Evaluation System of High-quality Development of Cities in the Yangtze River Economic Belt under the New Development Pattern

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Abstract: In view of the high-quality development of cities in the Yangtze River Economic Belt, and in combination with the characteristics of the new development pattern, this paper constructs the evaluation index system of high-quality development of cities in the Yangtze River Economic Belt from five aspects which contain innovative development, coordinated development, green development, open development, and shared development. Firstly, this paper constructs the evaluation model of the high-quality development of the cities in the Yangtze River Economic Belt. Secondly, the paper uses the analytic hierarchy process to determine the weight of the indicators. Thirdly, the paper uses the fuzzy comprehensive evaluation method to establish the evaluation set of the indicators. Finally, it concludes that the high-quality development level of the cities in the Yangtze River Economic Belt is at the middle level.

Key word: The new development pattern; high quality development; evaluation.

1. Introduction

On May 14, 2020, at the meeting of the Standing Committee of the Political Bureau of the CPC Central Committee, the strategic idea of building a new development pattern of domestic and international double circulation and mutual promotion was put forward for the first time. High quality development is the endogenous driving force for building a new pattern of dual cycle development at home and abroad. Cities in the Yangtze River Economic Belt have unique transportation advantages. They need to make due contributions to the promotion of domestic and international double cycle development pattern with high-quality as the theme. Therefore, it is of great significance to build a high-quality development evaluation system for cities in the Yangtze River Economic Belt to promote the economic and social development of cities in the Yangtze River Economic Belt

2. Literature Review

In recent years, more and more scholars have focused on issues related to high-quality development. Jinchang Li believed that the evaluation index system of China's high-quality development was composed of five first-level indicators which contained economic vitality, innovation efficiency, green development, people's life, social harmony and 27 second-level indicators which contained GDP growth rate, total factor productivity, air quality index [1]. Ning Jiang believed that the evaluation index system of high-quality development of national new areas was composed of 7 first-level indicators, including quality and benefit, integration of industry and city, opening up, reform and innovation, regional coordination, green development and regional charm, and 33 second-level indicators, including tax ratio, population density and foreign exchanges [2]. Ling Xin believed that the evaluation system of high quality agricultural development in our country included 4 first-level indexes, which were green development leadership, supply quality and efficiency improvement, scale production and industry diversity integration, 8 second-level indexes such as resource utilization level, improvement of production quality and improvement of intensive scale, and 22 third-level indexes such as fertilizer application intensity, the yield proportion of green products and land intensification index [3]. Mingshun Song believed that the evaluation index system of economic development quality includes 4 first-level indicators, namely market quality, people's livelihood quality, environmental quality and shared quality, and 16 second-level indicators, such as the qualified rate of random inspection of products, urbanization rate and per capita energy consumption [4]. Junhui Han believed that the evaluation index system of high-quality development included 4 first-level indicators of production link, distribution link, exchange link and consumption link, as well as 23 second-level indicators such as the comprehensive utilization rate of industrial

solid waste, the growth rate ratio of urban and rural residents' disposable income, and the per capita proportion of urban consumption of education, culture and entertainment [5]. Ru Ma believed the evaluation system of high-quality development of China's regional economy included 5 first-level indicators, namely opening to the outside world, high-quality supply, development efficiency, high-quality demand, and economic operation, and 28 second-level indicators, including the number of patents granted by 10,000 people for invention, the ratio of internal expenditure of R&D funds between enterprise funds and government funds, and per capita expenditure of residents on education, culture and entertainment [6]. Xiaoxue Chen believed that the evaluation system of high-quality social and economic development was composed of six first-level indicators, namely innovation, opening up, coordination, green, effective and sharing, and 34 second-level indicators, such as the transaction volume of technology market, the degree of population aging, and per capita forest area [7]. Yongbing Xu believed that the high-quality development indicator system of Hebei Province was composed of 6 first-level indicators, namely innovation-driven, structural optimization, economic stability, economic vitality, improvement of people's livelihood and ecological friendliness, and 24 second-level indicators, such as the proportion of local financial science and technology appropriations in local financial payments, final consumption rate and inflation rate [8]. Lixia Liu believed that the evaluation system of high-quality economic development in western provinces included 5 first-level indicators, such as the degree of imbalance and inadequacy, resource consumption rate, new driving force, stability of economic growth and better life, and 16 second-level indicators, such as urbanization rate, elasticity coefficient of electricity consumption and proportion of tertiary industry [9]. Ji Zhou believed that the evaluation system of high-quality inter-provincial development included 6 first-level indicators, such as structural coordination, innovation-driven development, economic development, development and upgrading, achievement sharing and ecological civilization, as well as 32 second-level indicators, such as per capita power consumption, urban ratio and number of R&D personnel, and makes an empirical analysis by taking Jiangxi Province as an example [10]. Chuanghai Xu believed the evaluation system for the high-quality development of large state-owned oil and gas enterprises includes 6 first-level indexes, including structural optimization, innovation-driven, development basis, business development, oil and gas supply and factor efficiency, 16 second-level indexes, including oil and gas reserves, product structure and innovation input, and 34 third-level indexes, such as the growth rate of economic recoverable reserves of natural gas, the growth rate of ethylene production capacity, and the intensity of R&D personnel input [11].

