

Analysis of Dalian's Railway Freight Market and Strategies for the Development of Multimodal Transportation

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Abstract

From 2020 to 2023, the growth rate of railway freight volume in Dalian was 12.3%. In order to implement the national dual-carbon strategy, this study will closely integrate with the actual situation in Dalian and innovatively adopt quantitative indicators such as freight volume and railway freight volume to analyze the railway freight market in Dalian. It focuses on the key factors that restrict the development of railway freight transportation and multimodal transport in Dalian, proposes strategies such as adopting multimodal transport to enhance the comprehensive benefits of logistics and transportation, promotes industrial agglomeration and regional development, provides support for Dalian's ecological priority and green development.

Keywords: Dalian, railway freight, multimodal transportation, multimodal transport information platform

1. Introduction

In recent years, the State Council and various ministries have successively issued policy guidance documents such as the "Work Plan for Promoting the Development of Multimodal transportation and Optimizing and Adjusting the Transportation Structure (2021-2025)" "Notice on Supporting the National Comprehensive Freight Hub to Strengthen and Supplement the Supply Chain," and "Action Plan for Promoting High-Quality Development of Rail-Water Intermodal Transportation (2023-2025)", "vigorously supporting the development of Multimodal transportation and proposing to basically form a development pattern dominated by rail and water for medium and long-distance transportation of bulk goods and containers by 2025. In addition, to implement the spirit of the "United Nations Framework Convention on Climate Change" and fulfill the responsibilities of a major responsible country, General Secretary Xi Jinping clearly pointed out at the 75th United Nations General Assembly in September 2020 that China aims to peak carbon dioxide emissions before 2030 and strives to achieve carbon neutrality before 2060. It is of great significance and urgency to implement the national dual carbon strategy, seize the historical opportunity of urban renewal, closely combine with the actual situation of Dalian City, analyze the railway freight market in Dalian, and study the development strategies for Multimodal transportation.

In addition, this study conducts an in-depth analysis of the development of multimodal transport abroad.

The United States boasts the world's most efficient freight transportation system, providing an excellent hardware foundation for the development of multimodal transport. It has established a multi departmental intermodal transportation committee, further opened up the railway transportation market, and the U.S. government passed the Staggers Rail Act, fully relaxing economic regulations on the railway transportation industry. This ensures that access to railway transportation resources is fair and open, allowing railway companies to freely set prices based on market demand and competition in most cases. At the same time, it strengthens the construction of the railway collection and distribution system in key port areas and places great emphasis on the standardization of intermodal equipment. The main forms of multimodal transport in the United States are hump transportation and sea-rail intermodal transportation. Hump transportation mainly serves medium- and long-distance transportation of domestic trade goods, while sea-rail intermodal transportation mainly transports foreign trade import goods from Asia. Multimodal transport in the United States originated from railway semi-trailer transportation in the 1920s, and this mode remained dominant in multimodal transport for more than 50 years[1].

Deutsche Bahn's subsidiary, DB Schenker, undertakes long-distance bulk cargo transportation and is the only railway freight company capable of operating across Europe. In 2020, its freight volume reached 213 million tons and cargo turnover amounted to 78.7 billion ton-kilometers, accounting for 66.6% and 72.6% of the national total respectively. DB Schenker Logistics primarily provides comprehensive logistics services including land, air, and sea freight, contract logistics, and supply chain management. It is one of the world's leading international transportation and comprehensive logistics service providers. To support the development of multimodal transport, DB Schenker vigorously promotes container or unitized load transportation. Based on specific market and customer needs, it provides customers with customized, diversified, and personalized value-added logistics services in procurement, distribution, warehousing, handling, processing, and other logistics links. It also attaches great importance to the informatization construction of railway logistics[2].

Based on the current research both domestically and internationally, it has been found that while most studies focus on hub cities in Europe, there are few studies examining the multimodal transport situation in emerging port cities in Northeast China. Therefore, in order to effectively implement the country's dual-carbon strategy and seize the historical opportunity of urban renewal, this study will closely align with the actual situation in Dalian, innovatively using quantitative indicators such as freight volume and railway freight volume to analyze the railway freight market in Dalian, and conduct research on multimodal transport development strategies. This is of great significance and urgency.

