

Article

TOE Configuration Analysis of Smart City Construction in China Under the Concept of Sustainable Development

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Abstract: The construction of smart cities is an effective path for sustainable urban development. Determining how to build smart cities and choose effective development models has attracted attention from all walks of life. Consequently, determining how to promote the development of smart cities and how to choose effective development models has also attracted attention. This paper takes 77 prefecture-level cities in China as case studies to explore the impact of technology, organization, and environment on the high-level development of smart cities. In this study, the fsQCA (fuzzy set-based qualitative comparative analysis) method was used to explore the configuration effects of three types of factors. The main findings are as follows: Firstly, no single factor among the three categories is a necessary condition for the high development level of smart cities, indicating that relying solely on technological conditions cannot build high-level smart cities. Secondly, the path of development of a smart city can be summarized into three modes: Both organizational and industrial environment type, both governance and cultural environment type, and balanced development type. Finally, among the three modes, the government's digital governance capability and industrial environment play a crucial role in achieving a high level of development in smart cities. This article examines the development of smart cities from a systems perspective and provides useful, practical insights for the construction of smart cities.

Keywords: smart city; allocation of government attention; sustainability; fsQCA



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1. Introduction

According to predictions of the United Nations, by 2025, 68% of the world's population will reside in urban areas. The rapid pace of urbanization places immense pressure on urban infrastructure and services, including traffic congestion, energy shortages, housing deficits, aging infrastructure, inadequate healthcare, education challenges, and other issues [1]. In order to effectively alleviate the above pressures and promote sustainable urban development, the academic community has proposed the development concept of “smart cities” [2–4], which has attracted widespread attention from practitioners in urban research, regional and urban planning, environmental research, commerce, public administration, and other fields [5–7].

As defined in the Chinese Standard GB/T 37043-2018 [8] “Terminology for Smart Cities”, a smart city is characterized as an innovative urban area that utilizes information and communication technologies to unify different urban management systems. This integration facilitates the sharing of information resources and collaboration among diverse systems, optimizes urban operations and management, improves public services, and boosts residents' satisfaction and happiness, while also striving for sustainable development. Since 2013, China has had phases of pilot projects aimed at constructing smart cities, including all municipalities directly under the central government, vice-provincial-level cities, provincial capitals, and several other prefecture-level cities [9]. The “14th Five-Year Plan for National Economic and Social Development and the Long-term Goals for

2035” of the People’s Republic of China highlights the urgency to hasten digital societal advancements and adapt to emerging trends where digital technology becomes deeply integrated into social interactions and daily life. It also encourages innovation in public service delivery methods as well as social-operational models while aiming to create a digital lifestyle accessible to everyone. This provides guidance for the construction and development of smart cities in the new era. As of 2021, more than 700 cities and regions worldwide have proposed smart city construction plans, and more cities are embracing smart cities as a future development direction.

Smart city construction is the process of achieving efficient, convenient, comfortable, and sustainable development of cities. The construction of smart cities has become a major focus of attention in China and around the world [10,11]. The COVID-19 pandemic has led to a profound rethinking of the planning and construction of smart cities as people begin to explore how to support their efficient operations and respond quickly and intelligently to emergencies [12]. In recent years, cities in China have gradually explored various development paths with unique characteristics in their smart city initiatives. However, due to the varying plans and levels of development across different urban areas, it can be inferred that various factors affecting the growth of smart cities are interdependent and heterogeneous. To summarize the innovative experience of smart city construction in practice and to account for the heterogeneity of different construction paths, this paper analyzes the complex causal relationships between the synergistic effects of different factors and the level of smart city development from a configuration perspective. The aim is to explore the driving path for achieving high-quality development of smart cities [13].

Specifically, this study aims to address several key questions: What factors impact the level of smart city advancement? What are the configuration conditions for achieving a high-level development? Which conditions are more influential along different developmental trajectories? Drawing from the concept of smart cities and related research on urban construction, it is clear that the construction of smart cities requires the coordinated interaction of technological, organizational, and environmental factors. Therefore, this paper proposes a comprehensive analysis framework for the development level of smart cities based on the TOE analysis framework, combined with the actual development status of smart cities in China. On this basis, using 77 prefecture-level cities in China as sample cases, this study systematically analyzes the different configurations and influencing mechanisms of the smart city development levels that lead to differentiation between cities. The ultimate goal is to provide reference suggestions for characteristic plans of smart city construction and to contribute to understanding the driving path behind the development of smart cities.

