

# Research on Regional Logistics Capability Evaluation Based on Factor Analysis

-- A Case Study of Gansu Province

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**Abstract:** The logistics industry has gradually become a fundamental driving force supporting China's economic development, but it faces problems such as unbalanced regional development. To promote the development of China's logistics industry and improve the level of logistics services, this study, based on existing research results, selects 9 indicators to establish a logistics capability evaluation index system for the research on logistics capability. Factor analysis is used to conduct an overall data analysis of 10 cities in Gansu Province, and the SPSS software is applied to analyze the data of the 9 selected indicators. Finally, the comprehensive scores and rankings of logistics capabilities of the 10 cities in Gansu Province are obtained. Based on the factor analysis, conclusions are drawn, and suggestions for the development of the logistics industry in Gansu Province are put forward to enhance regional logistics capabilities.

**Keywords:** Factor Analysis; Logistics Capability; Development Suggestions.

## 1. Introduction

As an important part of the modern service system, the logistics industry plays an undeniable role in driving the steady growth of the national economy. Since 2009, it has been identified as one of the ten key areas supported by the state for revitalization, continuously promoting the optimization and upgrading of the economic structure. To enhance the vitality and competitiveness of the logistics industry, the Chinese government has successively issued documents such as Guiding Opinions of the State Council on Deepening the Reform of the Circulation System and Promoting the Development of the Circulation Industry and Policy Measures of the General Office of the State Council on Further Promoting the Healthy Development of the Logistics Industry. These policy initiatives have laid a solid policy foundation and created a favorable market environment for the vigorous development of the logistics industry.

Data shows that by 2017, the total social logistics volume in China had jumped to a new high of 252.8 trillion yuan, fully demonstrating the core position of the logistics industry in the national economic landscape. From 2010 to 2023, this total surged from 125.4 trillion yuan to 352 trillion yuan, with an average annual growth rate of a steady 10.53%, highlighting the strong growth momentum of logistics demand and the continuous expansion of the industry scale.

However, with the rapid expansion of the logistics industry, a series of challenges have gradually emerged, including high logistics costs, room for improvement in operational efficiency, imbalanced supply and demand structure, the urgent need to standardize market order, and uneven development among regions. The logistics industry is a strategic industry highly valued by both the country and Gansu Province. It is an important part of promoting regional economic development and also the key and core of regional development. The improvement of regional logistics capacity is directly related to regional economic development, serving as a crucial and central link in regional development, and

enhancing regional logistics capacity plays a decisive role in its development.

Therefore, in-depth analysis of the current situation of Gansu Province's logistics industry, accurate identification of its development bottlenecks and challenges, and formulation of scientific and reasonable response strategies based on this are of far-reaching strategic significance and practical value for promoting the high-quality development of the logistics industry in Gansu Province and even the whole country.

## 2. Literature Review and Theoretical Analysis

At present, academic research on regional logistics capabilities has focused on aspects such as the development models, development planning, network site selection, and influencing factors of regional logistics. Chen Hao (2011) and others took Anhui Province as an example and used factor analysis to study the logistics of various cities in Anhui Province. Wang Xiaoli (2013), based on the logistics development data of Henan Province from 2000 to 2011, proposed a logistics capability evaluation index system and conducted an evaluation and empirical analysis of Henan Province's logistics capability. Gao Xincan (2014) and others used the fuzzy matter-element method to evaluate the logistics capabilities of the five northwestern provinces. They found that although the overall trend is upward, the improvement speeds vary, and they are profoundly affected by economic levels and location conditions. Chen Da (2018) constructed an index system from four aspects: the basic level of product logistics, the degree of logistics transportation and informatization, and the level of human resources, and used factor analysis to analyze the development capability level of agricultural product logistics in Anhui Province. Cao Bingru (2018) and others, taking Jiangsu Province as an example, used the analytic hierarchy process (AHP) and the technique for order preference by similarity to ideal solution (TOPSIS) to describe the pattern of "strong in the south and weak in the north" in Jiangsu Province's logistics development. Liu

Chengjun (2019) and others, through methods such as the gravity model and hub-and-spoke theory analysis, revealed that the logistics capability of the Yangtze River Economic Belt has been increasing year by year and the inter-regional connections have become increasingly close, while pointing out the spatial distribution characteristic of "strong in the east and weak in the west". Wang Bo (2019) and others used the three-stage DEA model to analyze the current situation that regional logistics along the "Belt and Road" is restricted by the external environment, pointing out that the overall development needs to be improved.

