Academic Journal of Management and Social Sciences
ISSN: 2958-4396 | Vol. 4, No. 3, 2023

Evaluation of Urban Logistics Competitiveness Based on Principal Component Analysis

--Taking 21 Cities in Sichuan Province as an Example

Chen Xue, Xinyu Yang

School of Economics and Management, Southwest Petroleum University, Chengdu, CO 610000, China

Abstract: The level of regional economic development is, to a certain extent, reflected by the logistics competitiveness of cities. This paper selects the logistics competitiveness of 21 cities in Sichuan Province, in order to assess the level of logistics competitiveness of cities in Sichuan Province, selects 21 provincial and municipal cities to get logistics indicators, using SPSS 23.0 software to get the evaluation results of the principal components of the analysis and sorting, and based on the results of the evaluation of the development of the corresponding recommendations. The results show that the evaluation results analyzed by the software are basically in line with the actual situation and can provide a reference basis for government departments to guide the development of cities.

Keywords: Principal Component Analysis; Logistics Competitiveness; SPSS.

1. Introduction

With the rapid development of the economy, the development of modern logistics industry has entered a new period, and the logistics industry has an inseparable relationship with the social and economic development. A city's logistics competitiveness and regional economic development promote each other, scientific evaluation of the level of logistics competitiveness of the city, for enterprises and the government to make decisions to improve the logistics environment, to promote the development of the regional economy has a positive significance, and even for the development of the entire modern logistics economy has significant significance. Sichuan is an important area for logistics in southwest China. In recent years, the economic development of major cities in Sichuan Province has been rapid, and the logistics demand has been expanding, but the logistics competitiveness needs to be improved. In addition, the logistics competitiveness of cities is interconnected with the comprehensive economic level of the region, such as gross regional product, per capita GDP, total retail sales of consumer goods and the number of highway mileage and other indicators. Since the modern industrial chain relies on the logistics network to a large extent, regional logistics competitiveness also has a certain degree of influence on the development of local enterprises, and a higher level of development of modern logistics will lead to a relatively greater competitiveness of enterprises. Based on this, this paper carries out relevant research and discussion, expecting to provide certain scientific basis for the enhancement of logistics competitiveness of cities in Sichuan Province, and at the same time, promote the further improvement of the overall logistics environment in Sichuan Province, and provide references for the development of logistics in Sichuan Province.

2. Literature Review

Jin Fangfang et al. (2013) divided the factors affecting logistics competitiveness into two aspects, logistics strength and logistics development potential, constructed an evaluation index system on this basis, and used factor analysis and cluster analysis to evaluate logistics competitiveness [1]. Yue Qi (2019) combed and summarized the related research literature, constructed the evaluation index system from six aspects such as industrial structure, marketization degree, informatization degree, urbanization degree, logistics infrastructure construction, and human resource status of logistics industry, and used three evaluation methods, namely, grey correlation analysis, principal component analysis, and entropy weighting, to conduct a combined evaluation [2]. Song Erxing and Zhou Xiaowei (2020) used comprehensive evaluation-entropy value method and coupling coordination degree model to construct logistics industry competitiveness evaluation system from four aspects, including logistics infrastructure, transportation capacity, economic efficiency and development potential, and evaluated the competitiveness of the logistics industry and the degree of coupling and coordinated development of the logistics industry in 31 provinces in China [3]. Sun Yan (2022) used the entropy weight TOPSIS method to construct a city logistics competition evaluation index system from several aspects of economic strength, logistics demand and logistics supply, and evaluated the logistics competitiveness of prefecture-level cities in Shaanxi Province [4].

In foreign countries, competitiveness research mainly focuses on the direction of supply chain. Ackermann (2007) constructs a three-layer structural model from the aspects of logistics infrastructure, demand process and transportation planning platform, and makes an analysis and evaluation of regional logistics competitiveness[5] . Alarcona (2012) and others constructed a theoretical framework for evaluating the logistics competitiveness of cities, and took the central region of Mexico as an example to carry out the empirical application [6]. Kwasnicki (2013) depicted the growth curve of logistics competitiveness in terms of population and economic level, and made suggestions for logistics development in the United States, Japan, China and other countries [7].

This paper aims at the study of logistics competitiveness,

constructs the evaluation index system of logistics competitiveness in Sichuan Province from three aspects, namely, economic level, logistics demand and logistics supply, and carries out the principal component analysis by using SPSS23.0 data analysis software, and gives the corresponding development suggestions according to the analysis results.