2. Literature Review and Research Framework

2.1. Research Progress of Smart Cities

Scholars from various countries have conducted extensive research on how to construct smart cities and their effects. They consider smart cities to be an advanced form following digital cities and intelligent cities, involving the deep integration of informationization, industrialization, and urbanization [14]. Smart cities serve as a transformer for urban economic transformation and development, featuring new structures and development modes with novel elements, features, and content [15]. The construction of smart cities can bring numerous positive effects, such as reducing urban carbon emissions [16], promoting regional industrial development [17], increasing entrepreneurial enthusiasm and success rates [18], improving residents’ happiness and comfort [19], and enhancing the social governance capacity of cities [20]. However, it can also pose various security risks [21,22]. Therefore, building smart cities is a complex system of engineering, and the government and other stakeholders must focus on the comprehensive development of various factors during the construction process.

Scholars place significant importance on developing an evaluation system for smart city development. Such a system can effectively measure the development status of smart

cities, as well as provide concrete ideas for their construction. In 2010, Giffinger et al. [23] evaluated the smart city development of 70 medium-sized cities in Europe based on six dimensions: “smart economy”, “smart people”, “smart governance”, “smart mobility”, “smart environment”, and “smart living”. They proposed an evaluation system that included 71 indicators. Yigitcanlar et al. [24] expanded the understanding of smart city practices by constructing a smart city evaluation framework that consists of three driving factors and five expected results based on the development practices of smart cities and an extensive literature review. Huovila et al. [25] provided guidance for the government to choose indicators that meet the evaluation needs by analyzing and comparing 413 indicators from seven smart city development evaluation systems published in the literature and developing a classification method that differentiated the suitable evaluation indicators for smart city development level into “city concepts”, “application areas”, and “process types”. However, existing literature lacks research on the complex mechanisms behind conditional factors and result factors, in contrast to the abundant research on evaluation systems.

After conducting a literature review, it is evident that previous research has provided many valuable insights and guidance for understanding the benefits of constructing smart cities and ascertaining how to develop them. Nonetheless, there are certain limitations that need attention. Firstly, the construction of smart cities is phased, and the policy focus varies in different stages, yet the construction cycle of smart cities has not been fully considered. Secondly, existing studies often concentrate on either a single factor or the combined effects of multiple factors on the outcome variable while neglecting the configuration effects, which refer to the mutual coordination and interaction between different factors. This oversight has resulted in an insufficient exploration of the complex causal relationships underlying the high-quality construction of smart cities. Recently, the fsQCA method, which is based on configurational analysis logic, has been used in various research fields with great success. Therefore, this paper aims to use the fsQCA method, combined with China’s current smart city development, to address the aforementioned shortcomings, offer suggestions for the high-quality development of smart cities, and make up for the limitations of existing research.

2.2. Model Construction of the Development Level of Smart Cities

The TOE analysis framework is a comprehensive analytical model based on technological application scenarios that analyzes the factors of organizational technological innovation from three dimensions: technological conditions, organizational conditions, and environmental conditions, and conducts systematic analysis. Its applicability is broad, having been widely used in enterprise strategic management, government governance, urban development, the digital economy, and other fields [26–29]. The model can replace the conditional factors according to the research content, making it adaptable to a wide range of scenarios. The TOE analysis framework acknowledges that the three factors do not function independently but cooperate and depend on each other, playing a role through linkage matching, which aligns with the concept of configuration analysis. Therefore, this paper adopts the TOE analysis framework as the theoretical basis for the configuration analysis of development levels in smart cities, combining with the specific contexts of Chinese cities about the development of smart cities, and constructs a theoretical model that affects the development level of smart cities, as illustrated in Figure 1.

Technical Conditions. It includes two variables: digital capability level (DCL) and digital resource level (DRL). In the process of technology and organizational interaction, technology characteristics can influence an organization’s attitude and behavior toward technology adoption and application. Smart cities are the product of the dual driving forces of urbanization and informationization, resulting from the mutual promotion of advanced technology in the Internet era and the development needs of urban modernization [30]. Therefore, digital technology conditions are crucial for the high-quality development of smart cities. Drawing on the analytical logic of Resources–Capabilities (RC) in the field of strategic management [31], we decompose digital technology conditions into two

sub-factors: digital resource level and digital capability level. The digital resource level measures the level of digital infrastructure construction, while the digital capability level measures the ability to effectively utilize digital resources and enhance business and social value. Firstly, in smart city construction, digital infrastructure support is vital for new technologies like big data, cloud computing, and artificial intelligence to operate smoothly. Only when the level of digital resource facilities reaches a certain level can new technologies be better promoted, enabling sustainable and stable smart city development [32]. Secondly, smart cities are more than just a conglomeration of digital infrastructure, artificial intelligence devices, and network technology facilities. A certain level of digital capability is needed to turn basic resources such as big data, artificial intelligence, cloud computing, and the Internet of Things into innovative elements [32], thereby promoting the leapfrog development of urban construction.