Li Xiang (2021) and others studied the efficiency of the regional logistics industry in Anhui Province, showing that although Anhui Province has high logistics efficiency, there is imbalance among regions, and emphasized the key role of technical efficiency and scale efficiency. Wei Guochen (2019) and others used the ANP-TOPSIS model to conduct an in-depth analysis of logistics development in the Beijing-Tianjin-Hebei region, revealing the differences in logistics development within the region, especially the significant leading growth rate of logistics in Beijing.

To sum up, current scholars mainly use single evaluation methods such as factor analysis, fuzzy comprehensive evaluation, analytic hierarchy process, grey relational analysis, and fuzzy matter-element method to evaluate regional logistics capabilities. Some scholars also comprehensively use two of these methods to construct evaluation models. Considering that factor analysis has certain objectivity and operability compared with other methods, this paper uses factor analysis to establish a logistics capability evaluation model for Gansu Province.

### 3. Establishment of Regional Logistics Capability Evaluation Index System

#### 3.1. Principles for Selecting the Index System

Establishing a scientific and reasonable evaluation index system is the basis for evaluating regional logistics capabilities. In this paper, the following five principles are followed when selecting regional logistics capability evaluation indicators, as shown in Table 1.

**Table 1.** Principles for Selecting Regional Logistics Capability Evaluation Indicators

Principles	Contents
Scientific Principle	The evaluation of regional logistics capabilities must be based on certain theoretical foundations to ensure the scientificity of evaluation conclusions. This principle specifically includes two aspects: first, reliable data: indicator data should come from reliable sources to ensure authenticity and accuracy; second, scientific methods: evaluation methods should be scientific and reasonable, enabling objective and fair evaluation of regional logistics capabilities.
Systematic Principle	The evaluation index system should comprehensively cover all aspects of regional logistics, including logistics infrastructure, logistics service level, logistics efficiency, logistics environment, etc.; and various indicators should be interrelated to form an organic whole, jointly reflecting the comprehensive level of regional logistics capabilities.
Practical Principle	The data of evaluation indicators should be easy to obtain, facilitating practical operation and application; at the same time, evaluation results should have strong guiding significance, providing valuable reference information for governments, enterprises and relevant institutions.
Objective Principle	Evaluation indicators should be mutually independent to avoid repetition and redundancy; moreover, the evaluation process should minimize the interference of subjective factors to ensure the objectivity and fairness of evaluation results.
Comparable Principle	Evaluation indicators should be comparable in time and space to facilitate comparative analysis of different regions and different periods, so as to observe the development and change process of regional logistics capabilities.

#### 3.2. Selection of Specific Indicators

Some scholars in the academic circle have conducted research on the evaluation of logistics capabilities and achieved certain research results, but there are differences in the selection of evaluation indicators for logistics capabilities. Firstly, logistics service is an economic activity carried out on the basis of certain infrastructure construction and development scale, and its main purpose is to obtain profits. Therefore, logistics infrastructure, the development scale of the logistics industry and logistics cost control have an important impact on logistics capabilities. Secondly, the level of regional economic development and informatization also have an important impact on logistics capabilities. Therefore, based on the principles for establishing the evaluation index system and drawing on the existing research results in the academic circle, this paper establishes a regional logistics capability evaluation index system from 9 aspects, including GDP, per capita regional GDP, number of permanent residents at the end of the year, total retail sales of social consumer goods, freight volume, freight turnover volume, highway mileage, number of mobile phone users and number of internet broadband users, as shown in Table 2.

**Table 2.** Evaluation Index Set of Regional Logistics Capability in Gansu Province

Number	Indicator
X1	GDP
X2	Per capita regional GDP
X3	Number of permanent residents at the end of the year
X4	Total retail sales of social consumer goods
X5	Freight volume
X6	Freight turnover volume
X7	Highway mileage
X8	Number of mobile phone users

This paper selects the values of 9 indicators of 10 cities in Gansu Province in 2022 (the data are sourced from the Gansu Development Yearbook and the statistical bulletins on national economic and social development of each city and district) to establish the original data table.

