Analysis of Influencing Factors of Air Side Industry of Logistics Core Hub Based on AHP Method

——Taking Hubei International Logistics Core Hub as an Example

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Abstract. The core hub of international logistics is an important part of the economic cycle, and its development is directly related to the success or failure of the economic double cycle. Taking Hubei International Logistics core hub as the research object, this paper adopts AHP method and entropy weight fuzzy comprehensive evaluation method to comprehensively analyze the international logistics demand conditions, international logistics production factors, international logistics related auxiliary conditions, opportunities and government, and constructs the evaluation index system of the core development capacity of logistics hub, which is calculated and analyzed in combination with statistical data, The results show that the comprehensive evaluation of Hubei International Logistics Port is at a medium level. By comparing with the traditional evaluation methods, it is found that the accuracy of AHP method is improved by 7.6%. This method provides a theoretical basis for exploring the development ideas of the core hub of international logistics.

Keywords: double-loop; entropy weight-fuzzy synthesis method; hubof Hubei international logistics core; development evaluation

1 Introduction

After China's entry into the WTO, economic globalization has further affected the development pattern of the domestic economy. With the development of world economic integration, the core international logistics hub can give full play to the advantages of the export port and maintain the logistics radiation ability of the riverside regions to the world.

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However, under the background of China's economic transformation cycle and the global technological innovation cycle (hereinafter referred to as the dual cycle), the development of the airside industry in the core international logistics hub is affected by many factors, and there is great ambiguity among these influencing factors.

2 Air cargo transportation is the short board of building a new development pattern of double cycle in China

2.1 Changes in traditional international trade transportation methods and rapid development of air cargo demand

The main mode of international trade transport is maritime transport, about 90% of China's total import and export freight is the use of maritime transport. The biggest problem of maritime transport is heavily dependent on import and export, due to the impact of the epidemic, the global industrial chain, supply chain is facing a major impact, import and export risks have increased. Based on the international situation and China's national conditions, China proposes to speed up the construction of a new development pattern with the domestic circulation as the mainstay and the domestic and international circulation promoting each other , and maritime transport is not suitable for the development requirements of "internal circulation as the mainstay".

As the demand for international transportation of high value-added and short delivery time products rises, and the disadvantages of slow traditional maritime transportation and high security risks become more and more obvious, leading to changes in traditional international trade transportation methods and rapid development of air cargo demand. 2021 China's express pieces volume 108.296 billion pieces, an increase of 29.9% over the previous year (2020), China's express delivery mainly relies on road transport, road The burden is increased, and the slowest transport speed, so we urgently need to increase the capacity of air cargo.

Table 1. 2017-2021 China express business volume changes

Year	Express business volume (Unit: billion pieces)	Year-on-year growth rate（Unit: %）
2017	1083	29.9
2018	833.6	31.2
2019	635.2	25.3
2020	507.1	26.6
2021	400.6	-

（Data from the State Post Office of the People's Republic of China）

Data show that the volume of air cargo accounted for about 1% of the total global trade, but the value of goods accounted for 35% of the total global trade, although air transport is not the most commonly used mode of transport, but its goods are mostly cell phones, chips and other high value-added products also make air cargo demand is strong, and air cargo speed, high security features in line with the current stage of transport requirements.

2.2 Rapid development of cross-border e-commerce

Global E-Commerce Retail Sales Growth Accelerates During COVID-19, Global retail e-commerce sales grow from $2.38 trillion to $4.87 trillion between 2017 and 2021, and will continue to grow at a faster rate in 2021-22. The e-commerce share of total global retail sales grows from 7.4% in 2015 to 18% in 2020. The scale of cross-border e-commerce transactions in China grew from 8.06 trillion yuan to 14.2 trillion yuan in 2017-2021, the degree of online foreign trade is rising, and the proportion of imports and exports accounted for by cross-border e-commerce is nearly 40%.With data showing that China's main imports and exports of apparel and textile articles, automatic data processing equipment and parts thereof, integrated circuits, and cell phones in 2020, there has been a large increase in goods suitable for air transport, thus Cross-border retail logistics requirements for timeliness and traceability have increased, leading to the growth in demand for air cargo logistics from cross-border e-commerce, and subsequently an increase in demand in the air cargo market.