3. Logistics Industry Competitiveness Evaluation System Construction

3.1. Evaluation System Construction of Logistics Industry Competitiveness

Based on the actual data situation of each prefecture-level city in Sichuan Province, this paper selects the indicators that can reflect the competitiveness of the city from the three aspects of economic level, logistics demand and logistics supply on the basis of availability, reliability and relevance of relevant data, and constructs the logistics competitiveness evaluation index system, as shown in Table 1:

Table 1. Logistics competitiveness evaluation index system

Level 1 indicators	Secondary indicators	variable symbol
economic level	Gross Domestic Product GDP	x1
	GDP per capita	x2
logistics needs	Agricultural GDP	x3
	gross industrial product (GIP)	x4
	Total retail sales of consumer goods	x5
Logistics supply	Number of road miles	x6
	Number of civilian vehicles	x7

Data source: Sichuan Statistical Yearbook (2021)

The economic level of a city has a great influence on the development of logistics. A high level of urban economic development will lead to the growth of people's consumption demand, and the growth of consumption demand will promote the development of the logistics industry; a high level of economic development represents a high level of urban trade, and trade represents the circulation of commodities, which also indicates that there is a great demand for logistics, such as the transportation of goods. At the same time, a high economic level can support the development of urban logistics industry, provide an economic basis for the improvement of logistics infrastructure, and enhance the level of logistics development.

In a series of links from the generation to the consumption of physical commodities, there will be a large number of logistics needs to be satisfied, and these needs bring countless jobs and economic profits, which has a positive impact on optimizing the structure of the city's industrial development and alleviating the problems of the population's employment, and at the same time attracts resources and talents for the development of the industry itself and improves the competitiveness of the city's logistics. Therefore, the strong logistics demand drives the progress of urban logistics industry while affecting the development of the city.

The level of logistics supply greatly affects the strength of urban logistics competitiveness. If the level of logistics supply is low, the logistics activities cannot run in an orderly and efficient manner, which will lead to many social problems such as material retention and transportation system confusion, and reduce the competitiveness of urban logistics. In contrast, smooth and orderly logistics activities can efficiently convert the opportunities and profits brought by logistics demand into industrial development power and improve the competitiveness of urban logistics.

3.2. Sample Selection

According to the availability of data, this paper selects the logistics indicators of 21 cities in Sichuan Province from three aspects, namely, economic level, logistics demand and logistics supply, and carries out the principal component analysis using SPSS 23.0, and ranks the 21 cities according to the analysis results, and gives the corresponding development suggestions, and the data come from the 2021 "Sichuan Provincial Statistical Yearbook".

4. Empirical Analyses

4.1. Feasibility Testing

The raw data were analyzed using SPSS 23.0 and the data were tested for validity through KMO test and Bartlett's test. The feasibility of the data was tested by KMO test, and from Table 2, the KMO value was 0.82, which is greater than 0.8; the value of Bartlett's spherical test statistic was 305.588, and the p-value obtained from the analysis was less than 0.05, and the significance level was less than 5%, which indicates that the data is suitable for principal component analysis.

Table 2. KMO and Bartlett's test

KMO Number of Sampling Suitability Measure.		0.820
Bartlett's test of sphericity	approximate chi-square (math.)	305.588
	(number of) degrees of freedom (physics)	21
	significance	0.000

4.2. Extraction of Principal Components

Using spss23.0 to analyze the data, as shown in Table 3, 2 main factors can be extracted from the 7 indicators in the previous period. The cumulative variance contribution of these 2 main factors reached 92.683%, indicating that the results of the factor analysis were reliable.

Table 3. Characteristic roots and factor contributions

ingredient	Initial eigenvalue			Extract the sum of the squares of the loads		
	(grand) total	Percentage of variance	Cumulative %	(grand) total	Percentage of variance	Cumulative %
1	5.159	73.698	73.698	5.159	73.698	73.698
2	1.329	18.986	92.683	1.329	18.986	92.683
3	.285	4.076	96.759			
4	.209	2.979	99.738			
5	.015	.219	99.957			
6	.002	.028	99.985			
7	.001	.015	100.000			

4.3. Interpretation of Principal Components

From Table 3 and Table 4, the first principal component contains a large amount of indicator information, with a variance contribution rate of 73.698%, including gross regional product GDP, gross agricultural product, gross industrial product, total retail sales of consumer goods and the number of civilian vehicles, which can be used to evaluate the level of economic development of the city; the second principal component, with a variance contribution rate of 18.986%, contains the number of highway mileage and covers the information on urban transportation.

