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Optimizing Multimodal Transport to Achieve Carbon Neutrality

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Abstract: Shaanxi's government has issued a circular on optimizing and adjusting the transport structure for multimodal transport development (2022–2025). The circular involves implementing structural reform policies for the supply side of transport logistics, optimizing Shaanxi's multimodal transport structure, promoting the integration of resources of the Shaanxi transport organization, and strengthening the coordination with regional development. As a result, a modern logistics and transport system that is green, safe, convenient, efficient, and economical, reduces carbon dioxide emissions, and contributes to carbon neutrality can be established. This paper includes an analysis of the general situation of multimodal transport in Shaanxi Province and the existing problems in railway transport, and several countermeasures are proposed.

Keywords: Multimodal transport; Logistics transport; Shaanxi Province

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1. Overview of multimodal transport and transport structure in Shaanxi Province

1.1. Multimodal transport

Multimodal transport is a mode of transport logistics that involves two or more modes of transport. Multi-subject cooperation in transport logistics brings complex and dispersed transport flows into a unified process. This not only reduces logistics costs and transport time but also effectively integrates transport resources. It enables the coordinated control of various modes of transport, including road, rail, and maritime logistics, fostering both horizontal and vertical integration for comprehensive development. Shippers only need to sign a contract, a document, and insurance to complete long-distance transport of goods. Multimodal transport is not a mode of transport but rather an organizational approach in which a multimodal carrier coordinates resources from various parties to accomplish the carriage of goods. There are four modes of transport involved in multimodal transport. (1) The first mode is road transport. Road transport is well-suited for short-distance transportation, being able to transport smaller volumes at a higher speed. It plays an indispensable role in logistics, particularly in facilitating "door-to-door" services, where it holds an irreplaceable position. However, road transport is not suitable for handling large quantities of goods and high traffic volumes, leading to

significantly higher prices in such cases. (2) The second mode of transport is rail transport. Rail transport is crucial for urban logistics, especially in areas like Shaanxi Province with a substantial demand for bulk cargo transportation. It offers advantages such as high volume, low prices, and enhanced safety. However, it may not be ideal for urgent short-distance goods transport due to longer transit times. (3) The third mode of transport is water transportation.

Water transportation, primarily conducted by cargo ships, is a dominant mode in international logistics. It is favored by merchants for its low freight prices and ample cargo capacity. However, water transportation is associated with longer transit times and additional costs, including booking fees, loading fees, and docking surcharges. There are also inherent risks, and the timing is less precise. (4) The fourth mode of transportation is air transportation.

Air transport is notable for its convenience and speed, but it is characterized by small cargo capacity and high prices, making it suitable primarily for small and medium-distance transport.

Multimodal transport optimally utilizes the strengths of each transportation mode, streamlining means of transport and efficiently utilizing resources to maximize transportation capabilities. As a crucial component of the "Central European Bandwagon," multimodal transport is essential for optimizing routes, minimizing costs, and promoting low-carbon practices throughout the transportation process. Prioritizing economic costs and development, it also aligns with the critical aspects of energy conservation and carbon neutrality in our economic progress. Multimodal transport, offering advantages such as environment friendliness, safety, and cost-effectiveness, will undoubtedly positively impact energy conservation and environmental protection in China [1].

