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Analysis of Production Efficiency of Container Port Based on AIS Data

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ABSTRACT. *Economic globalization has made modern ports not only assume the role of transport transit nodes, but also integrate transportation, finance, industry and trade, information, and multimodal transport, and continue to develop in the direction of integrated logistics centers. In this context, the accurate and scientific evaluation of port production efficiency not only has important reference value for port operation decision, but also has important significance for the economic operation planning of port cities and even regions. Using the data information such as the Automatic identification system(AIS) ship trajectory as the analysis basis, the port throughput index, the number of container ship unloading operations per container, the average vessel time of the container ship in Hong Kong, the effective operation time, the container arrival time, the average time of departure and the like, etc. Based on the indicators, the company compares the port production efficiency of Shanghai Port, Guangzhou Port, Ningbo Port and Zhuhai Port, and studies the production efficiency of the four ports. Data mining methods are used to draw relevant analysis conclusions, and relevant development suggestions are given based on this.*

KEYWORDS: *port, integrated logistics, container, ship trajectory, production efficiency*

1. Introduction

Limited by the relevant data, this paper uses the April 2017 Automatic identification system(AIS) data as the original data, through the relevant data processing, calculates the four port partial quantity indicators, and compares them with each other to analyze the production efficiency of the four port container terminals.

The cargo indicators are generally divided into the cargo and the carrier of the cargo. The paper has studied the cargo through the conduct of the cargo. The port throughput index can reflect the scale of the port to a certain extent, the role and position of the port and the exchange of foreign trade materials. However, due to the different types of cargo flow and loading, the flow of goods is different, resulting in throughput. There are unequal problems in the quantity indicators. In this paper,

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only the actual port cargo throughput issued by the Ministry of Communications is used, and the conversion factor changes caused by the cargo structure and the flow direction of the goods are not considered.

2. Throughput indicator

2.1 Cargo throughput

Table 1 Cargo throughput (ten thousand tons)

Zhuhai Port	Shenzhen Port	Guangzhou Port	Ningbo Port	Shanghai Port
1296.81	1857.16	4717.38	4714.54	5990.53

In the comparison of the above cargo throughput, due to the data, Shenzhen Port was added as a reference. From the chart (1) bar cargo throughput bar chart, it can be concluded that in the above five ports, Zhuhai Port cargo throughput and neighboring Shenzhen Port is relatively close, thanks to its unique geographical advantage in the Xijiang River estuary, resulting in relatively more transshipment of water and water, although the economic development level is not as good as Shenzhen Port, but its throughput data is almost the same as Shenzhen Port; however, Zhuhai port cargo throughput is still far less than that of Guangzhou Port and Ningbo Port, which is located in the Yangtze River Delta. It is far from Shanghai Port. The main reason is that its port city hinterland economy is relatively backward and trade demand is relatively low, resulting in low freight demand. This affects the port cargo throughput.

Overall, the best performer is Shanghai Port, which is benefited from the developed economic support in the hinterland of the Yangtze River Delta and the geographical position of the Yangtze River estuary. Secondly, the cargo throughput of Guangzhou Port and Ningbo Port is basically the same, and Far beyond Shenzhen Port and Zhuhai Port, Shanghai Port is undoubtedly the first echelon among the five ports. Guangzhou Port and Ningbo Port are in the second echelon, while Shenzhen Port and Zhuhai Port are in the third echelon.

Zhuhai Port is located on the west bank of the Pearl River and is the only natural deep-water port in the western part of the Pearl River Delta. It is adjacent to Hong Kong and borders Macao. It is the most important bridgehead for deepening cooperation between Guangdong, Hong Kong and Macao. As the most important estuary of the Pearl River system, it can be transported through Xijiang Shipping. It is connected with the vast hinterland of Guangxi, Guizhou and Guizhou provinces. It has unparalleled advantages in river and sea transport. Guangzhou Port is connected with major cities in the Pearl River Delta and Hong Kong and Macao. It is connected to the southwest of China by Xijiang. It is the largest foreign country in South China. Trade port; the Yangtze River Delta port group with Ningbo Zhoushan Port and Shanghai Port as the core is the fastest-growing port group of the five major ports. There is still a co-opetition relationship between the ports within the

