Evaluation of Urban Development Quality Based on the Connotation of High-Quality Development: A Case Study of Guangdong Province

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Abstract In this paper, based on the interpretation of the connotation of high-quality development, an urban development quality evaluation index system was established from six aspects of economic strength, the level of science and education, government management, resources and environment, the level of openness, and infrastructure, the entropy method and cluster analysis were used to conduct an empirical analysis of the quality of urban development in Guangdong Province, and relevant suggestions were proposed accordingly. The results showed that: ① the level of science and education was the most important factor affecting the quality of urban development in Guangdong Province; ② the quality of urban development in Guangdong Province was extremely uncoordinated; ③ cities with stronger economic strength had lower resource and environment evaluation; ④ cities of Guangdong Province could be divided into three categories: cities in a quality optimization stage, cities in a quality improvement stage, and cities in a quality lagging stage that could be further divided into three categories.

Keywords High-quality development, Urban development quality, Entropy method, Cluster analysis, Guangdong Province
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The report of the 19th National Congress of the Communist Party of China (CPC) made a major judgment that "China's economy has shifted from a high-speed growth phase to a high-quality development phase." The Central Economic Work Conference once again emphasized this major judgment and further proposed "accelerating the formation of an indicator system, a policy system, a standard system, a statistical system, performance evaluation, and government performance auditing to promote high-quality development", so as to create and improve the institutional environment. At present, the research on the connotation of high-quality development mainly starts from three levels. Firstly, from the perspective of economic development, it emphasizes that high-quality development is the development of product quality improvement, input and output efficiencies, high-quality supply demands, industrial structure optimization, consumption upgrading, environmental friendliness, and economic cycle[1-4]; secondly, from the perspective of social welfare progress, it stresses that high-quality development is the development that can better meet the people's growing needs for a better life[5-6]; thirdly, from the perspective of five development concepts, it underlines that high-quality development is innovative, coordinated, green, open and shared, and is the development realizing people's all-round development[7-8]. In general, high-quality development is the development that takes economic development as the basis, meeting people's growing needs for a better life as the goal, and innovation, coordination, green, openness, and sharing as the foothold.

The Central Urban Work Conference pointed out that "cities and economic development complement each other and promote each other". The high-quality development of the economy will be accompanied by the high-quality development of the city. Under the background of grasping the connotation of high-quality development, it is of great practical significance to explore the optimization path of high-quality development of cities. Currently, there are two types of evaluation of urban development quality: one is evaluation research related to it, such as urbanization quality, urban sustainable development, urban modernization, urban competitiveness, urban comprehensive strength, harmonious urban development, healthy urban development and urban development index, etc; the other is evaluation research focusing on one aspect of it, such as urban human settlements, ecological cities, livable cities, urban life quality, urban environmental quality, urban economic development quality, recycling urban social development, etc[9]. When constructing the urban development quality evaluation index system, scholars select a representative index from one or more aspects of politics, economy, society, ecology and coordination from a certain research perspective[10-12], but there is no unified view of development yet.

High-quality development is important transformation of China's development concept in the new era. Guided by the connotation of high-quality development, constructing the urban development quality evaluation index system to reveal the status, characteristics and regional differences of urban development quality and provide a theoretical basis for urban development quality optimization and regional coordinated development, will have important practical value and theoretical significance. Therefore, based on the interpretation of the connotation of high-quality development, this paper constructed an evaluation index system of urban development quality multi-dimensionally, used the entropy method and the cluster analysis to empirically analyze the prefecture-level cities in Guangdong Province and reveal the quality of urban development, and proposed relevant suggestions, so as to promote high-quality urban development and coordinated regional development.

1 Research methods and data

1.1 Construction of an urban development quality evaluation index system

Based on the interpretation of the connotation of high-quality development, it is believed that high-quality development is the

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development that takes economic development as the basis, meeting people's growing needs for a better life as the goal, and innovation, coordination, green, openness, and sharing as the foothold. In this paper, guided by the connotation of high-quality development, based on the comprehensive, hierarchical, objective, scientific and accessible principles of indicator selection[13], a multi-dimensional urban development quality evaluation index system, which included 47 indicators concerning economic strength, the level of science and education, government management, resources and environment, the level of openness, and infrastructure, was established (Table 1).

Economic strength is the fundamental driving force for the city's high-quality development. When it comes to indicator selection, indicators reflecting the total development and per capita level were selected, including regional GDP, per capita regional GDP, annual average salary of employed persons in urban units, and per capita disposable income of permanent urban residents, total retail sales of consumer goods, etc. The level of science and education is the driving force for innovation and the source of innovation. Much attention was paid to innovation achievements, technological development and personnel training in the selection of indicators, and indicators included fixed-asset investment of scientific research and technical services, scientific and technological public budget expenditures, patent grants, the proportion of value added of high-tech manufacturing industry in the added value of industrial enterprises above designated size, education public budget expenditures, etc. Government management is the mechanism guarantee for the coordinated development of cities. Coordinated development requires strong government power to regulate and manage. Indicators that could reflect government management capacity, social equity factors, and administrative strength were selected, such as medical insurance coverage rate of permanent residents, endowment insurance coverage rate of permanent residents, rate of death from work safety accidents per 100 million yuan GDP, urban registered unemployment rate, per capita local general public budget revenue, etc. Resources and environment are the most intuitive reflection of green development. When selecting indicators, ecological conditions and environmental governance were comprehensive considered, so that indicators covered industrial waste gas emissions per square kilometer, industrial smoke (powder) dust emissions per square kilometer, comprehensive ambient air quality index, urban per capita green area, etc. The level of openness is a measure of the external exchanges in urban development, and is an important measure of open development. When selecting indicators, the internal and external links of the city were considered comprehensively, and indicators included actual use of foreign investment, port cargo throughput, total import-export volume, international tourism foreign exchange income, etc. Infrastructure is the main way to share the results of urban development. Equalization of public facilities can achieve shared development of the city. Thus, the per capita public service level was the main consideration in the selection of indicators, and indicators selected included the number of urban public transport vehicles per 10,000 people, the number of practicing (assistant) physicians per 10,000 people, the number of hospital beds per 10,000 people, and the number of mobile phone users per 10,000 people.

