Grey correlation analysis of influencing factors on logistics transportation development in Guizhou province

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Abstract. Transportation is an indispensable link in the logistics industry, so this paper uses the "gray correlation for analysis of the factors on the logistics transportation industry development in Guizhou Province" as the theme. Firstly, it briefly analyzes the development status and existing problems of the logistics transportation industry in Guizhou Province. Secondly, it mainly analyzes the highway freight volume, railway freight volume, and their main influencing factors through the gray correlation degree method. This paper tries to find out the main factors influencing logistics transportation in Guizhou Province and gives some suggestions based on these results.

1. Introduction

With the rapid development of modern logistics, the logistics industry has become an important indicator to measure the economic development of various regions, and the transportation industry is an indispensable link [1]. Therefore, we should pay attention to the reasonable planning of transportation links in logistics, and through continuous management and optimization of transportation links, to improve the operation efficiency and role of logistics activities in the whole national economic circulation [2]. Based on the development theory of the logistics transportation industry, this paper constructs a measurement model. From the perspective of various transportation and economy, it mainly constructs the gray correlation model of highway transportation and railway transportation freight volume in logistics transportation, and empirically analyzes the development of logistics transportation industry in Guizhou Province [3]. Through the calculation and analysis of the relevant data of the factors affecting the freight volume of highway transportation and railway transportation, the comprehensive score and ranking of them are obtained, to determine the main economic factors influencing the logistics transportation industry in Guizhou Province. Qualitative analysis and quantitative analysis are adopted in this paper. First of all, qualitative analysis is made on the development status of the logistics and transportation industry in Guizhou Province, and then the gray correlation analysis method is used to quantitatively analyze the highway freight volume and railway freight volume respectively. Finally, the objective data and conclusions are obtained through calculation. Grey relational analysis is a quantitative description and comparison method for the development and change trend of a system. Its basic idea is to determine the geometric similarity...
between reference series and several comparative series to judge whether they are closely related. It reflects the degree of correlation between curves [4].

2. Current situation of the logistics and transportation industry in Guizhou province

2.1. Current situation of logistics and transportation scale in Guizhou province

Guizhou is an important transportation hub connecting Sichuan, Chongqing, and South China. According to the statistical data in the statistical bulletin of national economic and social development of Guizhou Province in 2017, the GDP of the postal industry, transportation industry, and warehousing industry in Guizhou Province from 2010 to 2017 were 480.32, 590.91, 68745, 772.44, 82869, 920.36, 98.747 and 107.022 billion yuan respectively. This shows that the scale of the logistics and transportation industry in Guizhou Province is in a steady growth state [5].

In recent years, with the continuous expansion of various production and circulation fields, the freight transportation volume, freight turnover, and the operating mileage of various transportation modes in Guizhou Province are also increasing, especially in the aspects of highway transportation and railway transportation [6]. Among them, the freight volume increased from 403.1 million tons in 2010 to 962.41 million tons, the freight turnover increased from 101.22 billion tons per kilometer to 165.625 billion tons kilometers, and the passenger volume was 918.04 million person-times, an increase of 10.2% over the previous year. As early as in the 12th Five Year Plan period, Guizhou Province started a series of transportation infrastructure construction actions to jointly promote the development of the logistics transportation industry [7].

2.2. Demand status of the transportation industry

With the rapid development of the economy, the demand for logistics in various regions is rising, and transportation is an indispensable part of logistics. Therefore, with the increasing demand for logistics, the demand for the transportation industry is also growing. Now I will summarize the demand of Guizhou Province for the transportation industry in recent years from the following aspects.

(1) Guizhou's GDP. The GDP of a region directly reflects the level of economic development and people's living standards. Only when people's living standards continue to improve, the material demand of the region will increase accordingly. Therefore, this also directly produces logistics demand, and thus transportation demand [8]. In recent years, Guizhou's GDP has been in a state of rapid growth. As of 2017, Guizhou's GDP has reached 1354.083 billion yuan, an increase of 10.2% over 2016.

