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MEASUREMENT OF THE BALANCE OF LOGISTICS DEVELOPMENT AND ANALYSIS OF IMPROVEMENT STRATEGIES-BASED ON THE YANGTZE RIVER DELTA REGION

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Abstract: After over 30 years of development, logistics has become the most dynamic and vital modern service industry, and gradually become the pillar industry of national economy. In China, the Yangtze River Delta region is the most economically developed region, the highest degree of urban agglomeration, as well as the most developed area of express delivery, taking the lead to achieve full coverage of express outlets and towns. Therefore, studying the logistics development in the Yangtze River Delta region is of great practical significance to promote the vigorous development of China's logistics industry. In this paper, we take logistics balance region as the research object, select 11 indicators to form an evaluation system, use SPSS software for factor analysis, and then put forward countermeasures and suggestions to promote the coordinated development of logistics.
Keywords: Yangtze River; Delta region; Logistics; Develop balance

1 INTRODUCTION

As a basic, strategic and leading industry, logistics promotes the smooth development of China's circulation system, improves the level of modern industrial system, and provides an important guarantee for the new development pattern. Regional logistics is the foundation of the regional economy, so is the Yangtze River Delta region. This economically developed region provides the solid foundation for logistics, but the development of logistics amongdifferent regions is unbalanced, so it is of great significance to study the balance level of logistics development in the Yangtze River Delta region[1-3].

Recently, scholars' research on the balance of regional logistics development has been continuously updated and enriched: Wen Xiaoyu [6] studies the imbalance and agglomeration degree of the development of the logistics industry in six central provinces and regions, and concludes that the imbalance of the logistics industry in this region is prominent and the agglomeration degree of the logistics industry is not high [4]; Rao Shuwen uses the entropy weight-TOPSIS method to quantitatively evaluate the regional logistics capacity gap of the five cities in the Southwest Fujian Collaborative Development Zone in 2021 [9]. Li Hong and Xue Pengcheng deeply analyzes the coupling and coordination degree of Liaoning's logistics supply and demand system and put forward countermeasures [8]. Based on the above research, this paper establishes a reasonable evaluation index system, in order to measure the balance of logistics development in the Yangtze River Delta region and provide valuable suggestions.

2 CURRENT STATUS OF LOGISTICS DEVELOPMENT LEVEL IN THE YANGTZE RIVER DELTA REGION

The Yangtze River Delta regiontion advantage and convenient water transportation of modern port groups, and a huge aviation network is formed between various airports. It also has dense highway trunk lines and high-speed railways connecting various central cities form a complete three-dimensional transportation network. The region studied has 12 coastal inland po includes Shanghai, Jiangsu Province, Zhejiang Province and Anhui Province, which has a unique geographical locarts, more than 20 civil aviation airports, and over 10 major railway lines, forming a highly developed highway network, ranking at the forefront of the country in the construction of transportation infrastructure[5-7]. The region isclosely connected, and continues to increase investment in transportation infrastructure to jointly build the "Yangtze River Delta on the track". The Yangtze River Delta region completed a total investment of 85 billion yuan in 2019, aiming at further improving the region's railway network. It is expected that over 1,000 kilometers of new lines will open, ranking first in the field of rail transit in the country. By the end of 2022, the Yangtze River Delta had 13,749.7 kilometers of railway-related operating mileage and 6,704.4 kilometers of high-speed rail accounting for one-sixth of the country's total, as well as 10 billion tons of freight transport accounting for about one-fifth of the country's total. In addition, the storage facilities in the Yangtze River Delta region have a high degree of market maturity and a large total amount of warehousing, with a total of about 125 million square meters in the core five cities, namely Shanghai, Suzhou, Wuxi, Jiaxing and Hangzhou. The construction scale of the logistics park is huge, the number of logistics parks reaches 433, and a large number of private express delivery enterprise headquarters such as Santong Yida, Baishi, Debang, Suning, and Tiantian are gathered here, and the express headquarters economy is developed. There are 30 national logistics hub construction lists in 2023, of which 5 are from the Yangtze River Delta region. Meanwhile, the Yangtze River Delta region vigorously develops core industries such as 5G, artificial intelligence, and big data, and gives full play to the existing advantages of e-commerce platforms, big data core technologies, and Yangtze River Delta manufacturing networks.