Table 4. Component matrix

	ingredient	
	1	2
Gross Domestic Product GDP (billions of dollars)	0.992	-0.019
GDP per capita (dollars)	0.576	-0.724
Gross agricultural product (billions of dollars)	0.884	0.218
Gross industrial product (billions of dollars)	0.989	-0.087
Total retail sales of consumer goods (billion dollars)	0.990	0.025
Number of road miles (km)	0.368	0.865
Number of civilian vehicles (10,000)	0.983	-0.015

4.4. Empirical Results

The coefficients of the principal component scores were calculated using spss23.0 and the results are shown in Table 5:

Table 5. Matrix of factor scores coefficients

norm	F1	F2
Gross Domestic Product GDP	0.4367	-0.0165
GDP per capita	0.2536	-0.6280
Agricultural GDP	0.3892	0.1891
gross industrial product (GIP)	0.4354	-0.0755
Total retail sales of consumer goods	0.4359	0.0217
Number of road miles	0.1620	0.7503
Number of civilian vehicles	0.4328	-0.0130

From the above table, the expressions for the two principal components are given:

$$F1=0.4367X1+0.2536X2+0.3892X3+0.4354X4+0.4359X5+0.1620X6+0.4328X7 \quad (1)$$

$$F2=-0.0165X1-0.6280X2+0.1891X3-0.0755X4+0.0217X5+0.7503X6-0.0130X7 \quad (2)$$

Based on the corresponding variance contributions of the first and second principal components in Table 5, the composite score formula can be obtained:

$$F=0.73698F1+0.18986F2 \quad (3)$$

Finally, the city logistics competitiveness scores and rankings are derived, as shown in Table 6, in the comprehensive factor scores, Chengdu, Nanchong, Mianyang City ranked the top. According to the ranking of logistics competitiveness score, the preliminary division of Sichuan Province logistics competitiveness of the first echelon of cities for Chengdu, the second echelon of cities for Nanchong, Mianyang, Yibin, Dazhou, Liangshan, Deyang (logistics competitiveness score > 0); the third echelon of cities for Luzhou, Leshan, Meishan, Neijiang, Guang'an, Zigong and so on.

Table 6. City Logistics Competitiveness Score and Ranking

as suffix city name, means prefecture or county (area administered by a prefecture level city or county level city)	F1	F2	Composite score F	rankings
Chengdu	9.4242	-1.1111	6.73	1
Nanchong prefecture level city in Sichuan	0.7218	0.5855	0.64	2
Mianyang prefecture level city in north Sichuan, Sichuan's second city	0.8185	-0.372	0.53	3
Yibin prefecture level city in Sichuan	0.6064	-0.364	0.38	4
Dazhou prefecture level city in Sichuan	0.1416	0.6743	0.23	5
Liangshan Yi autonomous prefecture, Sichuan	-0.09	0.8639	0.1	6
Deyang prefecture level city in Sichuan	0.3059	-0.7216	0.09	7
Luzhou prefecture level city in Sichuan	-0.0986	0.0134	-0.07	8
Leshan prefecture level city in Sichuan	-0.2028	-0.5011	-0.24	9
Meishan prefecture level city in Sichuan	-0.6328	0.1571	-0.44	10
Neijiang prefecture level city in Sichuan	-0.6781	0.2423	-0.45	11
Guang'an prefecture level city in Sichuan	-0.799	0.426	-0.51	12
Zigong prefecture level city in Sichuan	-0.6493	-0.2793	-0.53	13
Guangyuan prefecture level city in Sichuan	-0.8125	0.2678	-0.55	14
Suining prefecture level city in Sichuan	-0.7861	0.0349	-0.57	15
Panzhihua prefecture level city in south Sichuan, bordering Yunnan, famous for steel production and pollution	-0.5723	-1.5196	-0.71	16
Bazhong prefecture level city in Shaanxi	-1.2008	0.8745	-0.72	17
Ya'an prefecture level city in Sichuan	-1.1581	-0.0753	-0.87	18
Ziyang prefecture level city in Sichuan	-1.3928	0.6197	-0.91	19
Garze or Kandze, Tibetan autonomous prefecture (Tibetan: dkar mdzes bod rigs rang skyong khul), formerly in Kham province of Tibet, present Sichuan	-1.4194	0.3987	-0.97	20
Aba Tibetan and Qiang prefecture, Sichuan	-1.5257	-0.0963	-1.14	21

Judged by the comprehensive score from the logistics competitiveness, the logistics competitiveness of the prefecture-level cities in Sichuan province has a large gap, the provincial capital city has a certain advantage, from the 21 sample cities selected in Sichuan province, the highest score of 6.73, while the lowest score of -1.14, before and after the gap is large; city logistics competitiveness score of less than 0 city has 14 cities, accounting for 66.67% of the total number of cities, indicating that the logistics industry of Sichuan province development is not balanced.

