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Digitally Driven Urban Governance: Framework and Evaluation in China

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Abstract: With the rapid development of digital technology, the role of digitalisation in urban governance continues to emerge. Building a theoretical analysis framework and evaluation system of digitally driven urban governance has important theoretical and practical significance for stimulating the efficiency of digital technology tools and improving the energy level of urban digital governance. This paper aims to explore the mechanism of urban governance enabled by digital technology, innovatively change the previous thinking mode that only attaches importance to facility construction and e-government platforms, adopt ecological thinking, and comprehensively consider the role of "soft elements" such as strategic support, industrial support, the security environment, talent support, and the market environment. Then, the extreme value variance method and the coefficient of variation method are used to calculate the overall capacity and secondary index scores of each city, and the standard deviation of secondary index scores is used to represent the sub-environmental balance of the cross-sectional data of China's provinces. In order to further explore which indicators restrict the improvement of China's urban digital governance capacity, this study also constructs an obstacle degree model. The results show the following: (1) The overall capability of China's digitally driven urban governance is low, with a total score of 27.25, indicating that China's digitally driven urban governance is in its infancy. (2) There is a significant development imbalance among Chinese provinces, with Beijing ranking first with a score of 81.16, and Tibet, Qinghai, Xinjiang, Heilongjiang, and Ningxia scoring less than 13.30 points, ranking as the bottom 5 among the 31 provinces. (3) The shortcomings of talent support, industrial support, and the security environment restrict the improvement of the entire digital ecological governance ability.

Keywords: digitalisation; urban governance; theoretical logic; evaluation system; balanced development

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1. Introduction

At a time when globalisation and informatisation are intertwined, urban development is undergoing unprecedented and profound changes. As the main gathering place for human activities, cities are the core carriers of multidimensional economic, social, and cultural development. However, with the acceleration of urbanisation, urban governance is facing many challenges, such as increased pressure on resources and environments, traffic congestion, and public safety hazards, etc. For example, with the rapid expansion of the urban scale and the limitations of the original urban scale, cities such as London and Beijing are facing serious traffic congestion problems, while cities such as Mumbai and Rio de Janeiro are facing prominent public safety hazards. The expanding scale of management institutions and the traditional governance model has struggled to cope with these complex and changing problems [1]. With the rapid development of new-generation information technologies, such as the Internet of Things, cloud computing, big data, and artificial

intelligence, digitalisation has become an important driving force to promote innovation and the sustainable development of urban governance [2]. Based on this, it is clearly stated in the Chinese government's work report that it is necessary to 'give full play to the role of digital technology, improve the level of urban planning, construction, and governance, and create livable, resilient, and smart cities', which indicates the future direction of urban governance modernisation. In this context, it is of great practical significance and theoretical value to explore how digitalisation drives the sustainability of urban governance, to construct a corresponding theoretical framework and to conduct empirical evaluation. Particularly, China's unique position as a digital leader and its ongoing urbanisation challenges make this study necessary as well as enlightening for digital governance in developing countries.

The earliest public understanding of digital governance was often limited to e-government and digital offices [3–5]. In the early 1980s, the government began to use computers to process some municipal affairs. During this stage, e-government mainly focused on the informatisation construction within the government, such as the application of file systems and database systems, as well as the electronicisation of data statistics and daily document processing. In the mid-1990s, with the popularisation of Internet technology, the e-government began to extend outward, realising information sharing and exchange across departments, regions and levels. The government portal website has become an important window for government transparency and policy promotion, providing services such as online consultation, online application, and online approval. The development of the e-government at this stage has achieved significant results, and many researchers still equate digital governance with e-government, believing that digital governance is the replacement and upgrade of e-government platforms [6,7]. However, this viewpoint oversimplifies the operation of digital city management. This is because, with the development over time and the iteration of digital technology, the mechanism by which digital technology affects urban governance has undergone changes. Digital governance emphasises collaboration and openness based on data platforms, achieving collaborative governance between government and society, regions, and departments; through data aggregation and mining, it obtain accurate portraits of service and regulatory targets, and achieves the precise delivery of policy resources; it reaches individuals and enterprises on a large scale, while individuals and enterprises can also provide timely feedback and suggestions to the government, forming a feedback loop of government social cooperation; and by utilising digital technology for temporal and spatial prediction, potential risks and problems can be identified in advance, and corresponding measures can be formulated [8]. In short, current digital governance has developed into an institutional arrangement and continuous process that empowers governance systems and capabilities through digitisation, with the goal of building a new governance system. Multiple entities such as the government, platforms, enterprises, social organisations, online communities, and individual citizens participate in relevant affairs, covering multiple aspects such as digital government governance, digital economic governance, digital social governance, and digital technology governance [9]. At the same time, this also puts forward higher requirements for technology, talent, industry, policies, and so on.

Therefore, this paper focuses on the mechanism of the framework of digitally driven sustainable urban governance. Specifically, a comprehensive theoretical analysis framework of digitally driven urban governance is constructed, and relying on this framework, the ability of digitally driven urban governance in Chinese provinces is empirically analysed. This article found that although many researchers have established evaluation systems for the level of urban digital governance, they generally measure a city's information infrastructure construction, e-government development level, and digital industry development level as core indicators, with only differences in secondary indicators. However, as mentioned earlier, digital governance not only achieves functional iteration compared to e-government, but also enhances the demand for policies, talents, markets, and other aspects. Evaluating the digital governance level of a city cannot ignore these key dimensions.

Moreover, in the highly interconnected information age of the system, any shortcoming will lower the efficiency of the entire digital governance system. For example, even if a city attaches importance to policies and has advanced technology, it will lose the ability for sustainable development without talent. Therefore, it is also necessary to evaluate the balanced level of digital governance within a city, which has been overlooked by existing research. Compared with the existing research in the literature, the contribution of this paper is mainly reflected in three aspects: first, from the perspective of ecological analysis, we construct a sustainable analytical framework for digitally driven urban governance, pointing out that digital technology does not only serve as a governmental tool to enhance the efficiency of the citizens' experience of participating in business, but also provides a full range of safeguards for urban governance in multiple ways, such as facilitating production, guaranteeing safety, and optimising the environment. Secondly, an empirical approach is adopted to measure the sustainable capability of the digitally driven urban governance of Chinese provinces as an example through methods such as the coefficient of variation method, and to explore the status quo of similar developing countries in the process of digital development and the enhancement of urban governance capability, as well as the general problems they face by means of cross-sectional comparisons. Thirdly, the degree of equilibrium between the indicators of different dimensions is further explored in detail, so as to judge where the potential of digitally driven urban governance capability enhancement lies.

2. Literature Review

Digitally driven urban governance has undergone a long theoretical development, and its concepts have shown different connotations with the iterations of technology as well as the developments of the times. Between the 1960s and the 1980s, information technology appeared and developed rapidly, and was gradually applied to the processes of government affairs. At that stage, the government mainly used electronic computers for data processing and management, as well as internal communication through e-mail and telegrams, and the concept of e-government had not yet been formed. In the 1990s, with the popularity of the Internet, the government began to use Internet technology to provide citizens with online services, such as online tax payment, online applications for permits, etc., and the e-government took shape [10]. Between the 2000s and the 2010s, the rise in mobile Internet technology, which allows the government to provide services to citizens through convenient channels such as mobile phone applications, allowed the e-government to further develop in the direction of mobility and convenience [11]. Since 2020, with the application of new technologies, such as big data, cloud computing, and artificial intelligence, digital governance has experienced improvements, with government services becoming more intelligent and personalised, and government–citizen interactions becoming more frequent and efficient. Specifically, first of all, the application of information technology makes government services more efficient and convenient [12]; through the digital service system, the government can achieve 'Internet + government services', to ensure that the public 'only has to enter through one door, and only run one leg', greatly improving the level of government services. Secondly, information technology promotes the optimisation of government functions, and the government is able to identify public demand more accurately through data analysis and intelligent algorithms, and to realise the change from 'supply determines demand' to 'demand guides supply', which improves the ability to accurately provide public services [13]. In addition, information technology also helps the government to build a highly efficient, collaborative, open, and shared governance platform, and through system integration and overall optimisation, it promotes the transformation of the governance model from departmental single-handedness to overall coordination and linkage [14], and enhances the government's overall governance capability. Finally, the application of information technology also helps to strengthen government transparency and public participation; through the e-government platform, the public can more conveniently access government information and services, and participate in

policy discussions and social supervision [15], which contributes to the construction of the rule of law government, clean government, and service-oriented government. In summary, information technology not only enhances government efficiency and service quality, but also facilitates fundamental changes in the structure and operation of government governance [16].

