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An Empirical Analysis of the Evaluation of Guangzhou Port Collecting and Distributing System

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Abstract

At present, China is making efforts to build Guangdong, Hong Kong, Macao and Dawan District and upgrading the regional economic structure. Guangzhou, which is located in the center of the Pearl River Delta, is the most prosperous trading place in the international metropolis and South China, and the structure of Guangzhou Port Collection and Transportation is optimal. Affects whether Guangzhou Port can meet the increasing volume of freight. This paper focuses on the status quo of Guangzhou Port Collection and Distributing System, compares the hardware, software and development characteristics of the three modes of transportation in Guangzhou Port, and makes a linear regression forecast for the future volume of cargo throughput in Guangzhou Port. The multi-level factor analysis method is used to evaluate the three collection and distribution modes of highways, railways and waterways commonly used in Guangzhou Port Collection and Transportation, so as to find out the main problems of the Guangzhou Port Collection and Distributing System. Based on this, Suggestions for the optimization of the Guangzhou Port Collection and Distributing System.

Keywords

Guangzhou Port; Collection and distribution system; Multi-level factor analysis.

1. Introduction

Research by domestic scholars focuses on inland gathering and transportation or the optimization of gathering and transportation systems. Among them, Huang Youping [1] conducts development strategy research on the gathering and transportation system of Nansha Port District of Guangzhou Port; Chen Haibin [2] is to optimize the transportation mode of multimodal transportation of Guangdong port clustering and transportation system; Wang Xiaoping [3] Using the method of combining points and lines, the main problem is to study the optimization of the inland gathering and transportation network of Guangzhou Port. The angle is also unique: the inland container transfer station and the gathering and transportation channel; Xia Xinhai [4] is proposed for the Guangzhou International Shipping Center. Improving countermeasures for port gathering and transportation system; Lin Shanqian [5] used AHP-fuzzy comprehensive evaluation model to evaluate Xiamen port container gathering and transportation system.

Foreign scholars are mainly studying the hardware facilities of the distribution and transportation system, port combined transportation and multi-modal transportation mode, cargo flow distribution and other aspects. Asian Shipping (1996-1998) [6] has always published the production-related data of large ports in Asia, and focused on the impact of the transportation cost on its production.

The utilization rate of the collection and transportation mode of a port can reflect the rationality of the transportation planning in that area. The research on the evaluation of the collection and transportation network is a relatively new topic, which has certain theoretical and practical

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significance. Hierarchical factor analysis method evaluates the Guangzhou port container transportation system from the perspective of three transportation methods of Guangzhou port container transportation. Therefore, this paper selects this angle to evaluate the Guangzhou port container transportation system and put forward optimization suggestions. However, while achieving results, the author also recognized the shortcomings of this article. The quantitative data of this model is less and the qualitative data is more, so that the conclusion is greatly influenced by subjective factors. The modular method is worth further study.

2. Development Status of Guangzhou Port Transportation System

2.1 Collecting and Distributing System

Guangzhou is the economic, cultural and logistics center of southern China, and the largest city in southern China. Guangzhou Port and Huangpu Millennium Ancient Port are in the same line. It is the origin port of the ancient Chinese Maritime Silk Road and the traditional logistics, business flow and information flow distribution center in southern China. With the enlargement of ships, the port area gradually extended along the Pearl River to the estuary, and the inner port area, Huangpu port area, Xinsha port area, and Nansha port area were constructed in order from the inside to the outside. The port areas are mainly distributed in Guangzhou and Dongguan. The city 's Pearl River coast or waters.

(1) Inner port area. It is located in various districts of the original Guangzhou (Old Eight District), including the west river channel, south river channel, Dongsha river channel and newly built river channel, and covers the land area of each terminal in the old city of Guangzhou. The throughput capacity of container cargo is estimated at 100,000 TEU per year. The shoreline length is about 785 meters, and the storage area is about 35,000 square meters. [7] The land area of the entire port area is about 125,000 square meters.