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group. Shanghai Port is superior to the Yangtze River estuary. The geographical location, especially the construction of large and small Yangshan, makes up for the lack of water depth conditions in Shanghai Port. Relatively speaking, the natural conditions of Ningbo Zhoushan Port are relatively good, and the completion of the Hangzhou Bay Bridge has brought the Yangtze River Delta region closer. Shipping distance. In summary, the above four major ports have their own advantages and disadvantages in terms of regional economy, geographical location, and national policies. In order to further develop port production efficiency, appropriate transformation of their terminals and yards Further improve its related infrastructure construction, expand port production capacity, improve port throughput capacity, give full play to its advantages of sea-rail combined transport, and continuously promote the intelligent operation of terminal operations and port area dispatching, which is more convenient for port operations and enhance port docking. The ability of international routes is particularly important.

2.2 Container throughput

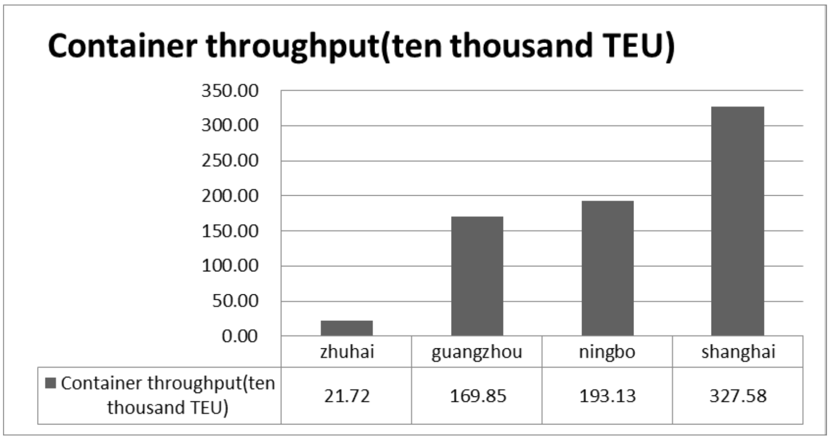

Figure. 1 Container throughput (ten thousand TEU)

From the bar chart of port container cargo throughput analysis in Figure (2), it can be concluded that the container throughput of Zhuhai Port in April 2017 isstillless than one-eighth of that of Guangzhou Port, regardless of the surrounding Guangzhou Port or Ningbo Port in the Yangtze River Delta. Compared with Shanghai Port,they are far apart, and the current level of container development is low.

In recent years, due to the fierce competition in the development of the ports in the Pearl River Delta, the neighboring Guangzhou Port and Shenzhen Port have developed wet ports and offices in the hinterland, and have developed into mature container trunk ports. Zhuhai Harbour wants such fierce competition. In order to

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stand out from the crowd, it is necessary to give full play to the unique advantages of its own sea-rail rail transport. Through the layout of the dry port network along the Xijiang River and the Guangzhou-Zhuhai Railway, the inland goods will be conveniently and efficiently, and the low-cost export through the Zhuhai Port will make the imported goods safe. Fast transportation to the mainland, continuous improvement of logistics network facilities, opening up a large logistics channel between the hinterland and Zhuhai Port, thus attracting shipping companies to increase the density of container trunk routes, thereby increasing the container throughput of Zhuhai Port. Compared with Shanghai Port, Guangzhou Port and Ningbo Port have the same economic support and location advantages in the hinterland, but their container throughput is still far from the Shanghai Port. Therefore, regardless of the production layout or collection and distribution system of the two ports All aspects must be further improved, perfected, and caught up.

3. Horizontal comparison of ship stay time indicators in port

3.1 The average time each vessel stays in port

The number of vessels leaving the port during the reporting period, from the time of entry to the time of departure, the average hour of each vessel being parked in port.

$$\overline{T_1} = \frac{\sum_1^N T}{N} \tag{1}$$

$\overline{\mathrm{T}}$: The average time each vessel stays in port

$\sum_1^N T$: The total number of hours a ship stays in Hong Kong refers to the total time of the ship's stay in port during the reporting period.

N: The total number of ships staying in port refers to the number of ships that have been parked from the time of entry to the port during the reporting period.