1.2 Research methods

1.2.1 Entropy method. The entropy method is a method based on information entropy to determine the weights of indicators in the overall evaluation[14]. The entropy method is characterized by determining the weights of the indicators according to the degree of difference between the indicator data. The greater the difference between the indicator data, the smaller the entropy value, the more effective information the data provides, and the greater the weight of the data, and vice versa[15]. Therefore, the entropy method can well reflect the degree of difference between samples while effectively calculating the weight of each indicator. In this paper, the entropy method was used to determine the weight of each indicator, and then the urban development quality evaluation score was calculated. Specific steps are as follows:

(1) Standardization of indicator data:

$$Y_i = [(X_i - X_{min})/(X_{max} - X_{min})] \times 100 \quad (1),$$

$$Y_i = [(X_{max} - X_i)/(X_{max} - X_{min})] \times 100 \quad (2),$$

where Y_i is the value after standardization of the original indicator data, X_i is the actual value of the sample, X_{max} is the maximum value of the indicator data sequence, and X_{min} is the minimum value of the indicator data sequence.

Formula 1 was used to calculate positive indicators; Formula 2 was used to calculate contrary indicators.

(2) Calculating the proportion of the indicator value of the *i*-th city under the *j*-th indicator:

$$P_{ij} = Y_{ij} / \sum_{i=1}^{m} Y_{ij} \quad (3),$$

where m is the number of cities.

(3) Calculating the entropy of the j-th indicator:

$$E_j = -k \sum_{i=1}^{m} P_{ij} \ln (P_{ij}) \quad (4),$$

where $k > 0$, ln is the natural logarithm, $E_j \geqslant 0$. Let $k = 1/\ln m$, so that $0 \leqslant E_j \leqslant 1$.

(4) Calculating the difference coefficient of the *j*-th indicator:

$$D_j = 1 - E_j \quad (5),$$

where D_j reflects the difference in the size of the indicator data. The greater the difference in data, the larger the D_j, and the greater the weight of the indicator. When the data under an indicator is completely equal, the coefficient of difference is the smallest, which is 0.

(5) Defining the entropy coefficient:

$$W_j = W_j / \sum_{j=1}^{n} D_j \quad (6),$$

where n is the number of indicators.

(6) Calculating the comprehensive evaluation index:

$$F_j = \sum_{j=1}^{n} W_j Y_{ij} \quad (7).$$

Each primary indicator evaluation index is obtained by weighted summations of the secondary indicators.

1.2.2 Cluster analysis. Cluster analysis is a method of combining clusters based on the distance between samples and the distance between classes[16]. In this paper, the cluster analysis based on the calculated primary index evaluation index was performed for each city [17]. This method had two advantages: firstly, compared with the direct cluster analysis based on the secondary index value, this method solved the problem of different data dimensions and used the weight to optimize the data to make the data results more reasonable; secondly, compared with the cluster analysis based on the comprehensive evaluation scores, it took into account the impact of various evaluation factors on urban classification so that it was more than just a simple comprehensive ranking result classification. And specific steps are as follows:

(1) Calculating the degree of similarity between cities by using the Euclidean distance:

$$d_{ij} = \sqrt{\sum_{k=1}^{n} (S_{ik} - S_{jk})^2} \quad (8),$$

where S_{ik} is the index value after the weighted summation of the primary indicator *k* of City *i*.

(2) Performing clustering by means of the between-groups linkage, which is based on the average of the distance between the two types of samples to determine whether to merge the two classes into a new class:

$$D(G_P, G_q) = \frac{1}{n_p n_q} \sum_{i \in G_P} \sum_{j \in G_P} d_{ij} \quad (9),$$

where $D(G_p, G_q)$ is the average of the distance between each sample.

1.3 Research objects and data sources

The research objects of this paper were 21 prefecture-level cities in Guangdong Province. The raw data were all the statistical data of each city in 2016, mainly from *2017 Guangdong Statistical Yearbook*, the statistical bulletin of 2016 national economic and social development of each city, and the urban ambient air quality of Guangdong Province in 2016, and other data were obtained through simple calculations of the raw data.

2 Result analysis

2.1 Analysis of the overall characteristics of urban development quality

According to the entropy method, the difference coefficient and weight of each primary indicator were calculated (Table 2). In the process of statistical analysis, the larger the calculated difference coefficient of the indicator, the greater the weight of the indicator, indicating that the greater the difference between the indicators and the greater the impact on the comprehensive evaluation.

