Analysis on the structure of port collection and distribution in China

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Abstract: On October 29, 2015, Xi Jinping's speech at the Second Plenary Session of the Fifth Plenary Session of the Eighteenth Central Committee of the Communist Party of China clearly put forward the development concept of innovation, coordination, green, openness and sharing. The new development concept conforms to my country's national conditions and conforms to the requirements of the times. In the development of the port and shipping industry, green shipping is becoming a new trend in the development of the port and shipping industry. The adjustment of the transportation structure of the port collection and distribution system is an important aspect of green shipping. The "Railway to Railway" policy aims to improve the comprehensive transportation network through government intervention and market guidance. By optimizing the transportation structure, reducing road transportation and increasing railway transportation, more goods are transferred from road transportation to railway, thereby promoting the adjustment of transportation structure, to achieve the goal of green sustainable development and a strong transportation country. Promoting the implementation of the "Railway Transfer" policy is actually related to the implementation of the structural reforms on the supply side of transportation, and is an important guarantee for the sustained and healthy development of my country's economy.

1. Introduction
The "Statistical Bulletin on the Development of the Transportation Industry in 2018" issued by the Ministry of Transport in April 2019 shows that in 2018, various domestic transportation methods completed a commercial passenger volume of 17.938 billion people, a passenger turnover of 3,421.743 billion person-kilometers, and a commercial freight volume. 50.629 billion tons, with a total cargo turnover of 19,988.5 billion ton-kilometers [1]. The communiqué shows that all statistics are among the top in the world. China can be said to be the country with the busiest transportation in the world, but as a major transportation country, my country's comprehensive transportation system still has some problems.

One of the more prominent problems is the unreasonable structure of the comprehensive transportation system. The data in the "Statistical Bulletin of the Development of the Transportation Industry" shows that the development of my country's transportation structure is uneven, and the road freight volume accounts for an excessively high proportion of the entire society's freight transportation. Taking 2018 as an example, road transportation accounted for 78.22% of freight completed, while railway transportation only accounted for 7.95% [2]. It can be seen that in recent years, the turnover of railway and waterway cargo has shown an initial increase, but it is still far from the growth rate of road transportation. There was no obvious change in the comparison of the three share in the total...
freight transportation of the whole society. In terms of port collection and transportation, more than 80% of the port transportation of bulk cargo such as coal, ore, steel, must be completed by road transportation. The development of multiple modes of transportation is not balanced, and the integrity, system, and coordination of the development of transportation needs to be further enhanced.

As a major freight country in my country, "report to rail" is undoubtedly a favorable policy related to side supply reform. The policy of "report to rail" aims to improve the comprehensive transportation network, optimize the transportation structure, and reduce the increase in road traffic through government intervention and market guidance. The volume of railway transportation has promoted more goods from road transportation to railway, thereby promoting the adjustment of transportation structure and realizing the goal of green sustainable development and a strong transportation country.

2. Problems in the development of port collection and distribution

2.1 The structure of the port collection and distribution system is unbalanced

The collection and distribution of cargo in my country's main ports rely on road transportation. From the perspective of the collection and distribution structure, import and export cargo and container cargo rely on water and public water transshipment to account for a relatively high proportion of all goods, while iron and iron transshipment is relatively small. According to statistics, the total amount of container cargo collection and distribution in my country's ports, road collection and distribution accounted for 85%, waterway collection and distribution accounted for 14%, and railway collection and distribution accounted for only about 1%. [4] Compared with public water transshipment, molten iron transshipment not only has the advantages of large volume, economy, and high accuracy, but molten iron transshipment is also more suitable for medium and long-distance transportation of goods. According to survey statistics, only Lianyungang, Xiamen, Guangzhou, and Zhanjiang ports have a proportion of more than 10% of my country's port cargo iron-water transfer; the proportion of container iron-water intermodal transportation does not exceed 5%, of which the proportion of Lianyungang container iron-water intermodal transportation is 4.6%; Ningbo The proportion of containerized iron-water combined transportation in Zhoushan Port is 0.8%; the proportion of containerized iron-water combined transportation in Qingdao Port is 0.8%; the proportion of containerized iron-water combined transportation in Dalian Port is 3.8%.