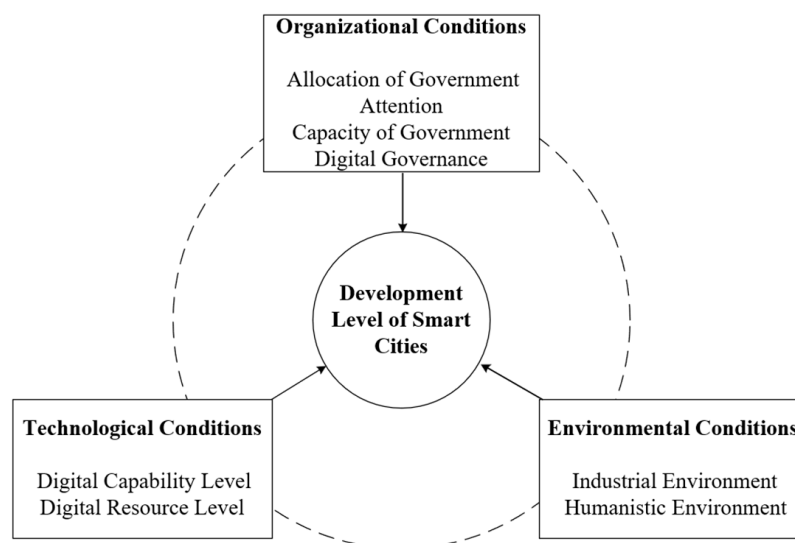


Figure 1. TOE framework.

Organizational Conditions. It includes two variables: allocation of government attention (AGA) and capacity of government digital governance (CGDG). The government plays a critical role in the development and implementation of plans and actions for urban organizations and is also responsible for organizing smart city construction. Although digital technology impacts the process of urban organizational intelligence reconstruction, it is equally influenced by the city construction organizers. The level of attention, support, and action capabilities of city construction organizers significantly impacts the development of smart cities. Firstly, in China's actual urban construction operation process, when the government recognizes the significance of smart city construction and invests significant attention and resources, corresponding policy and resource tilts will help achieve goals [33]. Therefore, this article identifies the degree of attention allocation by local governments for the high-quality development of smart cities as an important factor in organizational conditions. Secondly, research has shown that the government's digital governance capabilities are crucial in realizing smart city construction [6,19]. Only when decision-making authorities possess adequate digital governance capabilities can they efficiently allocate material and non-material resources, better unleashing the potential value of digital resources and attention resources in smart city construction. Consequently, this article views the capability of government digital governance as another critical measure of organizational conditions.

Environmental Conditions. It includes two variables: industrial environment (IE) and cultural environment (CE). Previous studies have shown that environmental conditions do not directly participate in organizational governance decision-making, but they do influence planning, actions, and the operation of the entire system [34]. This also applies to government decision-making behavior in urban construction. Smart city construction

benefits both the rapid development of enterprises and the significant improvement of citizens' lives. However, it is also affected by the counteraction of the industrial environment composed of enterprises and the cultural environment composed of citizens [5]. In an industrial environment with a high density of high-tech enterprises, the availability of sufficient financial and intellectual resources and the high demand for smart city construction by enterprises make the government more willing to increase construction efforts [12]. In an environment with a high overall education level and good cultural environment, residents can fully utilize smart city achievements and actively support their construction [15]. Providing the government with good opinions and suggestions will give them a clearer direction for the construction and development of smart cities, promoting their high-quality development. This study represents the environmental factors affecting smart city construction through the industrial environment and cultural environment.

In summary, this paper's research model includes three primary conditions: technology, organization, and environment, and six secondary conditions nested within them. Among these, digital capability level, digital resource level, industrial environment, and cultural environment are objective endowments, while attention allocation and capability of government digital governance are subjective controllable conditions. From a configurational perspective, technology, organization, and environment interact with each other and produce a synergistic effect through their intrinsic connections, which may either reinforce or offset each other [35]. Therefore, the subsequent sections of this paper will examine how these three conditions interact and affect the level of development of smart cities from a configurational perspective.

3. Research Design

3.1. Method Selection

This paper employs the QCA method for two primary reasons. Firstly, the growth of smart cities is shaped by multiple factors, making it inadequate to analyze the isolated impact of any single factor. The QCA method acknowledges that multiple factors interact to create various simultaneous causal relationships, which helps to explore the impact mechanism of smart city development from a holistic perspective. Secondly, the level of smart development varies among cities, with each city focusing on and developing different factors. The QCA method can reveal the complex causal relationships behind the phenomenon, identify diverse configurations of conditions that lead to achieving high development levels of smart cities, and identify different driving paths. On this basis, considering that the variable values in this study are continuous data and have certain fuzzy characteristics, compared with the QCA method based on clear sets, the fsQCA method based on fuzzy sets is more suitable for this study. Therefore, this paper chooses to use the fsQCA method to study the configuration of achieving high development levels of smart cities.