In terms of weight size, the level of science and education ranked first, followed by the level of openness, economic strength, infrastructure, government management, and resources and environment. The weight of the level of science and education was the largest, which indicates to a certain extent that the cities in Guangdong Province have the greatest difference in the level of science and education. The level of science and education represents innovation ability and is the main factor affecting the quality of urban development. According to the statistical data, there were large differences in factors of scientific and technological expenditures, scientific and technological personnel, patent grants of cities, and the scientific and technological investment and development of cities were extremely unbalanced. The level of openness represents the degree of inclusiveness of urban development. The degree of internal and external links of the city as a node on the region is a very important factor affecting the quality of urban development. There were large differences in the port cargo throughput, total import-export volume, and international tourism foreign exchange income of cities across the province, which resulted from the differences in the location and development level of the cities. Economic strength is the basic driving force for urban development and an important engine for the city's high-quality development. The weight of economic strength was large, indicating that the gap in regional economic development in Guangdong Province is still large, and the problem of uncoordinated economic development is still prominent. The weights of infrastructure, government management, and resources and environment were relatively small, suggesting that to a certain extent, the differences between the three aspects of cities in Guangdong Province were small.

Through further calculation, the results of urban development quality evaluation in Guangdong Province were obtained (Table 3).

In terms of the comprehensive evaluation scores and rankings, there were large differences in the evaluation of urban development quality in Guangdong Province. The development quality evaluation scores of Guangzhou and Shenzhen were much higher than that of other cities, and Chaozhou, Yunfu, Jieyang, and Shanwei were lower-ranked. The score of Guangzhou was 12 times larger than that of Chaozhou. Cities in the Pearl River Delta region generally scored high, but Zhaoqing earned a lower score. Zhanjiang in western Guangdong, Shantou in eastern Guangdong, and Shaoguan in northern Guangdong were at a medium level on the development quality score. They had great development potential, and were important growth poles in their regions.

In terms of economic strength, Guangzhou and Shenzhen scored far higher than other cities, Foshan and Dongguan also earned higher scores, and cities in northern Guangdong such as Yunfu and Meizhou ranked lower. In terms of the level of science and education, Guangzhou and Shenzhen also scored far higher than other cities, and Shanwei and Chaozhou ranked lower. In particular, Heyuan made a good score, mainly because of the large proportion of advanced manufacturing and high-tech manufacturing in Heyuan's industrial output. In terms of government management, Shenzhen outclassed other cities, thanks to its comprehensive social security system and open government management model. In terms of resources and environment, Heyuan scored highest, which was closely related to its high-quality ecological environment and abundant resource reserves. However, as a result of excessive pollution emissions, cities with strong economic strength and rapid development, such as Guangzhou, Shenzhen, Dongguan, and Foshan, were at the lower-middle level in this term. In terms of the level of openness, Guangzhou and Shenzhen were still far ahead, Dongguan ranked three as a national first-class port with high throughput, and Zhanjiang ranked higher because of its geographic location of as a port city. In terms of infrastructure, Zhuhai, Shenzhen, Dongguan, and Guangzhou had higher scores, which were closely related to their perfect transportation facilities, higher medical level and convenient living services.

2.2 Cluster analysis of urban development quality

In order to further analyze the development quality characteristics of 21 cities in Guangdong Province, according to the evaluation index of primary indicators in Table 3, the cluster analysis was performed by using SPSS 22.0. In the process of the cluster analysis, the metrics of the sample interval adopted the Euclidean distance, and the between-groups linkage was used to obtain the cluster pedigree map (Fig.1). According to the results of cluster analysis and the comprehensive evaluation score of urban development quality, 21 cities in Guangdong Province were classified into three categories (Table 4): cities in a quality optimization stage, cities in a quality improvement stage, and cities in a quality lagging stage that could be subdivided into three categories (Table 5).

The average value of the evaluation scores of each indicator of each city category and the average value of the evaluation scores of each indicator of the province (the dotted line is the provincial average) were obtained to make radar maps (Fig.2).

Cities in a quality optimization stage included Guangzhou and Shenzhen. They had the following characteristics: their comprehensive scores of urban development quality were much higher than the provincial average; their scores were far higher than the provincial average in terms of economic strength, the level of science and education, and the level of openness, slightly higher than the provincial average in terms of infrastructure, and slightly lower than the provincial average in terms of resources and environment. Rapid economic development and population expansion led to a relative shortage of resources and a large amount of pollutant emissions. As for Guangzhou, its 2016 comprehensive ambient air quality index ranked lowest. How to coordinate the relationship between economic development and environmental benefits is still one of the important issues that need to be solved urgently. Their scores were higher than the provincial average in terms of government management, but there were large differences between the two cities. To be specific, Shenzhen had higher social security and welfare, and its relatively free