3 INDICATOR CONSTRUCTION AND DATA SOURCES

This paper takes the balance of logistics development in the Yangtze River Delta region as the research object, covering four regions: Shanghai, Jiangsu, Zhejiang and Anhui. On the basis of existing literature, combining with the actual situation of logistics development in the Yangtze River Delta region, we select four first-level indicators: regional logistics development environment, regional logistics scale level, regional logistics capacity level and regional logistics infrastructure construction level [10]. We also construct 11 second-level indicators: per capita GDP, regional transportation industry and general public budget expenditure, etc. as an index evaluation system for the balanced level of regional logistics development, shown in Table 1.

Among them, the environmental indicators of regional logistics development include per capita GDP, general public budget expenditure of regional transportation industry, regional online retail sales and the number of regional ordinary colleges and universities; The indicators of regional logistics scale level include the number of regional postal outlets and the number of employees in the regional logistics industry; Indicators of the level of regional logistics capacity include regional postal business volume, regional cargo turnover and regional freight volume; The indicators of the level of regional logistics infrastructure construction include regional transportation land and the length of regional transportation routes [11].

Table 1 Evaluation indicators of the balance level of regional logistics development

Indicator type	The name of the pointer	Variable Code
Development environment of regional logistics	Per capita GDP	X1
	General Public budget expenditure of regional transportation industry	X2
	Regional network retail sales	X3
	The number of general institutions of higher learning in the region	X4

Regional logistics scale level	Number of regional postal outlets	X5
	Number of employees in regional logistics industry	X6
	Regional postal business volume	X7
Level of regional logistics capability	Regional turnover of goods	X8
	Regional freight volume	X9
Construction level of regional logistics infrastructure	Land for regional transportation	X10
	Length of regional transport lines	X11

The evaluation index data in this paper are all from the 2019-2022 China Statistical Yearbook, which represent the statistical values of each indicator in the study area from 2019 to 2022.

4 EMPIRICAL ANALYSIS

4.1 Kmo Test and Bartlett Spherical Test

Firstly, the KMO test is used to compare the simple correlation coefficient and partial correlation coefficient between the variables, and the Bartlett spherical test is used to test whether each variable is independent. The test results are shown in Table 2:

Table 2 KMO and Bartlett test

KMO and Bartlett test		
KMO sampling suitability quantity		0.643
	Approximately chi-squared	293.817
Bartlett, sphericity test	Degree of freedom	55
	Significance	<0.001

In this paper, SPSS27.0 software is used to perform the moderation test, and the results are shown in Table 4.1, the KMO value is 0.643, which is greater than 0.50, indicating that it meets the basic conditions required for factor analysis, and the Bartlett sphericity test shows that the correlation significance is less than 0.001, which is lower than the significance level of 0.05, which can be judged to meet the requirements of factor analysis.

4.2 Factor Analysis

With the help of SPSS27.0 software, this paper adopts factor analysis method to reflect most of the information of the original data with a few factors, so as to analyze the indicators for intuitive comprehensive ranking. Firstly, the principal component analysis method is used to extract the common factors according to the initial eigenvalues and variance contribution rates of each factor, and the results are shown in Table 3.

Table 3 Explanation of total variance

Explanation of total variance									
Ingredients	Initial eigenvalue			Extract the sum of squares of loads			Sum of squares of rotational loads		
	Total	Percentage of variance	Accumulation %	Total	Percentage of variance	Accumulation %	Total	Percentage of variance	Accumulation %
1	5.920	53.820	53.820	5.920	53.820	53.820	4.318	39.250	39.250
2	3.215	29.224	83.044	3.215	29.224	83.044	3.858	35.077	74.327
3	1.349	12.264	95.309	1.349	12.264	95.309	2.308	20.982	95.309
4	0.275	2.504	97.812						
5	0.117	1.068	98.880						
6	0.057	0.520	99.400						
7	0.038	0.343	99.743						
8	0.018	0.159	99.902						
9	0.006	0.055	99.957						
10	0.004	0.034	99.991						
11	0.001	0.009	100.000						

Note: Extraction method: principal component analysis

As can be seen from Table 3, there are three component factors with eigenvalues greater than 1, indicating that they have a high degree of interpretation of the indicators. Moreover, the cumulative variance contribution rate of these three common factors reaches 95.309%, indicating that the extracted factors could fully reflect the information represented by the 11 indicators selected in this paper. Therefore, the first three factors are selected as common factors to evaluate the balance level of regional logistics development, which are named F1, F2 and F3 respectively.