To sum up, most scholars construct the evaluation index system of high-quality development from the national level or the perspective of the industry, while a few scholars conduct relevant research based on the actual situation of a certain province or a certain enterprise. On the basis of summarizing the previous research experience and combining with the characteristics of the economic development of cities in the Yangtze River Economic Belt, the author constructs a high-quality development evaluation system for cities in the Yangtze River Economic Belt.

3. Construction of the High-quality Development Evaluation System for Cites in the Yangtze River Economic Belt Based on AHP

The Analytic Hierarchy Process is a method combining qualitative analysis and quantitative analysis proposed by T. L. Saaty, an American operational research scientist, in the early 1970s [12]. The main steps of analytic hierarchy process include constructing hierarchical structure model, constructing comparative discriminant matrix and consistency test.

3.1 Construct the Hierarchical Model

Based on the relevant literature of domestic high-quality development index system, the author constructs the initial hierarchical structure model of the high-quality development evaluation system for cities in the Yangtze River Economic Belt. According to the initial model, the author consulted the advice of experts in related fields and made appropriate adjustments to obtain the final hierarchical structure model, as shown in Figure 1.

As can be seen from Figure 1, the evaluation system of the high-quality development evaluation system for cities in the Yangtze River Economic Belt(S) consists of five first-level indicators, including innovative development(A), coordinated development(B), green development(C), open development(D) and shared development(E), and 15 second-level indicators, namely, transformation of scientific and technological achievements(A1), high-level talents(A2), high-tech investment(A3), coordinated development between urban and rural areas(B1), coordinated development between industries(B2), coordinated development of economy and culture(B3), urban greening(C1), sewage treatment(C2), air quality(C3), foreign investment(D1), labor export(D2), cultural exchange(D3), mass cultural services(E1), medical services(E2), and public library services(E3).

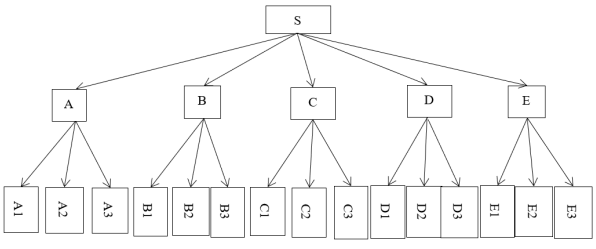

Figure 1. The hierarchical model of the high-quality development evaluation system for cities in the Yangtze River Economic Belt

3.2 Construct Comparative Discriminant Matrix and Consistency test

Comparative discriminant matrix is used to judge the degree of importance between two elements in the same level. The comparison discriminant matrix of this paper adopts 1-9 scale method. For two elements, 1 means equally important. For two elements, 3 means slightly important. For two elements, 5 means obviously important. For two elements, 7 means extremely important. For two elements, 9 means strongly important. 2, 4, 6 and 8 respectively represent the intermediate values between 1, 3, 5, 7 and 9.

According to the hierarchical model of the evaluation system of the high-quality development evaluation system for cities in the Yangtze River Economic Belt, the author made relevant questionnaires and distributed them to experts in related fields. Based on the questionnaire data, the comparative discriminant matrix of the hierarchical structure model is obtained, as shown in Table 1 to Table 6.