However, more and more researchers have found that the function of digitally driven urban governance is not limited to the government platform, but rather it has contributed to the overall governance efficiency. In this context, the concept of digital governance has been proposed as a new model of government governance that integrates digital technologies and governance theories and is centred on public participation. Mirakovic, a professor of political science and public administration at the University of Miami, pointed out in his book *Digital Governance: New Technologies for Improving Public Service and Participation* that digital governance is a citizen-centred approach to government at all levels to achieve the goals of economic recovery, strategies to reduce costs, and meet citizens' expectations [17]. Governance based on digital intelligence not only has the 'instrumental rationality' of technological logic, which helps to improve the scientific, precise, efficient, and experiential urban governance, but also has the 'value rationality', which helps to promote the pluralism, transparency, and democratisation of urban governance, and thus achieve inclusive governance. At the same time, it also has 'value rationality', which helps to promote the diversification, transparency, and democratisation of urban governance, thus achieving inclusive development and high-quality development [18]. Considering this, many researchers have paid more specific attention to the fact that the digital process has brought about a full range of changes in the urban environment, economy, and social relations, and thus triggered completely new governance challenges, such as digital infrastructure, transportation, labour relations, public safety, and other issues. For example, the rise of the digital economy has changed the way value is created and distributed, giving rise to new city-based labour production relations (e.g., urban delivery takeaways), and the rapid development of digital technologies has triggered challenges in privacy protection and data security. With the continuous development of digital technology, the continuous expansion of application scenarios, and the pluralism and variability of the objects and subjects of urban governance, the concepts, methods, structures, systems, and processes of urban governance are also dynamically changing and evolving. The theory of digital governance provides a new research perspective for urban governance. Dunleavy (2006) earlier put forward the concept of 'Digital Era Governance' (DEG) [2], which believes that digital governance is a movement in the digital era of the whole society, but digital governance is not only about the digitisation of the internal government agencies. Digital governance refers to the digital empowerment of the governance system and governance capability, with the construction of a new type of governance system as the goal, under the leadership of the government, the platform and enterprises, social organisations, network communities, individual citizens and the multiple other subjects who participate in the relevant affairs of the institutional arrangements and the ongoing process [11]. The main elements of governance include the governance subject, governance means, governance process, governance evaluation, and so on [19]. From the viewpoint of governance subjects, governance subjects are more diversified, including the collaborative governance of the government, the market, social organisations, and individual citizens. In the process of digital governance, the government not only has to play a leading role, but also needs to guide platform enterprises, social organisations, individual citizens, and other orderly participation in governance. From the viewpoint of governance means, while emphasising traditional policies, laws, regulations, and justice, including a variety of administrative means, as well as price mechanisms, competition mechanisms, incentives and other diversified market mechanisms, it should also highlight the advantages and roles of big data, artificial intelligence, platforms, and other digital means. From the perspective of the governance process, urban digital governance needs to adhere to the combination of 'top-down' and 'bottom-up' feedback processes, and to give full consideration to the role

of the 'bottom-up' feedback mechanism and the joint participation of multiple subjects. The role of the 'bottom-up' feedback mechanism and the joint participation of multiple subjects should be given full consideration [20]. From the point of view of governance evaluation, the content of the evaluation should be oriented to human needs, fully reflecting the refinement and precision services brought about by digital governance.

In comparison, the era of e-government mainly focuses on using information technology to provide public services and manage public affairs, such as government websites, microblogs, weChat, and other e-government applications [21]. The era of digital governance emphasises the application of advanced technologies such as big data, artificial intelligence, and machine learning, providing intelligent support for government decision-making and management through data analysis [22]. In the era of e-government, the relationship between government and society is relatively one-sided, mainly focusing on the government providing services and information to the public. In the era of digital governance, the relationship between government and society is closer and more interactive [23]. The government is committed to creating an open, inclusive, and collaborative innovation governance ecosystem. More precisely, in the era of digital governance, technology has driven the formation of a digital ecosystem, achieving the goal of multi-party interaction and multifunctional implementation [24]. For example, when the transportation department discovers an abnormal increase in traffic flow in a certain area, it can promptly notify the public security department to strengthen security patrols in that area, and at the same time notify the environmental protection department to monitor whether the air quality in that area is affected. This data-sharing and collaboration mechanism can ensure informational flow and cooperation among various government departments, and improve the efficiency and accuracy of government services; for example, after upgrading traditional government platforms, AI can be used to interact and communicate with users, and data can be pushed to relevant departments in the background, which not only improves work efficiency but also supports the scientific implementation of big data decision-making.

With the continuous development of digital technology and the continuous expansion of application scenarios, digital governance issues will be more complex, dynamic, multidimensional and variable [25]. However, regarding urban digital governance, both theoretical and practical research are still in the initial stages, and the scientific connotation, theoretical innovation, institutional innovation, policy innovation, technological innovation, and application practice of urban digital governance are yet to be studied in depth [26]. More importantly, or more specifically, it can be found from the existing research that the study of digitally driven urban governance has risen to the height of digital governance [27], and researchers have paid extensive attention to the instrumental significance as well as the value significance that digitalisation has brought to urban governance, but there are people who have constructed a framework for evaluating the ability of digitally driven urban governance from the theoretical level, and there is a lack of empirical measurements at the empirical level. In the few empirical studies that exist, researchers often only consider the supporting role of information infrastructure or government service platforms for urban governance [28,29]. For example, the International Telecommunication Union considers urban digital governance (ICT access, ICT use, ICT skills) from a purely technical perspective [30], the World Bank selects dimensions such as information infrastructure, network connectivity, data privacy, and security [31], and the United Nations Conference on Trade and Development (UNCTAD) considers Internet use from a purely technical perspective. Secure Internet servers, postal reliability, infrastructure, payment methods, legal frameworks, and other dimensions are evaluated [29]. In contrast, in recent years, more Chinese researchers have begun to pay attention to other factors besides technology and facilities. For example, some researchers have investigated the situation of digital governance from the dimensions of the basic carrier, customs environment, financial services, and technical support [32]. The downside is that these studies fail to look at digital governance from an ecological perspective, and therefore invariably miss out on factors that play a key role in reality. In addition, the existing studies often use the entropy method

in empirical methods, which is mainly based on the degree of data dispersion to determine the weight of attributes, which may lead to ignoring the correlation between attributes and the actual meaning of attribute values. This simplified processing of information may cause some important information to be left out, resulting in incomplete decision analysis. In addition, the weight determined by the entropy method is fixed, which lacks flexibility and adaptability in analysis. These are the key problems to be solved in this paper.

3. Theoretical Analysis and Research Methods

3.1. Theoretical Analysis

This study argues that the empowerment that digitalisation brings to urban governance is all-encompassing, and the needs derived to achieve this are also all-encompassing. Specifically, the realisation of urban digital governance contains not only the need for hardware equipment, but also a series of supporting conditions to support it. These conditions can be more deeply perceived and inspired through the ecosystem theory.

