Research on The Current Situation and Development Measures of Rail-Water Intermodal Transport in Guangzhou Port Group

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Abstract. The development of rail-water intermodal transport is not only the strategy of national development, but also the inevitable result of the adjustment of national transport structure. The development of rail-water intermodal transport will greatly reduce the logistics cost of the whole society and promote the development of social economy. In this paper, Guangzhou Port Group in Guangdong, Hong Kong, Macao and Pearl River Delta region is the main research object. The problems faced by the development of rail-water intermodal transport are analyzed, and corresponding countermeasures are put forward to promote the development of rail-water intermodal transport in Guangzhou Port Group and increase the proportion of container rail-water intermodal transport.

1. Introduction
In recent years, China's economic development mode has changed, and more attention has been paid to the development quality. As mentioned in the three-year action plan for promoting the adjustment of transportation structure (2018-2020) issued by the General Office of the State Council of China. Encourage railway, port, shipping and other enterprises to strengthen cooperation and promote the collection and distribution of shipping containers through railway. [1] In terms of transportation, the concept of "Highway to Railway" is put forward. The development of rail-water intermodal transport will fit the development concept of China well, and provide strong support for the sustainable and healthy development of China's economy.

Rail-water intermodal transport is a modern mode of transport with high efficiency, low pollution, large volume, low cost and high timeliness. It is an important choice for a country to develop modern logistics and an important support for a country to develop its economy. The development of rail-water intermodal transport will greatly improve the efficiency, volume and timeliness of cargo transport, reduce the energy consumption of cargo transport, reduce carbon emissions, and realize green transport. In addition, the development of rail water intermodal transport can reduce the pressure of national road network and the incidence of traffic accidents, thus reducing the logistics cost of the whole society.

Guangzhou is located in the south of China and close to the South China Sea. At present, Guangzhou Port Group has four major ports, including Inner port, Huangpu port, Xinsha port and...
Nansha port. The four major ports along the two sides of the Pearl River, from north to south, and gradually close to the Pearl River Estuary, the geographical advantages of Guangzhou Port Group provide favorable preconditions for the development of rail-water intermodal transport. The distribution of the four major ports of Guangzhou Port Group is shown in Figure 1.

Although the road network and waterway network are very developed in Guangdong Province, there is still a lot of pressure for port dredging. If the railway as a major support of port dredging, it will be able to solve some problems in the process of port dredging, especially the negative impacts of highway. Railway port dredging is not only the transformation of transportation structure, but also the need of China's current development mode. The adoption of railway to dredge port will vigorously promote the development of China's rail-water intermodal transport. At the same time, it also provides the strong support for China's economic development.

Figure 1. Distribution of four major ports of Guangzhou Port Group.

2. Development status

Container rail-water intermodal transport is a modern mode of freight transport suitable for long distance and large volume, which not only has scale benefits, but also has good environmental and social benefits. At present, it is a modern mode of freight transportation which is strongly advocated and supported by all countries in the world.

At present, the proportion of transportation between ports and railways in developed countries is usually about 30%. Among the world's major ports, New Jersey Port in New York accounts for 11%, Los Angeles port for 24%, Antwerp Port in Belgium for 8%, Hamburg Port in Germany for 18%, and Rotterdam port in the Netherlands for 7%. The proportion of rail-water intermodal transportation in the world's major ports is shown in Figure 2.

Figure 2. The proportion of rail-water intermodal transportation in the world's major ports.
In 2018, China's ports above Designated Size completed 4.5 million TEU of container rail-water intermodal transportation, accounting for 1.8% of the container throughput of ports above designated size. [2] It can be seen that the overall proportion of China's port container rail-water intermodal transport is still less than 2%, much lower than that of developed countries.

Guangzhou port is the starting point of the maritime Silk Road and the largest comprehensive main hub port in South China. In 2018, the cargo throughput reached 613 million tons, ranking the fifth in the world; the container throughput reached 21.922 million TEU, ranking the fifth in the world. Guangzhou port is located at the estuary of the Pearl River and the center of the Pearl River Delta region where China's export-oriented economy is the most active. Adjacent to Hong Kong and Macao, it is an important strategic fulcrum of the Guangdong, Hong Kong, Macao and Pearl River Delta region and the largest foreign trade port in South China.

In recent years, Guangzhou port has made some breakthroughs in the development of rail-water intermodal transport. In addition to the realization of rail-water intermodal transport by containers, it also actively explores the "change bulk cargo to container" rail-water intermodal transport of grain and bulk cargo. "Change bulk cargo to container" is a new way to develop grain and bulk cargo rail-water intermodal transport.

In 2017, the volume of container rail-water intermodal transportation was 52300TEU, and the volume of container rail-water intermodal transport of grain and bulk cargo was 248000 tons. In 2018, the volume of container rail-water intermodal transportation was 61536TEU, and the volume of container rail-water intermodal transport of grain and bulk cargo was 329700 tons. It is estimated that the whole year of 2019, the volume of container rail-water intermodal transportation is 80700TEU, and the volume of container rail-water intermodal transport of grain and bulk cargo is 554500 tons.