3.2 The average time the ship stays at the dock every hour

During the reporting period, the ship was docked from the dock to the terminal, and the average time each boat stayed at the dock for an hour.

$$\overline{T_2} = \frac{\sum_1^N T}{N} \tag{2}$$

$\overline{\mathrm{T}}$: The average time the ship stays at the dock every hour

$\sum_1^{\mathrm{N}} \mathrm{T}$: The total number of hours the ship stays at the terminal refers to the total time of the ship's stay at the terminal during the reporting period.

N: The total number of ships staying at the terminal refers to the number of times the ship has been docked from the time of entering the terminal.

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3.3 The average non-productive berthing time of the ship in port

Refers to the average time each vessel stays in port during the reporting period, except for the average time each vessel stays at the terminal.

$$\overline{T_3}=\overline{T_1}-\overline{T_2} \tag{3}$$

The terminals referred to in this paper are container terminals, and the terminal and port areas are the scope defined by the author according to experience, which contains subjective factors, so it affects the accuracy of relevant indicator data. For the indicator results, see four more. Compare between ports.

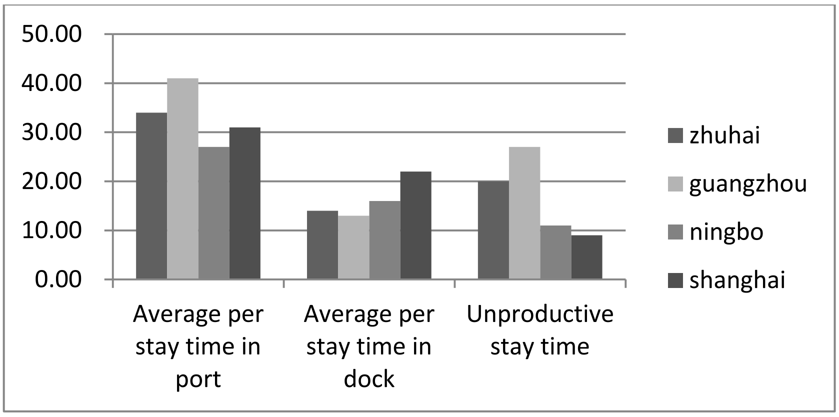

Figure. 2 Ship stay time indicator in port

Analysis of the above figure (3) Ships in Hong Kong stay time indicators, first of all, analyze the average ship stay time per port, found that, except for the Guangzhou Port time data slightly larger, the average of each port port time index of the remaining three ports is maintained In the 30-hour period, Ningbo Port was the smallest 27 hours, indicating that Ningbo port port customs clearance procedures are the most efficient. Overall, the Ningbo Port and Shanghai Port indicators in the Yangtze River Delta are relatively small, while the Pearl Harbor in the Pearl River Delta and The Guangzhou Port indicator data is too large, and the side also maps the gap between the customs clearance procedures of the port ports in the Pearl River Delta and the ports in the Yangtze River Delta. Then: Analyze the average time of each dock stay of the ship. Except for the longer stay time at the port of Shanghai Port, the average stay time of the ships in the other three ports is basically the same. The author believes that the main reason is that Shanghai is the most important area in Asia. The container trunk hub port is also the world's largest container throughput container, and there are many large-scale container ships in the trunk line, resulting in longer loading and unloading time. On the other hand, the average stay time of other three-port ships is about 15 hours, which indicates that the loading and unloading efficiency of Zhuhai Container Terminal is basically consistent with other

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ports. Secondly, it analyzes the average non-productive berthing time of ships, that is, the time after the ship enters the port, except for loading and unloading at the dock berth, such as anchorage and other moorings, customs clearance procedures, and so on. It can be seen from the figure that compared with Ningbo Port and Shanghai Port in the Yangtze River Delta, the non-productive stay time index of Zhuhai Port and Guangzhou Port in the Pearl River Delta is still at a high level, indicating that the overall customs clearance efficiency of the Pearl River Delta Port is lower than that of the Yangtze River Delta. port. However, at the same time, it is considered that there are many rivers at the mouth of the Pearl River. Most of the wharfs are distributed on both banks of the river. As a result, the time for passing some rivers through the rivers is included in the statistical non-productive stay time, and the statistics on the non-productive time of the above ships are certain. Impact, but overall, the non-productive retention time of ships in the Pearl River Delta port is still greater than that of the Yangtze River Delta. Finally, on the whole: the production performance of container terminals in the Pearl River Delta is slightly inferior to that in the Yangtze River Delta. As far as the Pearl River Delta is concerned, the production performance of Zhuhai Port Container Terminal is slightly ahead of Guangzhou Port.