Table 1. The comparative discriminant matrix of S

	A	B	C	D	E
A	1.0000	0.2500	0.5000	0.5000	3.0000
B	4.0000	1.0000	3.0000	3.0000	4.0000
C	2.0000	0.3333	1.0000	1.0000	3.0000
D	0.3333	0.2500	0.3333	1.0000	0.3333
E	2.0000	0.3333	1.0000	3.0000	1.0000

Table 2. The comparative discriminant matrix of A

	A1	A2	A3
A1	1.0000	4.0000	3.0000
A2	0.2500	1.0000	0.3333
A3	0.3333	3.0000	1.0000

Table 3. The comparative discriminant matrix of B

	B1	B2	B3
B1	1.0000	2.0000	5.0000
B2	0.5000	1.0000	4.0000
B3	0.2000	0.2500	1.0000

Table 4. The comparative discriminant matrix of C

	C1	C2	C3
C1	1.0000	0.3333	0.2000
C2	3.0000	1.0000	0.3333
C3	5.0000	3.0000	1.0000

Table 5. The comparative discriminant matrix of D

	D1	D2	D3
D1	1.0000	3.0000	0.3333
D2	0.3333	1.0000	0.1667
D3	3.0000	6.0000	1.0000

Table 6. The comparative discriminant matrix of E

	E1	E2	E3
E1	1.0000	0.2000	4.0000
E2	5.0000	1.0000	8.0000
E3	0.2500	0.1250	1.0000

Consistency test is to check whether the importance of each element has a certain logical rule in the comparison discriminant matrix [13].

The consistency test includes 2 steps. Firstly, the maximum eigenvalue(λmax) of the comparison discriminant matrix is calculated. Secondly, the consistency index(CI) is calculated. When n is the order of the comparison discriminant matrix, $CI=\frac{\lambda_{max}-n}{n-1}$. Thirdly, the consistency ratio(CR) is calculated. $CR=\frac{CI}{RI}$, RI is a consistency indicator. When CR<0.1, it means that the consistency of the comparison discriminant matrix passes the test.

In the comparison discriminant matrix of S, λmax=5.1566, CI= 0.0392, CR= 0.0349<0.1, pass the consistency test. In the comparison discriminant matrix of A, λmax=3.0735, CI= 0.0368, CR=0.0707<0.1, pass the consistency test. In the comparison discriminant matrix of B, λmax=3.0246, CI= 0.0123, CR= 0.0236<0.1, pass the consistency test. In the comparison discriminant matrix of C, λmax=3.0385, CI= 0.0193, CR= 0.0370<0.1, pass the consistency test. In the comparison discriminant matrix of D, λmax=3.0183, CI= 0.0092, CR= 0.0176 <0.1, pass the consistency test. In the comparison discriminant matrix of E, λmax=3.0940, CI=0.0470, CR= 0.0904<0.1, pass the consistency test.

4. The Empirical Analysis of the High-quality Development Evaluation System for Cites in the Yangtze River Economic Belt Based on FCE

Fuzzy Comprehensive Evaluation is a method to quantitatively analyze some factors with unclear boundaries and obtain clear judgment with the help of fuzzy mathematics theory [14]. Fuzzy comprehensive evaluation can be divided into the following steps. Firstly, determine the index set. Secondly, determine the weight of evaluation indicators. Thirdly, set up a set of comments. Fourthly, establish the evaluation membership matrix. Fifthly, make a comprehensive evaluation.

4.1 Establishment of Evaluation Index and Weight

According to the hierarchical model of the high-quality development evaluation system for cities in the Yangtze River Economic Belt, the author established the fuzzy comprehensive evaluation index system of the high-quality development for cities in the Yangtze River Economic Belt.

According to Table 1 to Table 6, the weight of each element in the comparative discrimination matrix is calculated, namely, the weight of the fuzzy comprehensive evaluation index of high-quality development for cities in the Yangtze River Economic Belt.

In the comparative discriminant matrix of S, its weight is $(0.1189\ \ 0.4450\ \ 0.1850\ \ 0.0660\ \ 0.1850)$ .In the comparative discriminant matrix of A, its weight is $(0.6144\ \ 0.1172\ \ 0.2684)$. In the comparative discriminant matrix of B, its weight is $(0.5694\ \ 0.3331\ \ 0.0974)$. In the comparative discriminant matrix of C, its weight is $(0.1047\ \ 0.2583\ \ 0.6370)$. In the comparative discriminant matrix of D, its weight is $(0.2499\ \ 0.0953\ \ 0.6548)$. In the comparative discriminant matrix of E, its weight is $(0.1991\ \ 0.7334\ \ 0.0675)$.

4.2 Questionnaire Production and Data Analysis

In the process of questionnaire design, the author determined the set of comments V5={excellent, good, medium, fair, poor}, and drew on the experience and methods of other scholars on questionnaire design, and divided the questionnaire into two parts. The first part included the basic situation of the surveyed people. In the second part, the problems are divided into four groups according to four types which contained innovative development, coordinated development, green development, open development and shared development. The author collected questionnaires by means of network distribution and field distribution, and received 150 valid questionnaires. The basic information of the surveyed population is as follows. 4.67% of the students with a college degree or below, 40.00% of undergraduates and 55.33% of postgraduates. Male respondents accounted for 54.00%, and female respondents accounted for 46.00%. Those working in agriculture accounted for 4.67%, those working in industry accounted for 7.33% and those working in service industry accounted for 88.00%.

