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Evaluation of Port Collection and Distribution System based on Multi Attribute Decision Model

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Abstract

China's coastline from the south to the north is covered with all kinds of ports, each port is an economic entity, which not only undertakes the domestic and international commercial trade, but also leads the economic development of the port location. The port economy has become an indispensable part of the modern Chinese economy. As an important driver of regional economic development, port economy is an important driving force to adjust the regional industrial structure. Its development not only benefits from the inherent favorable conditions of the port and external promotion factors, but also has a close relationship with the port collection and distribution system. The collection and distribution system is the basis for the survival and development of ports, and is one of the important pillars of port development. In recent years, port throughput has been showing a rapid growth trend. The rapid growth of port throughput not only puts forward higher requirements for the construction of port infrastructure, but also brings greater challenges to the further improvement of port collection and distribution system. At present, the evaluation of port collection and distribution system lacks a relatively unified standard. In this regard, this paper selects Tianjin, Qingdao, Ningbo and Guangzhou as the research object, uses the multi-attribute decision-making model, uses the relevant evaluation index to carry on the comprehensive evaluation comparison, and puts forward the corresponding policy suggestions according to the related insufficiency.

Keywords

Port collection and distribution, Multi-attribute decision-making, Analytic hierarchy process.

1. Development background of port collection and distribution system in China

1.1 Port infrastructure system gradually improved

State owned port enterprises are the main body of the development of China & apos; s port industry. At present, China has formed a port system with reasonable layout, clear hierarchy, complete functions, giving consideration to both river and sea, complementary advantages, complete supporting facilities and high degree of modernization. The port is developing towards large scale, deep water and specialization. Five large-scale and relatively concentrated coastal port groups have been formed in the five major regions around Bohai Sea, Yangtze River Delta, southeast coast, Pearl River Delta and southwest coast. The waterway passenger and freight transportation system has been constructed with the focus on coal, ore, oil, container, grain and other cargo and passenger transportation. The software and hardware facilities of China's main coastal ports have entered the world-class level, and the port handling technology and service efficiency are in the forefront of the world. In addition, the appearance of the main ports in China's inland rivers has been greatly improved. The Yangtze River system, the Pearl River system, the Beijing Hangzhou canal and Huaihe River system, Heilongjiang and Songliao water systems have formed the port belt along the river (River).A

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number of specialized berths for containers, bulk cargo and RO ro vehicles have been built in the Yangtze River and Xijiang River trunk lines, and the Yangtze River Delta and Pearl River Delta water network areas. The level of mechanization and specialization of inland river ports has been significantly improved.

Since the reform of port system, the integration of coastal port resources has been accelerated and the market concentration has been improved. According to the survey data, the average cargo throughput of state-owned port enterprises accounts for 70% of the cargo throughput of the local port. The average throughput of coal, ore, oil and container accounts for about 70% of the total throughput of port enterprises, which indicates that the four major cargo types are still the main cargo types operated by port enterprises in China .In contrast, the Yangtze River port market concentration is low and the market competition is fierce. According to statistics, there are more than 2700 operators along the Yangtze River, of which only more than 70 have a throughput of more than 5 million tons. Small, scattered and weak are the important characteristics of the ports along the Yangtze River, and the low price competition is particularly prominent.

1.2 The construction of port collection and distribution network system has been continuously promoted

In recent years, the relevant national transportation authorities have accelerated the development of port collection and distribution network system, and successively issued the 13th five year plan freight hub (Logistics Park) construction plan, the action plan for promoting the construction of logistics channel (2016-2020), the 13th five year plan for port collection and distribution system construction, and the promotion of supply side structural reform to promote logistics industry cost reduction about the "one belt, one road" initiative, and accelerating the promotion of international road transport facilitation, we have promoted about 150 public transport services with prominent properties, wide range of radiation and strong driving power, and the main port roads and railway container central stations have been basically completed. The construction of 6 container rail water intermodal transport demonstration channels has continued to deepen, about 200 drop and pull transport pilot projects have achieved remarkable results, and the construction of the first batch of 16 multimodal transport demonstration projects has been fully launched. The volume of intermodal transportation of container iron and water increased from 1.41 million TEU in 2010 to 2.366 million TEU in 2015, with an average annual growth of more than 10%.By the end of 2016, 2964 trains had been opened and 39 lines had been operated. In 2016, the volume of railway container, commodity automobile and bulk cargo express increased by 40%, 53% and 25% respectively over the previous year. One belt, one road construction, was also launched to accelerate the construction of port collection and distribution system, solve the short board problem of the last mile of port, enhance the radiation capacity and the level of conversion of ports, and effectively support the construction of "one belt and one road". The Ministry of transport, the State Railway Administration and the China Railway Corporation jointly issued the "13th Five-Year" port collection and distribution system construction plan. The plan proposes that by 2020, the collection and distribution capacity of port railway and highway will be significantly improved, the layout will be further optimized, and the connection efficiency with the port area will be steadily improved. The arrival rate of main coastal and inland river ports will reach 80% and 70% respectively, the arrival rate of Railways in important port areas will exceed 60%, and the coverage rate of class II and above highways will reach 100%.