3.2. Sample and Data Sources

From 2013 to 2015, China announced a total of 290 pilot cities for smart city construction. This article conducts research on these 290 cities as a sample population. Firstly, four municipalities directly under the central government, 15 sub-provincial cities, and the remaining 18 provincial capitals were selected. Secondly, a total of 77 cities were selected as the research sample for this article, which are not included in the list of smart city pilot cities and ranked among the top 40 in terms of GDP in 2021. This article completed a round of data collection for the 77 cities mentioned above, using the same time span and statistical indicators. The data sources for this paper mainly consist of three categories: first, the "China Digital Ecological Index" and "Digital Government Development Index Report" published by authoritative domestic universities and research institutions; second, the "China Statistical Yearbook" published by the National Bureau of Statistics or local statistical bureaus, as well as the "Statistical Yearbooks" of various provinces and cities and the "China Torch Statistical Yearbook"; third, government websites of various prefecture-level

cities, government work reports, and the economic and social big data research platform of CNKI (China's National Knowledge Infrastructure). To account for the time lag effect of the impact of factor inputs on results, this paper employs a one-year lag period [27], with data for the dependent variable taken from 2021 and data for the independent variables taken from 2020.

3.3. Measurement

3.3.1. Dependent Variable

The dependent variable of this study is the “development level of smart cities” (DLSC). Based on the two national standards of “Evaluation Index System of New Smart City” released in 2016 and “Evaluation Model and Basic Evaluation Index System of Smart City” released in 2017, as well as a third-party evaluation system, Chen Jin et al. developed a comprehensive smart city evaluation index system [36], and the index system includes seven primary indicators. These seven primary indicators are as follows: smart infrastructure, smart social governance, smart public services, smart security system, smart industrial economy, smart population, and additional evaluation. The weight of two indicators (smart infrastructure and smart social governance) is 20%, while the weight of the other four indicators (except for additional evaluation) is 15%. The highest score for additional evaluation is 5 points, and the highest score for the other indicators is 100 points. Due to its relatively broad application basis, it was used to measure the development level of smart cities in this study.

3.3.2. Independent Variable

Technical Conditions: The measurement of digital capability level and digital resource level in this study utilized data from the “digital capability” and “digital foundation” secondary indicators in the “Digital Ecosystem Index”. The “Digital Ecosystem Index” was jointly developed by the National Engineering Laboratory for Big Data Analysis and Application Technology at Peking University and the Scientific Evaluation and Big Data Application Laboratory of the Department of Information Management. Its purpose is to comprehensively depict the level of digital development and structural characteristics in various regions of China, provide a scientific evaluation for creating a sound digital ecosystem, and contribute to the construction of Digital China.

Organizational Conditions: The measurement of the allocation of government attention is based on the method developed by Tan Haibo et al. [37]. Since the announcement of smart city pilot programs by the national government in 2013, various local governments have issued policy guidelines to implement smart city construction requirements, and the number of policy guideline documents is used to measure the level of attention allocation. Data is sourced from the websites of prefecture-level city governments. The measurement of capability of government digital governance uses the “2020 Digital Government Development Index Report” published by the Data Governance Research Center of Tsinghua University, which includes four dimensions aimed at measuring the performance of local governments in digital transformation and governance modernization.

Environmental Conditions: The measurement of the industrial environment is based on the number of high-tech enterprises in each region, and the data is sourced from the “2020 China Statistical Yearbook” and the “2020 China Torch Statistical Yearbook”. The measurement of the cultural environment is based on the proportion of the population with a college education or above in each region, and the data is sourced from the “2020 China Statistical Yearbook”.

3.4. Calibration

Prior to conducting the analysis, it is essential to calibrate the data of both the dependent and independent variables, resulting in calibrated set membership degrees ranging from 0 to 1. Given the absence of external standards for defining “high” or “non-high” degrees of the indicators used in this study, and since the level of smart city development

is relative to the comparison between cities, this paper adopts the direct calibration method based on relevant research perspectives [38]. For calibration purposes, the 0.75, 0.5, and 0.25 quantiles of the dependent and independent variables are established as anchor points for complete membership, cross point, and complete non-membership, respectively. To prevent cases where the membership degree after calibration is precisely 0.5 and therefore excluded, a constant of 0.001 is added to the membership degree of 0.5 [39]. The specific calibration data is shown in Table 1, where the data in the “fully subordinate” column is the value of each variable at the 75% percentile, the data in the “intersection” column is the value at the 50% percentile, and the data in the “completely non-subordinate” column is the value at the 25% percentile.

Table 1. Calibration of dependent variable and independent variable.