The ecosystem is a core concept in the field of biology [33]. In the early 1990s, scholars gradually introduced the concept of the ecosystem into the field of business research, and considered that the business ecosystem is an interactive consortium between multiple sectors in the market, which consists of multiple subjects in the market and the external environment [34]. Among them, the external environment consists of the infrastructure environment, the market transaction environment, the labour force environment, and the government service environment [35]. The effective support of the external environment is the key to the sustainable development of each market subject within the ecosystem [36]. Similarly, the impact of digital technology on urban governance is profound and all-encompassing, and its related subjects are engaged in activities in the ecosystem composed of various external environments such as the governmental governance environment, the legal and regulatory environment, the macroeconomic environment, the talent supply environment, the market transaction environment, etc., and these environments constitute the so-called digital ecosystem [37]. At the same time, the digital governance environment constructed based on the ecosystem theory focuses more on the external environmental variables which the market subject is located in and the possible impact of the interrelationships between the various environments on the market subject [38]. This is because digital economy market players are affected by the influence from the government's digital strategy, the influence of digital infrastructure, the support from the innovation and market environment, the constraints from the data and security environment, the constraints from the government's regulation and services, and the support from the supply of digitalised talents throughout their lifecycle of establishment, development, maturity, and decline. Therefore, these six environments constitute the core ecological conditions for digital economy market players to engage in business activities. The importance of these six environmental indicators has shown a lot in reality. For example, Zhejiang Province attaches great importance to strategic support, infrastructure and government affairs development, and has launched a mobile government service platform such as "Zheli Office", and a smart city management system such as "City Brain", which not only provides convenient online government services for citizens, but also realises real-time monitoring and intelligent early warning of the city's operating status, especially during the COVID-19 epidemic; Guangdong Province attaches great importance to Safe environment, Talent support, and Market environment, and has created a fully intelligent monitoring platform for digital finance and a data element trading market. With the support of high-quality talents, it has achieved important results in financial risk prevention and control and digital economy development year after year.

In order to more clearly analyse the mechanism relationship of digitalisation that is driving urban governance, we drew the mechanism diagram (see Figure 1). Specifically, from the ecological perspective, the urban digital governance system is a large ecosystem, including seven dimensions, namely the strategic support, infrastructure, industrial support, the security environment, government development, talent support, and the market

environment. From the perspective of the relationship between various subjects, strategic support is the original driving force to promote digital technology to empower urban governance; infrastructure is the material foundation, ensuring the material carrier supply of digital technology; industrial support is the endogenous driving force, catalysing the value of digital technology and contributing to the ecological cycle; government development is crucial in realising the direct docking or resource exchange between the government, enterprises and citizens; the talent market is a long-term support to ensure that the whole ecology can receive a steady stream of intellectual support; the safe environment is the basic guarantee to ensure the safety and stability of the entire ecosystem; and the market environment is the ecological climate, ensuring that this ecology has the attraction of gathering various elements.

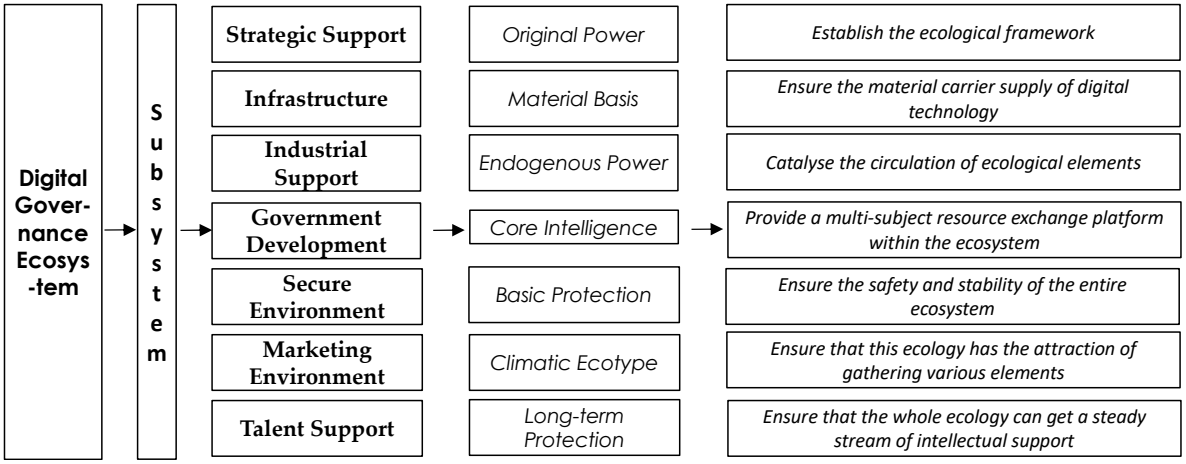

Figure 1. Mechanism map of the digitalisation driving urban governance from the perspective of the ecosystem. Source: Author's calculations.

Based on the above theoretical analysis and combined with the actual situation in China, this study makes the following assumptions: (1) China's overall capability of digital governance is not strong and is still in its initial stage. (2) Based on the previous focus of digital governance work, the development of China's digital infrastructure and government affairs has obvious advantages compared with other indicators. (3) There is a large gap between the digital governance capabilities of provinces and regions in China. In order to carry out further empirical analysis, the secondary indicators of each indicator and the selected data sources are specifically defined in this study, as shown in Table 1. The values in the table are the calculated results of the weights of each indicator.

Table 1. Evaluation system construction for digitally driven urban governance.

Primary Indicators	Secondary Indicators	Abbreviation	To Evaluate the Content	Data Sources
Strategic support (7.12%)	*Digital policy*	A1	Frequency of government policy words (3.32%)	CNRDS China Research data service platform economic characteristic database
	Financial support	A2	The portion of science and technology expenditure in general public budget expenditure (3.81%)	China Statistical Yearbook

Table 1. *Cont.*

Primary Indicators	Secondary Indicators	Abbreviation	To Evaluate the Content	Data Sources
Infrastructure (22.93%)	*The use of a computer*	B1	Number of Internet users per 100 people (3.22%)	China Statistical Yearbook
	Mobile phone popularisation	B2	Mobile phone penetration rate (3.37%)	China Statistical Yearbook
	Internet applications	B3	Internet broadband access port (3.43%)	China Statistical Yearbook
	Realm name	B4	Internet domains (5.98%)	Statistical report on Chinas Internet development survey
	Website	B5	Number of websites by province (6.02%)	Statistical report on China's Internet development survey
	IPv6 application	B6	IPv6 Composite Development Index (0.91%)	The National IPv6 Development Monitoring Platform
Industrial support (16.88%)	*Information technology industry*	C1	Software business revenue (7.61%)	China Statistical Yearbook
	Digital market demand	C2	E-commerce sales volume (6.23%)	China Statistical Yearbook
	Digital financial inclusion	C3	Digital financial inclusion (3.04%)	Peking University Digital Financial Inclusion Index Report
Safe environment (14.89%)	*Personal data protection*	D1	Big Data Security Index (3.90%)	Chinas big data security index analysis report
	Information safety	D2	Information security revenue (10.99%)	China Statistical Yearbook
Government affairs development (8.93%)	*Digital organisation*	E1	Party and government organisations and social organisations of digital government development (1.87%)	The Digital Government Development Index report
	Digital system	E2	Policies and measures related to digital government development (1.69%)	The Digital Government Development Index report
Governmental internal closed department panel	*Governance capability*	E3	Platform management, data opening, government services and civil affairs interaction (2.56%)	The Digital Government Development Index report
	Governance effect	E4	Coverage, penetration, response and satisfaction of the digital government function carrier (2.82%)	The Digital Government Development Index report
Talent support (18.41%)	*Education level*	G1	Number of undergraduate and graduate students in the total population (1.99%)	China Statistical Yearbook
	Information service industry employment	G2	The proportion of information service industry employees in the employed population (6.82%)	Official website of each provincial statistics bureau