1.2. Overview of transport structure in Shaanxi Province

1.2.1. General situation of railway transport

Shaanxi province, the country's largest coal producer, produced 95.927 million tons of coal as of Nov. 7, 2022, according to the Shaanxi Coal Industry Survey. According to data analyses, exports from Shaanxi Province have always been natural resource-intensive. In 2020, the provincial transport structure formed the basic pattern of mass goods being transported by rail. Approximately $7 billion has been invested in dedicated railway lines, expected to be completed this year. In terms of road freight, highway freight traffic reached 1.22 billion tons by the end of December 2021, indicating a notable 17.3% year-on-year increase. The highway network in our country spans over 100,000 kilometers, covering more than 90% of the provinces. The oversight of Shaanxi Rail Transport Organization falls under the leadership of Shaanxi Railway Logistics Group Co. Ltd. This organization is authorized to supervise several small and medium-sized logistics transport enterprises in Shaanxi Province. It holds responsibility for the construction and operation of Shaanxi Coal Group's self-financed regional railway line, ensuring the transportation of commodities and materials such as coal, chemicals, steel, and cement for Shaanxi Coal Group. The implementation of the "Belt and Road Initiative" in Shaanxi is expected to significantly enhance the integration of the regional transport system. Additionally, within Shaanxi province, the construction of a network of freight lines, known as "county lines," aims to efficiently reduce transport costs, enhance service quality, address customer needs, and improve overall competitiveness.

1.2.2. General information on multimodal transport

On June 21, 2020, the first Haifangxi-Xi'an-Almaty international freight train departed from Xi'an International Port Station of China Railway Xi'an Bureau Group Co., Ltd., traveling westward to Almaty, Kazakhstan. This marks the initiation of the first "Western Land and Sea New Corridor + Central Europe Bandwagon" international freight train from Shaanxi province, establishing a new transportation mode to bolster international

trade. In addition, the freight volume on Central European Bandwagon (Chang'an) in Xi'an Port has increased since 2018, particularly with a significant rise in the proportion of container multimodal transport. The provincial government has been actively implementing the "1 + N" logistics development model. Two projects, the "One Nuclear Integration, Two Network Link, Light and Heavy Coordination" Container Intermodal Transport Demonstration Project by Huayang Logistics in Shaanxi Province and the "Dual-core Drive, Three-way Radiation" Iron Water Intermodal Transport Demonstration Project by Shaanxi Luhei Energy Link, have been selected to establish the National Multimodal Transport Demonstration Project. The continuous improvement of the province's multimodal transport system has yielded notable experimental results. It is anticipated that the development of multimodal transport across the entire province can be expedited through initiatives such as "developing an area bit by bit" and "driving the development of the province through regional development." Additionally, with the "Shanghai-Hui-Shaanxi and Xinjiang" railway, north-south connectivity and the joint development of railway and waterways can be achieved.

2. Problems with railway transport

2.1. The railway transport network does not match the demand

Shaanxi province's primary transportation network relies on four railways: Jingbian-Shenmu Railway, Fenghong Railway, Hongling Railway, and Yuheng Railway, which connect with seven other railways, namely Haolebaoji-Ji'an Railway, Baotou-Xi'an Railway, Taizhongyin Railway, Shenmu-Shuozhou Railway, Watang-Rizhao Railway, Daqin Railway, and Mengji Railway. By 2022, Shaanxi had shipped 435.05 million tons of coal, ranking eighth in the country. In the same year, demand for coal across the country rebounded in phases due to the closure and exit of coal capacity in the eastern and southern regions, coupled with restrictions on coal imports. Pressure on coal capacity is concentrated in the country's northwest. The pressure on coal capacity is particularly concentrated in the northwest of the country. Shaanxi, being a major coal-producing province and a crucial hub in freight and rail transport, experienced high demand, with 50 million tons of rail traffic and nearly 300 million tons of car traffic in 2017. However, the combined capacity of Jingbian-Shenmu Railway, Fenghong Railway, Hongling Railway, and Yuheng Railway are only limited to 100 million tons, leading to a significant mismatch between supply and demand.

2.2. High rail freight costs

The costs involved in transporting coal-like bulk goods are mainly economic costs, time costs, and additional costs. Economic cost represents the fundamental transport price of bulk goods, including freight transport costs, incidental expenses, new road prices, construction funds, and more. Transporting and handling large quantities of goods, such as coal, takes more time compared to other ordinary goods, and the longer the duration, the higher the cost. Additional costs, especially for goods like coal, involve higher storage requirements, necessitating stricter transport conditions. This is accompanied by increased maintenance costs for transport vehicles and higher costs for environmental cleanliness post-coal transport. Furthermore, there is a greater risk of transport disruptions. Despite these challenges, attempting to use these resources without corresponding costs is challenging, ultimately resulting in resource waste and energy loss [2].

