Analysis of Port Container Sea-Rail Intermodal Transportation System

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Abstract- With the continuous deepening of the China-Europe freight train, the interconnection of countries and regions along the “Belt and Road” has been accelerated, and railway transportation has become an important carrier and transportation backbone linking China-Europe road logistics, effectively promoting the new development of the geo-economics of China and Europe. The container sea-rail intermodal transportation system has developed rapidly. Based on the composition of the existing port container sea-rail intermodal transportation system, this paper uses system analysis to describe its various subsystems, and analyzes the port container sea-rail intermodal transportation system composed of the external structure and the internal structure.

1. Introduction
The sea-rail intermodal transportation of containers has the characteristics of large volume, low cost, and environmental friendliness. At present, domestic and foreign scholars have also done multi-angle research on the development of container sea-rail intermodal transportation. Katarzyna Anna Kuzmicz, Erwin Pesch, etc.[1], used a mixed-integer programming model to optimize the railway transportation route and sea transportation route for the dispatch of empty containers. Baicheng Yan, Xiaoning Zhu and others[2] used the rolling horizon method to optimize the transshipment business of sea-port and railway terminals in sea-rail intermodal transportation. Li Wei and Zhang Gaiping[3] proposed that information sharing and feedback mechanisms must be established in order to accelerate the development of sea-rail intermodal transport, and gave development strategies. Yang Yan[4], established an equipment optimization model to optimize the problem of sea-rail intermodal transportation of ports and containers. Di LIU, Hualong YANG and others[5] comprehensively optimized the multimodal transport mode involved in sea-rail intermodal transport. The above studies rarely give a comprehensive and systematic description of the entire sea-rail intermodal transportation system. This article will describe the container sea-rail intermodal transportation system from a system perspective and use the principles of cybernetics, and analyze the factors that affect the container sea-rail intermodal transportation system.

2. Port container sea-rail intermodal transport system
The factors that affect the port container sea-rail transportation system can be divided into internal factors and external factors. The external factors are shown in Figure 1.
The specific composition of each subsystem of the internal structure of the container sea-rail intermodal transportation system is shown in Figure 2.

3. Composition of container sea-rail intermodal transport system

3.1. Internal composition

(1) Infrastructure subsystem

Through the systematic analysis of the relationship between the infrastructure subsystems, the establishment is shown in Figure 3.
facility will then send the information via route 6, and the container will be transferred via the yard facility via route 3. To the railway facility, the task completion information is finally sent via Route 2.

From the perspective of the feedback relationship, the feedback of this subsystem is all positive feedback. The development of channel facilities drives the development of berth facilities, which significantly increases the proportion of container sea-rail intermodal transportation and makes terminal facilities more complete.

(2) Production equipment subsystem

The information of the production equipment subsystem is shown in Figure 4.

Figure 4 Information relationship diagram of production equipment subsystem

When the information equipment sends operation information to the loading and unloading equipment via line 5, and then transmits it to the transfer equipment via line 1, the information is transmitted to the railway equipment via line 3 for sea-rail intermodal transportation.

From the perspective of the feedback relationship, there is a negative feedback relationship in the subsystem. When the information equipment sends loading and unloading work information through line 7 and line 6, if too many loading and unloading equipment participate in the unloading operation of the container, the operation of transferring the container into the yard needs to wait, which reduces the efficiency. The negative feedback relationship in the production equipment subsystem shows that the equipment must develop in a coordinated and balanced manner in order to promote the improvement of port productivity.

(3) Resource scheduling subsystem

In the resource scheduling subsystem, the configuration of the crane, loading and unloading equipment, transfer equipment, and proportional configuration are shown in Figure 5.

Figure 5 Resource scheduling subsystem information

The information between the bridge crane configuration and the proportional configuration is two-way flow, which can grasp the number of bridge cranes in real time and perform related tasks better according to the work intensity and interval.

From the perspective of the feedback relationship, there is a positive feedback relationship. The configuration of bridge cranes and related equipment can be mastered in real time, helping the proportion of production equipment to be equipped with a suitable proportion of related equipment for another production activity.
(4) Transmission service subsystem

The transportation and processing information needs to be classified and processed after the collection of the information, and then the information is collected and updated to complete the data. After that, transportation arrangements are made and customs clearance is optimized. As a sea-rail intermodal transportation system, it is also necessary to grasp logistics information in real time, and the supplier can view it in real time. As shown below.