Nearly three years, the volume of container rail-water intermodal transportation is shown in Figure 3, and the volume of container rail-water intermodal transport of grain and bulk cargo is shown in Figure 4.

Figure 3. The volume of container rail-water intermodal transportation in three years.
Figure 4. The volume of container rail-water intermodal transport of grain and bulk cargo in three years.

As a whole, the volume of container rail-water intermodal transportation and the volume of container rail-water intermodal transport of grain and bulk cargo are on the rise. Therefore, the proportion of Guangzhou Port Group container rail-water intermodal transport is on the rise. When we are happy with these achievements, we should also consider more shortcomings, because there are too many problems and obstacles, which hinder the further development of container rail-water intermodal transport.

3. Existing problems

3.1. Poor information exchange
Several ports of Guangzhou port group have their own specific information system and internal network. The railway department also has its own unique railway information system and internal network. The freight transportation information between railway departments and ports lacks an information system platform which can share the freight transportation information in real time. As a result, the freight transportation information cannot be shared and interconnected in real time between the two departments, and the circulation and sharing of freight transportation information are severely hindered. In addition, the network information security of information sharing platform is also a major concern of all departments. As for the existence of the above-mentioned problems, the freight transportation information in the current rail-water intermodal transport cannot be queried in real time.

3.2. Container not shared
The railway department has special containers for railway, and each shipping company has its own water containers. Due to the different ownership of containers, when the railway containers carry goods to the port, the railway containers cannot be directly loaded into the water for water transportation, but they need to be unloaded in the port, and then reloaded into the water containers of the shipping company, then they can be launched into the water for water transportation. The existence of container reloading not only increases the time and cost, but also greatly reduces the efficiency of rail-water intermodal transportation. The existence of changing loading directly increases the number of empty containers in port water transportation, and also causes the problem of returning empty containers in railway.

3.3. Open container for inspection
The classification of name of goods transported by water is relatively rough compared with that of goods transported by railway. In water transportation, goods with one name will be divided into
multiple names in railway transportation. Due to the difference in the classification of goods' names, there are differences in the packing requirements and charging standards between railway and waterway, so it is necessary to re-open container and repacking and recalculate transportation costs when connected.

There are differences in the division of dangerous goods between waterway transportation and railway transportation. According to the current transportation safety standards, the safety standard of railway transportation is stricter than that of waterway transportation. In addition, the existing railway transportation network in China has the phenomenon of mixed passenger and freight transportation, high-speed rail transportation cross line and so on. In order to ensure the safety of railway transportation to the maximum extent, the railway transportation of dangerous goods has become the focus of supervision, which is also an important reason for the containers transferred from waterway transportation to railway transportation to be re-opened for security inspection.

3.4. Insufficient empty container stock
Guangzhou Port Group has a dedicated wharf for bulk cargo. Some of the ore, coal and grain in bulk cargo is transported to the terminal customers by railway after "change bulk cargo to container". "Change bulk cargo to container" is a new way to develop bulk cargo rail-water intermodal transport, which can well support the development of container rail-water intermodal transport. The biggest limitation is shortage of empty containers and the large demand of terminal customers, so the port cannot meet the demand of the terminal customer. Because there is a large shortage in the number of empty containers. Most of the time, customers need a large number of bulk cargoes, and the demand is relatively continuous. However, the number of containers that bulk cargo wharf can provide for filling bulk cargoes is not enough, which leads to a large part of bulk cargoes cannot be evacuated through containers.

3.5. The inadequate capacity of railway transportation
The existing special railway lines of Guangzhou port group can be directly connected to the national railway network at Xiayuan station and Huangpu station of Guangzhou Shenzhen railway. There are Xinsha station and Xingang station which have been built. Nansha railway special line is still under construction. It is expected to be completed in 2020 and put into operation. In terms of the existing railway infrastructure and the capacity of railway transportation, it can only meet the requirements of Guangzhou Port Group for a tiny proportion of the port cargo dredging, and it is difficult to meet the requirements of large amount of port cargo dredging. Nansha port railway is the special railway line and the main port dredging channel of Nansha port. Before Nansha port railway was built and put into use, most of the container and bulk cargo in Nansha port can only be dredged by road transportation and barge transportation, and only a very small number of goods are dredged by railway. Therefore, from the current point of view, Nansha port in the use of railways to dredge the container and bulk cargo from the port there are still great deficiencies.