Table 1. *Cont.*

Primary Indicators	Secondary Indicators	Abbreviation	To Evaluate the Content	Data Sources
Talent support (18.41%)	*Scientific research and technology services employment*	G3	Proportion of employees in scientific research and technical services in the employed population (4.83%)	Official website of each provincial statistics bureau
	Labour costs	G4	Average salary of employees in the information services industry (4.77%)	China Statistical Yearbook
Market environment (10.83%)	*Open to the outside world*	I1	Investment by foreign-invested enterprises (5.01%)	China Statistical Yearbook
	Economic development level	I2	Per capita GDP (4.33%)	China Statistical Yearbook
	The degree of marketisation	I3	Urban marketisation level (1.48%)	China by province market index report

3.2. Research Methods

In this paper, we refer to the relevant practises of Ma D [39] and Chen L [40], etc., and adopt the utility value method to measure the capability index score of digitally driven urban governance. Specifically, the data are first standardised using the extreme variance method, followed by the coefficient of variation method to calculate the weights, and finally, all the scores are weighted and combined to arrive at the composite score of each province.

3.2.1. Data Standardisation

The data sources of this study can be found in Table 1. In order to present the overall picture of indicators in the digital governance ecology as comprehensively as possible, this study selects the cross-sectional data of various provinces in China in 2023 to carry out empirical analysis, because the data of this year is the latest and most comprehensive and most consistent with the research framework. In the evaluation system of this paper, there is a large quantitative difference in the second-level evaluation indexes. In order to solve this problem, this paper adopts the extreme difference method to standardise the raw data. The advantage of the range method lies in its lower sensitivity to outliers (i.e., extreme values) compared to other standardised methods. Therefore, in some datasets containing outliers, the range method can still maintain good stability; at the same time, it can effectively eliminate the dimensional differences between different indicators, making them comparable, which is of great significance for multi-indicator comprehensive evaluation and data analysis. Since the indicators are all positive indicators, this paper selects the following equation to deal with the relevant data:

$$y_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \times 100 \quad (1)$$

where x_{ij} denotes the original value of the jth indicator in the ith district, and y_{ij} denotes the standardised indicator value, $I \in (1, N)$, $j \in (1, K)$. The values of max x_{ij} and min x_{ij} represent the maximum and minimum values of x_{ij}. The indicators in the evaluation system are chosen to be set positively, i.e., the higher the value, the better the condition of the digitally driven urban governance that is represented.

3.2.2. Calculation of Weights

The coefficient of variation method uses the information contained in each indicator directly and obtains the weight of each indicator through calculation. It evaluates the

degree of variation in data by calculating the ratio of the standard deviation to the mean, so it is not affected by the data unit and can be used for the data analysis of various units; Since the coefficient of variation is a relative value, it can be used for comparing data of different orders of magnitude, thereby more objectively reflecting the degree of variation in the data. Its has the advantage of calculating the weights objectively rather than subjectively assigning them, so it is more scientific than the subjective method. In terms of the specific calculation process, the standard deviation of the *j*th indicator in the Nth region is first divided by the mean value of the indicator in that region (see Equation (2), where $V(j)$ represents the value of the coefficient of variation of an indicator, s_j represents the standard deviation of the *j*th indicator for the *n*th region, and x_j represents the average value of the indicator in this area), and the value of the coefficient of variation is then derived initially.

$$V(j) = s_j / \overline{x}_j \tag{2}$$

Subsequently, the weights of the indicators were calculated by dividing the resulting coefficient of variation values by the sum of the overall coefficients of variation. Then, the calculated weights are multiplied by the corresponding y_{ij} values to arrive at the scores for each region and each of the secondary indicators (see Equation (3), where w_j represents the weight of each indicator). The scores of all the secondary indicators are totalled to give a final score for each of the seven primary indicators.

$$w_j = V(j) / \sum_{j=1}^{K} V(j) \tag{3}$$

Finally, the overall score of region *i*, u_i, is calculated, and the higher the value of u_i, the higher the region's ability to drive urban governance with digitalisation (see Equation (4), where u_i represents the overall score of region *i*, P_{ij} is obtained by multiplying y_{ij} and w_j, which represents the comprehensive score u_i of the evaluated region *i*. The larger the value of u_i, the better the digital business environment of the region).

$$u_i = \sum_{j=1}^{K} P_{ij} \tag{4}$$

This paper is based on a sample of 31 provinces, municipalities, and autonomous regions in mainland China, and the data sources are detailed in Table 1.

4. Results of the Capability Evaluation of Digitally Driven Urban Governance with Comparative Analysis

4.1. Analysis of the Overall National Situation

This paper calculates the overall score of China's digitally driven urban governance capability evaluation. In the results presented in Table 2, the total score of China's digitally driven urban governance evaluation is 27.25, showing that China's digitally driven urban governance is in the beginning stage of its development, and there is still much room for improvement. This is mainly due to the fact that China only formally proposed the macro-strategic concept of building a "digital China" in 2017, and included "accelerating digital development" and building a "digital China" in the "14th Five Year Plan" in 2020. Although a series of policies were later released in quick succession, the time period was relatively short, and the digital governance system has not yet been fully developed. In terms of the secondary indicators, the scores of infrastructure development and government affairs development are relatively high, at 6.88 and 4.74, respectively, which stems from the strong promotion by the government in recent years. It also indicates that China has a relatively solid foundation in the era of e-government. However, the focus is more on informatisation, represented by network facilities' renewal and government system iteration, while the promotion of new technologies and concepts such as digitisation has only just begun, so the

score for strategic support is only 2.61, which needs to be further strengthened. Meanwhile, the digital security environment score is only 1.82, the lowest among the seven secondary indicators. As for the other indicators, the score of talent support is 4.13, which is in the middle of all the secondary indicators; the scores of industrial support and market environment indicators are 3.46 and 3.60, respectively, which to a certain extent shows the inadequacy of industrialisation and marketisation in promoting the construction of digitally driven urban governance, and indicates that the construction of digitally driven urban governance in China is still mainly driven by the administration. Moreover, in the process of leading e-government, the government has focused on the accumulation of hardware infrastructure and the construction of government platforms, using "technical thinking" rather than "ecological thinking" to carry out work, resulting in significantly lower scores for other indicators outside of infrastructure and government platforms.

Table 2. Combined scores for the evaluation of digitally driven urban governance capability.

Strategic Support	Infrastructure	Industrial Support	Secure Environment	Development of Government Affairs	Talent Support	Market Circumstances	Total Points
2.61	6.88	3.46	1.82	4.74	4.13	3.60	27.25

4.2. Analysis of the Situation by Province

In terms of specific provincial scores (see Table 3 on the following page for details), the top six provinces in terms of national scores for digitally driven urban governance capability are Beijing, Guangdong, Shanghai, Jiangsu, Zhejiang, and Shandong. In-depth analysis of the six provinces' advantageous score indicators can be found below, and each province has shown a differentiated development style and advantages: Beijing belongs to the comprehensive advantage type; in addition to the strategic support indicators, its other secondary indicators of digitally driven urban governance ranked among the top three in the country. Guangdong belongs to the "strategy + industry" leading type, with strategic layout and industrial quality development for digitally driven urban governance. Guangdong is a 'strategy + industry' pioneer, with its strategic layout and high-quality industrial development laying a good foundation for digitally driven urban governance. Shanghai is 'government + market' oriented, with obvious advantages in market-based and digital government reform. Jiangsu is more market-industry synergistic, and pays more attention to the security environment, but is relatively weaker in other aspects. And, Zhejiang has similar advantages to those of Beijing, but all its other indicators are ranked among the top three in the country. Zhejiang has similar strengths to those of Beijing, but ranks several places below Beijing in all indicators and has shortcomings in the security environment. In contrast to the above provinces, Shandong's strengths in digitally driven urban governance are similar to those of Jiangsu, with only a small difference in rankings between the two in terms of strategic support, infrastructure, industrial support, and the security environment. In particular, Beijing, Shanghai, and Guangdong rank among the top three provinces in several dimensions, demonstrating their leadership roles in digitally driven urban governance across the country.

