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Comparative Analysis of the Modernization Level of Shanghai Port, Hong Kong Port and Singapore Port

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Abstract: This article selects three ports of Shanghai, Hong Kong and Singapore, using the AHP method to comparative study on the level of modernization of port, it is concluded that the modern comprehensive ranking of three ports, and each index ranking, providing a certain reference for further development of the Shanghai port.

Keywords: Port; Level of Modernization; Method of AHP

1. Introduction

Shanghai port relies on its strong economic strength, within the title of the Yangtze River Delta, connecting the Pearl River Delta in the south, Bohai Sea in the north, going westward through the penetration of the Yangtze river golden waterway, brief Busan and Incheon the east, becoming China and the world's leading international port. More noteworthy is that the Shanghai port is the only one that is classified as international port in China. By comparing and analyzing the modernization level of the port of Shanghai, Hong Kong, Singapore, concluding that Shanghai port needs to improve some aspects to develop.

2. The Introduction of Port

2.1. The port of Shanghai

In 2014, cargo throughput of Shanghai port reached 755.2889 million tons, down by 2.6% over the previous year; container throughput attained 35,285,300 TEU, an increase of 5%. The ratio of container water-water was 45.8%, up 0.4 percentage points over the previous year. International transfer ratio was 7.1%, increased by 0.1%, comfortably remained the world's largest port.

At present, the maximum quantity of container terminal handling has reached 529.23 cases per hour, the capacity of brachial-bridge portal container crane has attained 81.85 cases, the average time that containerships stay in the port , has dropped to about 25 hours.

Now the route of Shanghai port stands at 296. Shanghai port opens up more than 200 shipping route all over the world, international direct liner routes include Americas, Europe, Australia, Africa, northeast Asia, southeast Asia and other places . Currently, the container ships sailing density has amounted to 1967 classes monthly, container inner branch has reached to 1007 classes. Shanghai port has become the most container routes, the highest density of sailing, the most widely coverage of harbor in the Chinese mainland.

The maximum depth is 24 meters beneath the surface. But the largest natural conditions advantages of Shanghai port is reflected in its strong economic hinterland, the main economic hinterland in addition to Shanghai, including Jiangsu, Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Sichuan and other provinces and Chongqing.

The amphibious transportation of Shanghai Port is convenient, collection and distribution channels is expedite, including water: 558 sea miles south of the coast of Dalian, north of Hong Kong 823 sea miles, west of Chongqing 2399 kilometers long. Highway: Shanghai-Ningbo, Shanghai-Hangzhou, and the other highway, which link the national highway system. Railway: railway within the port area connected with Shanghai-Hangzhou and Shanghai-Ningbo railway. Shanghai-Ningbo line which links the Jinpu line to become the transportation artery from north to south in eastern China; Shanghai-Hangzhou line connected with the Zhejiang-Gannan and Xiao Yong line, may reach South, Southwest and Eastern Zhejiang.

2.2. The port of Singapore

In 2014, container throughput rose 4% to 33.9 million TEU, the port of Singapore from the scale of the throughput standing the world's second, from the fuel oil sales point of view, is still the world's first port of refueling, sales in 2014, the total amount of fuel reach to 42.4 million metric tons.

The port of Singapore is located in the shipping routes between the Pacific and Indian Ocean – the import and export of the Strait of Malacca, the Strait of Malacca is one of the world's busiest international channel. Singapore has the advantageous geographical position, pro-

moting the development of the transfer trade and manufacturing and processing industry, with access to the world's third largest oil refining center, world's aviation centers, electronic industrial center, trade center, financial center, conference center and shipping center.

Although container quantity that Singapore national import and export is only more than 300 million TEU, while the total throughput of the port has reached 18.1 million TEU, transit proportion is 82%. Hinterland through its direct transit are Malaysia, Indonesia, Thailand and other Southeast Asian countries, the transshipment containers from these countries accounted for 60%-70% of Singapore's port container throughput. Singapore port, relying on high technology storage equipment, automatic stereoscopic warehouse, wireless scanning equipment, automatic escrow system and other modern information technology equipment, implements that every 2 ~ 3 min there is a ship out of port, handling about 42 container ships per day.