(2) Huangpu Port Area. Located on both sides of the Pearl River Basin in Huangpu District and Luogang District, it is divided into Huangpu Old Port District and Huangpu New Port District. The working berth of the old port is about 2,858 meters. The port has 4 10,000-ton working anchors and 10 berths, of which the storage area is 330,000 square meters and the storage capacity is up to 360,000 tons. It mainly carries bulk cargo and coal, supplemented by some containers. There are 6 terminals in the Huangpu New Port area, with a total length of 1223.7 meters. It is an important domestic trade distribution center of Guangzhou Port, of which Wuchong Terminal is an important and core LCL cargo container. Among them, Xiji Coal Professional Wharf is one of the largest dedicated coal loading and unloading wharves in the Pearl River Delta, with a maximum storage capacity of up to 280,000 tons. The cargo throughput of Huangpu Port Area is about 8.8 million tons throughout the year.

(3) Xinsha Port District. Located in Machong Town, Dongguan City, close to Guangzhou, there are 10 berths in the port area. This port area has the highest modernization level and the largest scale. The terminal is enough for 50,000-ton ships to berth all day[8].

(4) Nansha Port Area. Located in Nansha District of Guangzhou, close to Nanfanshun (Nanhai, Panyu, Shunde), it is a seaside link between the Guangfo Economic Circle and the western part of the Pearl River Delta. As an extremely important part of Guangzhou's "Nantuo" strategy, despite its short production time, Nansha has become a major growth point for container transportation at Guangzhou Port. Nansha Port District is equipped with the most advanced equipment and the most advanced information system to provide quality services for various commodities. So far, Nansha Port has a water depth of 15.5 meters in front of the channel and pier, and 10 large-scale deep-water container berths have reached 100,000 tons. Its deep-water coastline is 3500 meters long, and the barge coastline is 480 meters long.

2.2 Conditions of highway transportation

Guangzhou has extremely convenient road gathering and transportation conditions, and now has formed a radial road gathering and transportation network centered on Guangzhou, mainly composed

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of 105, 106, 107 National Highway, Guangfo Expressway, Guangshen Expressway, Xuguang Expressway As well as the South China Express Line and Beijing-Zhuhai Expressway. The entire highway network has more than 120,000 kilometers of operating mileage, of which highways occupy more than 4,200 kilometers, and there are more than 9,000 kilometers of primary roads and 19,000 kilometers of secondary roads, and the road density is as high as 70 kilometers per 100 square meters. Kilometers.

2.3 Conditions of waterway transportation

Regarding the collection and transportation of waterways, Guangzhou Port relies on the developed Pearl River water network to provide efficient, high-quality, convenient and economical water transportation services, and opened the “shuttle bus” service of Guangzhou Port, which is specifically operated by its shipping companies and is located in the Nansha Port Area. As a distribution center, it provides fixed-point, fixed-shift, and fixed-price barge transportation services to customers. It currently covers the main small and medium-sized terminals in the Pearl River Delta, and connects to Guangxi, Hainan, Yunnan, Guizhou and other places in China through the Pearl River system. The number of domestic trade branches reached 21. At the same time, the shipping company also provides the water-to-water (load reduction) business of crane ships. It has nearly 20 years of rich work experience and safe and reliable floating crane water operation regulations. It has long been engaged in Sanmen Island, Lantau Island, Shajiao and the pier. The load-reduction loading and unloading operation of the gear can provide a full range of anchor-load reduction services for all kinds of large-scale bulk ships at the anchorage around the clock.

In September 2017, the first phase of the Guangzhou Port Deepwater Channel Widening Project was successfully completed, and the 100,000-ton container ship and the 150,000-ton container ship (reduced load) achieved two-way navigation; the six 150,000-ton containers in the third phase of the Nansha Port Area The berth was completed and put into operation; key projects such as the Nansha Port Railway and Nansha International Cruise Terminal started construction. Through three years of construction, the annual comprehensive berth and container capacity of the Guangzhou Port reached 374 million tons and 15.76 million TEUs respectively, an increase of 9.0% and 34.6% compared to 2014.