(2) Freight volume in Guizhou. The transportation modes of Guizhou Province include highway transportation, railway transportation, waterway transportation, and air transportation [9]. At present, highway transportation and railway transportation are mainly used. As of 2017, the freight volume has reached 962.41 million tons, an increase of 7.5% over 2016.

(3) Disposable income and fixed asset investment of urban residents. The disposable income and fixed asset investment of urban residents reflect the production, consumption, and circulation, which also directly reflect the demand for logistics transportation. In 2017, the disposable income and fixed asset investment of urban residents in Guizhou Province were 29080 yuan and 1528.801 billion yuan respectively. This is an increase of 7.5% and 20.1% over the previous year.

2.3. Current situation of transportation enterprises

With the increasing demand for the transportation industry, a large number of transportation enterprises are emerging in the market. Up to now, there are 7 registered logistics and transportation enterprises in Guizhou Province, which are located in Guiyang, Zunyi, Bijie, Tongren, Liupanshui, Anshun, and minority autonomous prefecture. The types of transport vehicles included in the enterprise include heavy dump trucks, heavy semi-trailer traction trucks, heavy warehouse rack trucks, heavy box trucks, and heavy tank truck [10]. At present, there are 379 freight transport agents and 564900 trucks, an increase of 7.2% over 2016. Besides, eight convenience points for large cargo
transportation were set up in 2018, respectively located in Xingyi BANBA, Shuicheng DuGe, Tongren Dalong, Daxing, Songkan, Chishui, Duyun new village, and Bijie vitality. The service points are equipped with large cargo transportation processing process display boards. To enable the transportation enterprises to grasp the "license" progress promptly, the service points also specially set up a dynamic bulletin board for the online application processing progress of large transport license.

3. Empirical analysis of the influencing factors of logistics transportation industry development in Guizhou province

Guizhou is located in the southwest of China. Because of its special karst landform, most logistics enterprises in Guizhou mainly choose road transportation and railway transportation. Therefore, this chapter mainly takes highway freight and railway freight as the breakthrough point to analyze the main factors influencing the development of logistics transportation in Guizhou Province under the gray correlation degree. Then, to find out the size of the influencing factors of the development of the logistics and transportation industry in Guizhou Province. This chapter selects the statistical data from 2010 to 2017 for grey relational modeling analysis. The relevant data is from the statistical yearbook of Guizhou Province.

3.1. Index for selection
Freight volume is the actual tonnage of goods transported by the transportation department in a certain period. It is used to assess the extent to which the regional transportation department has completed the national plan. The amount of freight volume also directly reflects the development of the transportation industry. Therefore, this chapter uses freight volume as a reference index. Because many factors affect the freight volume, this chapter selects six main factors as the comparative series for highway and railway freight volume.

Because many factors are affecting the highway freight volume, this chapter selects six main influencing factors to analyze the highway freight volume, Highway freight volume (Y1), Gross Regional Product (x1), fixed asset investment (x2), total retail sales of consumer goods (x3), disposable income of urban residents (x4), truck (x5), and employment (x6) as the comparative series;

Railway transportation is also another important mode of transportation in Guizhou. Here, we also select six main influencing factors of railway freight volume as the comparison series, Railway Road freight traffic volume (Y2), GDP (X1), fixed asset investment (X2), total retail sales of consumer goods (X3), highway operating mileage (X4), railway operating mileage (X5) and raw coal production (X6).

3.2. Calculation of grey correlation degree between the highway and railway freight volume and its influencing factors
By selecting the data in Table 3, using the following formula (1), the absolute difference between the comparison sequence and the reference sequence at each time point is calculated. The calculation results are shown in Table 4; Secondly, through formula(2), the maximum difference and minimum difference are obtained; Finally, according to formula(3), the degree of association obtained is sorted. The correlation coefficient and correlation degree between the freight volume of highway and railway and its influencing factors are shown in Table 1-4.