2.3. The port of Hong Kong

In 2014, the port of Hong Kong handled 22.2 million TEU. It is an international container hub port that processing and transformation in both. It takes the broad area of continental (mainly in south China, southwest and partly in the Yangtze River area) as its economic hinterland, formed its own capacity of manufacturing industry. Hong Kong's international shipping center and an international container hub port is an important support that it has become a trade center in the Far East, financial center and economic center. Hong Kong's geographical location and economic development process determine that Hong Kong must share international cargo quantity with Guangdong Province. Hong Kong's location is shown in Figure 1.

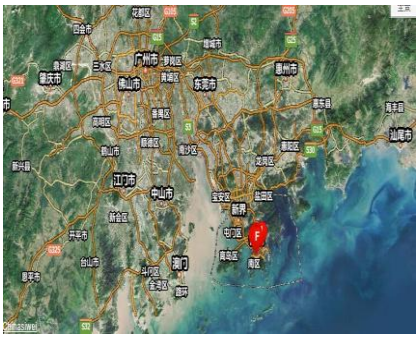

Figure 1. Hong Kong's Location

After decades of development, the port of Hong Kong has established a good logistics infrastructure and international shipping network that can reach global major ports. Hong Kong port gained the title of the world's busiest ports 9 times in 10 years. The port of Hong Kong is high efficiency, a 8000 TEU container ship, moored in Hong Kong for 16 hours, can be loaded and unloaded 520 TEU, with an average 325 TEU per hour. Shenzhen Yantian port stops for 12 hours plus to wait six hours in the harbor, leading to load and unload only 2,000 TEU, 111 TEU per hour. Long Beach, handling 14,000 TEU takes five days, 117 TEU per hour.

Port of Hong Kong Marine logistics industry development disadvantage embodied that the supply of goods is not in Hong Kong but in manufacturing center in the Pearl River Delta of

Guangdong province. 70.61% of export goods in the Pearl River Delta transported all over the world through Hong Kong. At the same time 92.71% of imports in the Pearl River Delta to be delivered via Hong Kong. With the continuous improvement of the coastal main ports' hardware and software facilities, the part of cargo importing and exporting through Hong Kong is likely to import and export from the port of Guangdong Province for some time in the future. This will be a serious challenge that port of Hong Kong will be facing in maritime logistics industry.

3. The AHP Analysis of Shanghai Port, Hong Kong Port, Singapore Port

3.1. Construction of container terminal modernization development level evaluation index system

With the passage of time, the port modernization standard is changing and dynamic. Therefore the elements constituted port modernization evaluation system must be converted to operate so that it is easy application and evaluation. For the concept and caliber of container terminal data are unified and it can be quantitatively calculated and compared, so the establishment and application of the Container Terminal Modernization development level evaluation index system take the container terminal as the object. Container Terminal Modernization development level evaluation index system and its levels are shown in Table 1.

Table 1. Container Terminal Modernization development level evaluation index system

Target layer	Rule layer(First order index)	Index layer(Secondary index)	Meaning Description
Container Terminal Modernization development level(A)	Geographic conditions(B1)	Comprehensive modernization index of the country or region(C11)	Reflecting the relative gap between the level of modernization and the world advanced level in different countries or regions
		Wharf front depth(C12)	below the Wharf front design low water

			depth
	Equipment and facilities(B2)	The berth number(C21)	Total number of dedicated berths for container terminals
		The length of container terminal(C22)	Container quay length
		The total number of container crane(C23)	the actual amount of container crane
	Management level(B3)	Management innovation and imitation level(C31)	Refers to relative other terminals, the terminal's level to introduce new way of management.
		Service level and the level of market strain(C32)	Refers to the relative to other terminals, the terminal services the client's level and reflect the adaptability in the face of the changeable market
		Information level(C33)	Refers to the relative to other terminals, the terminal software level, business dependence on computer information, paperless level, electronic commerce and electronic data interchange levels, etc.
	Production performance(B4)	Container Throughput(C41)	Annual number of containers in and out of the terminal and loading and unloading by sea route.
	Environmental Protection(B5)	Environmental awareness(C51)	Awareness and importance of environmental protection
		Oil spill handling capacity(C52)	Emergency handling capacity of oil spill accident