2.2 The efficiency of collection and distribution is low, and conflicts between the port and the city are serious

Among the top ten ports in the world in 2019, there are seven ports in my country. There is no doubt that ports have made great contributions to promoting urban development. However, with the year-on-year increase in the volume of import and export goods trade, the originally designed collection and distribution system layout with road collection and distribution as the main body has been unable to meet the increasing demand for cargo collection and distribution. The continuous growth of port throughput has led to land-side collection and distribution systems. With the drastic increase in traffic volume, the contradiction between the port and the city in terms of land use, transportation, and environment has become increasingly prominent in the process.

3 Port collection and distribution cargo volume forecast

Ningbo Zhoushan Port is located in Ningbo City, Zhejiang Province, and is a comprehensive large-scale port. In recent years, it has developed rapidly in China. As a core port in China's coastal areas, Ningbo Zhoushan Port's cargo throughput reached 1.119 billion tons in 2019, ranking first in the country's port throughput, and it is an important hub of the national integrated transportation system. Based on the railway container traffic data of Ningbo Zhoushan Port in the past five years, this paper predicts the future railway freight volume of Chinese ports.
3.1 Establishment of prediction model

3.1.1 Forecast model selection
The model chosen here is the Gray Forecast Model, which was researched by Professor Deng Julong of Huazhong University of Science and Technology in the 1880s. This model promotes the gray prediction model, which can establish a mathematical model for information prediction under the condition of small samples and little information. Because the model has the advantages of fast calculation and high accuracy, it has a wide range of applications in many prediction fields and is an effective tool for predicting small sample problems.

At present, some commonly used forecasting methods (regression analysis, etc.) require larger samples. If the sample is small, it is easy to cause big mistakes. The gray prediction model requires little modeling information, simple operation, and high modeling accuracy. Therefore, this article uses this method to predict the transportation volume of Ningbo Zhoushan Port’s containerized sea-rail combined transportation in the next five years based on the data of the previous five years.

3.1.2 Establishment of GM (1,1) model
The modeling process using GM (1.1) gray prediction is as follows:

① Let a set of data \( x^{(0)} = [x^{(0)}(1), x^{(0)}(2), \ldots, x^{(0)}(n)] \) as the original data, \( n \) is the number of data. Accumulate \( x^{(0)} \) in order to weaken the volatility and randomness of the random sequence, and generate a new data sequence as:
\[
x^{(1)} = [x^{(1)}(1), x^{(1)}(2), \ldots, x^{(1)}(n)]
\]
among them:
\[
x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i); k = 1, 2, \ldots, n
\]

② Generate \( x^{(1)} \) adjacent mean equal weight series:
\[
z^{(1)} = [z^{(1)}(2), z^{(1)}(3), \ldots, z^{(1)}(n)]
\]
among them:
\[
z^{(1)}(k) = 0.5x^{(1)}(k-1) + 0.5x^{(1)}(k), k = 2, 3, \ldots, n
\]

③ According to the gray theory, the whitened form of the first-order one-variable differential equation GM(1,1) is established for \( x^{(1)} \):
\[
\frac{dx^{(1)}}{dt} + ax^{(1)} = u
\]

Among them, \( a, u \) are the coefficients to be solved, which are called development coefficient and gray action amount respectively, and the effective interval of \( a \) is (-2, 2), and Remember that the matrix formed by \( a, u \) is the gray parameter \( \hat{a} \), only the parameters \( a, u \) are required to find \( x^{(1)}(t) \), and then \( x^{(1)}(t) \) Predicted value.