	Variable	Calibration		
		Complete Membership	Cross Point	Complete Non-Membership
Dependent Variable	DLSC (high)	66.454	59.684	54.205
Technical Conditions	DCL (high)	28.224	23.244	20.303
	DRL (high)	17.638	13.577	11.579
Organizational Conditions	AGA (high)	102	47	11
	CGDG (high)	64	56.1	48.3
Environmental Conditions	IE (high)	2918	1255	657
	CE (high)	0.258	0.178	0.128

4. Analysis Results

4.1. Necessary Condition Analysis

Prior to performing the analysis of the configuration condition, it is essential to assess the necessity of each condition individually. The important criterion for determining whether a condition is necessary is its consistency, and a condition can be classified as necessary if its consistency exceeds 0.9 [40]. In this study, fsQCA 3.0 software was utilized to evaluate the necessity of these conditions, and the results are presented in Table 2. In the “DLSC (high)” column, only three variables have a consistency higher than 0.8, but this value does not exceed 0.9, indicating that there are no necessary conditions that affect the high development level of smart cities. In the “DLSC (non-high)” column, only one variable has a consistency higher than 0.8, but it does not exceed 0.9, indicating that there is no necessary condition that affects the low development level of smart cities.

Table 2. Necessary condition analysis.

Independent Variable	DLSC (High)		DLSC (Non-High)	
	Consistency	Coverage	Consistency	Coverage
DCL (high)	0.805	0.786	0.306	0.324
DCL (non-high)	0.309	0.291	0.798	0.816
DRL (high)	0.786	0.793	0.302	0.330
DRL (non-high)	0.335	0.307	0.810	0.804
AGA (high)	0.635	0.630	0.414	0.445
AGA (non-high)	0.441	0.410	0.656	0.661
CGDG (high)	0.820	0.785	0.343	0.355
CGDG (non-high)	0.327	0.314	0.793	0.827
IE (high)	0.849	0.783	0.329	0.329
IE (non-high)	0.273	0.273	0.783	0.849
CE (high)	0.698	0.679	0.386	0.407
CE (non-high)	0.391	0.370	0.696	0.714

4.2. Condition Configuration Analysis

Using the fsQCA 3.0 software, the calibrated data underwent configuration condition analysis. Based on existing research, the original consistency threshold for configuration analysis was set to 0.850, the case frequency threshold was set to 1, and the PRI consistency threshold was set to 0.700 [41]. Following current mainstream practices [42], the intermediate solution was chosen as the primary result, and the parsimonious solution was used as a supplementary result. If a conditional variable or a combination of conditional variables in a configuration constitutes a necessary condition for the result or appears in a simplified solution, these conditions or combinations of conditions are called “core causal”, and the conditional variables in the configuration other than the core conditions are called “peripheral causal”. “Core causal” conditions are the key elements of configuration, while “peripheral causal” are non-core elements. Based on the above method, we identified the core and edge conditions of each configuration.

According to the results, four driving paths were obtained in Table 3 with a consistency of 0.890 for the corresponding solutions. This indicates that among all the smart city development cases that satisfy these four types of configuration conditions (four configurations), 89% exhibit a high development level of smart cities. The solution coverage is 0.734, implying that these four types of configuration conditions can explain 73.4% of the cases with high development levels of smart cities. As the solution consistency and solution coverage meet the critical threshold requirements, this analysis is considered effective. Among the four configurations mentioned above, configuration 1 is “both organizational and industrial environment type”, configuration 2 and configuration 3 can be merged into one type of development model, called “balanced development type”, and configuration 4 is “both governance and cultural environment type”.

Table 3. Configuration analysis of DLSC (high).

	Both Organizational and Industrial Environment Type	Balanced Development Type		Both Governance and Cultural Environment Type
DCL (high)		●	●	⊗
DRL (high)		●	●	
AGA (high)	●	●		⊗
CGDG (high)	●		●	●
IE (high)	●	●	●	⊗
CE (high)	⊗			●
Consistency	0.945	0.884	0.889	0.936
Raw Coverage	0.162	0.520	0.666	0.091
Unique Coverage	0.027	0.016	0.127	0.023
Representative Cases	Chongqing, Shaoxing	Dalian, Wuxi	Chengdu, Foshan	Yinchuan
Solution Consistency		0.890		
Solution Coverage		0.734		

Note: ● = Core causal condition present; ● = Peripheral causal condition present; ⊗ = Core causal condition absent; ⊗ = Peripheral causal condition absent.