Considering that each factor is associated with multiple index variables, in order to better explain each factor, this paper chooses to use the maximum variance method to perform orthogonal rotation of the initial load matrix. The purpose of rotation is to make it easier to determine the factor attribution of the variables and then analyze the economic significance of each factor. The results of the rotated component matrix are shown in Table 4:

Table 4 Rotated composition matrix

The component matrix after rotationa			
	Ingredients		
	1	2	3
X1 Per capita gross domestic product	-0.289	0.925	0.165
X2 General Public budget expenditure of regional transportation industry	0.610	0.637	0.439
X3 Regional network retail sales	-0.017	0.414	0.893

X4 The number of general institutions of higher learning in the region	0.963	-0.057	-0.128
X5 Number of regional postal outlets	0.802	-0.128	0.532
X6 Number of employees in regional logistics industry	-0.084	0.963	0.091
X7 Regional postal business volume	-0.039	0.001	0.945
X8 Regional turnover of goods	-0.799	0.569	-0.058
X9 Regional freight volume	0.560	-0.810	-0.063
X10 Land for regional transportation	0.917	-0.275	-0.041
X11 Length of regional transport lines	0.701	-0.650	-0.282

Note: Extraction method: principal component analysis
Rotation method: Cäsar normalized maximum variance method
rotation converges after 5 iterations

From Table 4, it can be concluded that the number of ordinary colleges and universities in X4, the number of postal outlets in X5, the freight volume in X9, the transportation land in X10 and the length of transportation lines in X11 have the highest scores in the first factor F1. X1 per capita GDP, general public budget expenditure of the transportation industry in X2, employment in the logistics industry in X6 and cargo turnover in X8 have the highest scores in the second factor F2. Online retail sales in the X3 region and postal business in the X7 region scored the highest in the third factor, F3.

Next, the component score coefficient matrix is generated by SPSS software and the scores of each factor are calculated, and the component score matrix is shown in Table 5:

Table 5 Component scoring coefficient matrix

Component score coefficient matrix			
	Ingredients		
	1	2	3
X1 Per capita gross domestic product	0.048	0.277	-0.059
X2 General Public budget expenditure of regional transportation industry	0.245	0.263	0.046
X3 Regional network retail sales	-0.032	-0.014	0.397
X4 The number of general institutions of higher learning in the region	0.297	0.163	-0.160
X5 Number of regional postal outlets	0.166	-0.018	0.222

X6 Number of employees in regional logistics industry	0.125	0.340	-0.127
X7 Regional postal business volume	-0.112	-0.187	0.506
X8 Regional turnover of goods	-0.143	0.098	-0.054
X9 Regional freight volume	0.043	-0.207	0.062
X10 Land for regional transportation	0.238	0.054	-0.067
X11 Length of regional transport lines	0.136	-0.080	-0.100

Note: Extraction method: principal component analysis
Rotation method: Cäsar normalized maximum variance method
Component score

According to Table 4.4, the score function for the three factors can be written:

$F_1 = 0.048X_1 + 0.245X_2 - 0.032X_3 + 0.297X_4 + 0.166X_5 + 0.125X_6 - 0.112X_7 - 0.143X_8 + 0.043X_9 + 0.238X_{10} + 0.136X_{11}$ （1）

$F_2 = 0.277X_1 + 0.263X_2 - 0.014X_3 + 0.163X_4 - 0.018X_5 + 0.340X_6 - 0.187X_7 + 0.098X_8 - 0.207X_9 + 0.054X_{10} - 0.080X_{11}$ （2）

$F_3 =- 0.059X_1 + 0.046X_2 + 0.397X_3 - 0.160X_4 + 0.222X_5 - 0.127X_6 + 0.506X_7 - 0.054X_8 + 0.062X_9 - 0.067X_{10} - 0.100X_{11}$ （3）

The contribution rate of each factor in Table 2 is used as a weighted value to calculate the composite score of the three factors. The linear expressions of the three principal component factors can be expressed synthetically as:

$F = 0.4118F_1 + 0.3680F_2 + 0.2201F_3$ （4）

The final factor scores for each region are shown in Table 6:

Table 6 Factor scores by region

District and time	F1	F2	F3	F	Four-year averages
Shanghai 2022	-1.3590	0.8955	0.0321	-0.2230	-0.2603
Shanghai 2021	-1.2901	1.0127	0.0906	-0.1387	
Shanghai 2020	-1.4895	0.7816	-0.4784	-0.4311	
Shanghai 2019	-1.2428	1.0987	-0.6399	-0.2483	
Jiangsu 2022	1.5410	0.9878	-0.2379	0.9457	0.7872
Jiangsu 2021	1.4659	0.9423	-0.3980	0.8628	
Jiangsu 2020	1.2039	0.6489	-0.1883	0.6931	
Jiangsu 2019	1.0390	0.8356	-0.4011	0.6471	
Zhejiang 2022	0.5186	-0.1351	1.4862	0.4910	0.1885
Zhejiang 2021	0.2064	-0.2331	1.1082	0.2432	
Zhejiang 2020	-0.1858	-0.7852	2.0499	0.0857	
Zhejiang 2019	-0.3133	-0.7495	1.5394	-0.0660	