4. Average ship time

Average ship time: refers to the number of tons of cargo loaded and unloaded per hour per ship that is berthed and loaded into port. The formula is:

$$\bar{P} = \frac{\sum_1^n Q}{\sum_1^N T} \left(\frac{\text{ton}}{\text{ship hour}}\right) \quad (4)$$

$\overline{\mathrm{P}}$: Average ship time (ton/boat)

$\sum_1^{\mathrm{N}}$ Q The sum of tons of cargo handled and unloaded by ships (10,000 TEU)

$\sum_1^{\mathrm{N}}$ T: Ship operation time (shiptime)

Since the port and the polygonal area of the dock are artificially divided, some ships enter the dock area, but they do not necessarily berth into the loading and unloading state. Therefore, during the calculation of the average ship time, the ship brought in is at the time of parking. Large, resulting in a small calculation result, so the above table only looks at the relative difference in the average ship time between ports, no more than its absolute value.

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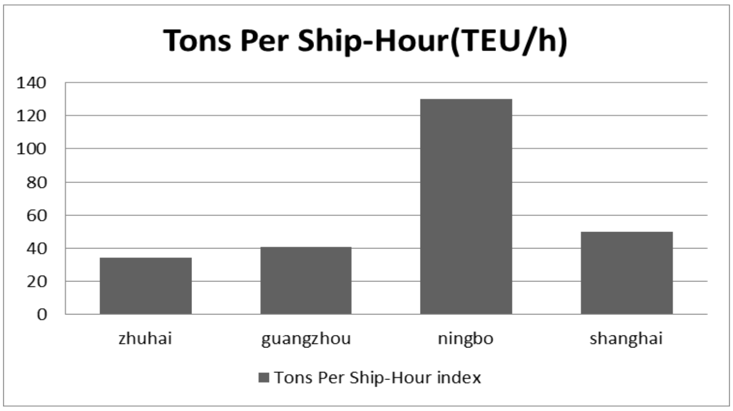

Figure. 3 Tons Per Ship-Hour index

5. Comparison of service efficiency between classed and non-classed ships

5.1 Index of staying time of the classed ship in port

Figure (5) is the indicator of the port time of the class of the ship. According to the industry experience, in general, the majority of the class-class ships are engaged in foreign trade transportation. Therefore, this paper uses the in-situ time indicator of the class ship to judge the port foreign trade ship service efficiency.

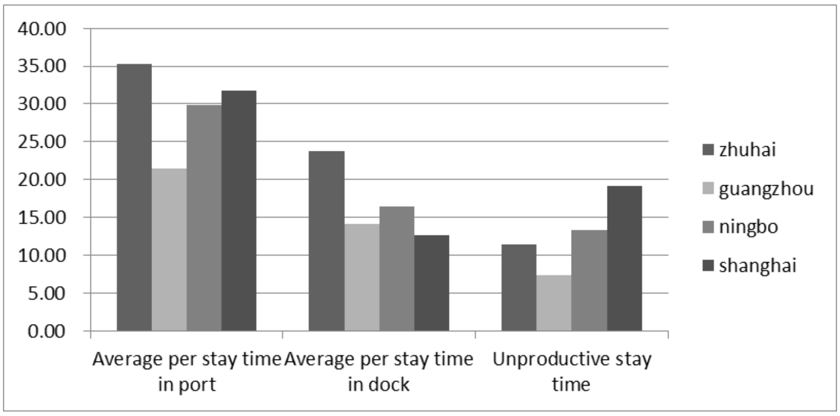

Figure. 4 Class ship service efficiency

First, compare the average terminal stay time of the four port-class ships. The average port stay time of the above-mentioned port-class ships exceeds 20 hours in Zhuhai Port, reaching 23.8 hours. The other three ports are around 15 hours, and the

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other three. Compared with the port, the Zhuhai Port class has an average residence time of more than 10 hours per port, and most of the ship terminal stay time is used for container loading and unloading time. This shows that the container loading and unloading efficiency of Zhuhai Port is higher than that of the other three. The ports are still at a lower level. Then comparing the average port time index of the class ship, it is found that Guangzhou Port is the shortest and Zhuhai Port is the longest, indicating that Zhuhai Port has a relatively low efficiency in the overall service of the classed ships. Secondly, comparing the average non-productive berthing time of the four port-class ships, it is found that Ningbo Port and Shanghai Port are generally high. Guangzhou is the shortest. The author believes that this is due to the large number of ships in Shanghai Port and Ningbo Port. Due to the phenomenon of the port, Zhuhai Port and Guangzhou Port are relatively small in terms of classification, so the time for ship docking is shorter. Finally, relatively speaking, Zhuhai port classed ships have a shorter non-productive time in port, and the actual loading and unloading time at the terminal is longer, which proves that the Zhuhai Port container terminal has low loading and unloading efficiency, and the ship is used for porting in port. The productive time is short.