The distribution of provincial scores shows that there are large regional differences between the digital governance capabilities of the provinces, with a difference of more than 27 points between Beijing, which scored first highest, and Guangdong, which scored second highest, and with the remaining provinces scoring less than 60 points, with most of them fluctuating around 28 points. Tibet, Qinghai, Xinjiang, Heilongjiang, and Ningxia have the worst scores, ranking in the bottom 5 of the 31 provinces.

Table 3. Scores of China's inter-provincial digitally driven urban governance capability evaluation.

	Strategic Support		Infrastructure		Industrial Support		Secure Environment		Development of Government Affairs		Talent Support		Market Circumstances		Overall Situation	
Province	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Total Points**	**Ranking**
Beijing	3.88	8	14.75	2	15.56	1	14.89	1	7.28	2	17.19	1	7.61	3	81.16	1
Tianjin	2.58	17	4.49	21	2.61	13	2.30	7	5.97	10	6.22	5	4.18	12	28.35	11
Hebei	1.65	23	7.90	10	0.77	25	1.97	9	5.06	14	3.43	12	3.46	16	24.24	16
Shanxi	1.73	22	5.01	19	1.37	20	1.65	11	4.51	18	1.58	31	1.69	22	17.54	20
Nei Monggol	0.17	31	2.56	28	1.20	22	1.58	12	4.04	21	1.95	28	2.17	18	13.66	25
Liaoning	0.68	30	5.06	18	2.35	14	2.39	6	3.55	24	3.28	13	2.07	19	19.37	19
Jilin	2.02	18	2.25	29	0.85	24	1.68	10	2.60	27	2.53	19	1.81	20	13.73	24
Heilongjiang River	0.68	29	3.14	27	0.68	27	1.15	18	3.20	26	1.82	29	1.12	28	11.80	28
Shanghai	3.95	6	8.11	9	10.83	3	2.72	4	7.39	1	11.58	2	8.98	2	53.55	3
Jiangsu	3.23	9	13.47	3	8.38	4	4.00	3	5.51	12	5.67	6	9.42	1	49.68	4
Zhejiang	4.74	3	12.74	5	7.74	5	1.48	13	7.09	3	6.87	4	6.08	5	46.75	5
Anhui	4.69	4	7.33	11	2.83	11	1.18	17	6.46	6	2.29	24	5.46	8	30.24	10
Fujian	2.79	13	13.20	4	3.89	7	1.19	16	6.03	8	2.67	16	4.13	13	33.92	8
Jiangxi	2.71	16	5.24	17	1.79	17	0.92	20	5.29	13	1.96	27	4.62	11	22.53	17
Shandong	3.02	10	12.21	6	6.94	6	4.77	2	6.13	7	3.16	14	5.50	7	41.73	6
Henan	5.25	2	10.09	7	2.15	15	0.98	19	4.01	22	2.62	17	5.19	9	30.29	9
Hubei	2.93	12	6.38	13	3.47	9	1.21	15	4.57	16	4.10	10	4.67	10	27.32	12
Hunan	2.76	14	6.51	12	2.06	16	0.75	21	4.52	17	2.53	18	5.88	6	25.02	14
Guangdong	6.13	1	19.42	1	13.90	2	2.28	8	6.96	5	9.43	3	7.13	4	65.24	2
Guangxi	1.01	28	5.42	16	1.55	18	0.56	22	4.26	20	2.33	23	1.19	27	16.32	21
Hainan	2.72	15	4.11	23	1.52	19	0.51	23	5.61	11	5.38	8	1.72	21	21.58	18

Table 3. *Cont.*

	Strategic Support		Infrastructure		Industrial Support		Secure Environment		Development of Government Affairs		Talent Support		Market Circumstances		Overall Situation	
Province	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Score**	**Ranking**	**Total Points**	**Ranking**
Chongqing	3.95	7	5.57	15	3.24	10	1.41	14	5.98	9	3.68	11	2.88	17	26.70	13
Sichuan	4.14	5	10.04	8	3.79	8	2.42	5	7.01	4	4.53	9	3.52	15	35.46	7
Guizhou	1.60	24	5.01	20	1.02	23	0.50	24	4.82	15	1.75	30	1.32	24	16.04	22
Yunnan	1.23	25	3.57	25	1.21	21	0.42	26	3.83	23	2.38	22	1.45	23	14.10	23
Xizang	1.08	27	0.93	31	0.57	28	0.37	27	1.65	30	2.73	15	0.45	31	7.79	31
Shaanxi Province	1.88	19	5.71	14	2.73	12	0.43	25	4.42	19	5.46	7	3.71	14	24.34	15
Gansu	1.73	21	4.25	22	0.53	30	0.35	28	3.48	25	2.14	25	0.78	30	13.25	26
Qinghai	1.13	26	1.87	30	0.41	31	0.25	29	2.43	28	2.43	20	1.00	29	9.52	30
Ningxia	1.86	20	3.61	24	0.55	29	0.12	30	2.28	29	2.39	21	1.22	26	12.03	27
Xinjiang	2.99	11	3.46	26	0.69	26	0.06	31	0.99	31	2.07	26	1.30	25	11.57	29

Source: Author's calculations.

In order to more intuitively present the scores of different provinces, this study made heat maps, and marked them with different colours according to the scores of different provinces (see Figure 2). From the colour distribution on the figure, it can be seen more intuitively that the digital governance ability of the eastern coastal region of China is significantly higher than that of the central region, and that of the central region is significantly higher than that of the western region, especially for Tibet and Qinghai. This figure more directly shows the strong imbalance between China's inter-provincial digital governance capabilities.