1.1 Current Status of Railway Freight in Dalian

As an important port city and logistics hub in Northeast China, Dalian boasts a highly developed railway freight network, serving as a crucial node connecting the hinterland of Northeast China, the Bohai Rim region, the entire country, and even the world. The main railway freight lines include the Harbin-Dalian Railway and the Dandong-Dalian Railway. The Harbin-Dalian Railway is the main artery of Dalian's railway freight, starting from Harbin in the north and ending in Dalian in the south, making it the most important railway trunk line in Northeast China. The Dandong-Dalian Railway is an important part of the eastern railway corridor in Northeast China, with a total length of about 290.7 kilometers. This line primarily focuses on passenger transport while also accommodating freight transport, connecting the Shenyang-Dandong High-Speed Railway and the Harbin-Dalian High-Speed Railway, forming the main framework of the "big triangle" railway network in central and southern Liaoning.

1.2 Analysis of Changes in Freight Volume

In recent years, the gross domestic product and industrialization level in the Dalian region have been continuously improving, and the total freight volume has been growing steadily. This study utilizes data from the Dalian Statistical Yearbook for the years 2020 to 2024 for analysis. From 2020 to 2023, the growth rate of railway freight volume in Dalian was 12.3%, and the total freight volume in Dalian in 2023 was 55,680 million metric tons. Specifically, the railway freight volume was 50.1 million metric tons, an increase of 1.5% compared to 2022, with a railway freight proportion of 9%; the highway freight volume was 40.34 million metric tons, with a highway freight proportion of 72.5%; the waterway freight volume was 9.37 million metric tons, and the air freight volume was 7.354 million metric tons. From 2020 to 2023, the railway freight volume in Dalian experienced a continuous growth trend, and the proportion of railway freight transportation tended to stabilize with minimal fluctuations. Details are shown in the table below.

Table 1. Changes in the volume of goods transported by various modes of transport in Dalian from 2020 to 2023 (Million Metric Tons)

Type	2020	2021	2022	2023
the volume of freight transport(Million Metric Tons)	46340	52970	51470	55680
railway freight volume(Million Metric Tons)	4460	4720	4930	5010
Proportion of railway freight transportation	10%	9%	10%	9%
Change rate of railway freight volume	3%	5.90%	4.50%	1.50%
Road freight volume(Million Metric Tons)	34260	39140	37120	40340
Waterway freight volume(Million Metric Tons)	7620	8240	8550	9370
Cargo(Million Metric Tons)	6.766	7.318	6.076	7.354
Pipeline freight volume (Million Metric Tons)	--	870	860	950