Configuration 1: Both organizational and industrial environment type. Configuration condition 1 reveals that the allocation of government attention, the capability of government digital governance, and the industrial environment are crucial factors in the development of smart cities. This configuration indicates that a “high” industrial environment (IE) can positively affect the entire region and compensate for the necessary technological conditions required for the development of smart cities. Moreover, with the government’s “high” allocation of government attention (AGA) on constructing smart cities and “high” capacity of government digital governance (CGDG), the positive influence brought by the industrial environment can be transformed into practical development of smart cities, leading to “high” development level of smart cities (DLSC). This driving path, composed of the allocation of government attention (organization), capacity of government digital

governance (organization), and industrial environment (environment), is named “both organizational and industrial environment type”.

The configuration consistency of this configuration is 0.945, with a raw coverage of 0.162 and a unique coverage of 0.027. This path explains 16.2% of smart city development cases, with an additional 2.7% of cases exclusively explained by this path. Examples of this configuration include Chongqing and Shaoxing. Taking Shaoxing City as an example, according to the original data, its ranking of digital capability level (47th) and digital resource level (47th) are both below average, and its performance in terms of cultural environment (46th) is not strong. However, its government’s allocation of attention to smart city construction (3rd) is very high, and its capacity of government digital governance (35th) and industrial environment (34th) are above average among 77 cities. Shaoxing is located in the core area of the Yangtze River Delta in Zhejiang Province. In terms of government attention allocation and digital governance capabilities, Shaoxing City has been paying close attention to the construction of smart cities in recent years, has made significant efforts in smart city construction, releasing policy guidelines and establishing the Shaoxing Smart City Group Co., Ltd. (Shaoxing, China) held by the Municipal City Investment Group to lead the city’s smart city construction and new types of technology research and growth, thereby upgrading the government’s digital governance level. In terms of the industrial environment, Shaoxing has also organized the “strongest digital team”, including digital enterprises such as Huawei, Alibaba, and Baidu, to settle in the Digital Economy Industrial Park and work together to assist in the construction of Shaoxing’s smart city, committed to achieving the goal of “collecting digital industry clusters, building a full-chain digital economy enterprise, realizing smart scenario applications, and assisting smart city construction”. Based on the above analysis, cities corresponding to Configuration 1 often receive high attention from the government, actively improve their digital governance capabilities, and utilize the advantages of the digital industry to continuously promote the high-level development of smart cities.

Configuration 2: Policy-oriented balanced development type. Configuration condition 2 highlights the pivotal role of digital capability level, allocation of government attention, and industrial environment in the development of smart cities, with the digital resource level playing a supportive role. The government leverages regions with “high” digital capability level (DCL) and “high” industrial environment (IE) to drive and facilitate smart city construction. By allocating more attention and introducing incentive policies, the government promotes digital technology development and industrial growth. The three conditions interact and reinforce each other, ultimately improving the development level of smart cities (DLSC). Given the interplay of technology, organization, and environmental conditions in this driving path, and it is relatively prominent in the “allocation of government attention (AGA)”, it is aptly named the “policy-oriented balanced development type”.

The configuration shows a consistency of 0.884, with a raw coverage of 0.520 and a unique coverage of 0.016. This path can explain 52% of smart city development cases, and approximately 1.6% of smart city development cases can only be explained by this path. Examples of this configuration include Dalian and Wuxi. Taking Dalian as an example, it demonstrates a strong digital capability level (29th) and digital resource level (32nd), although its capability of government digital governance (41st) is relatively low. Nevertheless, the allocation of government attention (11th), industrial environment (24th), and cultural environment (24th) are very good. As a result, the development level of smart cities in Dalian is very high. Dalian is located in Liaoning Province, one of the five national-level planned cities, and is one of the most important cities and ports in northern China. Since its selection as one of the first batch of smart city pilots, the Dalian government has been committed to the construction of smart cities, issuing instructive documents such as the “Comprehensive Smart City Planning” and “Dalian 2049 Smart City Vision Planning”, and establishing a Smart City Research Center. After years of investment in research, development, and construction, Dalian has made considerable progress in digitization and informationization, including the successful launch and operation of the “One Network

Management" operation command center application system. This has officially launched the new model of "data governance" in Dalian and won numerous awards at domestic and foreign smart city exhibitions. Currently, Dalian is advancing towards the goal of "improving innovation driving ability, cultivating industrial leadership and control ability, and reshaping smart city construction driven by big data technology". Based on the above analysis, the cities corresponding to configuration 2 have achieved high-quality development of smart cities due to the government's attention and continuous promotion of digital technology research and development, encouragement of joint cooperation among high-tech enterprises, and the mutual promotion of various factors.