Table 1 An urban development quality evaluation index system

Primary indicator	Secondary indicator	Unit	Indicator attribute
Economic strength	Regional GDP	100 million yuan	Positive
	Per capita regional GDP	Yuan	Positive
	Annual average salary of employed persons in urban units	Yuan	Positive
	Fixed-asset investment	100 million yuan	Positive
	Local and foreign currency deposits of financial institutions	100 million yuan	Positive
	Per capita disposable income of permanent urban residents	Yuan	Positive
	Per capita consumption expenditure of permanent urban residents	Yuan	Positive
	Total retail sales of consumer goods	100 million yuan	Positive
	The proportion of the output value of the secondary and tertiary industries in GDP	%	Positive
The level of science and education	Fixed-asset investment of scientific research and technical services	100 million yuan	Positive
	Scientific and technological public budget expenditures	100 million yuan	Positive
	The proportion of value added of advanced manufacturing industry in the added value of industrial enterprises above designated size	%	Positive
	The proportion of value added of high-tech manufacturing industry in the added value of industrial enterprises above designated size	%	Positive
	Scientific and technological expenditure	10,000 yuan	Positive
	Scientific and technological personnel	Person	Positive
	Patent grants	Piece	Positive
	Education public budget expenditures	100 million yuan	Positive
	Teacher-student ratio in ordinary middle schools	%	Positive
	Teacher-student ratio in secondary vocational schools	%	Positive
Government management	Medical insurance coverage rate of permanent residents	%	Positive
	Endowment insurance coverage rate of permanent residents	%	Positive
	Rate of death from work safety accidents per 100 million yuan GDP	Person	Contrary
	Urban registered unemployment rate	%	Contrary
	Per capita local general public budget revenue	Yuan	Positive
	Per capita local general public budget expenditure	Yuan	Positive
Resources and environment	Industrial waste gas emissions per square kilometer	10,000 m^3	Contrary
	Industrial smoke (powder) dust emissions per square kilometer	t	Contrary
	Per capita wastewater emissions	t/person	Contrary
	Comprehensive ambient air quality index	–	Contrary
	Urban sewage treatment rate	%	Positive
	Harmless treatment rate of municipal solid waste	%	Positive
	Urban per capita green area	m^2	Positive
	Per capita water resources	m^3/person	Positive
The level of openness	Actual use of foreign investment	10,000 U.S. dollars	Positive
	Port cargo throughput	10,000 t	Positive
	Freight turnover	Trillion ton-km (tkm)	Positive
	Passenger turnover	Trillion passenger-km (pkm)	Positive
	Total import-export volume	100 million U.S. dollars	Positive
	Total communication services	100 million yuan	Positive
	International tourism foreign exchange income	10,000 yuan	Positive
	Domestic tourism income	100 million yuan	Positive
Infrastructure	The number of urban public transport vehicles per 10,000 people	Standard vehicle	Positive
	The number of practicing (assistant) physicians per 10,000 people	Person	Positive
	The number of hospital beds per 10,000 people	Piece	Positive
	The number of mobile phone users per 10,000 people	Household	Positive
	Road network density	m/km^2	Positive
	Per capita power supply	kW·h/person	Positive

Table 2 Difference coefficients and weights of primary indicators

Indicator	Difference coefficient (DJ)	Weight (WJ)
Economic strength	1.775 71	0.188 19
The level of science and education	3.181 40	0.337 16
Government management	0.604 78	0.064 10
Resources and environment	0.500 38	0.053 031
The level of openness	2.710 20	0.287 23
Infrastructure	0.663 15	0.070 28

and open policy system had created a more relaxed social environment, which had promoted the introduction of talents and technological innovation to a certain extent. In comparison, Guangzhou's government management evaluation was relatively low, and it still needed to be strengthened in terms of social security and public management.

Cities in a quality improvement stage included Huizhou, Zhongshan, Zhuhai, Foshan, and Dongguan. Such cities had the following characteristics: their comprehensive scores of urban development quality were slightly higher than the provincial average; their scores were higher than the provincial average in terms of economic strength, infrastructure, and government management. Besides, they scored high in terms of the level of openness, especially Dongguan, thanks to its huge import and export trade and foreign investment. Their scores were slightly lower than the provincial average in terms of the level of science and education as well as resources and environment. Due to the strong innovation appeal of Guangzhou and Shenzhen, other cities were dwarfed by the development of scientific and technological innovation. Relatively speaking, Dongguan had a certain