Data source: Dalian Statistical Yearbook 2020-2024

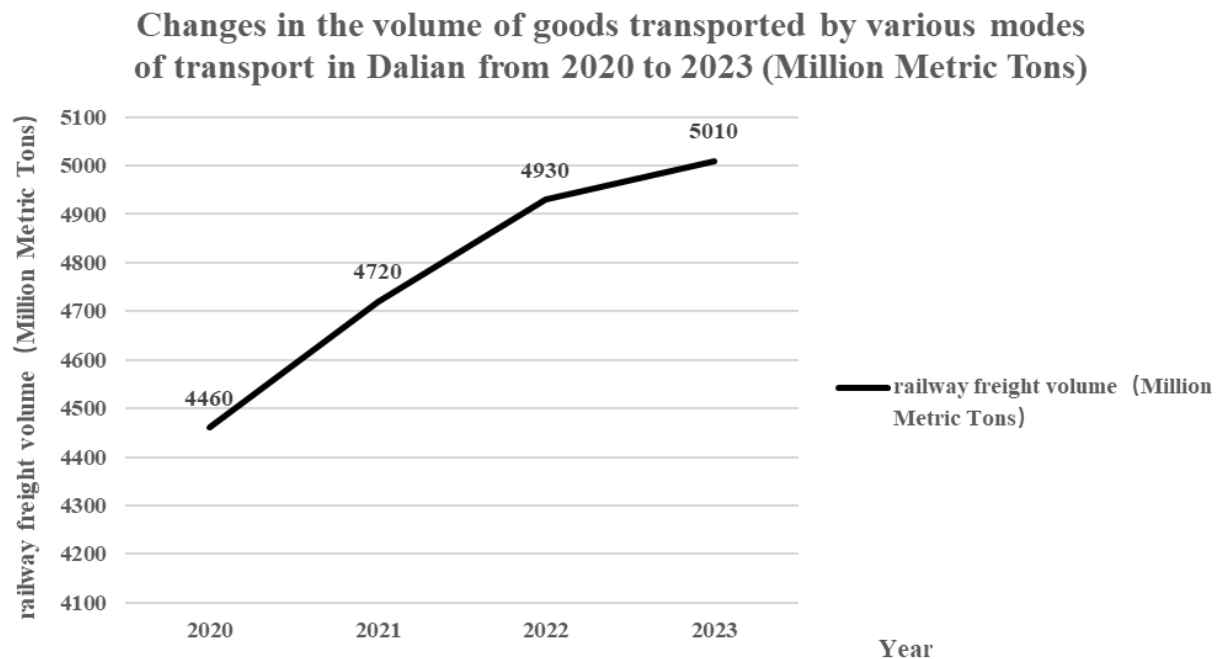


Figure1. Changes in cargo transportation volume by various modes of transport in Dalian from 2020 to 2023 (Million Metric Tons)

1.3 Analysis of Railway Freight Transport Structure

The railway freight categories in Dalian are primarily concentrated in four major types: bulk cargo, containerized goods, energy and chemical products, and specialized transportation. Among them, the dominant bulk cargo accounts for over 70% of the transportation volume, mainly including grains (corn, rice, soybeans), metal ores (iron ore, manganese ore), and steel products (plates, profiles), etc. Containerized goods mainly consist of electromechanical equipment, chemical products, and automotive parts, which are exported to Europe, America, and Southeast Asia. Industrial and energy categories primarily include petroleum and its products, equipment manufacturing products, etc. For details, please refer to Table 2.

Table 2. Analysis Table of Export Categories of Railway Freight in Dalian

Category	Representative goods	Key transportation nodes
Bulk cargo	Grain, ore, steel	Beiliang Port, Dalian Bay Station
Containerized cargo	electromechanical goods, daily necessities, cold chain	Dayaowan Station
Energy and Chemical Industry	Refined oil products, liquefied gas	dedicated lines for petrochemical enterprises
Special transportation	Commercial vehicles, large equipment	Dayaowan Automobile Terminal

2. Issues in Dalian's Railway Freight Market and Multimodal Transportation

2.1 In Terms of Transportation Costs

The overall cost of railway transportation is not advantageous. The high costs of short-distance transportation at both ends, along with loading, unloading, and other operations, have increased the overall freight rates. In addition, there are irregularities in road transportation, such as overloading, driven by profit motives. The occurrence of overloaded trucks and the use of inferior fuel often leads to vicious competition and safety hazards, further weakening the price competitiveness of railways. According to the research results in Dalian, the time taken for railway transportation on the same route is generally 2-4 times that of road transportation.

In addition, railway freight rates are not flexible, with pricing power resting in the hands of the China Railway Group or railway sub-bureaus. Freight stations, as grassroots units, have limited room for adjustment when negotiating business with customers. Furthermore, the railway price adjustment process is cumbersome, with

uncertain approval times and poor transportation timeliness [3]. This inability to meet the timely needs of high-value-added goods leads to customer loss.

2.2 In Terms of Transportation Timeliness

The efficiency of railway transportation is low and cannot meet the time requirements for high-value-added goods. Based on the research and analysis of Dalian Railway Bureau, the delivery speed of railway freight from the start of loading to the completion of unloading is approximately 13.7 km/h. Transporting goods over 1000 kilometers by rail takes about 4 days, while by road it only takes about 1.5 days; railway transportation procedures are complicated with too many steps. The data formats and content between different transportation systems are not compatible, leading to frequent manual data entry. Due to strict data confidentiality policies, a large amount of data cannot be shared, resulting in increased difficulty in coordinating transportation organization.