2.4 Conditions of railway transportation

Guangzhou Port is connected to the national railway network through Beijing-Guangzhou, Beijing-Kowloon, Guangzhou-Shenzhen, Guangzhou-Guangzhou-Guangzhou-Guangzhou-Meishan railways and other railways, and the port cargo is distributed to all parts of the country. Guangzhou Port Co., Ltd. Railway Branch is a production unit under Guangzhou Port Co., Ltd., which is mainly responsible for the railway transportation tasks of the cargo assembly and distribution of Guangzhou Port Xingang Port Area and Xinsha Port Area. The special railway line under the jurisdiction of the Railway Branch has a total length of 60 kilometers. The direct service scope runs through the Xingang Port Area, Development Zone, Dongguan and Xinsha Port Area. It has 3 stations, 8 diesel locomotives, and a strong freight, Professional teams in business, machinery, engineering, electricity, and inspection. [11] The special railway of the railway branch company is connected to the Guangzhou-Shenzhen Railway, and the cargo transportation leads to all parts of the country. The annual railway haulage capacity reaches 10 million tons. The subordinate Huangpu Port Branch has a 2,965-meter long railway dedicated line connected to the National Railway Huangpu Station, and is connected to the Beijing-Kowloon Line and Beijing-Guangzhou Line through the Guangzhou-Shenzhen Line to the national railway network. The Nansha Port Railway is a key railway construction project of the country and Guangdong Province. [9]It is an important channel for the Nansha Port District to connect to the railway transportation network in the central and southern and southwestern regions of China and integrate it into the Belt and Road strategy. The total length of the line is 8.026km. It is constructed on a dual line. The construction started in 2015 and is scheduled to open by the end of 2020.

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3. Comprehensive Evaluation of Guangzhou Port Collecting and Distributing System

In this part, a multi-level factor analysis method is used to conduct a comprehensive evaluation and study of three types of gathering and transportation methods in Guangzhou Port. These three methods are the road gathering and transportation method, the railway gathering and transportation method and the waterway gathering and transportation method. The evaluation content includes four aspects: the condition of the collection and transportation channel, the service level of the collection and transportation, the organization and management level of the collection and transportation, and the external environmental factors of the collection and transportation. [10]Using the SPSS 24 software, it proposes the most influential from various secondary indicators Common factor. Next, calculate the first-level index score. Therefore, the evaluation results of each first-level indicator are integrated and used as a new variable. Do the factor analysis again, and finally get the overall score and ranking of the entire system, that is, the score and ranking of the gathering and transportation system of different gathering and transportation methods.

3.1 Source of original data

The data sources selected in this article include: "Thirteenth Five-Year Plan" Port Collection and Transportation System Construction Plan, "2017 China Expressway Transportation Inspection Report", Guangzhou Port Co., Ltd. official website, "2017 Railway Statistics Bulletin", Ministry of Transport Websites of the Pearl River Navigation Administration and the Ministry of Communications. For quantitative indicators, such as the scope of the radiating area of the collection and transportation, the number of collection and transportation channels, the size of the freight volume, the number of transportation routes opened, and the transportation speed, this article directly extracts data from the above literature or website, as shown in Table 1 below.

Table 1 Quantitative index data

	First-level indicators	Secondary indicators	highway transportation	railway transportation	waterway transportation
Collection and distribution system (quantitative index)	Condition of gathering and transportation channel U1	Radiation area of gathering and transportation（km）	8338	5461.3	2320
		Number of gathering and transportation channels	6	6	4
		Freight volume（100 million tons）	3.8	0.095	5.47
	Service level U2	Number of transportation routes opened	6	5	
		Transport speed（km/h）	100	100	25.9
	Level of organization and management U3	/	/	/	/
	External environmental factors U4	/	/	/	/

For the qualitative indicators, this article ranks the qualitative indicators according to the effect of the above literature and the website and the related literature, and ranks them according to the ranking results (A, B, C), and assigns the level: A level 90, 60 for level B and 30 for level C. For example, for the quantitative indicator of transportation frequency, first sort it, according to the “Thirteenth Five-Year Plan for the Construction of Port Consolidation and Drainage System”, “From a structural point of view, in the port enterprise cargo and container throughput, The transfer volume in public

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water is relatively large, and the transfer volume in molten iron is relatively small. According to relevant statistics, highways account for about 85%, waterways account for about 14%, and railways only account for about 1% of the total volume of port transportation. "It can be concluded that for this indicator, highway transportation is ranked first, waterway transportation is ranked second, and railway transportation is ranked last. After the ranking is obtained, the rating is made according to the ranking, the first is A level, and so on, and finally the value is assigned according to the rating. The qualitative indicators selected by this evaluation index system are all positive indicators (that is, the greater the factor index value, the better the factor index of the network), the rating results and assignment results are shown in Table 2 and Table 3 below.

