Evaluation of Urban Digital Transformation Level and Improvement Path Based on Entropy Value and Analytic Hierarchy Process: A Case Study of the Yangtze River Economic Belt

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Abstract—Digital transformation is an inevitable path for cities with the rapid development of emerging technologies, and it is important to promote the efficient development of urban agglomerations. Taking the Yangtze River Economic Belt as an example, this paper establishes an evaluation model of urban digital transformation level based on entropy value-hierarchy analysis by constructing an index system of digital transformation level, and conducts a comparison of the differences in digital transformation level in the Yangtze River Economic Belt in time and space. It analyzes the differences in the contribution of each index and the gap in the digital transformation level of various provinces and cities in the Yangtze River Economic Belt, and explores the path to improve the digital transformation level of the Yangtze River Economic Belt. The results show that the overall digital transformation of the Yangtze River Economic Belt needs the support of economy, ecology, life, industry and other aspects, while the digital transformation of provinces and cities mainly depends on the digitization of economy and industry.

Keywords—Urban digital transformation, entropy method, comprehensive evaluation.

I. INTRODUCTION

With the development of 5G, artificial intelligence and other emerging technologies, digital construction has become the mainstream of China's development, and it is also a necessary means for cities to adapt to the development of The Times and carry out transformation. At present, the digital development in our country has crossed the embryonic stage and is in the period of rapid development, but there is still a long way to go to the maturity. Digital transformation is an important plan for the future development of cities in China, and studying it will help promote the urban governance system and governance capacity to be more advanced, university and accurate, accelerate the process of digital development in China, and promote the construction of digital China.

At present, the existing research results have comprehensively studied the level of urban digital transformation in the context of digitization from different perspectives. Wu Na, by constructing a fixed effect model and an intermediary effect model, this paper empirically tests the mechanism of digital transformation of manufacturing industry on the quality of export products. Some studies find that the digital transformation of the manufacturing industry can significantly promote the upgrading of export product

quality, and summarizes the differences in the degree of promotion between economies with different incomes. It provides a reference for the development of industrial digital transformation. Yu Chao and some other people, by constructing the relationship model of "digital transformation, innovation rhythm and innovation performance", and taking environmental dynamics as the moderating variable, the positive correlation between digital transformation and the incoherent and irregular innovation rhythm of enterprises is studied. The conclusion that innovation rhythm has an inverted U-shaped effect on innovation performance provides reference value for enterprises' innovation and development in the context of urban digital transformation, and also provides theoretical guidance for enterprises' high-quality innovation practice in the process of digital transformation. Han Huijuan, taking urban parks as the research object, this paper studies the management of urban parks under the background of carbon peak and carbon neutrality. The study found that the park management cost under the background of digital transformation can be effectively reduced, reflecting the role of digital transformation in environmental governance, ecology and other aspects, which has important reference value for China's future sustainable development, and also provides a more three-dimensional idea for the research of digital transformation level. Guo Huifang and some other people, with the help of Python crawler technology and text mining technology, the degree of digital transformation is quantitatively measured, and the impact of digital transformation on the total factor productivity of service industry and its internal mechanism are empirically tested. It is concluded that digital transformation can significantly improve the total factor productivity of the service industry, and the differences between different natures of enterprises and different regions are analyzed. It provides a useful reference for promoting the transformation of the development momentum of the service industry and achieving high-quality economic development under the background of digital transformation.

In a word, the above research conclusions focus on digital transformation, use appropriate models and technologies to explore the level of digital transformation from the aspects of economy, industry, ecology, life and so on, highlight the key

points and difficulties of research, and give targeted suggestions to improve the level of digital transformation. In order to provide a valuable direction for the future digital transformation and development of the city.Based on this, this paper takes the Yangtze River Economic Belt as the research object, constructs the digital transformation index system, introduces the relevant data from 2017 to 2021 from 11 provinces and cities in the Yangtze River Economic Belt, establishes a time series model of the digital transformation level of the Yangtze River Economic Belt, and focuses on the regional differences in the digital transformation level of first - and second-tier cities. In order to provide the direction for the digital development of provinces and cities in the Yangtze River Economic Belt.