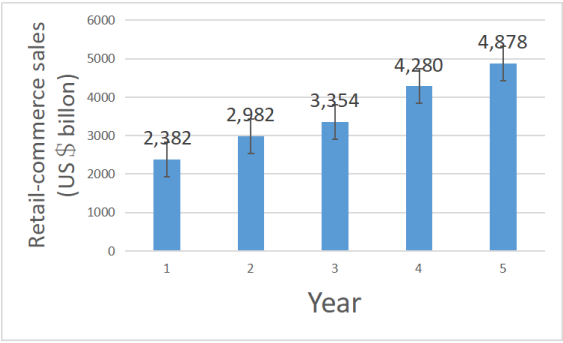

Fig. 1. Global e-commerce retail sales 2017-2021

（Data from WTO, e Marketer）

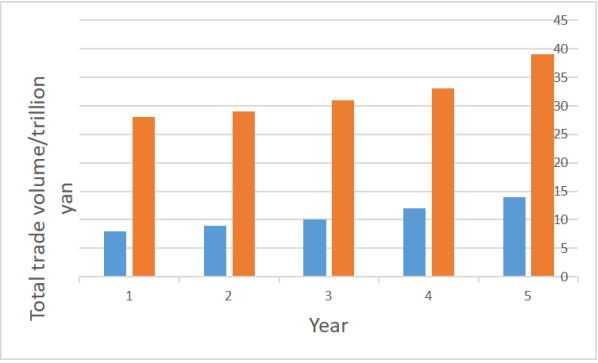

Fig. 2. China's total import and export trade and cross-border e-commerce transaction scale, 2017-2021

（Data from the General Administration of Customs, e-commerce research center of the Net）

Table 2. China's top 10 major import and export commodity categories in 2020.

Commodity composition (by SITC classification)		Export	Import
		January - December	January - December
Electric machinery, apparatus and its electrical parts	Amount (thousand USD)	395,821,434	476,900,665
	Growth rate (%)	11.0	11.6
Telecommunications and sound recording and playback equipment	Amount (thousand USD)	310,365,379	67,012,298
	Growth rate (%)	1.5	3.0
Office machinery and automatic data processing equipment	Amount (thousand USD)	217,426,177	59,431,407
	Growth rate (%)	8.9	4.7
Miscellaneous products	Amount (thousand USD)	186,006,626	26,785,364
	Growth rate (%)	6.0	-1.3
Spinning, fabric, finished goods and related products	Amount (thousand USD)	154,186,508	14,151,985
	Growth rate (%)	28.9	-9.9
Clothing and clothing accessories	Amount (thousand USD)	141, 587.105	9,497,602
	Growth rate (%)	-6.6	6.2
General industrial machinery and equipment and parts	Amount (thousand USD)	128,354,774	49,822,887
	Growth rate (%)	4.2	-3.4
Metal products	Amount (thousand USD)	107,092,613	14,409,152.
	Growth rate (%)	6.1	-8.6
Land vehicles (including air cushion type)	Amount (thousand USD)	81,746,022.	73,900,074
	Growth rate (%)	3.4	-1.5
Furniture and parts thereof; mattress cushions and similar padded products	Amount (thousand USD)	69,075,213	2,261,227
	Growth rate (%)	8.6	-17.6

（Data from the General Administration of Customs of the People's Republic of China）

2.3 New crown outbreak affects air passenger traffic

IATA data show that 45%-50% of the current international cargo volume by passenger aircraft belly class to complete. by the important impact of the epidemic, people's demand for air travel greatly reduced, a large number of passenger flights canceled, Global shipping passenger demand declines by around 60% in 2020, 2021 compared to 2019, the rapid shrinkage of air passenger transport. the second half of 2020, the global capacity decline of about 30%, which bears the international business of passenger aircraft belly class cargo capacity fell by about 70%, passenger aircraft air belly class capacity supply Severe shortage.