Table 3 Urban development quality evaluation results

City	Economic strength		The level of science and education		Government management		Resources and environment		The level of openness		Infrastructure		Comprehensive evaluation	
	Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking	Score	Ranking
Guangzhou	17.339 6	1	25.805 5	1	2.827 5	3	2.112 0	17	25.043 2	1	4.953 9	4	78.081 7	1
Shenzhen	16.989 6	2	19.560 0	2	6.213 0	1	2.313 1	14	17.980 1	2	5.085 1	2	68.140 9	2
Zhuhai	6.535 1	5	3.198 8	6	4.404 6	2	1.909 0	19	3.771 5	5	5.394 5	1	25.213 5	4
Shantou	2.787 7	9	1.294 8	20	1.225 7	15	3.028 9	9	1.114 1	10	2.036 7	9	11.488 0	10
Foshan	9.014 6	3	2.025 6	11	2.034 9	7	1.271 9	21	4.634 3	4	4.078 2	6	23.059 5	5
Shaoguan	1.612 8	14	1.711 3	15	1.133 2	18	3.649 1	3	0.529 1	16	1.700 4	11	10.335 9	13
Heyuan	0.866 4	18	2.9741	7	1.532 9	9	4.155 1	1	0.450 1	18	0.862 9	18	10.841 5	11
Meizhou	0.805 1	19	1.970 7	12	1.457 4	11	4.087 2	2	0.742 3	14	1.107 1	17	10.169 9	15
Huizhou	4.606 3	7	3.699 8	4	2.147 4	6	3.566 4	4	3.238 8	6	2.964 1	7	20.222 9	6
Shanwei	0.737 8	20	2.092 8	10	1.222 0	16	3.454 1	6	0.104 4	21	0.712 4	21	8.323 5	18
Dongguan	7.144 7	4	5.353 4	3	2.185 9	5	1.756 5	20	8.187 3	3	5.078 9	3	29.706 6	3
Zhongshan	5.578 8	6	3.690 4	5	2.490 9	4	2.146 6	16	1.777 7	9	4.393 6	5	20.078 0	7
Jiangmen	3.251 8	8	2.538 5	8	1.666 3	8	2.963 9	12	2.452 1	8	2.250 5	8	15.123 3	8
Yangjiang	1.367 2	16	1.745 2	14	1.411 0	12	3.387 7	7	0.328 9	20	1.612 9	12	9.852 8	16
Zhanjiang	1.928 3	11	2.365 1	9	0.890 5	21	2.989 4	11	2.730 4	7	1.483 0	13	12.386 7	9
Maoming	1.777 1	12	1.847 6	13	1.310 1	14	3.532 1	5	0.947 0	11	1.172 4	16	10.586 3	12
Zhaoqing	2.049 6	10	1.422 2	17	1.203 5	17	3.251 4	8	0.941 9	12	1.273 6	15	10.142 2	15
Qingyuan	1.549 3	15	1.395 6	18	1.402 4	13	2.994 8	10	0.756 9	13	1.739 7	10	9.838 8	17
Chaozhou	1.059 9	17	0.874 5	21	0.896 9	20	2.068 1	18	0.491 8	17	1.404 7	14	6.795 8	21
Jieyang	1.634 9	13	1.521 4	16	1.097 6	19	2.199 5	15	0.648 5	15	0.803 1	19	7.905 1	19
Yunfu	0.304 7	21	1.346 9	19	1.509 2	10	2.943 9	13	0.352 2	19	0.731 7	20	7.188 6	20

Table 4 Classification of cities in Guangdong Province

Category	City
Cities in a quality optimization stage	Guangzhou and Shenzhen
Cities in a quality improvement stage	Huizhou, Zhongshan, Zhuhai, Foshan, and Dongguan
Cities in a quality lagging stage	Jiangmen, Zhanjiang, Meizhou, Shanwei, Heyuan, Yunfu, Shaoguan, Yangjiang, Qingyuan, Maoming, Zhaoqing, Shantou, Jieyang, and Chaozhou

Table 5 Classification of cities in a quality lagging stage

Category	City
Cities of the first kind	Jiangmen and Zhanjiang
Cities of the second kind	Meizhou, Shanwei, Heyuan, and Yunfu
Cities of the third kind	Shaoguan, Yangjiang, Qingyuan, Maoming, Zhaoqing, Shantou, Jieyang, and Chaozhou

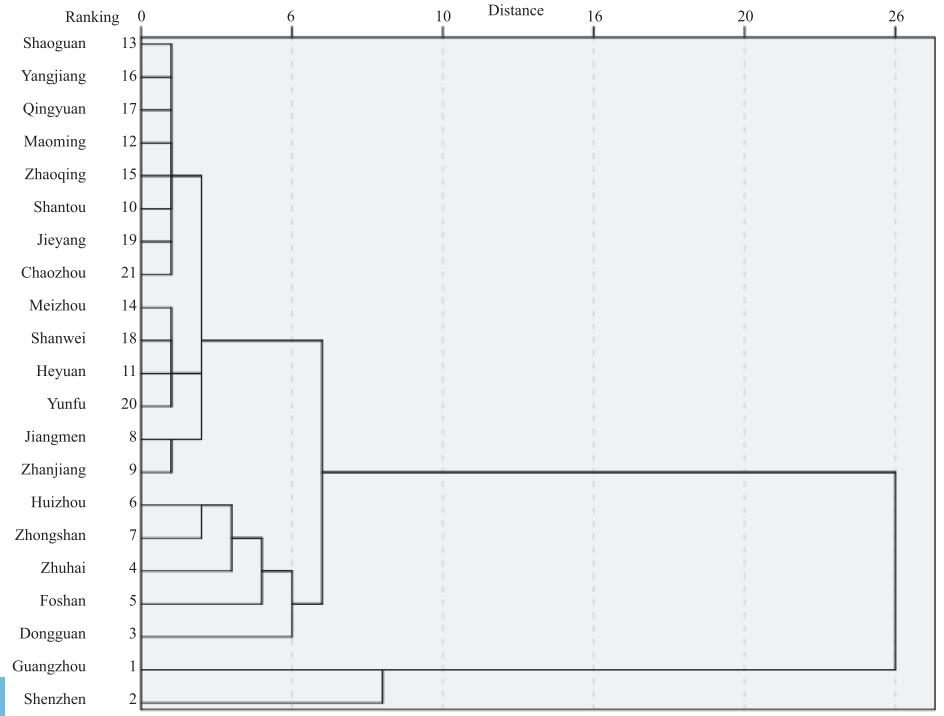


Fig.1 Urban development quality clustering pedigree

quality advantage, which was due to its strong investment in science and education as well as high patent grants. These cities made poor scores in terms of resources and environment because of large population agglomeration and over-exploitation of resources, especially Foshan, mainly because of its poor air quality and large emissions of pollutants.