II. INDEX SYSTEM CONSTRUCTION

A. Construction Principle of Evaluation Index System of Urban Digital Transformation Level

Under the background of the rapid development of some emerging technologies, urban digital transformation is to improve the comprehensive competitiveness of the city for the future by taking the improvement of business value as the guidance and the application of technological innovation as the means. The focus of urban digital transformation is the digital transformation of urban industry, which is closely related to the economy of the city itself and people's life. The difficulty of urban digital transformation is the digital transformation of urban ecology. How to reduce the consumption rate of resources while developing digitally and how to make good use of digital capabilities in ecological construction is the top priority that needs to be explored and studied. Therefore, when constructing the index system of urban digital transformation, it comprehensively covers the aspects of economy, ecology, people's life and industry. Urban digital transformation is reflected in the economic strength of the whole region and the individual people. In the ecological aspect, it is reflected as the regional pollutant discharge; In terms of life, it is reflected in the utilization rate of digital resources in education and other aspects. In terms of industry, it is reflected in the utilization rate of labor and machinery and resource consumption. In addition to comprehensiveness, we should also pay attention to the Yangtze River Economic Belt when constructing the index system of urban digital transformation. It is necessary to follow the development characteristics of the Yangtze River Economic Belt, pay attention to ecology and resource consumption while improving the level of digital transformation, and comply with the development principle of sustainable development.

B. Construction of Urban Digital Transformation Level Evaluation Index System

The selection of digital transformation indicators of the Yangtze River Economic Belt should be based on the development characteristics of various provinces and cities in the Yangtze River Economic Belt, and comprehensively cover the aspects of economy, ecology, life and industry. Based on this, this paper selects 9 indicators: Regional GDP (100 million yuan), per capita GDP (100 million yuan/person), total

emission of major pollutants in waste gas (10 thousand tons), total emission of major pollutants in wastewater (10 thousand tons), digital education resource utilization rate (%), community digital resource utilization rate (%), construction labor productivity (10 thousand yuan/person), total number of major agricultural machinery and equipment (10,000 units), total electricity consumption (100 million) Kilowatt-hours).Regional GDP and per capita GDP reflect the digital transformation of the Yangtze River Economic Belt. The total amount of major pollutants discharged from waste gas and waste water reflects the ecological digital transformation of the Yangtze River Economic Belt. The utilization rate of digital educational resources and community digital resources reflects the digital transformation of life in the Yangtze River Economic Belt. The labor productivity of the construction industry, the total number of major agricultural machinery and equipment, and the total electricity consumption reflect the industrial digital transformation of the Yangtze River Economic Belt.

C. Variable Definition

The comprehensive evaluation index system constructed in this paper contains 9 indicators, and the following variables are defined respectively: Gross regional product ($x1$), gross per capita product ($x2$), total emission of major pollutants in waste gas ($x3$), total emission of major pollutants in wastewater ($x4$), utilization rate of digital education resources ($x5$), utilization rate of community digital resources ($x6$), labor productivity of construction industry ($x7$), total number of major agricultural machinery and equipment ($x8$), total electricity consumption ($x9$) .

III. EVALUATION

A. Overall Level of Digital Transformation in the Yangtze River Economic Belt

Using the software to calculate and analyze the entropy-analytic hierarchy process, we can get the comprehensive score of the Yangtze River Economic Belt in each year under the evaluation index. Judging by the result:(a)From 2017 to 2021, the comprehensive score is getting higher and higher, indicating that the level of digital transformation of the Yangtze River Economic Belt is gradually improving, the degree of digital development of provinces and cities is gradually deepening, and the digital capability is gradually enhanced, and the overall digital development trend of the Yangtze River Economic Belt is good.(b)The overall score shows a growing trend, which reflects the overall digital development strength of the Yangtze River Economic Belt and the potential for sustained growth.(c)The entropy values of various indicators related to economy, ecology, life and industry are relatively average, indicating that the digital transformation has penetrated into all aspects of the Yangtze River Economic Belt, and it also shows that to improve the level of digital transformation, all aspects of the economy and industry need to make joint changes and efforts, rather than limited to a certain aspect. In general, with the development of modern emerging technologies, the overall level of digital transformation in the Yangtze River Economic Belt is getting

higher and higher, and the growth rate is becoming more and more significant.

B. Level of Digital Transformation by Region

Using the software to calculate and analyze the entropy-analytic hierarchy process, we can get the comprehensive scores of each province and city in the sub-region under the evaluation index. Judging by the result:(a)The comprehensive score gap between the upstream region and the middle and downstream regions is larger than that between the middle and downstream regions, and the comprehensive score gap between the middle and downstream regions is smaller. This indicates that there is little difference in the level of digital transformation in the middle and downstream regions, while the level of digital transformation in the upstream region is much higher than that in the middle and downstream region.(b)Compared with the overall digitization level of the Yangtze River Economic Belt in the same year, the difference coefficient of the relevant indicators of economy and industry is large, indicating that the economy and industry have contributed more to the digital transformation development of the subregion, which is different from the overall digital transformation development of the Yangtze River Economic Belt.(c)Looking at the specific provinces and cities in each region, Shanghai in the upstream region has the highest comprehensive score. As a first-tier city, Shanghai is ahead of other cities mainly because of its developed economy and the promotion of high and new technology to industrial development. However, Shanghai has a low score in eco-related indicators. Guizhou City has the lowest comprehensive score, which is also related to its backward economy and industry.