2.3. Connection of railway transport with other modes of transport

To address the challenges posed by the limitations of railway transport, which cannot be fully satisfied by a single mode of transport, multimodal transport is employed in conjunction with road and water transport. Road transport can be a powerful tool to compensate for the limited capacity of rail transport over short distances.

However, the cost increases with increased distances. Water transport may be capable of carrying larger volumes, but it is not suitable during periods of low rainfall in the dry season, leading to reduced canal traffic. Therefore, the form of multimodal transport should be selected according to the market needs and geographical circumstances.

2.4. Significant regional and administrative segmentation of transport logistics

Logistics, as a process of integrating interconnected resources, initially began as a state-led industry. As economic development progressed, the state has increasingly delegated authority to enterprises in various regions. Due to varying administrative practices across regions, differences, contradictions, duplications, and complications have emerged in establishing logistics standards and technical requirements. This challenge extends beyond railway transport to all forms of logistics. Therefore, there is an urgent need to find practical solutions for these issues.

3. Problems in multimodal transport

3.1. Data information is difficult

The construction of the multimodal information-sharing public platform in Shaanxi Province lags behind, resulting in restricted logistics transport information and a mismatch in supply and demand. The pilot for the Shaanxi Transportation Logistics Information Platform began in late 2018 and was officially implemented in mid-2019. The pandemic severely impacted China's transport and logistics industries in late 2019, with a slow recovery observed in the latter part of the following year. Therefore, the platform of data information sharing in Shaanxi province has only been developing for about a year. Secondly, there is an imbalance in the development and application of online logistics information transport sharing platforms, hampering information exchange across regions. Variability in information openness is observed among different modes of transport, including railway, road, waterway, and air transport, with notable disparities in multimodal data sharing.

3.2. The early stage of the development of the main body of business

The development of multimodal transport in Shaanxi is still at its infant stage. Therefore, there is a need for a good platform to provide comprehensive services, ensuring the efficient and orderly operation of multimodal transport connections. Multimodal transport emphasizes synergy among different modes of transport, necessitating the involvement of various parties. This places heightened demands on enterprises to integrate their resources effectively. At the operational level, the primary emphasis is on the transportation of goods and warehousing. However, there are currently only slightly more than 20 enterprises with a certain level of development quality engaged in multimodal transport in Shaanxi Province. Apart from Shaanxi Railway Logistics and Transportation Group, most other enterprises have been established in less than 20 years, and some may not even have a decade of operational history. These have led to inefficiencies and high costs in the implementation of multimodal transport. Many enterprises are relatively small, exhibiting a low level of expertise, limited service areas, and a need for strengthened organizational capacity. This inadequacy is evident in meeting the comprehensive needs of Shaanxi Province and its external expansion. The absence of leading enterprises results in a lack of a unified and effective logistics development structure, resource integration, professionalization, and scientific methodologies.

3.3. Complex service rules

In multimodal transport, the movement of goods from one link to another requires adherence to uniform

standards and regulations. However, this often leads to ineffective cooperation between transport enterprises. Different modes of transport have distinct requirements, and the disparities in service rules are noticeable [3]. Docking according to different modes of transport is essential in multimodal transport, and the complexity and diversity of service rules significantly impact the entire transport process.

4. Measures to optimize transport structures

As per the circular released by the General Office of the Shaanxi People's Government regarding the implementation plan for optimizing and adjusting the transport structure (2022-2025) to promote multimodal transport development, several recommendations are presented. These suggestions aim to modernize and standardize logistics development in Shaanxi Province, addressing current challenges and drawing insights from both domestic and international transport structures.