Cities in a quality lagging stage included Jiangmen, Zhanjiang, Meizhou, Shanwei, Heyuan, Yunfu, Shaoguan, Yangjiang, Qingyuan, Maoming, Zhaoqing, Shantou, Jieyang, and Chaozhou. Their comprehensive scores of urban development quality were lower than the provincial average, and there were large differences in their own development conditions. There were Jiangmen and Zhanjiang, which were close to the cities in a quality improvement stage, and there were also relatively backward cities such as Yunfu and Chaozhou. According to the results of cluster analysis, the cities in a quality lagging stage were further divided into three categories.

Cities of the first kind included Jiangmen and Zhanjiang. Jiangmen is a city in the Pearl River Delta region, and Zhanjiang is an important port city in western Guangdong. Their scores in all aspects were relatively balanced. Except for in resources and environment, they scored lower than the provincial average, and there was large potential for development. Despite its especially poor score in government management, Zhanjiang made good a score in the level of openness, which was attributed to its high-quality ports and developed sea, land and air transportation. Its port cargo throughput ranked second in the province in 2016, second only to Guangzhou.

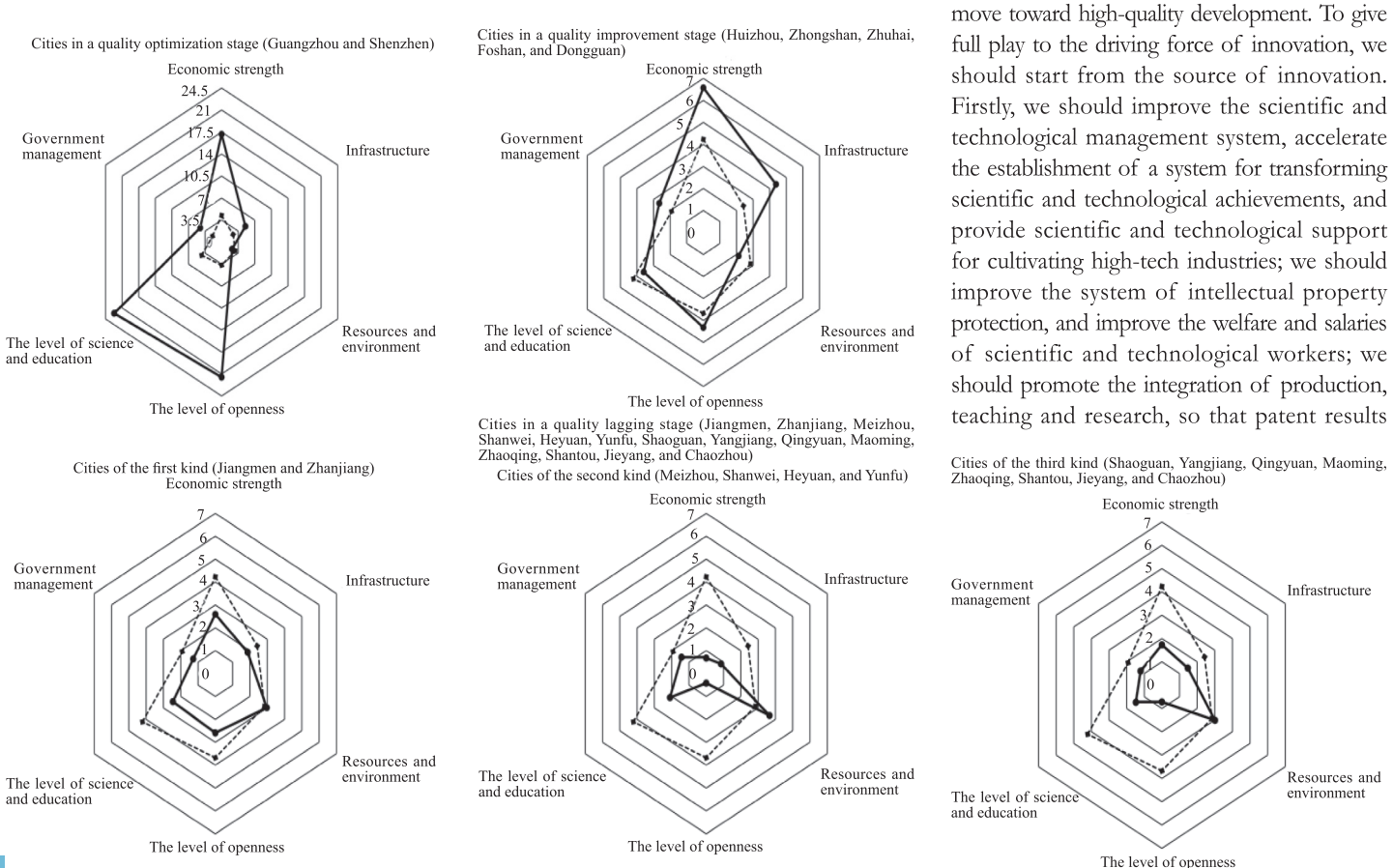
Cities of the second kind included Meizhou, Shanwei, Heyuan, and Yunfu. These cities made poor scores in economic strength, infrastructure, and the level of openness, but good scores in the level of science and education, government management, and resources and environment. Thanks to their high-quality ecological environment and less pollution discharge, they scored higher than the provincial average in resources and environment. Their scores were slightly lower than the provincial average in the level of science and education and government management, and significantly lower than the provincial average in the level of openness, economic strength, and infrastructure.