Table 2 Evaluation results of qualitative indicators

	First-level indicators	Secondary indicators	highway transportation	railway transportation	waterway transportation
Collecting and Distributing System (Qualitative Index)	Condition of gathering and transportation channel U1	Channel level	A	A	A
	Service level U2	Transportation frequency	A	C	B
		Cost	C	B	A
		Handling efficiency	A	B	B
		Service flexibility	A	B	C
		Service continuity	C	A	A
	Level of organization and managementU3	Information level	A	B	C
		Transfer turnover efficiency	A	B	C
	External environmental factors U4	Government policy guidance	A	A	B
		Environmental friendliness	C	B	A

Table 3 Summary of qualitative index assignment

	First-level indicators	Secondary indicators	highway transportation	railway transportation	waterway transportation
Collecting and Distributing System (Qualitative Index)	Condition of gathering and transportation channel U1	Channel level	90	90	90
	Service level U2	Transportation frequency	90	30	60
		Cost	30	60	90
		Handling efficiency	90	60	60
		Service flexibility	90	60	30
		Service continuity	30	90	90
	Level of organization and managementU3	Information level	90	60	30
		Transfer turnover efficiency	90	60	30
	External environmental factors U4	Government policy guidance	90	90	60
		Environmental friendliness	30	60	90

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3.2 Data standardization

In order to make each indicator comparable and integrated, in order to make a more scientific comparison and analysis in the future, it is necessary to do a data preprocessing on the data, that is, data standardization, dimensionlessness can eliminate different bands of data dimensions as much as possible Given the impact of the evaluation results, the dimensionless data processed by SPSS 24.0 is shown in Table 4 below.

Table 4 Index data after standardization

	First-level indicators	Secondary indicators	highway transportation	railway transportation	waterway transportation
Collecting and Distributing System	Condition of gathering and transportation channel X1	Radiation area of gathering and transportation x11	0.98503	0.0293	-1.01433
		Channel level x12	0.57735	0.57735	-1.1547
		Number of gathering and transportation channels x13	0.57735	0.57735	-1.1547
		Freight volume x14	1.09445	-0.86603	-0.22841
	Service level X2	Number of transportation routes opened x21	1	0	-1
		Transportation frequency x22	1	-1	0
		Transport speed x23	0.57735	0.57735	-1.1547
		Cost x24	1	0	-1
		Handling efficiency x25	1.1547	-0.57735	-0.57735
		Service flexibility x26	1	0	-1
		Service continuity x27	-1.1547	0.57735	0.57735
	Level of organization and management X3	Information level x31	1	0	-1
		Transfer turnover efficiency x33	1	0	-1
	External environmental factors X4	Government policy guidance x41	0.57735	0.57735	-1.1547
		Environmental friendliness x42	-1	0	1

3.3 Empirical analysis based on multi-level factor analysis

First of all, select the second-level evaluation indicators of the collection and transportation service level, and make an evaluation on the collection and transportation service levels of various collection and transportation methods.

3.3.1 Extract factors and solve factor load matrix

Use SPSS 24.0 to calculate the cumulative contribution rate. And the eigenvalue and variance contribution rate of the correlation matrix R. Finally, the number of common factors is determined, see Table 5.

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Table 5 Explanation of total variance

ingredient	Initial eigenvalue			Extract the sum of squared loads			Rotational load sum of squares		
	total	Variance percentage	accumulation %	total	Variance percentage	accumulation %	total	Variance percentage	accumulation %
1	5.679	81.135	81.135	5.679	81.135	81.135	3.874	55.342	55.342
2	1.321	18.865	100.000	1.321	18.865	100.000	3.126	44.658	100.000
3	6.637E-16	9.481E-15	100.000						
4	1.640E-16	2.343E-15	100.000						
5	1.232E-16	1.760E-15	100.000						
6	7.157E-18	1.022E-16	100.000						
7	-4.619E-16	-6.598E-15	100.000						

3.3.2 Factor rotation

When the factor load matrix is rotated, the extraction method used is the principal component analysis method. The rotation method used is Caesar's normalized maximum variance method. The rotation of this model has converged after 3 iterations, see Table 6.