Configuration 3: Governance leads balanced development type. Configuration condition 3 suggests that the digital resource level (DRL), the capability of government digital governance (CGDG), and the industrial environment (IE) play a central role in the process of smart city construction, while the digital capability level (DCL) plays a supporting role. Cities that fall under this configuration have a high level of digital infrastructure construction, which is advantageous for the development of smart cities. When they also have a high-quality industrial environment and a government with strong digital governance capabilities, they can leverage their strengths to develop high-quality smart cities and improve their overall development level. This driving path consists of three conditions: digital resource level (technology), the capability of government digital governance (organization), and the industrial environment (environment). They work in conjunction with one another, and the government has a "high" capability of government digital governance (CGDG). Thus, it is named the "governance leads balanced development type".

The configuration consistency of this type is 0.889, with a raw coverage of 0.666 and a unique coverage of 0.127. This path can explain 66.6% of smart city development cases, and approximately 12.7% of smart city development cases can only be explained by this path. Typical examples of this configuration include Beijing, Shanghai, Shenzhen, Hangzhou, Chengdu, and Foshan. For instance, Foshan has a "high" digital capability level (23rd) and digital resource level (26th), moderate levels of allocation of government attention (48th) and cultural environment (44th), and a "high" capability of government digital governance (20th) and industrial environment (12th). Foshan is a leading city in smart city development and is located in Guangdong Province, a key manufacturing base in China designated by the State Council, and an important transportation hub in the Pearl River Delta region. The Foshan government has established a dedicated government service data management bureau responsible for digital technology research and development, digital government construction, smart city development, and more, which has effectively improved the digital governance capabilities of the Foshan government. Foshan's smart city construction relies on the "industry-university-research-application" cooperation model, aiming to build a "Digital Foshan" innovation space based on mutual trust and independent participation of multiple parties, creating a "digital economy" engine and a "digital government" promoter to comprehensively promote smart city development. In summary, the cities corresponding to configuration 3 rely on the government's excellent digital governance capabilities, integrate digital technology and digital industries, and transform their own advantages into the main driving force for building smart cities, achieving rapid development of smart cities.

Configuration 4: Both governance and cultural environment type. Configuration condition 4 highlights the crucial role of the capability of government digital governance (CGDG) and cultural environment (CE) in the development of smart cities. A "high" cultural environment and "high" capability of government digital governance can transcend technological limitations. In the context of smart city development, when the government introduces new technology, residents in cities with higher cultural environments tend to provide constructive feedback and improvement suggestions to the government. With the "high" capability of government digital governance, the government can effectively incorporate feedback and suggestions, continuously iterate the use of new technologies, and elevate the development level of smart cities (DLSC). This driving path comprises the

capability of government digital governance and cultural environment and is therefore coined “both governance and cultural environment type”.

The configuration consistency of the model is 0.936, with a raw coverage of 0.091 and a unique coverage of 0.023. This path accounts for 9.1% of smart city development cases, while about 2.3% of cases can only be explained by this path. One typical example of this configuration is Yinchuan City. In Yinchuan, the original data shows that the city ranks poorly in digital capability level (62nd) and digital resource level (67th), as well as allocation of government attention (47th) and industrial environment (50th). However, Yinchuan performs “high” in the capability of government digital governance (38th) and cultural environment (18th). As a demonstration city for smart city development in China, Yinchuan is the capital of Ningxia Province and an important center city in northwest China. In 2014, Yinchuan signed a strategic cooperation agreement with ZTE Corporation to start the construction of a smart city. The city prioritizes the government’s digital governance capabilities and is adept at using high-tech tools. Yinchuan organized the “Western Digital Valley” computing industry conference to jointly discuss computing construction, application, and industrial development, thereby improving the government’s digital governance capabilities. Moreover, Yinchuan has hosted smart city summits for several years, which have had a strong influence both domestically and internationally. The summit’s theme has always revolved around “people-oriented”, “Internet + medical health”, “Internet + education”, “Internet + government services”, and other aspects, leading the country in these areas. In these processes, Yinchuan’s favorable cultural environment has promoted the construction of its smart city. In summary, the cities corresponding to configuration 4 utilize digital technology to enhance government digital governance capabilities, meet residents’ needs, listen to public opinions, and develop high-level smart cities through continuous improvement.

5. Conclusions

5.1. Research Conclusions

The construction of smart cities has become an important guarantee for improving people’s living standards, enhancing urban competitiveness, and achieving sustainable urban development. This article examines the configurational path that influences the high development level of smart cities, using 77 prefecture-level cities in China as case studies and employing the fsQCA method. The research findings are summarized as follows:

In the dimensions of technology, organization, and environment, no single factor is a necessary condition for the high development level of smart cities. While the six factors of digital capability level, digital resource level, allocation of government attention to smart city development, the effectiveness of government digital governance, industrial environment, and cultural environment are essential to smart city construction, improving any single factor alone cannot support the high-level development of smart cities. This indicates that to achieve the construction and development of high-level smart cities, it is insufficient to focus on one element alone. It is necessary to comprehensively develop multiple elements and pay attention to the synergistic effects of relevant factors.