$$\Delta i(k) = |y_1(k) - x_i(k)|, i = 1, 2, \ldots, m$$

$$m = \min |x_0(k) - x_i(k)|, M = \max |x_0(k) - x_i(k)|$$

$$r(x_0, x_i) = \frac{1}{N} \sum_{k=1}^{n} r(k)$$

Table 1. The correlation coefficient between highway freight volume from 2010 to 2017.

| Year | x1(100 million) | x2(100 million) | x3(100 million) | x4(yuan) | x5(10000) | x6(ten thousand) |
|------|----------------|----------------|----------------|--------|------------|-----------------|
According to Table 2, we can rank the correlation between highway freight volume and its influencing factors in Guizhou Province from 2010 to 2017, that is GDP > total retail sales of consumer goods > disposable income of urban residents > ownership of trucks > investment in fixed assets > several employees.

According to Table 4, we can rank the correlation degree between the railway freight volume and its influencing factors in Guizhou Province from 2010 to 2017, that is raw coal output > highway operating mileage > railway operating mileage > total retail sales of consumer goods > GDP > fixed assets investment.

### Table 2. Correlation between highway freight volume and influencing factors from 2010 to 2017.

| Year | x1 (100 million yuan) | x2 (100 million yuan) | x3 (100 million yuan) | x4 (kilometre) | x5 (kilometre) | x6 (10000 tons) |
|------|-----------------------|-----------------------|-----------------------|----------------|----------------|-----------------|
| 2010 | 0.99005               | 0.41182               | 0.90066               | 0.64539        | 0.52232        | 0.36846         |
| 2011 | 0.84703               | 0.44845               | 0.76443               | 0.60485        | 0.58452        | 0.41359         |
| 2012 | 0.84989               | 0.54167               | 0.76628               | 0.65309        | 0.71359        | 0.51341         |
| 2013 | 0.73245               | 0.92222               | 0.75657               | 0.82372        | 0.78644        | 0.91909         |
| 2014 | 0.60406               | 0.56407               | 0.59881               | 0.58879        | 0.65452        | 0.54618         |
| 2015 | 0.98498               | 0.64259               | 0.89546               | 0.78923        | 0.80343        | 0.58605         |
| 2016 | 0.94321               | 0.57064               | 1.00000               | 0.85145        | 0.74441        | 0.51421         |
| 2017 | 0.70530               | 0.46559               | 0.83730               | 0.84044        | 0.69030        | 0.43123         |

### Table 3. Correlation coefficient between railway freight volume from 2010 to 2017.

| Year | X1 (100 million yuan) | X2 (100 million yuan) | X3 (100 million yuan) | X4 (kilometre) | X5 (kilometre) | X6 (10000 tons) |
|------|-----------------------|-----------------------|-----------------------|----------------|----------------|-----------------|
| 2010 | 0.41289               | 0.36599               | 0.42146               | 0.57962        | 0.53838        | 0.65342         |
| 2011 | 0.51924               | 0.44579               | 0.53670               | 0.70899        | 0.64146        | 0.76366         |
| 2012 | 0.67252               | 0.58113               | 0.70230               | 0.86352        | 0.71735        | 0.94871         |
| 2013 | 0.87873               | 0.78907               | 0.89555               | 1.00000        | 0.76898        | 0.94702         |
| 2014 | 0.91125               | 0.92214               | 0.91720               | 0.96178        | 0.97111        | 0.90221         |
| 2015 | 0.63531               | 0.58196               | 0.65609               | 0.76435        | 0.69996        | 0.83508         |
| 2016 | 0.52807               | 0.43860               | 0.53645               | 0.71387        | 0.54541        | 0.88505         |
| 2017 | 0.41534               | 0.34712               | 0.43518               | 0.64729        | 0.51076        | 0.88087         |

### Table 4. Correlation between railway freight volume from 2010 to 2017.

| Year | X1 | X2 | X3 | X4 | X5 | X6 |
|------|----|----|----|----|----|----|
| 2010 | 0.62167 | 0.55897 | 0.63762 | 0.77993 | 0.67418 | 0.85200 |

3.3. Result from analysis of influencing factors of grey correlation degree between highway and railway transportation in Guizhou province

Through the analysis of highway and railway freight volume by using grey correlation degree, the influence degree of various factors is obtained. Generally speaking, Guizhou Province has made
progress in recent years, whether in the development of highway transportation or railway transportation.