2. Description of problems in port collection and distribution system in China

2.1 Port collection and distribution system structure imbalance

The proportion of Railways and waterways is relatively low. From the perspective of structure, the volume of water to water transfer and public water transfer is relatively large in the cargo and container throughput of port enterprises, while the proportion of hot metal transfer is relatively small. According to relevant statistics, highway accounts for 85%, waterway accounts for 14%, and railway accounts for only 1%.According to the survey data, only Lianyungang Port Holding Group Co., Ltd.,

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Xiamen Port Holding Group Co., Ltd., Guangzhou Port Group Co., Ltd. and Zhanjiang port (Group) Co., Ltd. account for more than 10% of the transshipment volume of liquid iron; the proportion of container iron water intermodal transport volume is also relatively small, no more than5%, of which: Lianyungang Port Holding Group Co., Ltd. accounts for 4.6%; Dalian Port Group Co., Ltd. for 3.8%; Qingdao port (Group) Co., Ltd. for 0.8%; Ningbo Zhoushan Port Group Co., Ltd. for 0.8%Tianjin Port (Group) Co., Ltd. accounts for 0.4% of the total.

2.2 The development of port multimodal transport is relatively backward

Compared with developed countries, the development of China's multimodal transport is still in its infancy. At present, China's multimodal transport volume only accounts for 2.9% of the total freight volume of the whole society, while that of the United States is about 10%. The cost of freight forwarding accounts for about 30% of the total logistics cost, which reduces the efficiency of transportation organization and increases the operating costs of enterprises. The development of multimodal transport system has lagged behind.

2.3 The investment and financing mechanism of port collection and distribution infrastructure is not clear, and port enterprises bear greater capital pressure

Taking Lianyungang port as an example, Lianyungang Port Holding Group Co., Ltd. is the main body of port investment, construction and operation defined by Lianyungang Municipal government, and undertakes the construction of highway, railway and other collection and distribution system supporting the port. At present, Lianyungang port and Lianyungang district are funded by Lianyungang Port Holding Group Co., Ltd. except for Provincial Construction subsidies.

Lianyungang port special railway is funded by Lianyungang Port Holding Group Co., Ltd. the state railway does not participate in the investment, and there is no government policy fund support for the time being. Due to the characteristics of large investment, low return and strong publicity of port special railway, for example, the special railway in Lianyungang port Xuwei, Ganyu and other port logistics parks is more than 15km away from the national railway connection station, and the total investment is about 1.5 billion yuan, which brings huge capital pressure to port enterprises. Inbound railway is the key point of port collection and distribution system construction. How to solve the problem of railway entering port area is an urgent problem.

3. Modeling

Combined with the above problems, this paper selects the multi-attribute decision-making model to systematically evaluate part of the port collection and distribution system according to the relevant decision-making parameters, and finds out the deficiencies of the relevant port collection and distribution system in this process, and puts forward relevant suggestions accordingly.

Multi attribute decision-making is an important part of modern decision-making science. Its theory and method are widely used in engineering design, economy, management and military fields, such as investment decision-making, project evaluation, maintenance service, weapon system performance evaluation, factory site selection, bidding, industrial sector development sequencing and comprehensive evaluation of economic benefits. The essence of multi-attribute decision-making is to use the existing decision-making information to sort or select a group of (limited) alternatives in a certain way. It is mainly composed of two parts: (1) obtaining decision information, which generally includes two aspects: attribute weight and attribute value (attribute value has three forms: real number, interval number and language). Among them, the determination of attribute weight is an important research content in multi-attribute decision-making; (2) attribute weight is an important part of multi-attribute decision-making. Through a certain way to gather the decision-making information and sort and select the best scheme.

