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Research and Evaluation on Logistics Competitiveness of Inland Node Cities Based on "One Belt and One Road"

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Abstract: The ten important node cities of "One Belt & One Road" were studied on their logistics competitiveness. The evaluation indicator system is established in this article, based on capacities of economic development, demand and environment of each city. By analyzing the principal components in competitiveness, those node cities are divided into three classes. According to this, the author also puts forward suggestions and countermeasures for the logistics development at the end of this paper.

Keywords Logistics competitiveness; B & R inland node city; Principal component analysis

INTRODUCTION

In 2013, the Silk Road Economic Belt and the 21st Century Maritime Silk Road strategy ("B & R" as follows) were proposed. Subsequently, the National Development and the Reform Commission, the Ministry of Foreign Affairs and the Ministry of Commerce jointly issued *Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road*, and proposed Xi'an, Lanzhou, Xining, Chongqing, Chengdu, Zhengzhou, Wuhan, Changsha, Nanchang and Hefei to be important node cities in inland areas in 2015 [Qin at al., 2015].

However, logistics in node cities is facing many problems. Firstly, there is a huge gap between the city traffic systems. Changsha, Wuhan, Chengdu and Chongqing are transportation centers with better economic development, while Lanzhou, Xining are lagging behind in economic development, in which logistics industry also starts late. Secondly, the cost of logistics is considerable. On the one hand, node cities of "B&R" are located in the Midwest areas, far away from the eastern seaports, so long-distanced highway transportation is necessary, which causes high transportation costs; on the other hand, the logistics facilities are not impeccable and the logistics operation is not standardized either, resulting in high cost of logistics too. Thirdly, government investment on node cities is small and limited for logistics park. These problems have restricted the implementation of "B&R", therefore it is also important to enhance the competitiveness of the logistics in node cities.

In recent years, domestic scholars have made great progress in the logistics competitiveness, which is mainly manifested in two aspects: Firstly, logistics competitiveness in different cities, provinces and regions have been studied by different scholars and experts. Jia and Xu have studied Yangtze River Delta region [Jia at al., 2013], and Mu et al. have studied the urban agglomeration in Northwest [Mu et al., 2015]. Liu and Si have studied Changsha-Zhuzhou-Xiangtan urban agglomeration rim and made a comparative analysis [Liu at al., 2015], and Sun has researched logistics industrial cluster in Zhengzhou [Sun at al., 2013]. What's more, Chen has researched logistics competitiveness of Chengdu urban areas [Chen at al., 2014]. Furthermore, Huang has studied Boyang lake ecological economic zone [Huang at al., 2015]. Secondly, a variety of methods have been used to study the competitiveness of logistics. Jia et al. have used intuitive fuzzy analytic hierarchy process (IFAHP) [Jia at al., 2015], and Yan and Wang have applied factor analysis [Yan at al., 2013]. Xu et al. have tried entropy method/double base point method [Xu at al., 2015], and Tang and Zeng have used fuzzy matter element model [Tang at al., 2015]. Meanwhile, Li and Xue have used fuzzy analysis [Li at al., 2010].

Considering that "B & R" strategy is still at the initial stage of implementation and the study of node cities logistics competitiveness is scarce and inadequate, the ten node cities, which are Xi'an, Lanzhou, Xining, Chongqing, Chengdu, Zhengzhou, Wuhan, Nanchang, Hefei and Changsha, were considered as the research objects in this article. By using principal component analysis method, the author is to study on the evaluation of logistics competitiveness so as to provide a reference for the logistics development.

PRINCIPAL COMPONENT ANALYSIS(*PCA*)

Concept of *PCA*

Principal component analysis (*PCA*) is a multivariate statistical analysis method, which is applied in assistance of the dimension reduction method to convey the majority of indicators into a

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few irrelevant indexes, and the few indexes can reflect the original information [Yang, 2012].