4.1. Optimizing transport supply hub structure

The Shaanxi railway line is centered in Xi'an and is spread out in a " 米 " (*mi*) pattern. The advantages of the transport hubs of Baoji, Ankang, Yulin, and Yanan, should be maximized to promote the development of surrounding cities, especially Yanan, which is a key link between Shaanxi and Shanxi, connecting the two major coal-producing provinces. The two provinces are expected to jointly develop transport logistics, optimize transport structures, and exchange needs, and jointly advance the development of logistics distribution. Simultaneously, aligning with Shaanxi's industrial structure, efforts are underway to establish a multimodal transport model integrating "road to rail" and "rail to water" [4]. The development opportunities presented by "China-EU banlieues" should be leveraged to make Shaanxi an international logistics transit hub and key junction for Europe and Russia. This initiative can enhance the carrying capacity and interface of multimodal transport to meet evolving requirements.

4.2. Unifying transport logistics standards and integrating multimodal transport services

Cumbersome logistics transport standards in all regions and administrative districts should be eliminated. Barriers to logistics transport need to be broken down, and unified standard requirements for railway transport market access should be established. This aims to reduce the frequency of loading and unloading of packing orders in different routes, simplify procedures, and improve the efficiency of railway logistics transport. Through container multimodal transport and the utilization of information technology, a logistics information transmission network can be constructed. This involves integrating logistics data, establishing a primary logistics transport database, and utilizing big data to reduce logistics transport costs. Besides, this measure also improves logistics transport efficiency, standardizes logistics management, and achieves visualization and digitization in logistics processes.

4.3. Standardizing multimodal transport equipment and utilizing new and clean energy sources

The government has been increasing its investment in logistics infrastructure construction, with efforts directed towards aligning logistics transport equipment standards with international benchmarks. Additionally, preparations have been made to facilitate integration with international logistics networks. Nevertheless, measures should be taken to reduce carbon emissions. This includes promoting the use of new and renewable energy, supporting green logistics in cities, increasing energy efficiency, and implementing emission reduction measures. A green development model should be established. Besides, preferential policies for the convenient

passage of vehicles should be implemented in new energy cities, with priority given to supporting the branding of new energy city distribution vehicles. All localities should develop practical and distinctive technical guidelines for the distribution of urban vehicles.

4.4. Increased government investment in the construction of a multimodal transport route

With the rapid development of economic globalization and the increasing competition in the international and domestic markets, establishing a robust and efficient multimodal transport system has become a pressing concern across industries. Currently, the development of multimodal transport route models is a focal point of interest and research among logistics experts globally. Examples include optimization models based on standards that prioritize carbon emissions and algorithm-centric models centered on cost considerations [5]. Major transport enterprises in Shaanxi Province should integrate research schemes with practical applications to formulate distinctive multimodal transport models tailored to their railway transport development needs while also considering the unique circumstances of the province.

4.5. Cultivation of logistics talents

The government has proactively attracted logistics talents and provided training to ensure the effective operation of the developing logistics transportation structure and mode. A skilled workforce is crucial for achieving the desired outcomes. Currently, Shaanxi Province has a substantial pool of logistics professionals in its colleges and universities. It is imperative to leverage this talent pool, prevent talent attrition, and recognize talent retention as a pivotal factor in local logistics development. Moreover, in coastal regions with well-established foreign trade, the sea-land transport pattern is mature, demanding advanced multimodal transport capabilities. Collaborating with external talents, fostering internal and external partnerships, and forming robust alliances are essential strategies to contribute to the development of Shaanxi's logistics and transportation mode.

5. Conclusion

Based on the in-depth analysis of railway transport in Shaanxi Province, the current state of multimodal transport, and suggestions for future development trends, it is evident that reforms in logistics transport's supply side and the optimization of multimodal transport are imperative in Shaanxi. With the implementation of the "Belt and Road" strategic layout and increasing national emphasis on the energy industry, aligning with the provincial government's latest document, there is a need to optimize transportation plans, adjust transportation modes, and reduce transportation costs in line with the actual situation in Shaanxi. This approach aims to achieve carbon neutrality and contribute to the sustainable development of Shaanxi Province.

Disclosure statement

The author declares no conflict of interest.

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