Table 3. Impact of the outbreak on global air passenger and cargo demand and global capacity

Year	2020	2021
Global shipping freight demand over 2019 growth rate (%)	-10.6	6.9
Global shipping passenger demand growth rate over 2019 (%)	-65.8	-58.4
Global air cargo capacity growth rate over 2019 (%)	-23.3	-10.9
Global air passenger capacity growth rate over 2019 (%)	-68.1	-65.3

（Data from IATA）

6.9% growth in global air cargo demand in 2021 compared to 2019 (7.4% growth in international demand); 10.9% decline in capacity in 2021 compared to 2019 (12.8% decline in international capacity). New crown epidemic has sharply reduced global air cargo capacity, leading to a surge in air cargo yields, according to WTO data. Countries have a surge in demand for cross-border cargo, especially the transport of anti-epidemic materials, the number of cargo aircraft is insufficient, a large number of idle passenger aircraft, the imbalance between supply and demand makes the cargo business a new profit point since the epidemic, in order to compensate for the huge losses caused by passenger aircraft, passenger aircraft to cargo aircraft increased in large numbers, using the belly, passenger cabin and other space to provide air cargo logistics services.

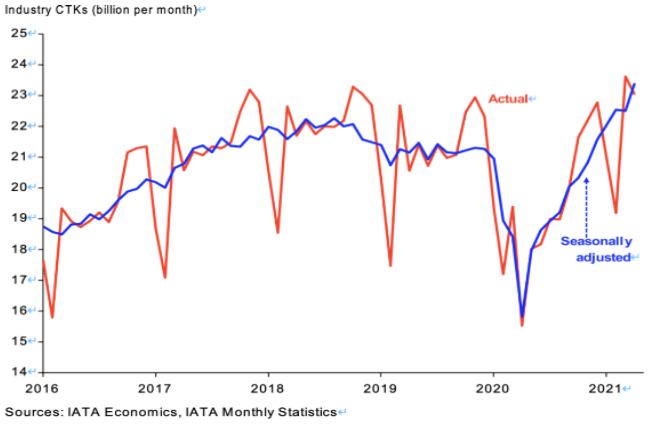

Fig. 3. Industry-wide cargo load factor (RHS) and global air cargo yield (LHS) changes, 2015-2020.

（Information from: WTO）

2.4 China's air cargo infrastructure and transport equipment backward

First, there is currently no domestic dedicated cargo airport, China's freight mostly depends on passenger airports, can only use the "point-to-point" direct mode, can not use the efficient linkage of the "hub fly" mode; second is the number of air all-cargo aircraft is seriously inadequate, 90% of China More than 90% of China's air cargo is dependent on passenger aircraft belly, as of March 2021, China has 173 all-cargo aircraft, accounting for only 4.5% of China's civil aviation transport fleet, while the United States has more than 550 all-cargo aircraft, the number is about 3.2 times that of China; Third, the development of air cargo enterprises is not enough, especially international air cargo transport, heavily dependent on foreign air cargo enterprises; Fourth, failure to get enough policy and financial support, due to the absence of favorable policies and the existence of technical barriers, resulting in little interest in investment in air hubs, insufficient market development incentives, and a shortage of funds leading to the slow development of air cargo.

2.5 The development of China's strong domestic market requires the rapid development of air cargo

The new development pattern is the choice made on the basis of the current international and domestic situation judgment, the development of the foothold more to the domestic, the use of China's huge domestic demand potential, improve production capacity and production efficiency, promote technological innovation and talent training, to create a new international cooperation and competitive advantage of China, the development of China's strong domestic market needs the rapid development of air cargo.

The domestic per capita income of over ten thond yuan (US dollars) , in the face of the new crown epidemic, China's economy wants to remain vibrant in this special period, we need to give full play to the huge advantage of the huge market and firmly grasp the strategic basis of expanding domestic demand. We need to build a strong consumer market, with both domestic and foreign consumer goods, especially e-commerce, cross-border e-commerce development, a higher degree of dependence on the airport. Also can see from the macroscopic index, Total social logistics compared with GDP, unlike in 2018 and 2019 before the epidemic, the growth rate of total social logistics has been consistently higher than GDP growth since 2020.the logistics demand coefficient (ratio of total social logistics to GDP) increases unceasingly, the domestic industrial structure has the change, the logistics demand also has the change, the air transportation is the fifth wave impact.