There are many information aggregation methods, such as weighted arithmetic average (WAA) operator, weighted geometric average (WGA) operator and ordered weighted average (OWA) operator

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Suppose the function $WAA: R^n \to R, (a_1, a_2, \dots, a_n)$ Is a given set of data if $WAA_w(a_1, a_2, \dots, a_n) = \sum_{j=1}^{n} w_j\, a_j$ In which $w = (w_1, w_2, \dots,\ w_2)^T$ Is a data group$(a_1, a_2, \dots, a_n)$ The weight vector of, $w_j \in [0,1], 1 \le j \le n$. If R is the set of real numbers, then the function WAA is called the weighted arithmetic averaging (WAA) operator.

Attribute types are generally effective benefit type, cost type, fixed type, deviation type, interval type, deviation type, etc. among them, benefit type attribute refers to the attribute with larger attribute value, cost type attribute refers to attribute with smaller attribute value, fixed attribute refers to attribute whose attribute value is closer to a fixed value, and deviated attribute refers to attribute value that deviates from a certain fixed value better. Properties of. Interval attribute refers to the attribute whose value is closer to a fixed interval (including falling into the interval), and the off interval attribute means that the attribute value deviates from a fixed interval $[q_1^j, q_2^j]$ The better. In order to eliminate the influence of different physical dimensions on the decision results, the data can be standardized according to the following formula:

If the attribute value is benefit type, then:

$$r_{ij} = \frac{a_{ij}}{\max_i a_{ij}} \text{ or } r_{ij} = \frac{a_{ij} - \min_i a_{ij}}{\max_i a_{ij} - \min_i a_{ij}}$$

If the attribute value is cost type, the

$$r_{ij} = \frac{\min_i a_{ij}}{a_{ij}} \text{ or } r_{ij} = \frac{\max_i a_{ij} - a_{ij}}{\max_i a_{ij} - \min_i a_{ij}}$$

If the attribute value is fixed, the

$$r_{ij} = 1 - \frac{a_{ij} - \alpha_j}{\max_i |a_{ij} - \alpha_j|}$$

If the attribute value is a deviation type, the

$$r_{ij} = |a_{ij} - \beta_j| - \frac{\min_i |a_{ij} - \beta_j|}{\max_i |a_{ij} - \beta_j| - \min_i |a_{ij} - \beta_j|}$$

If the attribute value is interval type, the

$$r_{ij} = \begin{cases} 1 - \dfrac{\max\left(q_1^j - a_{ij}, a_{ij} - q_2^j\right)}{\max\left(q_1^j - \min_i a_{ij}, \max_i a_{ij} - q_2^j\right)}, a_{ij} \notin \left[q_1^j, q_2^j\right] \\ 1, a_{ij} \in \left[q_1^j, q_2^j\right] \end{cases}$$

If the attribute value is a deviation interval type, the

$$r_{ij} = \begin{cases} \dfrac{\max\left(q_1^j - a_{ij}, a_{ij} - q_2^j\right)}{\max\left(q_1^j - \min_i a_{ij}, \max_i a_{ij} - q_2^j\right)}, a_{ij} \notin \left[q_1^j, q_2^j\right] \\ 0, a_{ij} \in \left[q_1^j, q_2^j\right] \end{cases}$$

4. Example calculation

In the port collection and distribution system, it is necessary to select indicators that can reflect its collection and distribution capacity, conduct a systematic evaluation, compare the advantages and disadvantages of port development, and put forward relevant construction suggestions. Therefore, this paper takes Tianjin Port (x1), Qingdao port (x2), Ningbo port (X3) and Guangzhou port (x4) as the research object, and analyzes the following five indicators (attributes) for their The evaluation of the collection and distribution system is shown in Figure 4-1: 1. Port throughput (U1); 2. Collection and distribution cost (U2); 3. Operating revenue of port companies (U3); 4. Container sea rail

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intermodal transport volume (U4); 5. The total distance of inland transportation hub connecting with the port (U5).