Table 6 Rotational component matrix

	ingredient	
	1	2
x21	0.880	0.475
x22	0.029	1.000
x23	1.000	-0.029
x24	-0.880	-0.475
x25	0.525	0.851
x26	0.880	0.475
x27	-0.525	-0.851

According to the above table, we can see that on component one, the number of transportation routes opened, the speed of transportation, and the flexibility of transportation services have larger loads, which are 0.880, 1.00, and 0.880, respectively. This shows that component one mainly explains these variables; and For component two, the transportation frequency and loading and unloading efficiency have larger loads, which are 1.00 and 0.851, respectively. This indicates that this component mainly explains these two variables, so the obtained component and the initial variable can be connected.

3.3.3 Calculate factor score

Use SPSS 24.0 to calculate the value of each common factor, see Table 7.

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Table 7 Component score coefficient matrix

	ingredient	
	1	2
x21	.231	-.007
x22	-.274	.508
x23	.425	-.301
x24	-.231	.007
x25	-.025	.290
x26	.231	-.007
x27	.025	-.290

According to Table 7 above, the component expressions (such as Equations 1 and 2) can be derived:

$$F_{21} = 0.231 \times x_{21} - 0.274 \times x_{22} + 0.425 \times x_{23} - 0.231 \times x_{24} - 0.25 \times x_{25} + 0.231 \times x_{26} + 0.25 \times x_{27} \tag{1}$$

$$F_{22} = -0.007 \times x_{21} + 0.508 \times x_{22} - 0.301 \times x_{23} + 0.007 \times x_{24} + 0.29 \times x_{25} - 0.07 \times x_{26} - 0.29 \times x_{27} \tag{2}$$

Symbol meaning:

$X(x_1, x_2, x_3, \cdots, x_p)$ is observable random variable;

$F(f_1, f_2, f_3, \cdots, f_k)$ is the common factors of observable random variables are unobservable and independent of each other. The expressions of each original observed variable all appear together.

3.3.4 Calculate the overall score

After calculating the factor scores, the score of each sample is obtained according to the variance contribution rate of each factor, see Equation 3.

$$F_2 = \left(55.342/100.00\right) \times F_{21} + \left(44.658/100.00\right) \times F_{22} \tag{3}$$

By analogy, according to the specific steps of the above factor analysis method and the factor analysis of the remaining three secondary indicators, the main components of each secondary indicator are extracted to obtain the variance contribution rate of each factor. As shown in Table 8 and Table 9 below:

Table 8 Variance and contribution rate of each secondary index factor

index	variance	Variance contribution rate (%)	Cumulative variance contribution rate (%)
F_{11}	2.681	67.026	67.026
F_{12}	1.319	32.974	100.000
F_{21}	3.874	55.342	55.342
F_{22}	3.126	44.658	100.000
F_{31}	2.000	100.000	100.000
F_{41}	1.866	93.301	93.301

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Table 9 Component score coefficient indexes corresponding to secondary indexes

index	ingredient		index	ingredient		index	ingredient	index	ingredient
	F11	F12		F21	F22		F31		F41
x_{11}	0.227	0.294	x21	0.231	-0.007	x31	1	x41	-0.966
x_{12}	0.419	-0.168	x22	-0.274	0.508	x32	1	x42	0.966
x_{13}	0.419	-0.168	x23	0.425	-0.301				
x_{14}	-0.207	0.872	x24	-0.231	0.007				
			x25	-0.025	0.29				
			x26	0.231	-0.007				
			x27	0.025	-0.29				

According to the component score coefficient matrix of the above table, calculate the score of each component, as shown in Table 10 below:

Table 10 Scores of various factors of secondary indicators

Collection and distribution method	F_{11}	F_{12}	F_{21}	F_{22}	F_{31}	F_{41}
Highway	0.4699	1.0500	0.0870	0.9829	2.0000	-1.5237
Railway	0.6784	-0.9406	0.8080	-1.0166	0.0000	-0.5577
Waterway	-1.1483	-0.1094	-0.8951	0.0337	-2.0000	2.0814