3.3.1. Analysis of the results of highway freight volume

According to the correlation degree ranking of the influencing factors of highway freight volume, we can see that the two influencing factors of GDP and total retail sales of consumer goods have the highest and second-highest correlation degree with road freight volume, which is about 0.8, and the correlation degree of urban residents' disposable income and truck ownership with road freight volume is about 0.7, indicating these two factors The correlation degree of elements is at a strong level. Fixed assets investment and the number of employed people have the lowest correlation with road freight volume, which indicates that the correlation degree of these two factors is at the general level.

There is a positive correlation between highway freight volume and GDP in Guizhou Province. The development of industry in Guizhou province directly drives the development of highway freight volume. The disposable income of urban residents and the total retail sales of social consumer goods are the basic purchase expenditure of people in daily life and are also universal economic activities. At present, due to the improvement of economic development level, people's income increases, and then consumption demand At the same time, stimulate the circulation of goods to speed up, thus driving the progress and development of the highway transportation industry.

The influence of truck ownership on road freight is also relatively large, so we can increase the number of the truck to promote the development of highway transportation; and for the construction of transportation infrastructure, we need a lot of capital investment, but from the ranking, we can see that the fixed assets investment ranks last, which shows that Guizhou invests in the construction process of highway transportation infrastructure The money in is not very stable.

3.3.2. Analysis of freight volume of railway transportation

According to the ranking, we can see that the correlation degree of raw coal production and highway operation mileage with railway freight volume is the highest and the second-highest, and the correlation degree of railway operation mileage and total retail sales of social consumer goods is about 0.65, which indicates that the correlation degree of these two factors is at a strong level, and the correlation strength between GDP, fixed asset investment and railway freight volume is strong At the average level.

The correlation degree of raw coal output and highway operating mileage to railway transportation in Guizhou Province is the highest, which are 0.85200 and 0.77993 respectively. The coal reserves in Guizhou Province have been relatively rich, and in recent years, the output of coal has been on the rise, and such goods as coal transportation cannot be separated from railway transportation, so the amount of raw coal production has a great impact on railway transportation; for highway operation mileage, in recent years, the highway operating mileage in Guizhou Province has been increasing rapidly It is the rapid development of highway that drives the development of highway transportation, so it will restrict the freight volume of railway transportation.

The correlation between railway operating mileage and total retail sales of consumer goods was the second-highest, 0.67418, and 0.63762, respectively. The railway operating mileage of each region will directly affect the freight volume; the total retail sales of consumer goods is an indispensable indicator to measure the economic development and consumption capacity of a region, so it plays an important role in any kind of transportation.

4. Conclusions

By using the grey correlation analysis method to analyze the correlation degree between the freight volume of highway transportation and railway transportation in Guizhou Province and their influencing factors, we can see that the consumption demand increases greatly with the rapid development of the economy and the continuous improvement of people's living standard, which brings a good opportunity for the development of logistics transportation industry. Therefore, Guizhou
Province should pay more attention to the integration of the existing logistics transportation resources, strengthen the research on the comprehensive utilization of highway-rail combined transportation and public water combined transportation, and ensure the smooth flow of the two main logistics transportation lines through the reintegration of the transportation capacity resources of the existing highway and railway transportation network. As soon as possible, we should build a comprehensive transportation network for the coordinated development of various transportation modes in Guizhou Province, and accelerate the construction of hub facilities and service facilities connecting various transportation modes. Besides, we should strengthen, improve and expand the consumption market, to strengthen markets’ competition, increase the scale of the wholesale and retail market, cultivate large-scale business enterprises, change the management mode and service concept, and provide personalized and high-quality services. Through these methods, we can stimulate the consumption of Guizhou Province and expand the consumption market, to promote consumption, and the demand for logistics transportation.

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