3.2. Evaluation method of modernization development level of container terminals

The paper uses AHP (Analytic Hierarchy Process (AHP) to evaluate the modernization development level of container terminals. AHP is an analysis of multiple criteria decision method combining with qualitative and quantitative. It can be divided into four steps using AHP to analysis, design and make decision. (1)Establish an analytic hierarchy structure model and put the question methodical and hierarchical. (2) Based on a certain criteria in the upper layer through the importance of same level of each element are compared, a pair of comparative judgment matrix can be constructed. (3) Hierarchical single sort and its consistency check. (4) Computing synthesis weights of each element on the system target and sorting. Using AHP evaluate the modern development level of three container terminals at home and abroad.

1) Determination of judgment matrix

The determination of judgment matrix is the key link to analyze the problem by using the AHP model. According to the views of experts, judgment matrix can be determined after repeated correction.

Rule layer judgment matrix. Rule layer judgment matrix S_B represents the mutual relationship between the various criteria in rule layer.

$$S_B = \begin{bmatrix} 1 & 5 & 1/3 & 3 & 9 \\ 1/5 & 1 & 1/5 & 1/3 & 3 \\ 3 & 5 & 1 & 5 & 7 \\ 1/3 & 3 & 1/5 & 1 & 3 \\ 1/9 & 1/3 & 1/7 & 1/3 & 1 \end{bmatrix}$$

Index layer judgment matrix $S_{B_i-C_{ij}}$

$$S_{B_1-C_{1j}} = \begin{bmatrix} 1 & 5 \\ 1/5 & 1 \end{bmatrix}$$

$$S_{B_2-C_{2j}} = \begin{bmatrix} 1 & 3 & 3 \\ 1/3 & 1 & 1 \\ 1/3 & 1 & 1 \end{bmatrix}$$

$$S_{B_3-C_{3j}} = \begin{bmatrix} 1 & 1/5 & 5 & 5 \\ 5 & 1 & 9 & 9 \\ 1/5 & 1/9 & 1 & 1 \\ 1/5 & 1/9 & 1 & 1 \end{bmatrix}$$

$$S_{B_5-C_{5j}} = \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$$

2) The weight of each index relative to the total target

Through judgment matrix it can be calculated the effects of each index corresponding to rule layer's weight in AHP model, further synthetic weights of Index layer to target layer are obtained. The maximum characteristic root λ =5.310 of the rule layer relative to the target layer, consistency Index CI=0.0775 and Check number CR=0.069<0.1 are obtained by calculation. Rule layer matrix passed consistency test. The weight vector WB=(0.28,0.08,0.48,0.12,0.04)T. Similarly, the four judgment matrixes of the index layer are calculated respectively, it is concluded and the weight vectors of the secondary index to the corresponding first order index are as follows:

W1=(0.83,0.17)T;

W2=(0.6,0.2,0.2)T;

W3=(0.23,0.67,0.05,0.05)T;
W4=(0.5,0.5)T.

The value of the synthetic weight of the index layer on the target layer is $W_{ij} = W_{B_i} \times W_{C_{ij}}$. The weight vector of the secondary index corresponding to the target layer is W = (0.2324,0.0476,0.0480,0.0160,0.0160,0.1104,0.3216,0.0240,0.0240,0.1200,0.0200,0.0200).

Weights of hierarchy total ordering are shown in Table 2.

3) Sorting of container terminals on the secondary indicators

Due to the qualitative indicators of the level of management, so it is necessary to obtain the index score through experts. The Reference data of three ports is shown as Table 3.

Sorting of three container terminals are calculated respectively based on the secondary indexes of evaluation index system. Obtained values are shown in Table 4. In Table 4 column represents sorting of three container terminals in the index and each line represents score of three container terminals on each secondary index. The maximum characteristic roots of each secondary index from C11 to C52 respectively are 7.18,7,7.0359,7.04,7.13,7.16,7.17,7,7,7.28,7.13,7.37.

