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Identification of key risk factors in port service supply chain based on factor analysis method

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Abstract: *On the basis of analyzing the connotation and structure of port service supply chain, this paper identify the exogenous and endogenous risks which include 30 events risk factors of 12 categories in the port service supply chain, analyzes the formation reason of risk by using the method of factor analysis, extracts four categories of key risk from the port service supply chain risk system, which are strategic risk, supply risk, cooperation risk and demand risk. It can provide decision-making basis for port logistics service supplier selection and optimization.*

Keywords: *factor analysis; port service supply chain; key risks*

Port logistics supply chain is the application of service supply chain in port field. Its concept was first put forward by Portuguese scholar Raul Lopez in 1998.On this basis, Tae-woo Lee, a Korean scholar, pointed out that the port service supply chain was different from the traditional manufacturing supply chain in 2003, and proposed the operation model diagram of the port service supply chain for the first time. According to Chinese scholars Yang Mingming (2006), Li Zhaokun (2010), Cao Linghai (2019) and Chen Donghui (2020), the concept of port service supply chain can be understood as: It is a complex network structure, of which the port is the core enterprise, the logistics service needs of the shipping company and owner's downstream is the starting point, the operation ability, running process, network information and service performance are effectively integrated, the upstream functional logistics service suppliers which provide transport, storage, loading and unloading, processing, distribution, information, finance and downstream customers are linked, providing the goods on time, on time, accurate delivery service for customers, and realizing the minimum cost of supply chain system.

Different from the production and sales in the product supply chain link, port is the demand of purchasing logistics service and logistics service integrator in the port service supply chain, and logistics providers who provide services such as warehousing, transportation, packaging, processing are functional logistics service provider in the port supply chain, the essence of which is a kind of pure logistics capability of supply chain cooperation and a cooperation network between port and upstream functional ability service providers and downstream customers.

1. Risk identification of port service supply chain

From the view of mechanism, the risk system of port service supply chain can be divided into two major categories: exogenous risks and endogenous risks, the former is related to the external environment of the port service supply chain, and it cannot be eliminated through the efforts of the supply chain itself, such as the congestion risk in the port caused by the strong winds and heavy fog weather, and the risk of freight rate fluctuation caused by the new crown outbreak, etc.; The latter is related to the internal structure, capacity management and cooperation relationship of the port service supply chain, such as the capital risk caused by the wrong strategic investment of the port, the ship can not berthing due to the insufficient water depth of the port, and the cargo damage and cargo difference caused by improper storage.The details are summarized in Table 1 below.

Table 1 Exogenous risk and endogenous risk factors of port service supply chain

	Primary risk factors	**Secondary risk factors**	**Tertiary risk factors**
Port service supply chain risk factors	Exogenous risk	Macroeconomic risks	Changes of industrial policy
			Fluctuation of exchange rate
			Fluctuation of interest rate
		Natural	Strong wind and fog weather

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		environmental risk	effect
			Impact of geological hazard
		Risk of competitive environment	Peer competition risk
			Service substitution risk
		Risk of demand fluctuation	Market forecast bias
			Service Price Variation
			Change in Capability Needs
		Shipping market risk	Rate fluctuation range
			Shortage of transport capacity
	Endogenous risk	Strategic Planning Risks	Positioning error of strategic plan
			Inconsistent strategic objectives
			Port strategic investment risk
		Infrastructure risk	Insufficient port handling equipment
			Insufficient harbor depth
			Insufficient area of wharf yard
		Risk of supply disruption	Supply quality risk
			Loss of key suppliers
		Service capacity risk	Port congestion level
			Improper storage measures
			Transportation accident
		Partnership Risks	Risk of Cooperation Ability
			Cooperative Performance Risks
			Partner default risk
		Moral trust risk	Trust risk
			Hidden behavioral risk
		Risk of information sharing	IT risk
			Degree of information sharing

2. Identification of key risks in port service supply chain

2.1 Questionnaire design and collection

According to the risk factors of 12 major items and 30 minor items in Table 1, the risk index system of port service supply chain was constructed and the questionnaire was designed. Questionnaire survey was carried out mainly through Email and field survey. A total of 163 questionnaires were sent out, 148 were received and returned, 146 were valid, and the effective recovery rate was 89.57%.SPSS software was used to conduct statistical analysis on the collected effective data. The higher is the score of a factor, the greater the potential risk caused by the factor in the port service supply chain.

2.2 Reliability and validity analysis

Firstly, the reliability analysis of statistical test was conducted to detect whether the score card recovered from the questionnaire was affected by measurement errors. KMO measurement is carried out on the scale of sample data obtained by SPSS software, and then factor analysis is carried out according to the statistical results to extract the key risk factors and risk variables of the port service supply chain. Cronbach coefficient of evaluation criteria was calculated. The results were shown in Table 2. The coefficient values of 30 risk factors were all greater than 0.7, meeting the minimum reasonable coefficient value standard.The results show that the risk factor scale and subscale designed in this questionnaire maintain a good level of internal consistency and have high reliability.