Anhui 2022	0.2423	-1.0586	-1.0155	-0.5133	
Anhui 2021	0.0480	-1.4115	-0.9683	-0.7128	-0.7154
Anhui 2020	0.0246	-1.3745	-0.9390	-0.7023	
Anhui 2019	-0.4091	-1.4556	-1.0399	-0.9330	

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

As shown in Table 4.5, the F-value of Jiangsu, Zhejiang and Anhui provinces increases year by year from 2019 to 2022, indicating that the level of logistics development has improved. Comparing the logistics development level of the Yangtze River Delta region, the four-year average score of its F value from high to low is: Jiangsu Province, Zhejiang Province, Shanghai City, and Anhui Province. The difference between the highest score and the lowest score is close to 1.5, indicating that the logistics development in the Yangtze River Delta region is quite different. From the above two points, it can be seen that there is a certain imbalance in the level of logistics development in the Yangtze River Delta region, and there are differences in logistics development between regions, which are analyzed as follows:

Analysis of the principal component factor F1: During the period from 2019 to 2022, the F1 values in Shanghai are all negative and don’t improve significantly. Conversely, Jiangsu Province has a positive F1 value for all four years, and in 2022, the difference in scores between the two is 2.9. As a municipality directly under the central government, Shanghai's land area is not as large as that of the other three provinces, so the transportation land area is small, the length of transportation lines is short, and the total freight volume is low.

Analysis of principal component factor F2: During the period from 2019 to 2022, the F2 values of Zhejiang Province and Anhui Province are negative, compared with Shanghai and Jiangsu Province, the number of employees in the logistics industry in Zhejiang Province and Anhui Province is low, but in the total number of people, the number of employees in the road transport industry, railway transportation industry and postal industry is the majority, indicating that the proportion of middle and low-level logistics talents in the two provinces is large, and it is difficult to adapt to modern and digital logistics. At the same time, the per capita GDP of the two provinces is also low, which often affects the consumption and shopping level of residents, and then affects the development of the logistics industry. Compared with Zhejiang Province, Anhui Province has the lowest F2 value, and its freight turnover is also the least among the three provinces and one city, indicating that its logistics operation efficiency and logistics service quality are still insufficient.

Analysis of the principal component factor F3: During the period from 2019 to 2022, the F3 values of Jiangsu Province and Anhui Province are negative, and compared with Shanghai and Zhejiang Province, the regional postal business volume of these two provinces is at a disadvantage, indicating that their investment in infrastructure construction is insufficient. At the same time, the online retail sales of Anhui Province are the least among the three provinces and one city, indicating that Anhui Province has not fully integrated online and offline, and there is still a certain gap compared with the information construction of other provinces and cities.

5.2 Recommendations

To sum up, this paper puts forward the following suggestions for the development of logistics level in the Yangtze River Delta region:

First of all, Shanghai should optimize the layout of the logistics and transportation network, strengthen the planning and management of the regional transportation network. It also should promote the organic connection of various modes of transportation, improve the infrastructure of railways, highways, waterways and other modes of transportation in addition to the improvement of the comprehensive transportation capacity and forming an efficient, convenient and integrated logistics and transportation system. At the same time, we should pay attention to inter-regional logistics cooperation, strengthen transportation links with surrounding areas and realize the coordinated development of regional logistics.

Secondly, Jiangsu Province and Anhui Province should strengthen logistics informatization and intelligence. With the development of information technology, logistics informatization and intelligence has become a development trend. Increase investment in information infrastructure, promote the construction of logistics information platform, improve the level of logistics information sharing. Meanwhile, promote the application of advanced technologies such as the Internet of Things, big data, artificial intelligence, etc., enhance the automation and intelligence level of logistics operations and improve logistics efficiency and reduce costs.

Thirdly, Zhejiang Province and Anhui Province should actively adjust the talent policy, attract more senior logistics talents, strengthen the integration of industry and education and school-enterprise cooperation, deepen the "industry-university-research" cooperation, and promote the construction of a Chinese-style modern logistics system with high-quality talent training, so as to serve Chinese modernization.

Finally, the Yangtze River Delta region should actively promote the development of green logistics according to local conditions, establish and improve the green standardization system of logistics, strengthen the formulation and implementation of environmental protection regulations, promote green packaging, energy conservation and emission reduction and other environmental protection measures, and reduce the impact of logistics activities on the environment.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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