C. Comparison of Overall and Local Digitization Levels

As a whole, the digital transformation of the Yangtze River Economic Belt needs the joint support of economy, ecology, life, industry and other aspects, which complement each other and promote each other. The evaluation of the digital transformation level of each province and city in the subregion mainly depends on the economic drive and industrial development, which is the digital development dominated by the digital economy and digital industry. By specific comparison of various provinces and cities, it can be seen that the provinces and cities with high comprehensive scores are more prominent in economic indicators and industrial indicators, but there are defects in ecological indicators, which also reflects the difficulty of improving the digital level and maintaining ecological construction. Therefore, the above content can be summarized in the following two points:(a)From the whole point of view, the relevant indicators of economy, ecology, life and industry all have a relatively average contribution status, which needs to be comprehensively taken into account and extensively covered in the research process.(b)From the local view of the whole, economy and industry are more prominent indicator groups, with a certain leading role and a higher contribution status. Compared with the whole, it has the focus of research and is closely related to the comprehensive scores of each province and city. Based on this, from the perspective of local development, all provinces and cities should focus on the development of digital economy and digital industry; From the perspective of overall development, it is necessary to take into account the digital development of economy, ecology, life, industry and other aspects.

IV. RELEVANCE SUGGESTION

The digital transformation should conform to the development situation of the region, combine all aspects, give play to the advantages and make up for the disadvantages, so as to improve the level of digital transformation and promote the efficient development of the region. By studying the level of digital transformation in the Yangtze River Economic Belt, this paper selects indicators that can reflect digitization, including economy, ecology, life, industry and so on. It can be seen from the analysis results: The overall digital transformation needs the joint support of all aspects, and the partial digital transformation is dominated by the digitization of the economy and industry, but at the same time, life and ecology cannot be ignored, especially the balance between maintaining ecological construction is a difficult point. Based on this, this paper puts forward the following suggestions:

A. Strengthen Modern Economic Strength

The improvement of the level of digital transformation cannot be separated from the support of the economy, which is not only the embodiment of financial capacity, but also the embodiment of production capacity. At present, the internal and external challenges facing our country are constantly increasing, and the development of economic strength has taken a certain impact, changing from the previous high-speed development to medium-high development. Therefore, strengthening economic strength is crucial. All provinces and cities should actively make use of their own development characteristics and advantages to enhance economic strength, increase production input, and promote economic development. Regions can also adjust the overall economic situation from a macro perspective, promote strengths and avoid weaknesses, and make up for each other to ensure steady economic development and investment in digitization.

B. Promote Digitization of Ecological Development

Green development has long been the main direction of China's development, so ecological construction is an important part of the development of various regions. Digitization itself can play a role in reducing pollution and maintaining ecology to a certain extent, so promoting digitization of ecological construction is the best of both worlds. The introduction of digital technology or related equipment to monitor the types and quantities of pollutants in waste gas and waste water, build an artificial ecological cycle system through digital technology, and promote digitization and ecological construction to complement each other. At the same time, we should also pay attention to the problem of resource consumption caused by the improvement of the digital degree, and we can save as much as possible by recycling and hierarchical consumption.

C. Diversify Digital Life

Digital life is an important part of digitization, and it is also directly related to the people of the country. To enhance the level of regional digital transformation, the improvement of the digital level of life is indispensable. Digitize equipment in important places such as schools and enterprises to improve efficiency; To realize the digitization of community information, through the construction of community network and community system, it is convenient for residents to grasp all aspects of community information in real time. The whole region can also build its own regional network according to its own development situation and refer to the difficulties in the development process, so as to make the situation in all aspects of the region more transparent and three-dimensional.

D. Enhance Industrial Digital Capabilities

Industry is the lifeblood of the development of various provinces and regions, and the improvement of industrial digital ability can make great contributions to the improvement of the overall digital level of the region. By increasing the investment in digital technology, the corresponding digital equipment is delivered to various industries, increasing the benefits of various industries, improving the degree of automation, and improving labor productivity, so that it is gradually transformed from artificial and mechanization to digital direction, and promoting industrial quality.

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