![Figure 6 Information relationship diagram of the transportation service subsystem](image)

The logistics information is transferred to the information collection system via route 8, and then to the information collection system via route 3. The optimization system transfers the optimized information to the information collection system via route 5. The information collection system is then transferred to the information update system via route 1, and then transferred to the information collection system via route 2. Then pass the updated information to other systems via routes 7, 4, and 6.

The feedback relationship existing in this system is a positive feedback relationship. The more information the information collection system receives, the more information available for processing and processing, and then it will be passed to other systems via Route 7, Route 4, and Route 6, and other departments will accept it. After processing the available information, work efficiency can be improved. Conversely, other systems can also provide more available information for processing through routes 3, 8, and 5 under high-efficiency working conditions, so the feedback relationship in this system is positive feedback.

3.2. External composition of the port container sea-rail intermodal transport system

The geographical location of the port determines the distribution of natural resources of the port. For example, a port in a high latitude area may face closure in winter, and the development direction of estuary ports and seaport ports is different. The step by step of the natural resources of the port also affects the types of ports. For example, if the waters near the port are deep water, then deep-water ports can be developed, and larger ships can enter the port, enabling the development of the port sea-rail combined transport system. The celestial characteristics of the port location determine the choice of transportation mode. If the area is characterized by more rainy weather, railway transportation will become a safe and fast container transportation method. The economic level of the port hinterland and the current status of the port's collection and distribution level and the tariff policy are mutually influencing.

The relationship existing in the external structure is a positive feedback relationship. With the development of logistics in the hinterland, the intensity of commercial flow has increased, and container sea-rail combined transportation has shown a growth trend. On the one hand, the economic development of the port hinterland enables the local government to have financial support to increase investment in the port, increase the port's throughput, and thereby increase the port's income. On the other hand, the
development of container sea-rail combined transportation can improve the port’s collection and distribution level, rationally develop and utilize the port’s natural resources, turn the port’s geographical disadvantages into advantages, and turn advantages into development drivers. The freight rate policy is tilted in the direction that is conducive to the development of the port, and ultimately promotes the economic development of the port hinterland, forming a cycle of positive feedback relationships.

4. Suggestions for the development of future port container sea-rail combined transportation

4.1. Speed up the construction of the railway network and strengthen cooperation with the western region
At present, the respective hinterland of eastern my country is relatively small, and it is necessary to actively expand hinterland resources and strengthen economic cooperation with the central and western regions. Railway transportation is not only stable but also has low emissions per unit of transportation, which is in line with the new idea of green logistics. At the same time, it can also develop green ports and sea-rail combined transport can help develop green logistics and green ports to a certain extent.

4.2. Upgrade the related equipment of intermodal transportation and establish a smart port
The information and feedback relationship diagram of the production equipment subsystem and the information and feedback relationship diagram of the transportation service subsystem illustrate that the processing of information is particularly important, and the establishment of a smart port to better process information. Thereby strengthening the information exchange between the various subsystems, thereby strengthening the positive feedback relationship.

4.3. Simplify transportation procedures and improve multimodal transportation
Compared with traditional transportation methods, although sea-rail combined transportation has many advantages, it involves more departments than traditional transportation. Therefore, it is necessary to have a high level of cargo agency service, uniform use of multimodal transport documents, strengthen coordination among various departments, simplify cargo clearance procedures, and provide "one-stop" services. On the other hand, an intermodal information platform should be established to provide real-time services for customers and strengthen communication between the two parties. Strengthen the logistics integration of sea-rail combined transport.

5. Conclusion
To sum up, this article analyzes the port container sea-rail intermodal transportation system from the perspective of a large system, uses the relevant knowledge of cybernetics in system engineering to divide the feedback relationship between the various subsystems, and proposes relevant information on this basis. The countermeasures and suggestions for the development of the port sea-rail intermodal transport system are conducive to promoting the rapid development of the port sea-rail intermodal transport system.

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