4. Countermeasures

4.1. Inland port as container freight yard
After the goods arrive at the port in a centralized way, the container will be transported to the inland port with the maximum railway capacity, and the inland port will be used as the rear cargo yard of the port, so as to make the most of the railway transportation capacity for port evacuation and ensure the smooth port evacuation at the front of the port. When the container arrives at the inland port by railway, it will be transported to the final destination by category and direction. As the rear cargo yard of the port, the inland port can effectively alleviate the container demurrage caused by the port railway station's dredging according to category and direction, reduce the backlog of port goods, and maximize the transportation capacity of port railway.
4.2. Building information sharing system

The railway, port, customs and other departments should build a third-party information sharing platform, which serves as a medium for information sharing. The departments participating in the joint construction can upload their own cargo transportation information to the information sharing platform for the relevant departments to query the relevant cargo transportation information. Only the department that uploads the information has the right to modify and delete the uploaded information, while other departments only have the right to query and request the relevant cargo transportation information. All departments participating in the information sharing platform belong to parallel relationship, and there is no subordinate relationship. The construction of information sharing platform must be based on the premise of ensuring the network information security of all departments, and at the same time, ensuring the information security of information sharing platform.

4.3. Reduce repetitive operations

In the process of rail-water intermodal transport, the main reason for repetitive operations such as box changing and open box security inspection lies in the difference of operation standards between the railway department and the port. There is not a unified operation standard recognized by both, so the necessary open box security inspection must be carried out again when the two modes of transportation are connected. Therefore, the establishment of a unified and commonly recognized operation standard is the basis and key to solve the repeated operations such as box changing and security check. Secondly, we should strengthen the interoperability between railway containers and water containers, reduce the proportion of changing containers in the port. On the one hand, it can reduce the rate of changing containers, reduce the operation steps, improve the efficiency of operation, on the other hand, it can solve a lot of problems such as empty containers returning and empty containers shortage.

4.4. Strengthen empty box delivery and empty box allocation

In the ports with a large number of bulk cargoes that need to be "change bulk cargo to container", for the ports with few absolute quantities of containers, the railway department should strengthen the delivery the quantity of empty containers and ensure a certain quantity of empty containers. For a port with few relatively quantities of containers, the railway department can organize empty containers to return to the port according to the arrival of the cargo source, so as to ensure the supply of empty containers in the port. Container is the freight carrier of rail-water intermodal transportation, the number of empty containers is an important factor to determine the proportion of rail-water intermodal transportation. Only with a sufficient number of empty containers, can we meet the needs of terminal customers for bulk cargo packing and transportation, and ensure the continuity of cargo demand and transportation, so as to promote the sustainability of container rail-water intermodal transport as a whole.

4.5. Improve the capacity of railway transportation

In order to improve the capacity of railway transportation and the handling capacity of railway infrastructure. The existing railway lines and yards of Xinsha station and Xingang station of the port station shall be expanded and reconstructed, and the loading and unloading equipment inside the railway yard shall be added or updated. Nansha port railway special line is a new railway line. On the premise of meeting the requirements of existing port dredging capacity, the space for future expansion and reconstruction should be reserved to cope with the substantial increase of Nansha port cargo throughput in the future. In addition, it is necessary to optimize the railway transportation organization method to improve the scientificity and standardization of transportation organization. Through the optimization of the transportation organization method, we should make the best use of the capacity of railway transportation and improve the passing capacity of railway transportation under the specific infrastructure conditions.
5. Conclusion
Guangzhou Port Group is located in the core area of Guangdong, Hong Kong, Macao and Pearl River Delta. Both geographical conditions and traffic conditions provide a good precondition for rail-water intermodal transport. The best goal of container rail-water intermodal transportation is to realize seamless connection. The purpose of seamless connection is to ensure that each process is carried out according to the plan, through scientific organization and management and advanced loading and unloading machinery, to shorten the waiting time and operation time as much as possible. [3] However, there are many problems that restrict the further development of rail-water intermodal transport, resulting in the proportion of rail-water intermodal transport less than 2%, far below the world average level of rail-water intermodal transport.

The development of rail-water intermodal transport in Guangzhou port is a major systemic problem. To realize the healthy and sustainable development of rail-water intermodal transport, it is necessary to coordinate customs, railway, port, shipping company and other departments to carry out unified cooperation standard and need a comprehensive consideration of so many departments. At the same time, it is necessary to realize the coordination and cooperation of cargo transportation information system, transportation organization method, external hardware facilities and equipment, and realize the good combination of soft science and technology. If we can solve the above problems, and realize the good operation of the whole rail-water intermodal transportation system, we will promote the development of rail-water intermodal transport to a large extent, reduce the cost of social logistics, and improve the quality and efficiency of social economic development.

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References
[1] General Office of the State Council of China, Three-year action plan for promoting transportation structure adjustment (2018-2020), October 9, 2018.
[2] LV Tongzhou, Xu Yining, Press the "fast forward" button in the development of China's container multimodal transport-Sidelights of 2019 Asian container multimodal transport exhibition, Maritime China, 2019 (06): 42-45+10-11.
[3] Zhang Ruifang, Research on seamless connection of container multimodal transport, Co-Operative Economy & Science, 2019 (10): 128-129.