2.3 In Terms of Transportation Services

The intermodal transport market environment is not mature. Firstly, Dalian's intermodal transport market is underdeveloped, lacking dedicated waybills and operators. There is no unified service entity in aspects such as intermodal product design, marketing, cargo sourcing, and shipper services. For instance, railway marketing primarily targets ports, while ports mainly focus on shippers, resulting in a lack of integrated marketing models for land and ports. Secondly, relevant policies, regulations, and service rules need improvement, as the trust and loyalty of shippers towards railway container transport need to be enhanced. Thirdly, the intermodal transport market has virtually no profit, and a favorable market environment has yet to be established. Additionally, Dalian has not yet set up a unified comprehensive freight-related platform, leading to significant data silos. Freight-related data is scattered among various stakeholders, and electronic inquiries, freight product searches, online customer service, in-transit information, and "one bill" one-stop services have not been fully realized. The controllability and transparency of the logistics process are weak, showing a certain gap compared to modern logistics service levels, and convenience needs to be improved. There is little communication and coordination between road and rail, and the development of the intermodal "one bill" system still requires further promotion[4].

3. Policy Recommendations for Promoting Multimodal Transportation in Dalian

3.1 Multimodal Transportation Model and Its Significant Advantages

Multimodal transportation refers to the combination of two or more modes of transport to achieve a complete transportation process from the starting point to the destination[5]. The main advantage is the integration and deep fusion of various transportation methods, promoting the optimization and adjustment of the transportation structure. It allows for seamless connections at each transfer point, reducing cargo loss and minimizing costs associated with transshipment and handling. It is an effective strategy for improving efficiency and reducing costs in modern logistics transportation. One of the roles of Multimodal transportation in railway logistics is to enhance the coverage of the railway logistics network. Through multimodal transport, it is possible to combine railway transportation with other modes of transportation, fully leveraging the advantages of different modes to expand the coverage of the logistics network [6].

The following suggestions and measures are proposed to address the key issues and bottlenecks in Dalian's railway freight and Multimodal transportation.

3.2 Reduce Overall Transportation Costs

1) Utilize the role of dedicated railway lines: Strengthen the construction of dedicated railway lines for factories (large industrial and mining enterprises), industrial parks and ports, reduce the short-distance transfer and loading and unloading processes between road and rail, and promote the shared use of dedicated lines among multiple enterprises.

2) Facilitate multi-modal transport connections: Implement "embedded" dedicated railway lines at key nodes, integrating railway loading and unloading tracks into the front of container/bulk cargo terminals in Dayao Bay and Dalian Bay to achieve "direct loading and unloading alongside the ship". Build dedicated lines behind bonded logistics parks, cold chain bases, and automobile roll-on/roll-off terminals to support direct "port-park-rail" connectivity. Promote the integration of the Changxing Island petrochemical base and equipment manufacturing park into the railway network to enable direct "rail-water" transportation of raw materials to factories. Upgrade the multi-modal transport hub functions, expand the container yard area, install intelligent rail cranes, and increase daily processing capacity to 10,000 containers. Establish "dry ports" in hinterland cities such as Shenyang and Changchun to achieve "local inspection and Dalian clearance", Standardize road transport behavior. Relevant departments should conduct joint law enforcement to address violations of medium and long-distance freight trucks overloading to lower freight rates.

3.3 Improve Transportation Efficiency

1) Enhancing the level of transportation organization: Innovate organizational models, adopt direct and full-process logistics services for stable and balanced bulk goods, ensuring stable transportation capacity; for time-sensitive sporadic cargo sources, rely on freight forwarding enterprises to increase marketing efforts, implement the regular operation of express freight trains without breaking up in the middle; gather international freight trains, increase the operation of China-Europe freight trains and "point-to-point" freight trains; operate dedicated trains and mixed-train services, expanding the transportation market for high value-added goods such as commercial vehicles. Strengthen organizational coordination, precisely allocate transportation resources; establish a multi-party linkage mechanism to unify the spatial layout of the port collection and distribution system; for "last mile" distribution, strengthen feeder services to shorten waiting times.