5.2 Non-classed ship staying time indicator in port

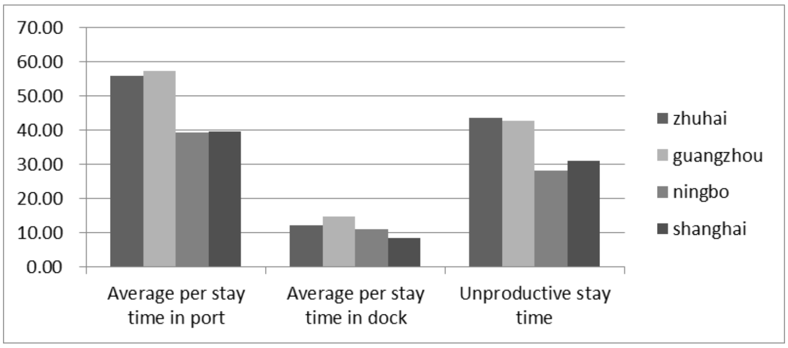

Figure. 5 Non-Classed ship service efficiency

Figure (6) is the indicator of the time of port non-classified ships in Hong Kong. According to industry experience, non-classed ships are mainly engaged in domestic trade transportation business. Therefore, this paper uses the non-classified ship terminal dwell time indicator to judge the port. Trade ship service efficiency.

Firstly, the average terminal stay time of non-classified ships is analyzed. The average terminal stay time of non-classified ships in the four ports is about 10 hours. The overall difference is not large, but the gap is still there. The average terminal stay time of non-classed ships in Shanghai Port is the lowest, which is mainly due to its efficient loading and unloading of automated container terminals. In contrast, the average terminal stay time of non-classed ships in Guangzhou Port and Zhuhai Port

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is higher. One of the reasons is that its container terminal handling equipment is relatively lagging behind Shanghai Port and Ningbo Port. The second reason is that its port has lower priority for domestic trade vessels and ship handling than Shanghai Port and Ningbo Port. Then compare the average port stay time of the non-classified ships of the four ports, and find that the ports in the Pearl River Delta are generally higher than the ports in the Yangtze River Delta. The average time of non-classified ships in Guangzhou port is the highest in Hong Kong. Secondly, the average non-classified ships are in Hong Kong. Non-productive stay time, it is found that Zhuhai Bay and Guangzhou Port in the Pearl River Delta are generally higher than Ningbo Port and Shanghai Port in the Yangtze River Delta. Finally, a comprehensive analysis of the above chart shows that the average terminal stay time of non-classified ships is not much different. Zhuhai Port is compared to Ningbo Port. It has a longer staying time with its non-classified ship port in Guangzhou Port. It mainly uses ship anchorage and other moorings to handle non-productive time such as port related procedures.

6. Conclusion

In summary, the overall production scale, productive time utilization efficiency and terminal loading and unloading efficiency of the Pearl River Delta port container terminal are slightly lower than those of the Yangtze River Delta port. The efficiency of foreign trade ship production in port is slightly higher than that of domestic trade vessels; The overall production scale, productive time utilization efficiency, and terminal loading and unloading efficiency of Zhuhai Port Container Terminal are lower than those of Guangzhou Port, Ningbo Port and Shanghai Port, and the production scale is far from the other three ports. The ultra-large container (10000TEU) Above), the service efficiency of ships is higher than that of other ship types. The service efficiency of foreign trade ships is higher than that of domestic trade ships. As far as Zhuhai Port is concerned, the overall production scale of container terminals in Gaolan Port Area and the production performance of terminals are higher than that of Hongwan Container Terminal. Moreover, the overall foreign trade ship port production efficiency is higher than that of domestic trade ships.

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