Based on the endowments and characteristics of different cities, there are multiple paths to achieve the high-level development of smart cities. The construction and development of smart cities require coordinated efforts in technology, organization, and environment. However, smart city development is not a one-size-fits-all approach. Different cities should fully consider their own resource endowments, regional environments, and industrial foundations to choose a development model that suits their unique characteristics. Cities with high digital resource levels and digital capability levels can consider the “balanced development type”, while those with a better industrial environment and higher allocation of government attention can consider the “both organizational and industrial environment type”. Cities with a better cultural environment and higher capability of government digital governance can consider “both governance and cultural environment type”.

In the construction and development of smart cities, the roles of the industrial environment and the effectiveness of government digital governance outweigh those of digital technology conditions. Although smart cities are a new form of city development driven by new technologies and rely heavily on a large number of Internet, digital, and artificial intelligence technologies, the development of digital technology alone cannot achieve the goal of constructing high-quality smart cities. Comparatively, the roles of capability of government digital governance and industrial environment are significant. The government's digital governance capacity is an important driving force for coordinating digital technology and realizing its efficient utilization. Meanwhile, a good industrial environment not only promotes the widespread use of new technologies but also positively impacts the overall development of cities.

5.2. Theoretical Contribution

The theoretical contributions of this paper are mainly twofold:

The application of the TOE analytical framework to the research field of smart city construction represents a significant contribution to the literature, expanding the scope of the TOE model and enriching our understanding of smart cities. Originally developed to study technology adoption in organizations, the TOE model has been applied to diverse domains, including corporate strategy, government governance, business environment, and the digital economy [26–29]. Building on this foundation, our study extends the model to the construction and development of smart cities, presenting innovative measurement indicators for the three dimensions of TOE, tailored to the characteristics of this context. In doing so, we address a common limitation of existing research, which tends to focus on isolated factors and overlook the synergies between them [12–14]. Specifically, we propose a model of six factors that influence the development of smart cities and analyze their interplay, offering a novel perspective that extends beyond previous work in this field.

This paragraph examines the complexity of smart city construction from the perspective of configuration effects, shedding light on the multi-factor concurrent synergy and linkage matching mode of building smart cities and enhancing our understanding of smart city construction. Firstly, existing research on smart cities mainly focuses on evaluating the effects of smart city construction [16–18] but lacks exploration of the factors that influence the construction and development of smart cities. Secondly, existing research on the factors influencing smart cities tends to focus on the mechanisms of these factors [19,20] but pays less attention to the synergies and substitutability relationships among different factors. From the perspective of configuration, this paper analyzes the concurrent synergistic effect and linkage matching mode of various conditions that affect the development level of smart cities and explains the “causal complexity” behind the high-quality development of smart cities. Additionally, it offers a holistic perspective for investigating the complex interactions and causal asymmetries among the various conditions that underpin the high-level development of smart cities.

5.3. Practical Implications

- (1) The construction of smart cities should choose development models according to local conditions.

Local governments should prioritize the coordinated development of technology, organization, and environmental factors in smart city construction and select a development model that fits their unique characteristics. Research indicates that the individual effects of each factor are not essential for achieving a high level of smart city development. Rather, it is the synergistic effects of multiple factors that contribute to the high-level development of smart cities across all driving paths. Therefore, in order to construct high-level smart cities, it is necessary to focus on the synergistic development of multiple factors. There is no single driving path to achieving a high level of smart city development, and the variations are significant. Hence, local governments should tailor their approach to smart city construction to local conditions and strive to build smart cities efficiently and expeditiously.

- (2) The construction of smart cities should take into account technological, organizational, and environmental factors.

Over the course of smart city construction, local governments should not limit themselves to digital technology alone, but also focus on government organization factors and environmental conditions. Research shows that while a certain level of technological foundation is necessary for building smart cities, the allocation of government attention in organizational conditions and the capability of government digital governance, as well as the industrial environment in environmental conditions, are even more important in achieving a high development level. These factors can even become dominant factors that go beyond technological conditions. Therefore, local governments should pay attention to these soft factors of organization and environment, give more attention to the development of smart cities, enhance their own digital governance capabilities, create a favorable industrial environment, and vigorously encourage the development of emerging industries.

5.4. Limitations

There are certain limitations to this study that require further analysis and research. First, the paper is constrained by the availability of data, with only a one-year lag period set for both the outcome and conditional variables. In the future, the lag period could be extended to 2–3 years to better observe the impact of input factors on the outcome. Second, the research methodology is limited as it is unable to clearly analyze the mechanism of the relevant factors' role, as in a longitudinal case analysis. In the future, the case analysis method can be further utilized, and means such as field interviews can be used to explore in-depth the influence mechanism between conditional variables and outcome variables.

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