Reliability refers to the consistency or stability of measurement results, which indicates whether the questionnaire data can better reflect the actual situation. Therefore, it is necessary to conduct reliability test on the questionnaire data. Cronbach'sαcoefficient was used to reflect the internal consistency of each second-level index under each first-level index. 0<Cronbach's α coefficient <1. The larger the Cronbach'sαcoefficient, the higher the reliability of the questionnaire data. When Cronbach's α coefficient < 0.5, the reliability of the questionnaire data is poor. When 0.5$\leqslant$Cronbach's αcoefficient < 0.6, the reliability of the questionnaire data is acceptable. When 0.6$\leqslant$Cronbach's αcoefficient < 0.7, the reliability of the questionnaire data is good. When 0.7$\leqslant$Cronbach's α coefficient < 0.8, the reliability of the questionnaire data is high. When 0.8$\leqslant$Cronbach's αcoefficient < 0.9, the reliability of the questionnaire data is very high. When Cronbach's α coefficient is $\geqslant$ 0.9, the reliability of questionnaire data is very good [15].

In this paper, SPSS software was used to test the reliability of the questionnaire data, and Cronbach's α values of each first-level index were shown in Table 7.

Table 7. Cronbach's α values of each first-level index

variable name	quantity	Cronbach's α
innovative development	3	0.871
harmonious development	3	0.896
green development	3	0.852
open development	3	0.851
shared development	3	0.830

As can be seen from Table 7, Cronbach's αvalue of innovative development is 0.871. The Cronbach's αvalue of coordinated development is 0.896. The Cronbach's α value of green development is 0.852. The Cronbach's α value of open development is 0.851. The Cronbach's α value of shared development is 0.830. To sum up, Cronbach's αvalues of all indicators are greater than 0.8, indicating high reliability of questionnaire data.

The author processed the questionnaire data to obtain the fuzzy evaluation set of each element, as shown in Table 8.

Table 8. Fuzzy evaluation set of the high-quality development for cities in the Yangtze River Economic Belt

Target layer	criterion layer		object layer	set of evaluation					
S	first-level index	weight	second-level index	weight	excellent	good	medium	fair	poor
	A	0.1189	A1	0.6144	0.1133	0.2467	0.5400	0.0600	0.0400
			A2	0.11	0.1267	0.40	0.380	0.04	0.04

				72		67	0	67	00
			A3	0.26 84	0.0867	0.35 33	0.4200	0.0800	0.0600
	B	0.4450	B1	0.56 94	0.0867	0.30 00	0.4667	0.1200	0.0267
			B2	0.33 31	0.0600	0.28 67	0.5267	0.0733	0.0533
			B3	0.09 74	0.0733	0.31 33	0.4800	0.0933	0.0400
	C	0.1850	C1	0.10 47	0.1667	0.44 00	0.2733	0.0933	0.0267
			C2	0.25 83	0.0800	0.24 67	0.3933	0.2200	0.0600
			C3	0.63 70	0.0800	0.18 67	0.4267	0.2200	0.0867
	D	0.0660	D1	0.24 99	0.1000	0.25 33	0.5067	0.1067	0.0333
			D2	0.09 53	0.0933	0.24 00	0.5733	0.0733	0.0200
			D3	0.65 48	0.1000	0.34 00	0.4667	0.0667	0.0267
	E	0.1850	E1	0.19 91	0.1267	0.26 67	0.4933	0.0800	0.0333
			E2	0.73 34	0.1200	0.28 67	0.4467	0.1000	0.0467
			E3	0.06 75	0.1400	0.35 33	0.4267	0.0733	0.0067

According to Table 8, the author calculates the comprehensive evaluation value of the high-quality development for cities in the Yangtze River Economic Belt. The specific steps are as follows.

