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Prediction and Analysis of Freight Transportation Demand Based on GM(1,1)-Markov Model

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Abstract: *The demand for cargo transportation can reflect the economic development level of different industries, and demand forecasting can solve the tense state of the transportation industry. Because the existing forecasting methods are limited to the description of economic indicators, the internal relationship between freight demand and various departments cannot be established, resulting in the prediction results are often higher than the actual freight demand. The research based on the GM(1,1)-Markov model Methods of forecasting freight transportation demand. Based on the GM(1,1)-Markov model to describe the demand index, the weighted theory divides the cargo transportation demand level to forecast, and completes the design of the cargo transportation demand forecasting method based on the GM(1,1)-Markov model. Experimental results: Taking the proportion of freight transportation demand in 2021 as the test object, the method in this paper and the traditional method are used to predict and compare. The prediction results produced by the traditional method are far lower than the actual proportion, while the method in this paper can be closer to the actual value and can It has practical application value to make a more accurate forecast of the demand for cargo transportation.*

Keywords: *Markov model; cargo transportation demand; demand forecasting; forecasting method*

1. Introduction

As a highly specialized science, prediction can evaluate and analyze the development status of things for a long time in the future, and can solve the fuzzy influence of uncertain factors on things. In response to problems from different angles, the use of scientific methods to conduct research on the development direction can quantitatively evaluate things that have not happened and things that have not happened according to the test results [1].

The special forecast for cargo transportation demand can provide a more prepared configuration plan for the subsequent development and resource consumption of the transportation industry, and through the demand orientation of different industries, comprehensively develop a variety of transportation channels to solve the tight situation of cargo transportation.

The Markov chain model can transfer the probability between different demand states, and use the direction and extreme value of the transfer to systematically analyze randomly changing things. Predictions are made dynamically in real time. Based on this, this paper designs a forecasting method of freight transportation demand based on GM(1,1)-Markov model to make more accurate judgments on freight transportation demand.

2. Prediction method of cargo transportation demand based on GM(1,1)-Markov model

2.1. GM (1,1)-Markov Model Describing Demand Indicators from Multiple Angles

The GM(1,1)-Markov model is used to calculate the regression prediction values of various indicators, establish the relative error between the actual value, and complete the description and classification of the indicators through the gray state theory, so as to transfer the classification standard of the probability and reduce the Error in demand forecast [2].

Set the relative error to $\triangle^0(Q)$, which represents a non-stationary random sequence, which

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includes the state of group W predictors, and the state set is represented by $E=\left(E_1,\ E_2,...,\ E_W\right)$. Generally, W takes 3 or 4 or 5. where $E_R=\left(E_R^1,\ E_R^2\right)$, E_R^1 and E_R^2 represent the upper and lower limits of E_R, respectively, representing the state at time $\left[Q\text{-}1\right]$, and for the Q state, there is a probability A_{RG} when transitioning to E_G, and the expression is:

$$A_{RG}=\left\{Z_Q=E_G\left|Z_{Q-1}=E_R\right.\right\} \quad (1)$$

In the formula: the reorganized set of ranking indicators is used to indicate that, according to the description time of different indicators, probability analysis can be performed on the predicted states of two adjacent groups, so as to find the largest element affecting the indicator. Based on the preliminarily established index classification and description set, the transport demand is graded by the weighting theory that comes with the model, and the transition state of different demand indicators is predicted directly according to the transfer direction of the probability, so as to complete the demand forecast between different transport channels and industries. [3].

2.2. The weighted theory divides the cargo transportation demand level to complete the forecast

The demand for cargo transportation is the main prerequisite for maintaining economic growth in all walks of life. In different production industries, the higher the demand for cargo transportation, the better the economic development level of the industry.

The GM (1,1)-Markov model is used to perform sequence analysis on the known data, describe the demand in different forecast indicators, and comprehensively consider the real demand of the industry under multiple cargo transportation routes. According to the above formula, the next step state of the indicator can be analyzed, and a probability matrix of state transition is established in two adjacent moments, where $R,G=1,2,...W$ is set, and the expression of the probability transition matrix is as follows:

$$A^{(1)}=\begin{bmatrix} A_{11} & A_{12} & \cdots & A_{1W} \\ A_{21} & A_{22} & \cdots & A_{2W} \\ \cdots & \cdots & \cdots & \cdots \\ A_{W1} & A_{W2} & \cdots & A_{WW} \end{bmatrix} \quad (2)$$

$$A_{RG}\geq 0,\sum_{G=1}^{W}A_{RG}=1 \quad (3)$$

In the formula: the state E_G of the next step of the indicator can be obtained through the transition probability, and the maximum probability interval is selected by the maximum probability criterion, and the indicator corresponding to $MAX\left\{A_{R1},A_{R2},...A_{RE}\right\}$ is predicted and classified. If the largest element indicator contains more than one, the calculation needs to be repeated. If there is only one largest element of this indicator, it is the largest demand connection between such transportation channels and the production industry, and the level of demand can be reduced in turn [4].