#### 3.3. Data Standardization Processing

This paper adopts the z-score standardization method, and the formula is as follows:

$$Z_i = \frac{X_i - X_{\min}}{X_{\max} - X_{\min}}$$

In this formula,  $X_i$  represents the original data, and  $Z_i$  represents the standardized data.

## 4. Empirical Analysis of Rural Logistics Development Level in Yunnan Province Evaluation and Analysis of Regional Logistics Capabilities in Gansu Province

### 4.1. KMO Test and Bartlett's Test of Sphericity

When using factor analysis to analyze this issue, it is necessary to apply SPSS 26.0 software to conduct KMO and Bartlett tests on the standardized original data to determine whether the research object is suitable for factor analysis. In this paper, the KMO value is 0.739, which is greater than 0.5. The approximate chi-square value of the Bartlett's sphericity test is 112.547, with 36 degrees of freedom, and  $P = 0.000$  ( $p$

$< 0.05$ ). This indicates that there is a correlation between variables, and the selected indicators are suitable for factor analysis, as shown in Table 3.

**Table 3.** KMO test and Bartlett's test of sphericity

KMO value		0.739
Bartlett's test of sphericity	Approximate chi-square	112.547
	df	36
	p value	0.000

### 4.2. Determining Common Factors

Given the high and numerous correlations among variables, representative common factors are selected for calculation.

(1) Explain the Total Variance Explained table

Using SPSS software, the eigenvalues and variance contribution rates of each factor are obtained.

**Table 4.** Total Variance Explained

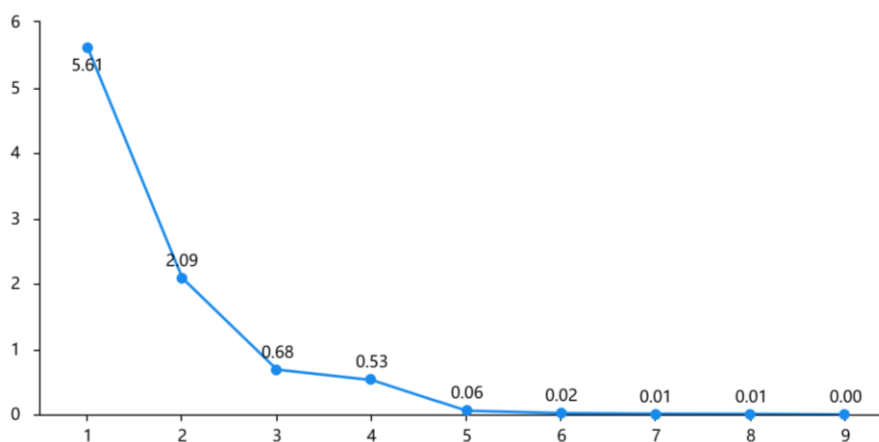
Component	Initial Eigenvalues			Extracted Sums of Squared Loadings		
	Total	Variance/%	Cumulative/%	Total	Variance/%	Cumulative/%
1	5.607	62.305	62.305	5.511	62.305	62.305
2	2.085	23.168	85.473	2.181	24.238	85.473
3	0.685	7.608	93.080			
4	0.526	5.849	98.929			
5	0.056	0.624	99.553			
6	0.022	0.241	99.794			
7	0.009	0.102	99.896			
8	0.009	0.095	99.990			
9	0.001	0.010	100.000			

By conducting factor analysis on the standardized original data, two principal components, D1 and D2, were extracted, and an analysis of these principal components was carried out. As can be seen from Table 4, the eigenvalues of these two principal components are both greater than 1, with variance contribution rates of 61.235% and 24.238% respectively. The cumulative variance contribution rate reaches 85.473%. This indicates that the two extracted common factors can explain 85.473% of the data from the original 9 indicators, retaining

most of the data in the original data and having strong representativeness. Using them to evaluate the regional logistics development level of Gansu Province reduces the complexity of the original data to a considerable extent.