Cities of the third kind included Shaoguan, Yangjiang, Qingyuan, Maoming, Zhaoqing, Shantou, Jieyang, and Chaozhou. Such cities scored slightly higher than the provincial average in resources and environment, and lower than the provincial average in economic strength, infrastructure, the level of science and education, and government management. There was a largest gap in the level of openness between these cities and the provincial average. Compared with cities of the second kind, these cities have advantages in terms of economic strength, infrastructure, and the level of openness although they scored relatively low in resources and environment, government management, and the level of science and education.

3 Conclusions and suggestions

With the transformation of the development goal in the new era, urban development in China will enter a stage of high-quality development. Based on the interpretation of the connotation of high-quality development, this paper established an urban development quality evaluation index system from economic strength, the level of science and education, government management, resources and environment, the level of openness, and infrastructure, used the entropy method and the cluster analysis to empirically analyze the quality of urban development in Guangdong Province, and proposed policy suggestions for urban development quality optimization and regional coordinated development in Guangdong Province according to the obtained relevant conclusions.

(1) Promoting innovation-driven urban development strategy, perfecting the scientific and technological management system, and improving the level of personnel training. It can be seen from the calculation of difference coefficients and weights of indicators that the level of science and education is the biggest factor affecting the quality of urban development in Guangdong Province. The level of science and education is the source of innovation, and innovation is an important means of high-quality development of cities. It is thus suggested to actively promote innovation-driven development strategies and build innovative urban development models that will help cities move toward high-quality development. To give full play to the driving force of innovation, we should start from the source of innovation. Firstly, we should improve the scientific and technological management system, accelerate the establishment of a system for transforming scientific and technological achievements, and provide scientific and technological support for cultivating high-tech industries; we should improve the system of intellectual property protection, and improve the welfare and salaries of scientific and technological workers; we should promote the integration of production, teaching and research, so that patent results



(*Note.* The dotted line is the provincial average.)

Fig.2 Comprehensive evaluation of urban development quality

can be accurately and quickly transformed into innovation power. Secondly, we should improve the level of personnel training, increase the investment in basic education, and cultivate students' awareness of innovation from basic education; we should strengthen exchanges and introduction of talents at home and abroad, and attract innovative talents to contribute ideas.

(2) Enhancing inter-regional urban cooperation and promoting regional coordinated development. It is observed from the comprehensive evaluation of urban development quality that the regional differences in urban development quality in Guangdong Province are significant, the development of regional cities is extremely uncoordinated, and the quality of urban development in the Pearl River Delta region is much higher than that in other regions. Therefore, it is necessary to strengthen inter-regional urban cooperation, increase the efforts of partner assistance of cities in Pearl River Delta region to cities in the eastern and western regions of Guangdong, and promote the development strategy of the revitalization of the eastern and western regions of Guangdong, and promote the integrated development of the Pearl River Delta region and the eastern and western regions of Guangdong. It is also necessary to cultivate the central cities of the eastern and western regions of Guangdong, and promote the coordinated development of the surrounding areas with the radiation of the regional central cities.

(3) Cultivating awareness of ecological protection, improving resource utilization efficiency, and promoting green recycling. Judging from the evaluation results of the primary indicators, it is concluded that cities with higher economic strength evaluations have lower evaluations of resources and environment and are faced with increasingly prominent problems arising from the extensive development model. Thus, we should strengthen energy conservation and emission reduction, accelerate the rectification of "black and odorous water bodies" in various cities; we should develop green industries and recycling industries, establish urban green infrastructure systems, and promote clean production; we should promote ecological restoration projects and strengthen protection of forest resources, marine resources, and urban wetland systems, etc.

(4) Guiding differentiated urban development according to the characteristics of cities. According to the cluster analysis results of urban development quality, cities in Guangdong could be divided into three categories: cities in a quality optimization stage, cities in a quality improvement stage, and cities in a quality lagging stage and that could be further classified into three categories. Each kind of the city has its own urban development characteristics. For different types of cities, differentiated development should be implemented according to its comparative advantages.

Cities in a quality optimization stage including Guangzhou and Shenzhen should continue to maintain the advantages of economic strength, the level of openness, the level of science and education, etc., strengthen exchanges with Hong Kong and Macao, actively integrate into the international market, and build an international central city. They should explore new institutional mechanisms, increase opening up, and accelerate the construction of the free trade zone in Nansha District, Guangzhou and Qianhai & Shekou Area of Shenzhen; they should actively participate in the "Belt and Road" construction, strengthen trade cooperation with countries along the route; they should promote ecological construction, energy conservation and emission reduction, and focus on protecting urban ecosystems and coastal waters.