④ Do the mean value of the accumulated data to generate \( B \) and the constant term vector \( Y_n \):
\[
B = \begin{bmatrix}
-z^{(1)}(2) & 1 \\
-z^{(1)}(3) & 1 \\
\vdots & \vdots \\
-z^{(1)}(n) & 1
\end{bmatrix},
Y_n = \begin{bmatrix}
x^{(0)}(2) \\
x^{(0)}(3) \\
\vdots \\
x^{(0)}(n)
\end{bmatrix}
\]

⑤ Use the least square method to solve the gray parameter \( \hat{a} \), then \( \hat{a} = (B^TB)^{-1}B^TY_n \),

⑥ Substitute the gray parameter \( \hat{a} \) into \( \frac{dx^{(1)}}{dt} + ax^{(1)} = u \), and compare \( \frac{dx^{(1)}}{dt} + ax^{(1)} = u \) to solve, get:
\[ \hat{x}^{(1)}(t+1) = \left[ x^{(1)}(1) - \frac{u}{a} \right] e^{-at} + \frac{u}{a} \]

(7) Accumulate and reduce the above results to get the predicted value

\[ \hat{x}^{(0)}(t+1) = \hat{x}^{(1)}(t+1) - \hat{x}^{(1)}(t) \]

(8) Use the model to make predictions:

\[ \hat{x}^{(0)} = [\hat{x}^{(0)}(1), \hat{x}^{(0)}(2), \ldots, \hat{x}^{(0)}(n), \hat{x}^{(0)}(n+1), \ldots, \hat{x}^{(0)}(n+m)] \]

(9) Check the accuracy of the established grey model:

I residual test
Residual: \( E(K) = x^{(0)}(k) - x^{(0)}(k) \)
Relative error: \( Q(k) = \frac{E^{(0)}(k)}{x^{(0)}(k)}, k = 2,3, \ldots, n \)

II posterior error test
Mean: \( \bar{X} = \frac{1}{n} \sum_{k=1}^{n} x^{(0)}(k) \)
Variance: \( S_1 = \sqrt{\frac{1}{n} \sum_{k=1}^{n} [x^{(0)}(k) - \bar{X}]^2} \)
The mean of the residuals: \( \bar{E} = \frac{1}{n-1} \sum_{k=2}^{n} E(k) \)
Variance of residuals: \( S_2 = \sqrt{\frac{1}{n-1} \sum_{k=2}^{n} [E(k) - \bar{E}]^2} \)
The posterior difference ratio: \( C = \frac{S_2}{S_1} \)
Probability of small error: \( P = P[|E(k) - \bar{E}| < 0.6745S_1] \)

III Comparison of prediction accuracy levels

| Forecast accuracy level | Good | Qualified | Barely Qualified | Unqualified |
|-------------------------|------|----------|------------------|-------------|
| P                       | P>0.95 | P>0.80 | P>0.70          | P≤0.70      |
| C                       | C<0.35 | C<0.45  | C<0.65          | C≥0.65      |

3.2 Forecast data collection
This article takes Ningbo Zhoushan Port as an object to make predictions. The following table shows the container sea-rail combined transport volume (including port throughput) of Ningbo Zhoushan Port from 2015 to 2019.

|                  | 2015 | 2016 | 2017 | 2018 | 2019 |
|------------------|------|------|------|------|------|
| Container throughput | 2063 | 2156 | 2461 | 2635 | 2753 |
| Container throughput of rail-sea combined transport | 17.05 | 25   | 40.1 | 60.2 | 80   |
| Proportion of rail-sea combined transport | 0.82% | 1.16% | 1.63% | 2.28% | 2.91% |
3.3 Forecast results and result analysis

3.3.1 Forecast results
Use the modeling software MATLAB for programming to complete the prediction. Obtain the following prediction results:

The forecast data is:
\[ G = 17.0500, 27.5204, 39.3506, 56.2663, 80.4535, 115.0382, 164.4899, 235.1994, 336.3049, 480.8727 \]

Output forecast trend chart:

![Figure 1 Forecast trend graph](image)