2) Establish and promote the door-to-door "one-document" freight service model. Establish and promote the "one-stop" freight service featuring "one entrustment" for the entire process, "one document" for the waybill, and "one payment" for settlement, to achieve the door-to-door "one-stop" freight service model. Develop rules for multimodal transport documents, multimodal transport business processes, multimodal transport responsibility division, and insurance compensation.

3.4 Improve Service Quality

1) Build a multimodal transport information platform: Support customers in logistics tracking, information exchange, data sharing, and business transactions; railway and other logistics service providers should have real-time and accurate grasp of basic freight data and conduct predictive analysis of the freight market; using multimodal transport, block trains, containers, and other products as leverage, actively connect with the transportation market, road ports, to achieve the organic integration of business flow, information flow, logistics flow, and capital flow within the supply chain.

2) Cultivate intermodal transport operators. Encourage railway transport enterprises to form specialized intermodal operating entities by integrating capital and sharing resources with ports, shipping companies, and third-party logistics enterprises. Build intermodal platforms and vigorously develop intermodal transport business; introduce carriers with global operating networks and international supply chain integration suppliers to nurture and strengthen logistics enterprises along the corridor.

3.5 Create a Favorable Market Environment

1) Actively improve intermodal support policies and regulatory systems: Explore subsidy policies for "road to water" and "road to rail." Focus on funding "road to rail" and "road to water" intermodal projects, and appropriately subsidize transportation companies for economic losses incurred during the transition from single road freight to multimodal transport models.

2) Promote the establishment of multi-modal transport demonstration projects: Select suitable projects for multimodal transport demonstration in various aspects and locations, such as the construction of wharves on freight railways, multi-modal transport information platforms, or standardization construction.

3) Choose suitable projects for the construction of terminals on freight railways, multimodal transport information platforms, or standardized construction, among other aspects, to demonstrate multimodal transport at multiple points.

4. Discussion

As the largest container port in the Mediterranean and a core hub for multimodal transport in Europe, the Port of Valencia's multimodal transport system is centered on efficiently connecting sea, rail, and road transportation. Relying on the unified logistics standards and advanced infrastructure of the European Union, it has become a core node in the supply chain of Southern Europe. This research component conducts a survey of the railway freight market in Dalian and draws fully on advanced domestic and international experience. Its future development will not only have a profound impact domestically but also serve as a reference internationally.

4.1 Research Deficiencies

This study lacks sufficient integration of multi-source data. For instance, during the current situation analysis phase, due to the significant difficulty in obtaining data, the comparison of Dalian's railway freight volume and operation mode with those of the country as a whole, developed regions, and the Northeast region has not yet been conducted. Furthermore, there is still room for further in-depth exploration of Dalian's railway freight source categories, structure and freight share.

In addition, this study did not construct a predictive model to forecast and analyze the future railway freight transportation situation in Dalian. The selection of predictive model is a difficult issue. In subsequent research, multiple models such as linear regression models and polynomial regression models in time series forecasting can be selected to predict the freight transportation volume in Dalian, respectively, to ensure the accuracy of the prediction results.

4.2 Future Development Direction

In the future, we can further develop a multimodal transport route optimization model and a prediction model for Dalian's railway freight system to quantitatively analyze the multimodal transport situation in Dalian. The construction of the prediction model for Dalian's railway freight system can predict the peak volume and flow direction of freight, scientifically allocate railway cars, yard equipment, and personnel, and reduce the empty running rate and waiting time. The construction of the prediction model for Dalian's railway freight system can further optimize resource allocation, improve service reliability, formulate reasonable strategies and pricing, and enhance supply chain resilience.

5. Conclusion

Optimizing the transportation structure, enhancing railway transportation efficiency, and reducing logistics costs are essential requirements for building a powerful transportation nation. Leveraging its unique comprehensive transportation location advantage, Dalian has overcome the bottleneck of railway transportation. It can leverage the advantages of multimodal transport in terms of reducing transportation costs, improving service quality, enhancing transportation efficiency, and creating a favorable market environment. This approach promotes a more reasonable transportation structure, facilitates industrial agglomeration and regional development, supports Dalian's ecological priority and green development, and provides valuable insights for other port cities to promote multimodal transport.

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