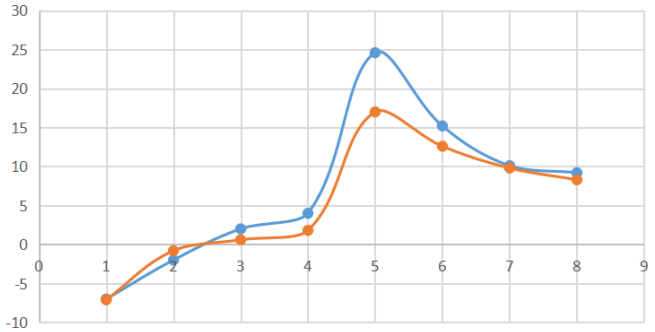

Fig. 4. Total Social Logistics and Comparable GDP Growth in China by Quarter, 2020-2021

（Data from China Federation of Logistics and Purchasing）

3 Analysis of the influencing factors of international logistics competition

There are many factors affecting international logistics competition, among which the influence degree of infrastructure, logistics industry scale, informatization level and other factors is relatively high.In the analysis, the evaluation index of international logistics competitiveness is based on the core competitiveness of international logistics of port cities. This paper selects international logistics production factors, international logistics demand conditions, international logistics related and auxiliary conditions, opportunities and government as the first-level indicators to evaluate the international logistics of port cities. The level of logistics competitiveness.The evaluation indicators are explained as follows：

3.1 International logistics production factors

- Natural conditions. To measure whether a city has one of the congenital conditions for the development of international logistics, port cities rely heavily on rivers, lakes and seas. Therefore, natural conditions are an important factor in the international logistics competitiveness of port cities.
- Port infrastructure. At present, 80% of international trade depends on maritime transportation, and the port infrastructure is very important for international logistics. As a port city, its port infrastructure is an important factor to evaluate a city's international logistics competitiveness.
- Aviation infrastructure. Aviation logistics is developing with the development of international logistics, but the availability of air transport has become one of the important conditions for the development of international logistics. The development of aviation logistics directly affects the development of international lo-

gistics in a city. Aviation infrastructure plays a decisive role in the development of aviation logistics, so aviation infrastructure is of great significance to the development of international logistics.

- Transportation. The transportation industry plays a central role in the development of international logistics. The construction of transportation infrastructure is of great significance to the international logistics transportation.

3.2 International logistics demand

- Urban economic strength. It mainly includes GDP and residents' consumption level. As the core accounting indicator of the national economy, GDP can measure the overall economic situation of a region and reflect the consumption level of local residents. The higher the consumption level, the greater the demand for international logistics. And the consumption level of the residents can see the proportion of the local residents' living needs and enjoyment needs, so as to see the extent to which the urban residents consume products and services.
- Import and export trade. The trade volume of import and export indicates a city's degree of opening to the outside world. The higher the degree of opening to the outside world, the richer the marketization, and the higher the relative international logistics demand; On the contrary, if a city is less open to the outside world, its demand for international logistics will be lower.
- Foreign investment. Foreign investment will promote the development of foreign trade economy, promote the local economy, drive the circulation of goods, and then stimulate the logistics demand.

3.3 Relevant and auxiliary conditions of international logistics

- International logistics service level. The service level of port city international logistics can not only reflect the international logistics competitiveness level of a city, but also relate to the sustainable development ability and development potential of port city international logistics. It mainly includes operation efficiency, service quality, service price, etc.
- Urban logistics talents. The rise and development of international logistics has brought new vitality and vigor to the economy of port cities. Logistics talents are an important support for the development of international logistics in port cities and play an important role in the construction of old industrial bases in Northeast China.
- Logistics informatization level. The development of information industry plays an important role in the development of international logistics.
- Management innovation ability. Both ports and logistics enterprises should have the ability to keep pace with the times, maintain innovative thinking, and pay attention to improving the management mode in different periods, so as to improve their logistics competitiveness.

3.4 Opportunities and policies

The development potential of urban international logistics. The international logistics competitiveness of port cities has a factor that can not be ignored, that is, the development potential of their cities' international logistics, which can also be called the ability of sustainable development. The international logistics system is a system that changes all the time, so the evaluation of the international logistics competitiveness of port cities should also be from a dynamic point of view. The development potential can reflect the dynamics of international logistics in port cities.