Different freight transportation channels can generate different transportation volumes, so in the process of industry development, it is necessary to match the relevant transportation types to complete the analysis and forecast of their annual or quarterly freight transportation needs. So far, based on the GM(1,1)-Markov model, which describes the demand indicators from multiple perspectives, the weighted theory is used to divide the demand level of cargo transportation, and the design of the forecasting method for cargo transportation demand is completed.

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3. Experimental testing and analysis

In order to verify that the prediction method designed this time has practical application effect and can achieve a more realistic prediction of the demand for cargo transportation, the experimental test method is used to demonstrate. Taking China's input-output value table in 2021 as a benchmark, the cargo transportation sector related to the national economy is classified in series, and its transportation demand in the previous year is taken as a test sample, and different methods are used to forecast. There is a relationship between the industries to which different freight transportation methods ultimately flow. The industries that account for a larger share of the overall proportion are more closely related to freight transportation and have a deeper impact on the demand for freight transportation. The details are as follows shown in Table 1.

Table 1: Distribution coefficient of connection between different modes of transportation and various industries (%)

Way	E-commerce	architecture	electricity	other
Rail transport	11.25	1.27	2.01	2.69
water transport industry	6.37	1.24	1.62	2.24
Air transport industry	26.28	1.24	3.25	3.82
road transport	30.09	1.24	4.27	1.12

According to the content in the table, in the process of classifying the ways of freight transportation, the freight transportation sector is mainly divided into railway freight transportation industry and waterway transportation industry, as well as air freight transportation industry and road transportation industry. The proportion of cargo transportation in different industries varies, among which the e-commerce industry accounts for %, the construction industry accounts for %, and the power production and supply industry accounts for %. Among them, e-commerce has a higher proportion of connections with air and road transportation, and is more closely related to the demand for cargo transportation, which can be used as the object of this experimental test.

In order to ensure the accuracy of the test results, the traditional methods were introduced for comparison, and the predicted value of the actual demand ratio of different methods was analyzed, whether it can truly reflect the demand for cargo transportation. Directly take the transportation demand required by the e-commerce industry as the test object, import the data on the proportion and content of different transportation routes into the MATLAB test platform, and connect the two prediction methods in turn. The proportion of demand for transportation routes is shown in Table 2 below.

Table 2: Predicted results of the proportion of demand for cargo transportation by different modes (%)

Rounds	Classification	The method of this paper	traditional method
1	Air transport industry	26.26 30.05	12.56 14.34
2	road transport	26.26 30.05	12.66 14.45
3	Air transport industry	26.26 30.05	12.26 14.75

According to the content in the table, the results of the three sets of forecasting processes are inconsistent. The traditional method has a large gap between the test results and the actual demand for freight transportation, which is less than half of the actual demand. Demand planning produces false guidance.

The prediction results obtained by the method in this paper are very close to the actual sample data, which can make a more realistic prediction of the cargo demand of different cargo transportation routes, ensure the distribution of cargo demand in different transportation industries, and have practical application effects.

4. Conclusions

Through the technical research of Markov model, this paper redesigns a demand forecasting method to provide accurate forecast data for freight transportation demand. The experimental results show that: under the application of the method in this paper, it can be closer to the actual cargo transportation demand ratio data, and make more accurate predictions, which has practical application significance.

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However, due to the lack of time and the selection of too few samples in the research process, the conclusions are biased to a certain extent. In the follow-up research, we will improve the shortcomings and select more data samples to provide a more scientific forecasting method for the demand of freight transportation.

References

[1] Lou Guoliang, Zhu Pengpeng, Xu Jiangchao, et al. Prediction Method of Expressway Freight Traffic Volume Based on Grey-Markov Model [J]. Automobile Practical Technology, 2022, 47(04): 88-91.

[2] Ni Jina, Zhang Wei, Liu Ningxin, et al. Demand forecast and development countermeasures for heavy haul railway transportation during the "14th Five-Year Plan" [J]. Railway Freight, 2022, 40(01): 7-11+19.

[3] Lu Zixuan, Suo Tongjia, Liu Wei. Prediction and analysis of cargo transportation insurance market demand in Shandong Province based on GM(1,1)-Markov model [J]. Journal of Ludong University (Natural Science Edition), 2022, 38(01):43-49.

[4] Liu Tian, Wang Yun, Yao Menglei, et al. Comparison of application effects of GM(1,1) grey model, Markov chain model and its combination model and SARIMA model in predicting the incidence of hepatitis A [J]. Prevention in South China Medicine, 2019, 45(02): 128-132.