Cities in a quality improvement stage such as Huizhou, Zhongshan, Zhuhai, Foshan, and Dongguan should deepen the cooperation in the Pearl River Delta region and continue to improve the cooperation mechanism in various fields of the Pearl River Delta region. They should improve the level of the open economy, vigorously attract foreign investment, play the role of the port, and strengthen external relations. They should promote the development of manufacturing industry. Specifically, Foshan, Zhuhai, and Zhongshan should accelerate the participation in the construction of the advanced equipment manufacturing industry belt on the west bank of the Pearl River; Dongguan and Huizhou accelerate the participation in the construction of the electronic information industry belt on the east coast of the Pearl River. Moreover, they should vigorously promote the comprehensive management of environmental pollution, improve urban water environment and atmospheric environment, intensively use land, and promote urban environmental protection infrastructure construction.

Cities in a quality lagging stage should be tailored to local conditions and develop corresponding development strategies based on their own characteristics. For cities with good resources and resources such as Heyuan, Meizhou, and Shaoguan, should vigorously develop tourism and health industries, build ecological functional zones, and develop green cities. They should also face up to the deficiency of development, increase infrastructure construction, improve transportation facilities, and establish a sound production and living service system. Cities with good economic development bases such as Jiangmen, Zhanjiang, and Shantou, should increase the upgrading and integration of industries, enhance the level of opening up, and give play to their own advantages. For example, Zhanjiang can play its own important port advantages and strengthen foreign exchanges and trade. Jiangmen can give full play to its geographical location and promote the development of the marine economy. As for other cities with weak economic foundations, they should seek reforms in key areas on the basis of solid foundations, vigorously introduce talent pools and improve personnel training systems; they should improve government management, improve people's livelihood and welfare, promote employment, and improve the level of medical and health services and social security.

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Xishuangbanna Dai Autonomous Prefecture Government has clearly proposed to adapt to the new format of tourism development, with transformation and upgrading, quality improvement and efficiency increase as the main line, reform and innovation and integrated development as a means to vigorously develop all-for-one tourism and actively promote the integrated development of "tourism +". Gaozhuangxishuangjing is listed as a key project of the cultural tourism industry in Xishuangbanna, and Xishuangbanna-based Wanda International Resort is listed as a key park of the cultural tourism industry in Xishuangbanna. The developers of the two complexes, namely Haicheng Group and Wanda Group, are classified as key enterprises. From the perspective of policy support, the two complexes have the conditions for co-opetition development. From the perspective of tourism image building of Xishuangbanna, the two complexes have the realistic basis and objective needs for co-opetition development.

3.2 Analysis of the strategies for the co-opetition development between Gaozhuangxishuangjing and Xishuangbanna-based Wanda International Resort

3.2.1 Strengthening regional infrastructure construction and building a good external environment. In the process of their respective construction, their internal infrastructure has been rationally planned and constructed. The perfect internal facilities and environment of the two completed complexes has a good driving effect on improving the overall hardware conditions of Xishuangbanna. However, the enhancement of overall tourism reception capacity of Jinghong and even Xishuangbanna is also dependent on the improvement of the entire regional infrastructure. Therefore, the government should pay attention to the overall environment and functions of the region during the planning and construction of infrastructure, and improve it from transportation, information, auxiliary facilities for the disabled, health and safety emergency response, etc., so as to create a good external environment for the co-opetition development between the two major complexes.

3.2.2 Strengthening joint marketing and changing the marketing propaganda awareness lack of coordination. As competitors, Gaozhuangxishuangjing and Xishuangbanna-based Wanda International Resort inevitably have an attitude of exclusion toward each other in their operation, sales and propaganda. However, this purely competitive concept and consciousness are unfavorable for the benign co-opetition development of the two complexes. In the process of propaganda, the two cultural tourism complexes are almost single-handedly, and they do not mention another cultural tourism complex that has a good co-opetition and win-win relationship with them. For tourists, the relevant tourist information they have learned may be one-sided, and the tourism experience based on this will also be limited and affected. For example, tourists who have already arrived at Wanda Theme Park and who do not know that there is Gaozhuangxishuangjing with rich regional characteristics and ethnic characteristics at a short distance, will choose to leave Xishuangbanna after the entertainment activities of Wanda Theme Park. If the tourists can effectively understand the situation of Gaozhuangxishuangjing when they play at Wanda Theme Park, they may extend their duration of stay to visit Gaozhuangxishuangjing. The mutual shielding propaganda of the two complexes ultimately affects the tourism reception revenue of both parties, and also reduces the diversified tourism experience that tourists can get in Xishuangbanna. Therefore, in the future tourism promotion and marketing process, it is recommended that both parties change their marketing propaganda awareness lack of coordination, strengthen joint marketing to obtain higher comprehensive tourism revenue.

3.2.3 Highlighting the characteristics of their respective tourism products and strengthening the overall image of regional tourism. In terms of development time, the two complexes were developed not long ago, and have not yet formed a mature image in the minds of tourists. In terms of development goals, they aim to shape the new image of tourism in Xishuangbanna and promote the secondary development of Banna's tourism industry. In terms of regional planning and development, they are all important elements of building a new tourism image of Xishuangbanna with other tourism resources. It is thus necessary for the two major cultural tourism complexes to deeply tap the ethnic culture connotation, enhance product creativity, highlight their own characteristics, and strengthen their own advantages. However, from the perspective of the overall image building of Xishuangbanna, the two must develop in a state of co-opetition and present them as new business cards for the tourism development of Xishuangbanna, rather than being separated.

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