The logistics competitiveness evaluation of Nanchong and Mianyang is in the second and third place in Sichuan Province. Nanchong, as the second most populous prefecture-level city in Sichuan Province, with the top five economic level, has the advantage of being a regional logistics center by integrating three major modes of transportation, namely water, land and air transport, and has large-scale outward-oriented production capacity, which is supported by the comprehensive level of the economy to have a strong demand for consumption and brings about a huge driving effect. As one of the eight key sub-regional logistics centers in Sichuan Province, the construction of regional logistics centers in the provincial government's strong support, in recent years, the initial establishment of a more complete regional logistics network platform, so the logistics competitiveness is relatively strong; and Mianyang as the second largest city in Sichuan Province, is a secondary transportation hub city in northwestern Sichuan Province, the logistics infrastructure is more complete, the location advantage is obvious, by the provincial government as the "Sichuan Province". Mianyang, as the second largest city in Sichuan Province, is a sub-transportation hub city in the northwest of Sichuan Province, with perfect logistics infrastructure and obvious location advantages, and has been recognized by the provincial government as "the key development area of modern logistics industry in Sichuan Province", and has already established a certain scale of modern logistics network system, and has attached increasing importance to the logistics industry to form large-scale logistics enterprises with strong competitiveness, so its logistics competitiveness is more prominent compared with other regions.

And Aba, Ganzi, Ziyang, Ya'an, Bazhong and other regions due to the economic level compared to the poor, transportation facilities are not perfect, small area, low consumer demand leads to low demand for logistics, logistics development is not enough incentive, therefore, the logistics competitiveness of the weaker, can be centered in Chengdu, cooperation and synergistic development.

5. Conclusion and Recommendations

5.1. Conclusion

This paper constructs the evaluation index system of urban logistics competitiveness from three aspects, namely, economic level, logistics demand and logistics supply, and evaluates the logistics competitiveness of each prefecture-level city in Sichuan Province by using principal component analysis. The results show that the ranking of logistics competitiveness of prefecture-level cities in Sichuan Province is divided into three echelons, and Chengdu, as the capital city of the province, ranks first in logistics competitiveness and has a large gap with other regions. This paper analyzes the factors affecting the logistics competitiveness of the cities in Sichuan Province by using the results of principal component analysis. The results show that economic strength represented by GDP and total retail sales of consumer goods and logistics supply represented by highway mileage are the main factors affecting the logistics competitiveness of cities.

5.2. Recommendations

First of all, the government should rationally plan the development system of urban logistics in Sichuan Province. From the results of the analysis of the competitiveness of city logistics in Sichuan Province, it can be concluded that the province's logistics development in various regions is extremely unbalanced, the government should carry out rational planning for the development of the logistics system, consolidate the foundation of logistics development, for the strong competitiveness of the city, should give full play to its advantages, drive the province's logistics industry high-quality development, the various cities can make full use of its location to establish the second level of logistics hubs, the formation of a clear-cut hierarchical logistics framework system.

Secondly, the process of logistics informatization should be accelerated. It is necessary to continue to accelerate the improvement of the construction of a modern urban logistics network system, to further improve the construction of urban logistics infrastructure, to improve the level of logistics informatization in conjunction with technologies such as the Internet of Matters, blockchain and big data, and to adopt modern information technology and advanced logistics management techniques to promote the integration of existing resources and to support the rapid development of the modern logistics industry.

Finally, high-quality logistics talents should be actively cultivated. Efforts should be made to create an objective environment for the development of modern logistics and attract high-quality logistics talents. At the same time, we should strongly support the education of logistics industry-related professions, fully mobilize the enthusiasm of enterprises, colleges and universities and scientific research institutes, encourage school-enterprise cooperation in running schools, and strengthen school-enterprise cooperation, so as to enable the reserve talents to combine logistics theories and practices; at the same time, universities in major cities can also give full play to their scientific research capabilities and apply advanced technologies to enterprises. In addition, a policy environment of "flexible mobility" of talents has been created to actively attract high-level talents from home and abroad.

References

[1] JIN Fangfang, HUANG Zuqing, HU Chenxia. Evaluation and cluster analysis of logistics competitiveness in Yangtze River Delta city cluster[J]. Science and Technology Management Research, 2013, (9):183-187.

[2] Yue Qi. Evaluation of China's regional logistics development level based on logistics competitiveness[J]. Business and Economic Research,2019, (9):96-99.

[3] SONG Er-Xing, ZHOU Xiao-Wei. Evaluation of regional logistics competitiveness and its coordinated development in China [J]. Price Monthly, 2020(8):70-78.

[4] Sun Yan. Evaluation of urban logistics competitiveness in Shaanxi Province[J]. Journal of Economic Research, 2022(6): 26-28, 133.

[5] Jorg Ackermann,Egon Muller.Modeling,planning and designing of logistic st-ructures of regional competence-cellbased networks with structure types[J].Rob-oticsand Computer Integrated Manufacturing,2007(6):601-607.

[6] Rodrigo Alarcona,Juan Pablo Antuna,Angelica Lozanoa. Logistics competitive-ness in a megapolitan network of cities:a theoretical approach and some application in the Central Region of Mexico[J].Procedia-Social and Behavioral Sciences,2012(39):739-752.

[7] Witold Kwasnicki.Logistic growth of the global economy and competitiveness of nations[J].Technological Forecasting& Social Change, 2013(80):50-76.