The weight is the ratio of the score of each factor and its corresponding variance contribution rate to the cumulative contribution rate. According to the calculation results of the weights, we get 4 comprehensive scores for the first-level indicators. Furthermore, factor analysis of these indicators, and the final score, as shown in the following Table 11:

Table 11 Ranking of first-level indicators and comprehensive ranking

Collection and distribution method	F_1	Rank	F_2	Rank	F_3	Rank	F_4	Rank	F	Rank
Highway	0.6612	1	0.4871	1	2	1	-1.5237	3	4.639	1
Railway	0.1446	2	-0.0068	2	0	2	-0.5577	2	0.6885	2
Waterway	-0.8058	3	-0.4803	3	-2	3	2.0814	1	-5.3275	3

From the above table, the average value of the factor analysis score and comprehensive score of various collection and transportation methods is 0. The way of collecting and distributing goods is generally performed in the collecting and distributing goods system of Guangzhou Port, and there is a lot of room for improvement. Therefore, it is concluded that the development of Guangzhou's market and transportation system is extremely uneven, and the way of road transport and transportation is close to saturation, but water transportation is seriously lagging, and the advantages of Guangzhou's natural inland rivers have not been fully developed.

3.3.5 Optimization suggestions

With reference to the experience of the construction and operation of the domestic and international collection and transportation system and the above evaluation results for Guangzhou Port, and combining with the real situation of the development of the Guangzhou Port collection and transportation system, several suggestions are proposed to promote the construction and development of the Guangzhou Port collection and transportation system :

(1) Accelerate the construction of the railway transportation system, because in the transportation network, especially inland, if road transportation and railway transportation go hand in hand, the cost

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of railway transportation is low, the scale is large (in line with economies of scale), and it is safer. The advantage will be highlighted, so it is likely to bear more haulage. And to speed up the investment and construction of railway transportation, more goods can be transported directly between the port and the city instead of transiting through the transfer stations, eliminating certain transportation links and saving transportation costs.

(2) Try to coordinate the proportion of the three modes of transportation: road, railway and waterway. Guangzhou Port needs to pay attention to the reasonable allocation of these three methods, while taking advantage of the advantages of road and rail transportation, actively supporting and opening highways and high-speed railways, and constantly improving the utilization rate of green transportation vehicles (electric cars, maglev trains), And accelerate the development of container intermodal transport. In fact, the implementation of barge transportation in the Pearl River Delta area is very cost-effective for container transportation, and barge transportation can be selected if possible.

(3) Speed up the construction of railway lines. At present, although Guangzhou Railway undertakes a large amount of gathering and transportation, the Guangzhou Railway has only three external channels: Beijing-Guangzhou Railway and Beijing-Kowloon Railway. The transportation capacity is still tight. For the rapid growth of the future, the railway transportation will still feel Strenuous.

(4) In terms of government support, inland river transportation assistance policies can be formulated. After all, inland transportation loses its cost advantage in short-distance transportation, according to the inland river development experience of foreign gathering and transportation systems, the development of inland transportation must be led by the government to support this environmentally friendly, energy-saving and low external cost transportation the way. Therefore, the government can effectively promote the changes in the overall distribution network structure by giving financial subsidies to inland transportation related enterprises, reducing some taxes, and providing large loan services, thereby making the distribution network to Guangzhou Port more comprehensive and complete And efficient.

4. Conclusion

This article deeply analyzes the transportation methods of Guangzhou Port Gathering and Transportation and its current situation, and uses the multi-level factor analysis method, especially the principal component analysis method to compare and evaluate the three transportation methods of Guangzhou Port Gathering and Transportation. The transportation mode is more reasonable and mainstream, and the waterway gathering and transportation mode is slightly inferior. Based on the evaluation results, the main problems of the current collection and transportation system of Guangzhou Port are analyzed, and a feasible optimization proposal is put forward: speed up the construction of the collection and transportation method of railway to coordinate the proportion of the three transportation modes of road, railway and waterway as much as possible. Speed up the construction of railway lines. The government formulates inland river container transportation assistance policies. Of course, this model has less quantitative data and more qualitative data, so that the conclusion is greatly influenced by subjective factors. Therefore, the influencing factors and modeling methods of the collection and transportation are worthy of further study.

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