Policy environment. International logistics is a semi open market. The guidance and policies of the government can determine the development of the entire international logistics market. Therefore, the policy environment plays a vital role in the development of international logistics industry in cities.

4 Evaluation index system of International Logistics Competitiveness

By extensively consulting the relevant theories of the research on the international logistics competitiveness of port cities, referring to and summarizing the previous research results, combined with the influencing factors of the international logistics competitiveness, and relying on the selection principle of evaluation indicators, an index system including four levels of international logistics production factors, international logistics demand conditions, international logistics related and auxiliary conditions, opportunities and government has been established. The evaluation index system is shown in Table4:

Table 4. international logistics competitiveness evaluation index system

Target layer	Primary index	Secondary index
International Logistics Competitiveness (A)	Production Factors (B_1)	natural resources (C_1)
		Infrastructure (C_2)
		Transportation (C_3)
	Demand Conditions (B_2)	Urban economic strength (C_4)
		Import and export trade (C_5)
		Foreign investment (C_6)
	Relevant and auxiliary conditions (B_3)	International logistics service level (C_7)
		Urban logistics talents (C_8)
		Logistics information level (C_9)
		Management innovation capability (C_{10})
	Opportunity and government (B_3)	Development potential of urban international logistics (C_{11})
		Policy environment (C_{12})

4.1 Source of competitiveness evaluation data

This paper takes port cities as the rating object. In order to make the results relatively objective, 15 professionals are invited to score the indicators. On this basis, the scores are audited and averaged to determine the final judgment matrix. After that, the judgment matrix is analyzed by the square root method, and MATLAB is used for auxiliary calculation to determine the weight of each indicator. Firstly, the fuzzy membership degree of each index in the international logistics index system of port cities relative to each evaluation criterion in the evaluation set is scored. Finally, the fuzzy comprehensive evaluation is carried out, the judgment matrix and the index weight are synthesized, and the three-level fuzzy comprehensive evaluation is carried out for all levels of indicators to construct the fuzzy evaluation matrix.

4.2 Evaluation method of International Logistics Competitiveness

Most of the indicators of international logistics competitiveness of port cities selected in this paper can not be quantified. Therefore, analytic hierarchy process and fuzzy comprehensive evaluation method are used to evaluate and analyze the indicators.

4.3 Analytic hierarchy process

Analytic hierarchy process (AHP) is a flexible multi criteria decision-making method. According to the nature of the problem and the goal to be achieved, the constituent factors of the problem are decomposed and divided, and the factors are hierarchized according to the relationship between the factors to form a hierarchical structure model. Then, according to the hierarchical analysis, the weights of the current level factors to the previous level factors are obtained.

- Establish a hierarchy table
- Build judgment matrix

For the indicators in the same level, by comparing the importance of each indicator to a factor in the upper level, the judgment matrix of the evaluation indicators is constructed in turn and recorded as:

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \quad (1)$$

Where, is the judgment matrix, which represents the comparison results of the importance of factor I to factor J. the quantitative scale of 1-9 can be used to reflect its importance, as shown in Table 5.

Table 5. Comparison scale of judgment matrix elements

Ratio	Significance
a_{ij}=1	Indicates that element I is of the same importance as element J
a_{ij}=3	Indicates that element I is slightly more important than element J
a_{ij}=5	Indicates that element I is significantly more important than element J
a_{ij}=7	Indicates that element I is more important than element J
a_{ij}=9	Indicates that element I is more important than element J
a_{ij}=2n	Indicates that the importance of elements I and j is between = 2n-1 and = 2n+1（n=1，2，3，4）
a_{ij}=1/a	Indicates the comparison and judgment results of factors I and J a_{ij} and a_{ji} are reciprocal to each other

4.4 Calculate the maximum eigenvalue and eigenvector of each judgment matrix

Each judgment matrix is calculated, and the maximum eigenvalue and corresponding eigenvector of the matrix are obtained.

