RI \) | 0.00 | 0.00 | 0.52 | 0.89 | 1.12 | 1.25 | 1.35 | 1.42 | 1.46 | 1.49 |

Compute consistency ratio \( CR \):

\[
CR = \frac{CI}{RI}
\]

If \( CR < 0.1 \), Judgment matrix has consistency and the test passes.

Finally, do a total hierarchy sort. The comprehensive weight and consistency test are calculated, and finally the weight ranking of target layer is obtained[8].

Risk Links and Indicators of International Aviation Logistics

In a narrow sense, international aviation logistics refers to the aviation logistics services, to meet customer demand for the purpose, starting from the source organization, after the ground transportation services, airport cargo terminal services and air transport services operation link, clients from starting to destination, the goods by freight forwarders, ground transportation enterprise, airport freight department, air transport enterprise and the customer, etc as a whole. However, since international aviation logistics needs government supervision, from a broad perspective, the international aviation logistics service chain also includes the supervision services of relevant government departments (such as customs, etc.). From the point of main link and operation main body, the international aviation logistics can be seen as starts, cargo transportation plan to source organization, clearance, air transport, port, goods storage and distribution of a complete process, including the main links (subject) has accepted the goods transportation (freight enterprise), warehousing, customs supervision warehouse, customs clearance (authorities), loading and unloading and air (airport, airlines).

In the above links, the organization of goods sources, collection and transportation, warehousing and ground distribution under non-customs supervision and other activities can be controlled by the freight forwarding enterprise, that is, its risks can be adjusted or avoided actively according to its own resources or environment. However, customs supervision and inspection application belong to the government's responsibility, and freight forwarding enterprises are difficult to control and can only be passively adapted. Due to the limitation of technical and economic conditions, air transportation is often subject to uncertainties caused by bad weather, mechanical failure, non-compliance of cargo security check and flight changes. Therefore, the risks from the perspective of freight forwarding enterprises mainly come from customs clearance regulated by the government and air transport which cannot be controlled.

Therefore, in addition to the cargo collection and transportation links that can be controlled by
consolidators, the main possible risk links and factors involved in this process are shown in the following table 3.

Table 3. Risk links and indicators.

| the target layer | criteria layer (risk link) | indicator layer (risk factors) |
|------------------|---------------------------|--------------------------------|
| International aviation logistics risk from the perspective of consolidator (A) | customs clearance (B1) | declaration (C1) |
| | | inspection (C2) |
| | | tariffs (C3) |
| | | release (C4) |
| | airport security, loading and unloading and air transportation (B2) | irregular flight (C5) |
| | | abnormal transportation (C6) |
| | | sudden market change (C7) |

Select consolidators which run airlines between Guangzhou and African in Guangzhou area as the research object. The management and business personnel of the selected consolidators were surveyed with the indicators set in table 3. According to the questionnaire results, after calculation (no longer listed due to space limitation), the following results in table 4 were obtained through consistency test:

Table 4. Risk weight of each link.

| project | weight |
|---------|--------|
| impact of risks in the declaration link(C1-A) | 0.156 |
| impact of risks in the inspection link(C2-A) | 0.032 |
| impact of risks in the tariffs link(C3-A) | 0.053 |
| impact of risks in the release link(C4-A) | 0.122 |
| impact of risks by the irregular flight(C5-A) | 0.417 |
| impact of risks by abnormal transportation(C6-A) | 0.209 |
| impact of risks by sudden market change(C7-A) | 0.011 |

Based on the above results, the risk factors in each link have a great difference in the degree of risk impact on international aviation logistics. The top several factors are abnormal flights, abnormal transportation, customs clearance declaration and other links. The above results are highly consistent with the actual logistics activities.

Irregular flights are the biggest factor. In fact, there are few direct flights between China and Africa. According to the data in 2018, the direct flights between China and Africa are only those between Beijing, Shanghai, Chengdu and Ethiopia, Beijing and Johannesburg, Guangzhou and Nairobi and Cairo. The reason for the current situation is that Africa's economy is relatively underdeveloped, and the total amount of aviation logistics market between China and Africa is not large. However, these flights cannot support the demand of aviation logistics between China and Africa in some periods of time, especially in peak seasons, and the shipping space is difficult to control. Take the route from Guangzhou to a country in East Africa as an example. Except the B777-200F freighter every day, all other flights need transfer. The first flight space of transfer flight can basically meet the demand, the second flight space is generally more nervous in most cases, especially in the peak season. If there is an abnormal flight, almost the whole logistics line will be
paralyzed, which can only be relieved by the nearby Hong Kong airport or by sea transportation. However, it will increase the logistics time and link, complicate the logistics link, increase the time cost, increase the uncertainty and bring greater risks.

Another major risk is abnormal transportation. Due to the restriction of hardware and software facilities of the airport, the cargo loss and error rate of this route is always high, which is also a big risk in the logistics process. Limited by economic conditions, most African countries have imperfect electric power and communication infrastructure, and the logistics facilities and equipment of the main logistics destinations and airports are relatively backward. The penetration rate of mobile payment, intelligent terminal equipment and 4G network in ground transportation and distribution is not high. In addition, most residents and even some business customers in Africa do not have bank accounts, and are accustomed to the transaction mode of cash and goods in person, and lack of trust in non-cash payment and online transaction. As a result of the above reasons, when the goods arrive at the destination, the links that could be processed and operated by intelligent equipment still need manual or traditional operation. On the one hand, the timeliness of logistics is low; on the other hand, the error rate and cargo damage rate are also high.

The risk of customs clearance is also consistent with the actual situation. Most countries in Africa set up trade technical barriers—Verification of Conformity. That is to say, even if the product quality meets the local technical standards, it cannot enter the local market without relevant certificates. Only by obtaining the relevant documents can the importer clear the goods at the local customs and then obtain the goods. African countries on the installation of VoC is multifarious, such as Nigeria, SONCAP, Zimbabwe is CBCA, most countries in East Africa for PVoC, no unified standard, the requirements of different countries have differences, which leads to many traders are confusingly, air freight forwarders operator is confused, make the goods didn't agree collector stage often appear file to the destination after customs clearance, cause customs clearance delay or mistake. In Guangzhou to a country in East Africa, for example, the country's 124 national mandatory standards (CES) and requires a mandatory product on the basis of the test and confirm the main items of conformity is the main object of Guangzhou with the country's aviation logistics: textiles, electronics, fine chemicals, and other products, because of VoC can't clearance, caused by clearance delay goods stranded also more common. For the above reasons, non-air logistics often encounter difficulties in customs clearance, which makes many air logistics service providers turn away.

Conclusions

Influenced by various factors such as international politics, economy and natural environment, international aviation logistics is often faced with a variety of risk factors, which pose a great threat to logistics activities. Scientific measurement and evaluation of risks in each link is an important prerequisite for effective risk control. However, the risk assessment of international aviation logistics is a multi-objective evaluation system, and the overall objective is difficult to be quantified. Freight enterprise under the perspective of international logistics risk identification and evaluation method of AHP to consider the freight enterprise cannot control of various main factors, can system comprehensively reflect the risk in the international aviation logistics, and the index system can be according to the actual situation of different routes or areas and improve the increase or decrease further, to the forwarding industry operators and managers to identify and assess the risks to provide the reference.
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