(2) Scree Plot of Factors

It can be seen from Figure 1 that the scree plot of the first two factors is relatively steep, while the scree plot becomes gentle afterwards. Therefore, selecting only the first two factors can reflect most of the information.



**Figure 1.** Scree Plot

### 4.3. Factor Rotation

The Varimax rotation method (maximum variance method) is used to rotate the factors so that the absolute value of the factor loading coefficient is greater than 0.4. When the absolute value of the factor loading coefficient is greater than

0.4, it indicates that there is a corresponding relationship between the item and the factor, and the results are shown in the table.

**Table 5.** Factor load coefficient table after rotation

Name	Component	
	1	2
X1	0.955	
X2		0.827
X3	0.914	
X4	0.951	
X5	0.634	0.646
X6	0.726	0.443
X7		-0.815
X8	0.983	
X9	0.980	

According to Table 5, common factor 1 has large loadings on GDP, the number of permanent residents at the end of the year, total retail sales of social consumer goods, freight volume, freight turnover volume, the number of mobile phone users, and the number of internet broadband users, which are to be explained by the first component; while it has large loadings on per capita regional GDP, freight volume, and

$$D1=0.169X1-0.044X2+0.186X3+0.166X4+0.086X5+0.114X6+0.053X7+0.190X8+0.186X9$$

$$D2=0.043X1+0.391X2-0.198X3+0.064X4+0.274X5+0.173X6-0.387X7-0.111X8-0.078X9$$

Finally, the standardized original data are brought into the expression of common factors to calculate D1 and D2. To accurately analyze the logistics capabilities of the 10 cities and districts, weighted calculation is required to obtain a comprehensive scoring model, namely:

$$D = \frac{0.61235}{0.85473}D1 - \frac{0.24238}{0.85473}D2 = 0.716D1 + 0.284D2$$

Taking 10 cities in Gansu Province as examples, this paper substitutes their values into the above calculation formula to obtain the scores and rankings of logistics capabilities of each city in Gansu Province, as shown in the table.

**Table 7.** Ranking of Logistics Capabilities of Cities in Gansu Province

Region	D1	D2	D	Ranking
Lanzhou	1.09	0.22	0.85	1
Jiayuguan	0.01	0.53	0.16	6
Baiyin	0.30	0.03	0.22	2
Tianshui	0.40	-0.40	0.17	4
Wuwei	0.29	-0.01	0.21	3
Pingliang	0.22	-0.27	0.08	10
Jiuquan	0.22	-0.06	0.14	7
Qingyang	0.31	-0.30	0.13	8
Longnan	0.30	-0.47	0.08	9
Linxia Prefectur	0.26	-0.10	0.16	5

#### 4.5. Results Analysis

It can be found from Table 7 that there is a significant gap in the development level of the logistics industry among the 10 cities in Gansu Province. Among them, Lanzhou City has the highest logistics level, ranking first. Baiyin, Wuwei, Tianshui, Linxia and Jiayuguan cities have relatively high logistics development levels. Dingxi, Wuwei, Baiyin and Pingliang have average agricultural product logistics levels, while Jiuquan, Qingyang, Longnan and Pingliang have relatively low logistics levels.

Based on the analysis of the development status of the

highway mileage, which are to be explained by the second component.

#### 4.4. Factor Analysis

Calculate the component score coefficient matrix, and the results are shown in the table.

**Table 6.** Component Score Coefficient Matrix

Name	Component	
	1	2
X1	0.169	0.043
X2	-0.044	0.391
X3	0.186	-0.198
X4	0.166	0.064
X5	0.086	0.274
X6	0.114	0.173
X7	0.053	-0.387
X8	0.190	-0.111
X9	0.186	-0.078

logistics industry in Gansu Province, this paper concludes the reasons for the sound development of the logistics industry in Lanzhou City: First, Lanzhou City is located in the central part of Gansu Province and is the transportation hub of the whole province, with unique geographical advantages. It connects multiple directions of east, west, south and north and is an important node city in the construction of the "Belt and Road Initiative", which endows Lanzhou with extremely high convenience and accessibility in logistics transportation. Second, as the provincial capital and an important economic center of Gansu Province, Lanzhou City has a strong market demand. The increasing demand for logistics services from various enterprises and merchants provides a broad market space for the development of the logistics industry. Third, Lanzhou City has invested a large amount of funds in the construction of logistics infrastructure and logistics information platforms, ensuring the rapid development of the logistics industry. At the same time, the government has actively guided social capital to invest in the development of the logistics industry, forming a diversified investment pattern.