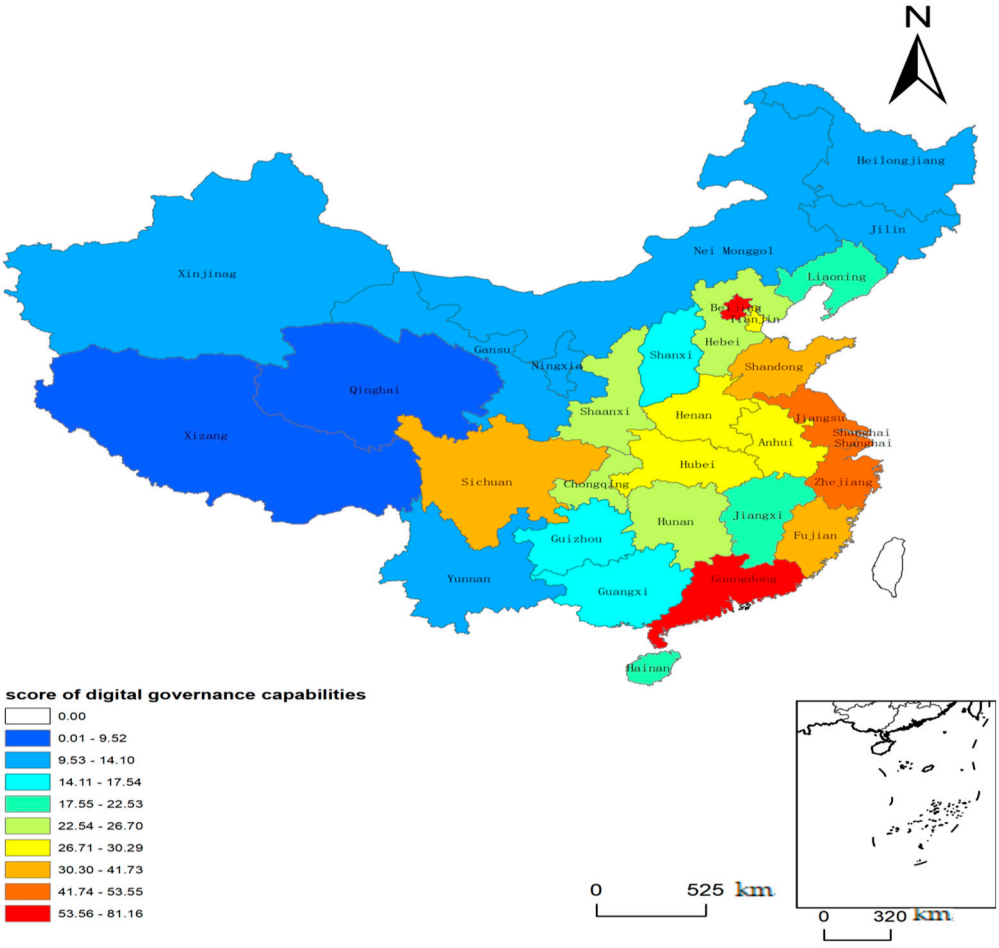

Figure 2. Heat map of empirical scores of digitally driven urban governance capability in China. Note: The above maps are based on the standard map No. GS (2020) 4619 from the standard map service website of the Ministry of Natural Resources, and the base map has not been modified.

4.3. Sub-Dimensional Analysis

In order to present a more detailed picture of the differences in the abilities of Chinese provinces to digitally empower government governance, this study further analyses the scores of the sub-dimension indicators in a comparative inter-provincial manner. As seen in Table 3, in terms of the strategic support indicator, Guangdong, Henan, and Zhejiang provinces score 6.1, 5.25, and 4.74, respectively, showing a clear lead, while the scores of the other provinces are mostly located in the range of 0–2, with a large difference in the scores of the above three provinces. Since this study uses cross-sectional data, this means that the above three provinces, in the same year, have reached a high level of attention to digitisation. In terms of infrastructure indicators, Guangdong, Beijing, and Jiangsu provinces score 19.42, 14.75, and 13.47, respectively, showing strong support for information infrastructure investment. In terms of the industry support indicator, Beijing, Guangdong, and Shanghai rank in the top three, with scores of 15.56, 13.9, and 10.83, respectively. This indicator has

the largest gap in provincial scores among all indicators, with all provinces except Jiangsu (8.38), Zhejiang (7.74), and Shandong (6.94) scoring less than 4, with most of them spreading out in the range of 0–2, once again proving from the data at the provincial level that China's ability to digitally empower government governance has not yet reached a market- and industry-driven level. In terms of security environment indicators, Beijing (14.89) is the only province with a score of more than 10, while all other provinces have scores in the 0–5 range, demonstrating the inadequacies of each province in the field of digital security, which has left a security risk that should not be ignored in digitally enabled government governance. In terms of government development indicators, provinces generally score high and have a small amount of variance. This is mainly due to the fact that since the creation of the e-government, provinces have always continued to improve their e-government platforms, and since there is a strong, cross-regional knowledge spillover effect between provinces, large development gaps have been avoided through mutual learning. In terms of the indicator of talent support, it is still Beijing, Shanghai, and Guangdong that rank among the top three in the country, and they show a more pronounced score difference compared to other provinces. Guangdong, which scored third highest (9.43), is 1.37 times higher than Zhejiang (6.87), which scored fourth highest, with a difference of more than 2.6. In terms of the market environment indicator, Jiangsu, Shanghai, and Beijing are among the top three in the country, but none of them scored more than 10 points. Based on the indicator settings in Table 1, this means that the degree of openness to the outside world, the level of economic development, and the degree of marketisation in each province need to be further improved to be more conducive to digitally enabled urban governance.

The reasons for the significant differences in sub-dimension scores among provinces are complex. Firstly, due to the differences in development endowments among provinces, China's regional economic development has always shown a division of developed eastern regions and relatively lagging central and western regions. Therefore, there are significant differences in the speeds of digital governance initiation and the amounts of available resources, as well as differences in facility construction and marketisation levels. For example, Xinjiang, Xizang, and other regions have low scores in various indicators, which is obviously constrained by their regional economic development level. Secondly, each province has different levels of emphasis on indicators of different dimensions, so there are some emphases in the development process. For example, Guangdong places more emphasis on industrial support, while Shanghai places more emphasis on talent support. Thirdly, some indicators are quite unique, such as the need for a very long cycle for the cultivation of digital governance talents. In the current situation where the stock of digital talents in China is limited, provinces such as Beijing and Shanghai have shown strong talent syphon effects, resulting in lower scores for other cities.

4.4. Analysis of the Balanced Degree of Digitally Enabled Urban Governance

Considering that there may be a large difference in strength between the scores of the various secondary indicators, in order to more accurately reflect the degree of balance of the secondary indicators of digitally driven urban governance in each province, this paper adopts the standard deviation of the rankings of the seven sub-environments in each province to measure the degree of balanced development, and the smaller the standard deviation indicates that the degree of balanced development of digitally driven urban governance in the province is higher. As seen in Figure 3, the ranking of the total score of digitally driven urban governance in each province basically maintains the opposite trend to the sub-environmental balance score, i.e., the higher the total score, the lower the degree of balance. This means that since the development of digitally driven urban governance in China is at an early stage, the overall digitally driven urban governance strength tends to be pulled by one or several key strength indicators, or the overall strength is strong but one indicator is significantly lower than the average of other indicators. In short, a state of strong equilibrium has not yet been achieved. At the same time, it can also be seen in Figure 3 that the Xinjiang, Qinghai, and Tibet provinces have lower balance scores for

secondary indicators, which indicates that these three provinces have a high degree of developmental balance for each secondary indicator; however, this balance comes at the cost of low developmental strength, i.e., the indicators generally score low, and have not yet formed a large score difference, nor is it an ideal state of development.