The calculation steps of the maximum characteristic root of the judgment matrix are as follows:

- Normalize each column of the judgment matrix:

$$\overline{A} = \frac{A_{ij}}{\sum_{k=1}^{n} A_{kj}}; \quad i, j, k = 1,2,.., \quad n \tag{2}$$

Add the normalized judgment matrix of each column to calculate the average by rows:

$$W_i = \sum_{i=1}^{n} \overline{A}_{ij}; i, j = 1,2,...,n \tag{3}$$

- Calculating the maximum eigenvalue of judgment matrix $\lambda_{\max}$:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{[AW_i]_i}{(W_i)_i}; i = 1,2,...,n \tag{4}$$

- Calculate the consistency index, perform consistency check and sort:

$$C_R = \frac{(\lambda_{\max} - n)R_I}{n-1} \tag{5}$$

The empirical values of randomness indicators R_I are shown in Table 6:

Table 6. Empirical values of randomness indicators

n	1	2	3	4	5
RI	0	0	0.58	0.90	1.12

5 Evaluation results of airside industry development in Hubei International Logistics Core Hub

Through the AHP formula calculation, the total weight of each first-level index and the weight of each second-level index in Table7 are obtained.

Table 7. The total weight of each primary indicator and the weight of each secondary indicator

Criterion layer	Weights	Indicator layer	Single sorting weight	Total ranking weight
B1	0.2761	C11	0.11	0.0304
		C12	0.381	0.1052
		C13	0.2982	0.0823
		C14	0.2108	0.0582
B2	0.3905	C21	0.1939	0.0757
		C22	0.7429	0.2901
		C23	0.0633	0.0247
B3	0.1953	C31	0.5662	0.1106
		C32	0.121	0.0236
		C33	0.2319	0.0453
		C34	0.0809	0.0158
B4	0.1381	C41	0.2	0.0276
		C42	0.8	0.1105

After the weight of each index is determined by the AHP, the evaluation set is taken to represent the risk degree of the C-level index: excellent, good, medium, poor, and four grades. Finally, the fuzzy comprehensive evaluation method is used to establish a single-factor evaluation matrix, and A three-level fuzzy evaluation matrix is established.

Establishing the first-level fuzzy evaluation matrix of Hubei.

Table 8. The first level fuzzy evaluation matrix of Wuhan international logistics competitiveness

Matrix	Index	Excellent	Good	Moderate	Poor	Evaluation results
R1	C11	0.76	0.24	0	0	Excellent

	C12	0.8	0.2	0	0	Excellent
	C13	0.14	0.78	0.08	0	Good
	C14	0.06	0.1	0.62	0.22	Moderate
R2	C21	0	0.06	0.88	0.06	Moderate
	C22	0	0.12	0.82	0.06	Moderate
	C23	0.02	0.76	0.22	0	Good
R3	C31	0.06	0.78	0.16	0	Good
	C32	0	0.12	0.86	0.02	Moderate
	C33	0.78	0.22	0	0	Excellent
	C34	0.24	0.76	0	0	Good
R4	C41	0.12	0.74	0.14	0	Good
	C42	0.82	0.12	0.06	0	Excellent

According to the first-level fuzzy evaluation matrix of Hubei, the fuzzy operator is used to calculate the second-level fuzzy evaluation of Hubei, as shown in Table9.

Table 9. The second level fuzzy evaluation matrix of Hubei international logistics competitiveness

Matrix	Eration	Index	Excellent	Good	Moderate	Poor	Evaluation results
R	W_1*R_1	B1	0.4428	0.3563	0.1546	0.0464	Excellent
	W_2*R_2	B2	0.0013	0.1489	0.7937	0.0562	Moderate
	W_3*R_3	B3	0.2343	0.5687	0.1947	0.0024	Good
	W_4*R_4	B4	0.6800	0.2440	0.0760	0	Excellent

According to the second-level fuzzy evaluation matrix of Hubei, the fuzzy operator is used to calculate the third-level fuzzy evaluation of Hubei, as shown in Table10.

Table 10. The third level fuzzy evaluation matrix of Hubei international logistics competitiveness

Matrix	Eration	Excellent	Good	Moderate	Poor	Evaluation results
Target layer	W*R	0.2624	0.3013	0.4011	0.352	Moderate

6 Conclusions

Through the calculation of the fuzzy comprehensive analysis model, the evaluation results of the international logistics competitiveness of the Hubei International Logistics Port are obtained. Logistics-related auxiliary conditions and opportunities and the government. The comprehensive evaluation results carried out based on this show that the comprehensive evaluation of Hubei International Logistics Port is moderate.

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