In addition, the relatively high logistics development levels in places such as Baiyin, Wuwei and Tianshui are due to the following reasons: Baiyin City is located in the central part of Gansu Province and is an important transportation hub connecting Lanzhou, Xining and other cities. It has good geographical advantages, facilitating logistics transportation and distribution. Meanwhile, the Baiyin Municipal Government has issued a number of policies to support the development of the logistics industry, including land guarantee, fiscal and tax support, and financing support, providing a favorable policy environment for the development of the logistics industry. Tianshui City is an important agricultural product producing area in Gansu Province, and high-quality agricultural products provide a good product foundation for the development of rural logistics in Tianshui. The carrying capacity of rural logistics infrastructure has been continuously improved, especially the development of cold chain logistics, which has provided strong support for the improvement of Tianshui City's

logistics level. Moreover, Tianshui City has formed a transportation network including railways, expressways, national and provincial highways, and county and township roads, with a long total mileage of open roads, providing convenient conditions for logistics transportation. Wuwei City focuses on the construction of logistics information network service platforms, and improves the level of logistics informatization through projects such as the construction of e-commerce entrepreneurship incubation bases and entrepreneurship training bases. Centering on logistics demand gathering places such as industrial agglomeration areas and industrial parks, Wuwei City has planned and built a number of logistics parks, forming a logistics service network integrating road-rail intermodal transportation and trunk-branch networking.

It can be seen from Table 7 that the common reasons for the low logistics levels in Jiuquan, Qingyang, Longnan and Pingliang mainly include limitations in geographical location and transportation conditions, backward construction of logistics infrastructure, low level of logistics informatization, small scale of the logistics industry, and insufficient policy support and capital investment. To address these issues, the government, enterprises and all sectors of society need to make joint efforts to strengthen infrastructure construction, improve the level of informatization, cultivate key enterprises, expand market demand, and increase policy support and capital investment, so as to promote the rapid development of the logistics industry in these cities.

## 5. Suggestions for Improving Logistics Capabilities in Gansu Province

### (1) Continuous improvement type

Regions of this type have strong regional logistics capabilities. Under the current development situation, they should seize development opportunities and formulate all-round and multi-level improvement strategies from aspects such as promoting informatization, optimizing the market environment, improving the quality of talents, and pursuing innovative development. Take Lanzhou City as an example. It has the highest comprehensive score and good potential for logistics development, but its D2 score is low, indicating poor basic logistics operation capabilities. Therefore, it is necessary to increase investment in modern transportation facilities such as expressways and high-speed railways to improve transportation efficiency and shorten the in-transit time of goods. At the same time, universities and vocational training institutions should be encouraged to offer logistics management majors and courses to cultivate more professional talents. Strengthen cooperation with enterprises, carry out order-based training and internship programs to enhance students' practical abilities and employment competitiveness.

### (2) Exploratory catch-up type

Regions of this type have average regional logistics capabilities. They still need to identify their own shortcomings, break through logistics bottlenecks, accelerate

the construction of logistics infrastructure, identify their own advantages, promote the transformation and upgrading of the logistics industry, replace old formats with new ones, and continuously improve regional logistics capabilities. Take Wuwei City as an example. It has a high D1 logistics capability score but a relatively low D2 score. Therefore, Wuwei City still needs to further enhance the support of the macro development environment for regional logistics in terms of per capita regional GDP, freight volume, and highway mileage.

### (3) Conservative and backward type

Regions of this type have relatively low regional logistics levels. They must, on the basis of strengthening infrastructure construction, raise logistics awareness, strengthen the concept of logistics development, give full play to their advantageous resources, focus on logistics innovation and development, increase investment in logistics funds and scientific research, promote the development of local logistics industries, and accelerate the improvement of logistics capabilities.

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