Port throughput: the container throughput of the whole year of the selected year (10000 tons);

Collection and distribution cost - the collection and distribution cost of the container in the selected year (yuan);

Operating revenue of port company - the total revenue of container business of port company in the whole year of selected year (100 million yuan);

Container sea rail intermodal transport volume - the total container sea rail combined transport volume of the port in the selected year (10000 TEU);

The total distance of inland transportation hub connecting with the port -- the total distance from the three adjacent hub node cities (km);

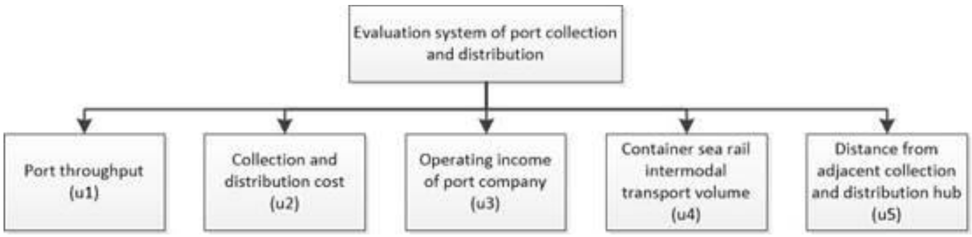

Figure 4-1. Port collection and distribution evaluation system

The evaluation results are shown in table 4-1. Among the evaluation indexes, the cost of collecting and distributing transportation and the total distance of inland transportation hub connecting with the port are cost type, and the rest are benefit type. The decision information is collected and normalized

Table 4-1 port collection and distribution data

	U1	U2	U3	U4	U5
X1	49220	2050	113.48	35.3	1015
X2	57736	1810	117.41	77.6	1755
X3	112009	2010	218.8	40.1	1514
X4	61313	1890	86.43	6.1	2707

Data source: Water Transport Research Institute of the Ministry of transport - operation of Port Container Rail water intermodal transport in China in 2017;

Table 4-2 normalization of relevant indexes of port collection and distribution

	U1	U2	U3	U4	U5
X1	0.4394	0.8829	0.5186	0.4549	1.0000
X2	0.51550	1.0000	0.5366	1.0000	0.5783
X3	1.0000	0.9005	1.0000	0.5168	0.6704
X4	0.5474	0.9577	0.3950	0.0786	0.3750

The comparison matrix of U1 to U5 is constructed by using the analytic hierarchy process of MATLAB software $A=\begin{bmatrix} 1 & \frac{1}{2} & 1 & \frac{1}{2} & \frac{1}{3} \\ 2 & 1 & 2 & 1 & 1 \\ 1 & \frac{1}{2} & 1 & 1 & \frac{1}{3} \\ 2 & 1 & 1 & 1 & 1 \\ 3 & 1 & 3 & 1 & 1 \end{bmatrix}$ The formula is as follows:

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$$CI = \frac{\lambda_{\max}-n}{n-1}]$$

Table 4-3. Consistency test RI value

Order	1	2	3	4	5	6	7	8	9	10
RI value	0	0	0.52	0.89	1.12	1.26	1.36	1.46	0.49	0.52

```
命令行窗口
>> cengcifenxi
请输入判断矩阵A(n阶)
A=[1 1/2 1 1/2 1/3;
2 1 2 1 1;
1 1/2 1 1 1/3;
2 1 1 1 1;
3 1 3 1 1;]
    0.1124
    0.2439
    0.1337
    0.2178
    0.2921

此矩阵的一致性可以接受!
CI=
    0.0272

CR=
    0.0243

fx
```

Figure 4-2. Consistency test using MATLAB software

After calculation, the weights of U1 to U5 are respectively: [0.1124, 0.2439, 0.1337, 0.2178, 0.2921].

$$WAA_w(a_1,a_2,\dots,a_n)$$

$$=\sum_{j=1}^{n} w_j\, a_j = 0.4394\times 0.1124 + 0.2439\times 0.8829 + 0.1337\times 0.5186$$

$$+0.2178\times 0.4549 + 0.2921\times 1.0000$$

$$=0.7252$$

By analogy, the scores of Tianjin port, Qingdao port, Ningbo port and Guangzhou port are 0.7252, 0.7603, 0.7741 and 0.4746 respectively, and the relative ranking of the collection and distribution system is Ningbo port, Qingdao port, Tianjin port and Guangzhou port.