T21=W21×R21=

$$\begin{pmatrix}0.6144 & 0.1172 & 0.2684\end{pmatrix}\begin{pmatrix}0.1133 & 0.2467 & 0.5400 & 0.0600 & 0.0400\\ 0.1267 & 0.4067 & 0.3800 & 0.0467 & 0.0400\\ 0.0867 & 0.3533 & 0.4200 & 0.0800 & 0.0600\end{pmatrix}$$

$$=(0.1077 \quad 0.2941 \quad 0.4890 \quad 0.0638 \quad 0.0454)$$

T22=W22×R22=

$$\begin{pmatrix}0.5694 & 0.3331 & 0.0974\end{pmatrix}\begin{pmatrix}0.0867 & 0.3000 & 0.4667 & 0.1200 & 0.0267\\ 0.0600 & 0.2867 & 0.5267 & 0.0733 & 0.0533\\ 0.0733 & 0.3133 & 0.4800 & 0.0933 & 0.0400\end{pmatrix}$$

$$=(0.0765 \quad 0.2968 \quad 0.4879 \quad 0.1018 \quad 0.0369)$$

T23=W23×R23=

$$\begin{pmatrix}0.1047 & 0.2583 & 0.6370\end{pmatrix}\begin{pmatrix}0.1667 & 0.4400 & 0.2733 & 0.0933 & 0.0400\\ 0.0800 & 0.2467 & 0.3933 & 0.2200 & 0.0600\\ 0.0800 & 0.1867 & 0.4267 & 0.2200 & 0.0867\end{pmatrix}$$

$$=(0.0891 \quad 0.2287 \quad 0.4020 \quad 0.2067 \quad 0.0749)$$

T24=W24×R24=

$$\begin{pmatrix}0.2499 & 0.0953 & 0.6548\end{pmatrix}\begin{pmatrix}0.1000 & 0.2533 & 0.5067 & 0.1067 & 0.0333\\ 0.0933 & 0.2400 & 0.5733 & 0.0733 & 0.0200\\ 0.1000 & 0.3400 & 0.4667 & 0.0667 & 0.0267\end{pmatrix}$$

$$=(0.0994 \quad 0.3088 \quad 0.4869 \quad 0.0773 \quad 0.0277)$$

T25=W25×R25=

$$\begin{pmatrix}0.1991 & 0.7334 & 0.0675\end{pmatrix}\begin{pmatrix}0.1267 & 0.2667 & 0.4933 & 0.0800 & 0.0333\\ 0.1200 & 0.2867 & 0.4467 & 0.1000 & 0.0467\\ 0.1400 & 0.3533 & 0.4267 & 0.0733 & 0.0067\end{pmatrix}$$

$$=(0.1227 \quad 0.2872 \quad 0.4546 \quad 0.0942 \quad 0.0413)$$

T1=W1×R1=

$$\begin{pmatrix}0.1189 & 0.4450 & 0.1850 & 0.0660 & 0.1850\end{pmatrix}\begin{pmatrix}0.1077 & 0.2941 & 0.4890 & 0.0638 & 0.0454\\ 0.0765 & 0.2968 & 0.4879 & 0.1018 & 0.0369\\ 0.0891 & 0.2287 & 0.4020 & 0.2067 & 0.0749\\ 0.0994 & 0.3088 & 0.4869 & 0.0773 & 0.0277\\ 0.1227 & 0.2872 & 0.4546 & 0.0942 & 0.0413\end{pmatrix}$$

$$=(0.0926 \quad 0.2828 \quad 0.4659 \quad 0.1137 \quad 0.0451)$$

According to the evaluation results of the high-quality development of the cities in the Yangtze River Economic Belt, the probability of 9.26% is excellent, the probability of 28.28% is good, the probability of 46.59% is medium, the probability of 11.37% is fair and the probability of 4.51% is poor. According to the principle of maximum membership, 0.4659>0.2828>0.1137>0.0926>0.0451. Therefore, the evaluation result of the high-quality development of cities in the Yangtze River Economic Belt is medium.

5. Conclusion

According to the evaluation system of the high-quality development of cities in the Yangtze River Economic Belt, this paper constructs the hierarchical model of the evaluation system of the high-quality development of cities in the Yangtze River Economic Belt.

The hierarchical structure model includes five first-level indicators, namely innovative development, coordinated development, green development, open development and shared development, and 15 second-level indicators, including scientific and technological achievements transformation, coordinated development between urban and rural areas, sewage treatment, and so on. Based on this model, the author calculates the corresponding index weights by using the analytic hierarchy process, and calculates the index evaluation set by combining the fuzzy comprehensive evaluation method. Finally, the evaluation result of the high-quality development of cities in the Yangtze River Economic Belt is medium. The evaluation results show that relevant departments of the cities in the Yangtze River Economic Belt need to take corresponding optimization measures in the aspects of medical services, air quality, coordinated development among industries,

high-tech investment, etc., so as to promote the high-quality development of cities in the Yangtze River Economic Belt, and make greater contribution to the construction of a new double-cycle development pattern at home and abroad.

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