Validity test refers to reflecting the usefulness of measurement according to the correctness of measurement content. It is generally measured by structural validity. In terms of statistical test, structural validity is judged by the cumulative contribution rate and factor load amount obtained from factor analysis. As can be seen from the results in Table 2, there are 4 factors with eigenvalues greater than 2, which collectively explain 81.725% of the total variance. The first factor explains 42.748%, and the

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second factor explains that there is no common error. Further analysis of the square and load amount of the factors after rotation shows that the 4 major factors have a great contribution to the explanation of the total sample.This indicates that the design structure of the questionnaire has passed the validity test.

Table 2 Total variance results of 30 factors

factor	Eigenvalue			Sum of squares			Sum of squares after Rotating		
	A total of	% of the variance	Cumulative %	A total of	% of the variance	Cumulative %	A total of	% of the variance	Cumulative %
1	14.534	42.748	42.748	14.534	42.748	42.748	11.505	33.838	33.838
2	5.813	17.097	59.845	5.813	17.097	59.845	7.494	22.042	55.880
3	5.243	15.421	75.266	5.243	15.421	75.266	6.291	18.503	74.383
4	2.196	6.459	81.725	2.196	6.459	81.725	2.496	7.342	81.725
5	1.020	3.000	84.725						
6	652.	1.918	86.643						
...	...	....	....						
29	006.	019.	99.997						
30	001.	003.	100.000						

2.3 Factor analysis

After the statistical test, the importance of each risk index score data from the questionnaire is input SPSS software for factor analysis. 30 risk index is calculated separately by the correlation coefficient matrix characteristic root, variance contribution ratio of the risk factors and the cumulative contribution rate, calculation, founding that the first four risk factors of the 30 characteristic root value were 14.534, 5.813, 5.243 and 2.196, the characteristic root value is greater than 1.The variance ratio of the first risk factor reached 42.748% of the total variance, and the variance ratio of the 2/3/4 risk factor was 17.097%, 15.421% and 6.459%, respectively, and the cumulative variance contribution rate reached 81.725%. Further, the lithotripsy diagram of 30 factors was obtained. It was found that the first 4 factors showed a sharp and steep slope decline trend, which also indicated that the variance contribution of the 4 factors was large, while from the fifth factor, the steep slope tended to be flat with the contribution less than 1.Therefore, this paper considers extracting the first four factors with high contribution rates as the common factors of the sample.

After the factor analysis, the original 30 risk variables of the port service supply chain risk system with correlative degree can be expressed by 4 categories of key risk factors, which respectively explain 6.459%, 42.748%, 23.556% and 15.421% of the total sample, and collectively explain 81.725% of the total variance of the sample data. Thirdly, the load matrix of 30 factors by principal component method was calculated, and the orthogonal rotation method was used for rotation to obtain 30 factor load matrices. The sum of the squares of the four factors was calculated and the load amount also explained 81.725% of the total variance, which further verified the conclusion.

2.4 Determination of key risks

Combined with the factor load matrix, the 12 major items and 30 minor items of risk in Table 1 are classified.

(1) The first kind of key risks are collectively referred to "strategic risk", which mainly includes two risk variables: positioning error of strategic plan and Port strategic. This kind of risk is associated with the strategic planning of port service supply chain, the uncertainty of these factors will usually cause the change of the target customer of supply chain, the changes of supply chain supplier service type in internal structure.

(2) The second category of key risks are collectively referred to "supply risk", which mainly includes twelve risk variables: winds fog weather, the impact of geological hazard, supply quality risk, loss of key suppliers, supply capacity, insufficient wharf yard area, ports, water depth, port congestion degree, warehousing, port loading and unloading equipment due to improper safekeeping measures, inadequate, transport accident risk and information technology. These variables are associated with the service supply of port service supply chain, the uncertainty of these factors will usually cause delay or interruption of the supply chain.

(3) The third key risks are collectively referred to "cooperation risk", which mainly includes nine risk variables: the competing risk, inconsistent alternative risk, strategic goals, cooperation ability risk, performance risk, default risk, the degree of information sharing, trust risks and hidden risks. These risks are associated with port service cooperation between supply chain partners, the uncertainty of these risk

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factors usually cause port service supply chain rupture or dissolve,.

(4) The fourth class key risks are collectively referred to "demand risk", which mainly includes seven risk variables: the market forecast, the ability to demand change, the change of industrial policy, the change of service and price, price volatility risk, exchange rate volatility risk and interest rate risk. This kind of risk are associated with demand, often cause port logistics service demand fluctuations.

3. Conclusion

Based on factor analysis, this paper analyzes 30 events risk factors of 12 categories of port service supply chain comprehensively, and extracts four major risks in the construction process of port service supply chain: strategic risk, supply risk, cooperation risk and demand risk. Four different types of risks have different risk consequences and risk degrees on the selection of port service supply chain suppliers, which will provide decision-making basis for the selection and optimization of port logistics service suppliers in the next step.

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