5. Suggestions on improving the collection and distribution system of relevant ports

Based on the evaluation and comparison of the collection and distribution of the four major ports, it is found that there are many problems in the ports, such as the high cost of collection and distribution, the problems of insufficient throughput and high cost of collection and distribution in Tianjin port, the problems of low income and small throughput in Guangzhou port, and the development of Ningbo port and Qingdao port in terms of collection and distribution system configuration are relatively perfect. However, it is impossible to cover up the problem of insufficient construction of collection and distribution system in China's port industry

5.1 Further improve the port collection and distribution system and accelerate the development of multimodal transport

In accordance with the idea of "strengthening railways, improving highways, and developing inland rivers", we should deepen and improve the port collection and distribution system planning, further

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improve the port collection and distribution system, continue to promote the construction of roads and railways in important port areas, accelerate the construction of inland dry ports, and promote the construction of multi-modal transport channels across regions, departments and industries.

(1) Strengthen the construction of railway collection and distribution facilities. Strengthen the construction of port railway collection and distribution channels and stations, focus on promoting the construction of railway collection and distribution channels and stations in large-scale dry bulk cargo ports and large-scale container ports, promote "port station integration", and realize seamless connection between railway freight stations and port areas.

(2) Improve the highway collection and distribution system. We will continue to promote the construction of expressways for major ports and important port areas, and the construction of special roads for large-scale comprehensive port areas; for important port areas which are greatly restricted by urban traffic, we will establish a road system for collecting and distributing passengers and goods.

(3) We will vigorously develop rail water intermodal transport. Strengthen the organization and coordination with the railway departments, and vigorously develop the rail water intermodal transportation of containers, ores, coal and other bulk cargoes. To accelerate the development of China's Container Rail water intermodal transport, the scale of Container Rail water intermodal transport and its proportion in port container collection and distribution will be significantly increased.

(4) We will improve river sea intermodal transport. We will continue to improve the river sea direct transportation and river sea transit transportation system with the focus on the Yangtze River and the Pearl River.

5.2 The government should increase the policy and financial support for the construction of port collection and distribution system

It is suggested that governments at all levels should increase support for the construction of port collection and distribution system, and formulate targeted support policies for port high-speed and port railway construction projects, such as providing certain fund subsidies, tax incentives, low interest loans, etc. In addition, the construction of port collection and distribution system involves sea acquisition, land acquisition and relocation. It is suggested that governments at all levels should coordinate at some levels and provide support in handling procedures.

References

[1] Li Xumao, Wang Chengjin. Distribution characteristics and collection and distribution capacity evaluation of China' s coastal ports [J]. World shipping, 2019, 42 (05): 10-14 + 19.

[2] Geng Jingjuan. Analysis and evaluation of port collection and distribution system in Tianjin port [D]. Hebei University of technology, 2015.

[3] Fu Ruimin. Study on planning and evaluation of coal railway infrastructure under the background of collection and distribution system [D]. Central South University, 2012.

[4] Lin Shanqian. Evaluation of Xiamen port container collection and distribution system -- Based on AHP fuzzy comprehensive evaluation model [J]. Journal of Huaihua University, 2016,35 (09): 52-58.

[5] Li Guizhi. Evaluation of port collection and distribution system in Liaoning Province [J]. Logistics technology, 2016,39 (04): 78-81.

[6] Liang Li, Han Yichun. Research on the impact of supply side structural reform on port collection and distribution system [J]. Comparative study on cultural innovation, 2018,2 (12): 162-163.

[7] Tang Liang. How to give full play to the advantages of container transportation in the construction of port collection and distribution system [J]. Enterprise reform and management, 2018 (07): 218 + 220.

[8] Yao Yifei, one belt, one road, the development strategy of container port and sea rail intermodal transport in Xiamen port [J]. containerization, 2019,30 (10): 1-4.

[9] Yu Yangyong, warm. Analysis on Development Countermeasures of Tianjin Port container sea rail intermodal transport [J]. Railway freight, 2019,37 (08): 49-54.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202012_6(12).0016

[10] Mathematics; International Islamic University Researchers Describe Findings in Mathematics (T-Spherical Fuzzy Einstein Hybrid Aggregation Operators and Their Applications in Multi-Attribute Decision Making Problems)[J]. Journal of Mathematics,2020.

[11] Pang yunning. Container sea rail intermodal transport scheme of COSCO [D]. Dalian University of technology, 2019.

[12] Qi Yingxiu, Lang Maoxiang, Dong Nan, he Jie, Feng Yuxiao. Research on the development strategy of container sea rail intermodal logistics service [J]. Railway transportation and economy, 2019,41 (05): 58-62.

[13] Zhang Zhi, Zhao Yujie. Development status and suggestions of sea rail intermodal transport of Ningbo Zhoushan port [J]. China port, 2019 (06): 21-23.