Theory of *PCA*

Supposed that there are *p*(*p* as number) indexes in the problems we want to study, recorded as *p* random variables, denoted by $X_1, X_2, X_3, ..., X_p$, then the indexes are shown and transformed in the way of linear equations, to obtain new index(principal component) credited by $F_1, F_2, F_3, ..., F_p$. The linear equations are as follows:

$$F_1 = a_{11}X_1 + a_{12}X_2 + a_{13}X_3 + ... + a_{1p}X_p$$
$$F_2 = a_{21}X_1 + a_{22}X_2 + a_{23}X_3 + ... + a_{2p}X_p$$
$$F_3 = a_{31}X_1 + a_{32}X_2 + a_{33}X_3 + ... + a_{3p}X_p$$
$$\cdots$$
$$F_p = a_{p1}X_1 + a_{p2}X_2 + a_{p3}X_3 + ... + a_{pp}X_p$$

If the equation is tenable, the following conditions should be needed:

(1)Coefficient matrix *A* is orthogonal matrix, the sum of square of coefficient of each principal component should be 1：

$$a_{11}^2 + a_{12}^2 + a_{13}^2 + ... + a_{1p}^2 = 1$$

(2)Principal components are independent mutually：

$$Cov(F_i, F_j) = 0, i \neq j, i = 1,2,3,...,n; j = 1,2,3,..., p$$

(3)The variance of principal components are in descending order, that is, its importance is in descending order：

$$Var(F_1) \geq Var(F_2) \geq Var(F_3) \geq ... \geq Var(F_p)$$

Non-dimensional Quantities of Raw Data

Matrix *X*, which is composed by *n*(*n* as number) samples of the original *p* dimensional random variables, is getting standardized to obtain matrix *Z*. The formula is as follows:

$$Z_{ij} = \frac{x_{ij} - \overline{x_j}}{s_j}$$

$$X = x_{ij}, Z = z_{ij}, i = 1,2,3...,n; j = 1,2,3,..., p$$

Using Non-dimensional Data Matrix to Get the Correlation Matrix *R*

$$R = \frac{Y^T Y}{n-1}$$

Calculating Characteristic Values and Characteristic Vectors of Correlation Coefficient Matrix *R*

$$\left| R - \lambda I_p \right| = 0$$

Calculating values λ_i , and corresponding characteristic vectors $L_i = (L_{i1}, L_{i2}, L_{i3}, ..., L_{ip})$.

Calculating Ratio of Variance to Deduce the Number of Principal Components

The established data of principal components shall satisfy the following conditions:

(1)The eigen-value should be equal to or greater than 1:

$$\lambda_1, \lambda_2, \lambda_3, ..., \lambda_p \geq 1$$

(2)Cumulative ratio of variance is equal to or greater than 85%:

$$\frac{\sum_{j=1}^{m} \lambda_j}{\sum_{j=1}^{p} \lambda_j} \geq 85\%$$

Calculating Comprehensive Score of Principal Components (*F*) and Getting Scores Ranked

(1)Calculating linear weighted value of each principal component:

$$F_i = l_{i1}Z_1 + l_{i2}Z_2 + l_{i3}Z_3 + ... + l_{ip}Z_P$$

(2)Calculating weighted sum of each principal component：

$$F = \frac{\sum_{j=1}^{m} \lambda_j}{\sum_{j=1}^{p} \lambda_j F_i}$$

EVALUATION INDICATOR SYSTEM OF LOGISTICS COMPETITIVENESS IN "B & R" NODE CITIES

An in-depth research on logistics competitiveness can not be separated from the study on environment for economic and logistics development, and "B & R" strategy emphasizes as well that the logistics should act as a hub to link other main industries in cities, and if a comprehensive logistics system is to set up, it is also necessary to conduct research on the demand of logistics. Meanwhile, in this article, the evaluation index system has been established with the principle of systematic, scientific, comparability and moderate quantity (shown in Table 1). Three second-grade indicators are established, i.e. economic development capacity, demand capacity and environmental capacity. And the author also decomposes second grade indicators to 12 third-grade indicators, which are regional GDP(*X1*),gross output value of agriculture, forestry, animal husbandry and fishery(*X2*),value added of industrial enterprises above state designated scale(*X3*),total export (*X4*), total social retail sales(*X5*), total output of architecture industry (*X6*), volume of freight traffic (*X7*), volume of cargo turnover(*X8*), total volume of postal service (*X9*), quantity of colleges (*X10*), number of college graduates(*X11*) and number of employees engaged in transportation, storage and postal industry (*X12*).