Table 3 Predictive Data Analysis

| Years | Actual value | Predictive value | Residual | Residual square |
|-------|--------------|------------------|----------|----------------|
| 2015  | 17.05        | 17.05            | 0.00     | 0.00           |
| 2016  | 25.00        | 27.52            | -2.52    | 6.35           |
| 2017  | 40.10        | 39.35            | 0.74     | 0.54           |
| 2018  | 60.20        | 56.27            | 3.93     | 15.44          |
| 2019  | 80.00        | 80.45            | -0.45    | 0.20           |

Relative residual Q test: \( Q = 0.0381 \)
C test of variance ratio: \( C = 0.0910 \)
P test for small error probability: \( P = 1 \)

By comparing with the prediction accuracy standard, it is judged that the prediction accuracy level of this prediction model is good. Finally, the forecast value of the container sea-rail combined transportation of Ningbo Zhoushan Port from 2020 to 2024 is obtained, as shown in the following table:

Table 4 Grey GM (1,1) Model Prediction Results (Million TEU)

| Years | 2020   | 2021   | 2022   | 2023   | 2024   |
|-------|--------|--------|--------|--------|--------|
|       | Container throughput of rail-sea combined transport | 115.03 | 164.48 | 235.19 | 336.30 | 480.87 |
4. Result analysis
The forecast results show that in the next five years, the container sea-rail combined transportation demand of Ningbo Zhoushan Port will show an upward trend, and the demand for container sea-rail combined transportation will exceed 4,808,700 TEU by the end of 2024. Compared with 2019, it increased by 4.087 million TEU, an increase of 501%. This result shows that its future demand transportation volume will continue to grow and increase at a faster rate. As a large-scale coastal port in my country, the annual cargo throughput of Ningbo Zhoushan Port exceeds 1 billion tons. The data has certain representative significance, and its prediction results can indirectly reflect the development trend of my country's port collection, distribution and transportation structure. This shows that it is necessary to accelerate the development of my country's port collection, distribution, and sea-rail combined transportation.

5. Suggestions on improving the collection and distribution system

5.1 Improving existing rail freight transportation pricing measures
The difference in pricing between railway transportation and road transportation is an important factor that affects the development of my country's "Rail Transfer". For many specific transportation distances and specific cargo types, the advantages of rail transportation cannot be reflected. Therefore, improving the pricing strategy of railway freight transportation is an effective means to promote the increase of "return to railway" transportation and realize the maximization of the interests of railway transportation enterprises.

5.2 Formulate relevant laws and policies
Enacting laws and regulations through relevant national departments has always been the simplest and most effective way to promote policy implementation.

Policy: Each region conducts in-depth research on the basis of existing policies, evaluates based on the research results, and adjusts existing policies or formulates new policies. The main research directions are: railway freight rate standards, the construction of key railway freight projects, the transportation business structure of freight demand enterprises, and the planning and construction of special railway lines. It is necessary to increase support for the construction of freight railway infrastructure and increase construction capital investment. Formulate preferential railway tariff policies for bulk cargo such as ore and coal, and establish a sound and flexible dynamic tariff adjustment mechanism.

Legal aspects: Improve the legal supervision of the phenomenon of indiscriminate charges in railway transportation, and increase the penalties of relevant laws and regulations for this type of behavior to ensure a fair market environment. In recent years, the state has vigorously promoted the development of "railway transfer", and various regions have actively implemented it. "Railway transfer" is gaining momentum, but in some regions, there has been a "one size fits all" phenomenon of road transportation. The establishment of compulsory policies and regulations to force the transfer of modes of transport, without any consideration of the characteristics of the local cargo transportation structure, is counterproductive.

6. Conclusion
In this paper, the “return to railway” of Ningbo Zhoushan Port's collection and distribution system is taken as an example to study the current problems of China's port collection and distribution system. In order to improve the contradiction between the expansion of seaports and urban development, it is imperative to transform the road-based collection and distribution system of traditional ports. It is foreseeable that railway transportation will be restricted by natural conditions such as rivers and water.
systems. It will replace the status of road transportation in the port collection and distribution system.

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