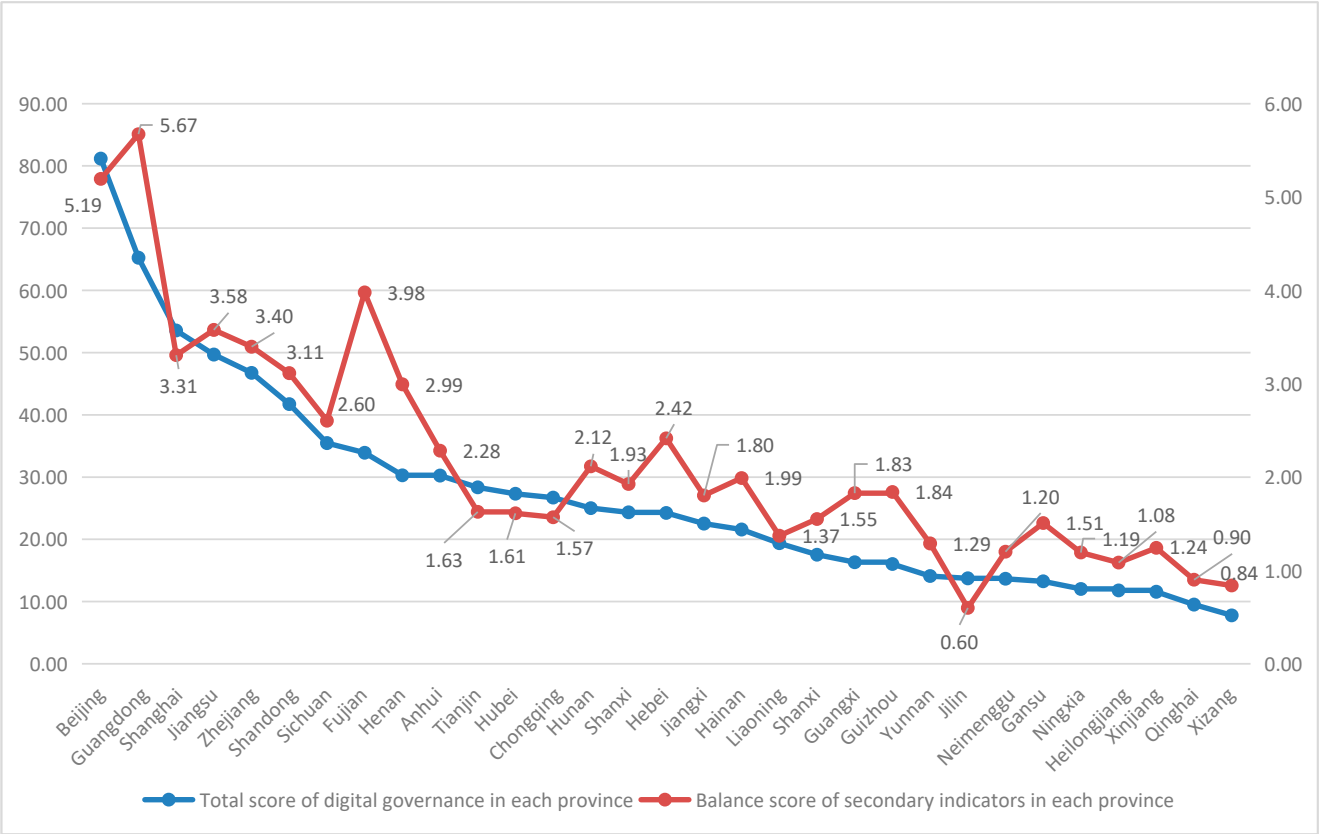

Figure 3. Balance of digitally driven urban governance sub-environments by province (used to determine whether the development of seven secondary dimensions in a city is balanced). Source: Author's calculations.

4.5. Diagnosis of the Obstacle Degree of Digitally Driven Urban Governance Capability Enhancement

The obstacle degree model can calculate the obstacle degree of each evaluation indicator in the comprehensive evaluation, find out the key factors that restrict the further development of things, clarify the factors that have a major impact on the evaluation results, make the degree of influence of key constraints clear, and provide a quantitative basis for scientific response. In order to further determine the specific indicators that constrain the improvement of digitally empowered urban governance capability, this study constructs an obstacle degree model to deepen the study.

4.5.1. Barrier Analysis Model

The obstacle analysis model consists of three indicators, namely factor contribution, indicator deviation, and obstacle degree, and ultimately identifies the core constraints according to the size of obstacle degree. The core constraints are identified according to the size of the obstacle degree.

(1) Calculate factor contribution F_j:

$$F_j = r_p w_j \tag{5}$$

where r_p is the first-level weight, derived by summing the weights of the second-level indicators, $p \in (1, P)$, and P is the number of first-level indicators. w_j represents the weight of each indicator.

(2) Calculate the index deviation degree H_{ij}:

$$H_{ij} = 1 - y_{ij}/100 \tag{6}$$

where y_{ij} denotes the standardised indicator value.

(3) Calculation of the degree of obstruction Q_{ij}:

$$Q_{ij} = \frac{H_{ij} \times F_j}{\sum_{j=1}^{K} H_{ij} \times F_j} \times 100\% \tag{7}$$

(4) Calculate the first-level index barrier degree Q_{ip}:

$$Q_{ij} = \sum Q_{ij} \tag{8}$$

where the summation range of j is all the secondary indexes contained by the *pth* primary index.

Factors with barriers greater than 20% are the core obstacle factors, factors with barriers between 15% and 20% are the main obstacle factors, and factors with barriers less than 15% are the secondary obstacle factors [41,42].

4.5.2. Analysis of the Obstacles to the Improvement of Digitally Driven Urban Governance Capability

According to the above formula, this paper first calculates the obstacles to the improvement of Chinas digitally driven urban governance capability, and the results are shown in Table 4. Among them, the barriers of industrial support and the safety of the environment exceeds 20%, which is the core obstacle restricting the development of Chinas digital business environment; the talent support barrier exceeds 15%, which is the main obstacle restricting the improvement of Chinas digitally driven urban governance capability; strategic support (13.21%), government development (11.04%), infrastructure (8.53%), and the market environment (7.70%) are secondary barriers restricting the improvement of Chinas digitally driven urban governance capability. This shows that China has obvious weaknesses in industrial support, the security of the environment, and talent support.

Table 4. Comprehensive scores of the evaluation of digitally driven urban governance capability.

Strategic Support	Infrastructure	Industrial Support	Secure Environment	Development of Government Affairs	Talent Support	Market Circumstances
13.21%	8.53%	22.36%	21.03%	11.04%	16.13%	7.70%

Source: Author's calculations.

4.5.3. Analysis of the Improvement of Provincial Digital Driven Urban Governance Capability

In this paper, the obstacles to the improvement of inter-provincial digitally driven urban governance capability are diagnosed, and the results are shown in Table 5. Among them, the frequency is 10 times greater than 20%, indicating that the safety of the environment is the core obstacle factor restricting the improvement of digital governance capability in 10 provinces, such as Anhui and Tianjin, and the frequency of industrial support barriers greater than 20% is 8, indicating that 8 provinces such as Beijing, Tianjin, and Liaoning lack sufficient digital industry support. In this case, the development of digital technology and the realisation of digital strategy all need the support of related industries to be realised. Regarding talent support, Shanghai, Shandong, Fujian, and five other provinces have talent support barriers that score more than 20%, equating to a frequency of 10, which means that in recent years China's infrastructure construction and government affairs platform

construction have made great improvements, however, due to the longer period of time, this has lead to digital-related talent being scarce, and has restricted the digitally driven urban governance ability.

Table 5. Diagnosis results of obstacles to the improvement of inter-provincial digitally driven urban governance capability in China.

Province	Strategic Support	Infrastructure	Industrial Support	Secure Environment	Development of Government Affairs	Talent Support	Market Circumstances
Beijing	22.52%	4.21%	20.38%	18.92%	8.07%	8.14%	17.76%
Tianjin	13.01%	4.85%	20.35%	27.50%	11.01%	11.30%	12.25%
Hebei	14.72%	9.51%	18.73%	14.82%	13.81%	10.44%	17.98%
Shanxi	16.04%	4.72%	14.12%	21.80%	15.52%	9.67%	18.12%
Nei Monggol	18.45%	0.87%	12.55%	22.46%	12.14%	16.16%	17.37%
Liaoning	12.81%	8.99%	29.20%	9.94%	10.28%	12.85%	15.92%
Jilin	16.28%	11.52%	19.29%	17.04%	12.02%	4.88%	18.98%
Heilongjiang	21.57%	6.30%	17.04%	15.51%	14.65%	5.18%	19.75%
Shanghai	12.58%	11.97%	11.08%	12.20%	5.94%	29.93%	16.30%
Jiangsu	8.44%	16.98%	18.00%	11.00%	7.84%	21.36%	16.38%
Zhejiang	10.58%	16.61%	16.01%	14.64%	6.89%	18.02%	17.24%
Anhui	9.30%	12.28%	13.56%	24.17%	9.45%	14.28%	16.97%
Fujian	10.21%	10.47%	16.06%	17.56%	8.01%	21.81%	15.87%
Jiangxi	9.75%	10.54%	11.44%	26.09%	13.28%	11.35%	17.56%
Shandong	9.63%	12.18%	21.29%	9.44%	9.86%	21.96%	15.64%
Henan	12.30%	10.63%	11.25%	19.48%	18.39%	9.16%	18.78%
Hubei	8.61%	13.66%	19.28%	18.14%	11.31%	12.19%	16.80%
Hunan	10.74%	12.50%	16.05%	16.50%	13.03%	13.76%	17.43%
Guangdong	8.75%	18.64%	12.49%	9.57%	8.70%	24.81%	17.04%
Guangxi	16.57%	5.37%	13.88%	19.64%	15.04%	11.28%	18.22%
Hainan	12.79%	3.41%	1.75%	14.58%	4.56%	48.87%	14.05%
Chongqing	10.72%	8.43%	22.54%	18.39%	8.40%	15.98%	15.54%
Sichuan	12.03%	10.67%	23.96%	14.29%	11.30%	10.97%	16.77%
Guizhou	10.92%	7.53%	27.61%	23.19%	9.79%	4.93%	16.03%
Yunnan	15.70%	3.84%	20.97%	18.27%	13.81%	10.36%	17.04%
Xizang	17.96%	2.91%	9.47%	34.98%	9.07%	7.15%	18.46%
Shaanxi	13.92%	21.41%	12.25%	9.35%	12.34%	10.42%	20.30%
Gansu	15.86%	7.80%	17.40%	20.37%	14.31%	5.71%	18.54%
Qinghai	24.32%	5.26%	9.64%	23.31%	11.74%	4.97%	20.76%
Ningxia	17.96%	4.74%	10.46%	32.60%	9.33%	6.12%	18.78%
Xinjiang	16.65%	3.15%	12.10%	25.02%	15.89%	8.89%	18.30%
frequency (>20%)	3	1	8	10	0	6	2