Table 1. Logistics Competitiveness Evaluation System

First Level Indicator	Second Level Indicator	Third Level Indicator
The evaluation of logistics competitiveness evaluation index based on node cities development capacity	Economic development capacity	Regional GDP(100 million)*X1*
		Gross output value of agriculture, forestry, animal husbandry and fishery (100 million)*X2*
		Value added of industrial enterprises above state designated scale (100 million)*X3*
		Total export (100 million dollar)*X4*
		Total social retail sales (100 million)*X5*
	Demand capacity	Total output of architecture industry (10 thousand)*X6*
		Volume of freight traffic (100 ton)*X7*
		Volume of cargo turnover (10 thousand ton kilometer)*X8*
		Total volume of postal service (10 thousand)*X9*
	Environmental capacity	Quantity of colleges(number)*X10*
		Number of college graduates(10 thousand persons)*X11*
		Number of employees engaged in transportation, storage and postal industry (number)*X12*

ANALYSIS AND EVALUATION OF LOGISTICS COMPETITIVENESS OF NODE CITIES

Data Sources

Inland node cities of "B & R" include Xi'an, Lanzhou, Xining, Chongqing, Chengdu, Zhengzhou, Wuhan, Nanchang, Hefei and Changsha. The statistics made in this article is based on twelve evaluation indexes, and all data concerned are taken from *Chinese Statistical Yearbook of 2013 and 2014*.

The Principal Component Analysis of Urban Logistics Competitiveness

Analyzed by SPSS 19.0, it can be seen in Table 2 that Accumulated Variance Contribution Rate of the first three common factors is as high as 90.05% and eigen-values are all greater than 1, which indicates that the first three common factors can reflect the information conveyed by all those 12 common factors.

Table 2. Explained the Total Variance

Component	Initial eigen-values			Extracting sum of squares and loading		
	Total	% of variance	% of cumulative	Total	% of variance	% of cumulative
1	7.67	63.9	63.9	7.67	63.9	63.9
2	2.005	16.7	80.6	2.005	16.7	80.6
3	1.134	9.45	90.05	1.134	9.45	90.05
4	0.478	3.98	94.03			
5	0.326	2.72	96.75			
6	0.256	2.14	98.89			
7	0.069	0.58	99.47			
8	0.041	0.33	99.8			
9	0.022	0.20	100.0			
10	.000	.000	100.0			
11	.000	.000	100.0			
12	.000	.000	100.0			

Component matrix (Table 3) and component score coefficient matrix (Table 4) can also be obtained by using SPSS19.0.

We can see from Table 3, the first principal component (F_1) can express information of regional GDP(*X1*),gross output value of agriculture, forestry, animal husbandry and fishery (*X2*), value added of industrial enterprises above state designated scale (*X3*), total export (*X4*), total social retail sales(*X5*), total output of architecture industry (*X6*), volume of freight traffic (*X7*), volume of cargo turnover(*X8*), total volume of postal service (*X9*) and quantity of colleges (*X10*), so which can be named as foundation capacity; while the second principal component (F_2) can express information of number of college graduates(*X11*), so which can be named as talent capacity; at last, the third principal component (F_3)can express information of number of employees engaged in transportation, storage and postal industry (*X12*),so which can be named as environmental capacity.

Table 3. Component Matrix

	Component		
	1	2	3
X1	0.973	0.033	0.154
X2	0.914	-0.189	-0.067
X3	0.442	0.577	0.644
X4	0.856	-0.354	0.186
X5	0.933	-0.03	-0.291
X6	0.933	0.249	0.099
X7	0.929	-0.14	-0.186
X8	0.668	0.021	-0.618
X9	0.892	-0.144	0.128
X10	0.824	0.523	0.05
X11	0.186	0.892	-0.288
X12	0.632	-0.58	0.208

Table 4. Component Score Coefficient Matrix

	Component		
	1	2	3
Z_{x1}	0.127	0.016	0.136
Z_{x2}	0.119	-0.095	-0.06
Z_{x3}	0.058	0.288	0.568
Z_{x4}	0.112	-0.177	0.164
Z_{x5}	0.122	-0.015	-0.257
Z_{x6}	0.122	0.124	0.087
Z_{x7}	0.121	-0.07	-0.164
Z_{x8}	0.087	0.011	-0.545
Z_{x9}	0.116	-0.072	0.113
Z_{x10}	0.107	0.261	0.044
Z_{x11}	0.024	0.445	-0.254
Z_{x12}	0.082	-0.289	0.184