4) Calculate the final result

According to the above data, it can be calculated 3 container terminals in the modernization level of relative order. The calculating formula is as follows.

$$D = \sum c_{ij} w_{ij}$$

D as index of port's level of modernization;

c_{ij} as secondary index score;

w_{ij} as secondary index's synthetic weights;

The final results are shown in Table 5.

Table 2. Weights of hierarchy total ordering in the evaluation index system of the modernization level of container terminal

		secondary index	weight WC_{ij}	Synthetic weight W_{ij}
B_1	0.28	C_{11}	0.83	0.2324
		C_{12}	0.17	0.0476
B_2	0.08	C_{21}	0.60	0.0480
		C_{22}	0.20	0.0160
		C_{23}	0.20	0.0160
B_3	0.48	C_{31}	0.23	0.1104
		C_{32}	0.67	0.3260
		C_{33}	0.05	0.0240
		C_{34}	0.05	0.0240
B_4	0.12	C_{41}	1.00	0.1200
B_5	0.04	C_{51}	0.50	0.0200
		C_{52}	0.50	0.0200

Table 3. Reference data of three ports

Container terminal	Comprehensive modernization index of national or regional	Wharf front depth/m	Berth number/unit	Length of container terminal /m	Total number of container loading and unloading bridge /unit	Container throughput /10000TEU
Shanghai port	77	-15	38	13124	153	3528.53
HONGKONG port	76	-15.5	24	7804	97	2228
Singapore port	83	-15.5	54	16000	190	3390

Table 4. Sorting of three container terminals on the secondary indicators

container terminal	C_{11}	C_{12}	C_{21}	C_{22}	C_{23}	C_{31}	C_{32}	C_{33}	C_{34}	C_{41}	C_{51}	C_{52}
Shanghai port	0.33	0.33	0.33	0.36	0.35	0.12	0.14	0.19	0.2	0.39	0.19	0.18
Port of HONGKONG	0.32	0.34	0.21	0.21	0.22	0.31	0.3	0.19	0.2	0.24	0.19	0.18
Singapore port	0.35	0.34	0.47	0.43	0.43	0.57	0.56	0.63	0.6	0.37	0.62	0.65

Table 5. The results of three container terminals' Sorting on the secondary indicators

Container terminal	C_{11}	C_{12}	C_{21}	C_{22}	C_{23}	C_{31}	C_{32}
Shanghai port	0.0767	0.0157	0.0158	0.0058	0.0056	0.0132	0.0456
Port of HONGKONG	0.0744	0.0162	0.0101	0.0034	0.0035	0.0342	0.0978
Singapore port	0.0813	0.0162	0.0226	0.0069	0.0069	0.0629	0.1826
Container terminal	**C_{33}**	**C_{34}**	**C_{41}**	**C_{51}**	**C_{52}**	**Total score**	
Shanghai port	0.0046	0.0048	0.0468	0.0038	0.0036	0.2420	
Port of HONGKONG	0.0046	0.0048	0.0288	0.0038	0.0036	0.2851	
Singapore port	0.0000	0.0144	0.0444	0.0124	0.0130	0.4635	

The calculation results show that the degree of modernization of three container terminals ranked from high to low is Singapore, Hong Kong and Shanghai. It can be seen from the calculation process and result that Singapore port shows great superiority in natural conditions, management level, production performance, ahead of the other three terminal's modernization development level. In such aspects as management level and production performance port of Hong Kong is prominent and it's modernization level is second only to Singapore port. Compared with other terminals equipped facilities of Shanghai port are strengths and it's modernization development level in the three terminals are in the middle.

4. Conclusion

Through comparative study as you can see, in order to improve the modernization level of development Shanghai port has a large room to improve in the management level and the environmental protection. Shanghai port should strive to develop sea-rail transport, the transit business, shipping service industry and pursue the port's refinement and agile management to improve the level of Shanghai's modernization development constantly.

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