Source: Author's calculations.

5. Conclusions

5.1. Main Conclusions

The evaluation of the capability of digitally enabling urban governance should not only be reflected in the evaluation of infrastructure construction, but should also give full consideration to the resources of industries, talents, markets, policies, and platforms necessary for the digital transformation of urban governance. This research innovatively uses the theoretical perspective of ecological analysis, takes the digital governance of various provinces in China as the research object, and builds the capability evaluation system of digitally enabling urban governance. This study found that the total score of China's digitally driven urban governance capability is low, indicating that it is in its initial stage of development, and there is still a lot of room for improvement. From the perspective of various secondary indicators, China's infrastructure construction and government platform construction are relatively sufficient. Compared with other secondary indicators, talent support for digital governance is at the middle level of the other secondary indicators. The scores of the industrial support and market environment indicators are relatively low, and the score of the digital security of the environment is the lowest. From the distribution of the scores of each province, there are large regional differences between the digital governance capability of each province. Except for Beijing, the digital governance capability of most provinces is obviously low, and the scores of Tibet, Qinghai, Xinjiang, Heilongjiang, and Ningxia are in the worst situation, ranking in the bottom 5 of the 31 provinces. From the perspective of the equilibrium degree of the development of different indicators in each province, the arrangement of the total score of digitally driven urban governance basically maintains the opposite trend to that of the sub-environment equilibrium score, that is, the higher the total score, the lower the equilibrium degree. Provinces with a strong digital governance ability are often driven by some dominant indicators, and there is a lack of provinces with relatively high scores in each indicator.

In order to further judge the specific indicators that restrict the improvement of digitally enabling urban governance capability, this study constructs the barrier model to deepen its research. The analysis results show that industrial support and safety environment barriers are the core barriers restricting the development of the digital business environment; talent support barriers restrict the improvement of Chinas digitally driven urban governance capability; strategic support, government development, infrastructure, and the market environment are the secondary barriers restricting the improvement of Chinas digitally driven urban governance capability.

5.2. Policy Recommendations

Firstly, innovate the existing digital governance evaluation system. To leverage the guiding role of evaluation system construction in urban digital governance, relevant departments of industry and information technology will introduce evaluation methods for urban digital governance. An evaluation system will be constructed from the levels of strategic support, infrastructure, industrial support, the security environment, government development, talent support, and the market environment to quantitatively evaluate the level of urban digital governance. Based on the evaluation results, the next step of financial special support will be determined to stimulate the enthusiasm for urban digital governance development.

Secondly, leverage the specific advantages of digital governance in each city, cultivate and promote the clustering, industrialisation, and scale of advantageous modules, and strive to provide market-oriented professional services to regions and even the whole country, thereby increasing the total supply of high-quality digital governance services nationwide.

Thirdly, implement the regional digital governance co-construction plan. Guide and encourage cities to explore collaborative development plans, including strategic coordination, data sharing, facility sharing, talent cultivation, and trading market construction,

based on economic alliances, economic co-construction belts, regional communities, and other carriers, in order to avoid redundant and inadequate construction.

Finally, enhance the cultivation of digital talents. Talent is the core element in promoting digital governance, so it is necessary to suggest a special industry cultivation plan, through the university professional directory adjustment, market trading standard construction, digital security legislation, a talent introduction subsidy plan, and to guide more resources to digital governance.

5.3. Limitation

In order to present a more comprehensive picture of dimensions of digitally enabled urban governance, this study has further carefully designed many third-level indicators under the second-level indicators (see Table 1). These indicators are more innovative and appear to be less common in previous studies but are very important. For example, to measure the development level of provincial government affairs, a digital organisation, digital system, and digital governance capability are adopted for empirical analysis; to measure industry support, in addition to the information technology industry income commonly used in existing research, indicators such as digital market demand and digitally inclusive finance are also adopted. However, the limitation is that, due to the high degree of innovation, these data can only be collected in various reports and yearbooks, and cannot be analysed in panels, so they cannot reflect the dynamic changes in digital governance capabilities of various cities over time. For example, a city may have consistently scored high, but due to special circumstances in that year, its score rapidly decreased, resulting in an underestimation of its digital governance capabilities; or, although a certain city has a low score, its growth rate may have been very fast in recent years, but this progress cannot be reflected in the existing evaluation framework. With the accumulation of relevant data, a cross-time comparative analysis can be attempted in the future to reflect the dynamic evolution of the digital governance capability of each province. Meanwhile, it is also possible to further broaden the research perspective and conduct longitudinal studies to investigate the interesting differences between "developing countries–developing countries" and "developing countries–developed countries". In addition, due to its easy dissemination and overflow characteristics, there may be a spatial correlation between the digital governance in different cities [43], which can also be focused on in the next step.

6. Discussion

In this paper, we aim to explore the digitally driven urban governance capability of China, and to elaborate on the evolution trend of government governance, from the e-government to digital governance, under the background of digital technology progress. Based on this, an innovative evaluation framework is proposed from an ecological perspective. This framework not only includes conventional e-government and digital infrastructure construction, but also takes into account various forces required for digital governance, such as the industrial foundation, policy support, security environment, and talent support. At the same time, the use of measurement methods such as the range method and the coefficient of variation method, through the comparative analysis of different cities between regions, as well as the comparative analysis of different dimensions within a city, has broadened the research perspective and greatly expanded the scope of the digital empowerment of government governance and the accuracy of evaluation. Based on this study, in the process of policy formulation and urban planning, China and similar developing countries should not only pay attention to the construction of traditional e-government platforms and information infrastructure, but they should also pay attention to the strategic support, industrial support, talent support, and the security environment needed to support the deep penetration of information technology into urban governance. At the same time, they should pay attention to the imbalance between regions and indicators within each city, and promote the digital construction of each city from an ecological perspective.

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Institutional Review Board Statement: This study is descriptive and analytical, involving no experimental manipulations on humans or animals, and no direct intervention in the rights and interests of any individuals or groups. According to local/national legislation, specific ethical review approval is not required for this study.

Informed Consent Statement: This study did not directly involve human subjects, and all data used were pre-existing statistical data or public datasets. Therefore, informed consent from any subjects was not obtained during the research process.

Data Availability Statement: The datasets presented in this study can be found in online repositories via China Statistical Yearbook. https://www.stats.gov.cn/sj/ndsj/ (accessed on 28 September 2024).

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