According to component score coefficient matrix, the scoring formula of the principal component can be calculated, as is shown below:

$$F_1 = 0.127Z_{x1} + 0.119Z_{x2} + 0.058Z_{x3} + 0.112Z_{x4} + 0.122Z_{x5} + 0.122Z_{x6} + 0.121Z_{x7} + 0.087Z_{x8} + 0.116Z_{x9} + 0.107Z_{x10} + 0.024Z_{x11} + 0.082Z_{x12}$$

$$F_2 = 0.016Z_{x1} - 0.095Z_{x2} + 0.288Z_{x3} - 0.177Z_{x4} - 0.015Z_{x5} + 0.124Z_{x6} - 0.07Z_{x7} + 0.011Z_{x8} - 0.072Z_{x9} + 0.261Z_{x10} + 0.445Z_{x11} - 0.289Z_{x12}$$

$$F_3 = 0.136Z_{x1} - 0.06Z_{x2} + 0.568Z_{x3} + 0.164Z_{x4} - 0.257Z_{x5} + 0.087Z_{x6} - 0.164Z_{x7} - 0.5454Z_{x8} + 0.113Z_{x9} + 0.044Z_{x10} - 0.254Z_{x11} - 0.184Z_{x12}$$

According to principal component of score results, the synthesis score can be calculated, as is shown below:

$$F = 0.6391575F_1 + 0.16707F_2 + 0.09448F_3$$

As is seen from result, based on the first principal component(F_1) , the top three cities are Chongqing, Wuhan and Chengdu, because of their strong economic strength and a large number of colleges and universities; and based on the second principal component (F_2), Wuhan, Zhengzhou, and Changsha rank as the top three cities, owing to a large number of college graduates, providing the development of logistics quantities of talents and professionals; Chengdu, Zhengzhou and Changsha, based on the third principal component (F_3), win the top three places, for more people engaged in the logistics related industries. And Chongqing ranks in the first place according to its comprehensive scores, followed by Wuhan and Chengdu as the second and third place. Furthermore, based on the comprehensive score ranking, the author divides the ten node cities of “B & R” into 3 classes, as is shown in Fig.1:

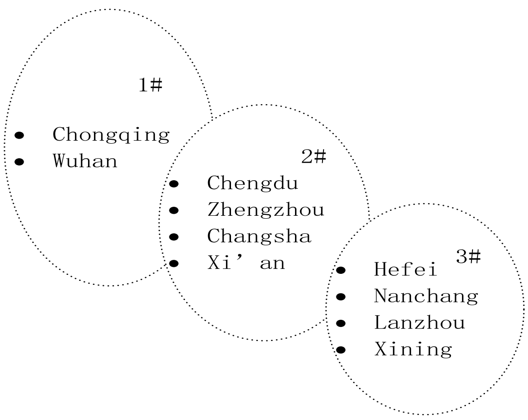

Fig.1. The Classification of the Inland Node Cities

Through the above analysis, we can see that based on the urban logistics competitiveness levels, Chongqing and Wuhan are in the first class, characterized by advanced economic development, large logistics demand, good logistics development environment and superiority of talents; Chengdu, Zhengzhou, Changsha, and Xi’an are in the second class, characterized by rapid economic development and potential of the logistics industry; in the end, Hefei, Nanchang, Lanzhou and Xining are in the third class for their relatively slow economic development and imperfect logistics infrastructure, which also leads to a relatively high logistics cost and shortage of logistics related employees.

LOGISTICS DEVELOPMENT SUGGESTIONS FOR NODE CITIES

On account of the comprehensive ranking of the logistics competitiveness and the specific problems the ten cities are faced with, suggestions are put forward in this article on how to improve their logistics competitiveness.

Completing Road Traffic in Inland Areas

Transportation is important to city's economy and logistics. Since the level of road traffic is different among the inland cities, government should increase its financial budget on road traffic, accelerate the construction of road traffic system as well as highway and railway, and also strengthen the road carrying capacity. Regulations also should be issued to ensure the orderly operation of the road traffic system.

Constructing Logistics Standardization System

Logistics standardization is the foundation and core of the construction of modern logistics, which determines the logistics costs cut-down and logistics efficiency increase [Han, 2004]. Therefore, it's urgent and vital to speed up the construction of logistics standardization of those node cities at present. Node cities should combine logistics standardization with their own characteristics to establish and improve their local and characteristic logistics standardization system, with expectations to extend to wider areas.

Recruiting and Training Logistics Professionals

Talents and professionals are the core of local logistics industry. The government should actively recruit logistics professionals, including senior logistics management personnel, college graduates and technical personnel.

CONCLUSION

Urban logistics competitiveness mainly depends on its economic development capacity, demand capacity and environmental capacity. Based on the three aspects above, an index system was proposed to evaluate "B & R" node cities logistics competitiveness. Suggestions were put forward for logistics development, as to provide a reference for logistics development in those cities.

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