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Digital Governance and Urban Government Service Spaces: Understanding Resident Interaction and Perception in Chinese Cities

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Abstract: With the rapid development of smart cities and the swift transition toward digital governance, optimizing urban spatial governance through digital technology remains underexplored in the Global South, particularly from the perspective of resident perception and interaction. Digitization of government services is a key area of interest in digital governance research; this study investigates the impact of government self-service systems on the spatial perception and behavior of residents in Guangzhou and Foshan, China. Through a mixed-method approach, combining questionnaire surveys and semi-structured interviews and analyzing them using a structural equation model, the findings reveal that government self-service systems significantly influence residents' spatial behavior and perception. These systems enhance the efficiency of administrative processes, increase convenience, and lead to temporal-spatial compression, thereby reshaping residents' physical interactions with urban spaces. The findings provide practical insights for policymakers to enhance urban governance by integrating digital technologies to improve residents' interaction with government services. These insights can guide the development of more efficient, resident-centered digital governance frameworks, particularly in rapidly urbanizing regions. This research contributes to a deeper understanding of how digital technology transforms urban spatial governance, highlighting the critical interplay between individuals, technology, and the urban environment. The study likewise provides examples of the ongoing digital transformation of public services in countries of the Global South that are lagging behind in the area of digital governance.

Keywords: smart cities; digital governance; spatial perception; government service spaces; structural equation model

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Citation: Li, L.; Lin, X.; Yang, X.; Luo, Z.; Wang, M. Digital Governance and Urban Government Service Spaces: Understanding Resident Interaction and Perception in Chinese Cities. *Land* **2024**, *13*, 1403. https://doi.org/10.3390/land13091403

Academic Editor: Tao Liu

Received: 19 August 2024
Revised: 29 August 2024
Accepted: 30 August 2024
Published: 31 August 2024

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1. Introduction

As essential public service facilities in urban spaces, government service spaces are closely tied to residents' daily lives and their quality, making them a notably important aspect of urban spaces [1]. China has long experienced a significant demand for government services, yet there exists a substantial gap between the high demand for these services and their limited supply in terms of both government services and the spaces where they are provided [2]. Due to the concentration of government service resources and population in urban spaces, various issues plague these spaces, including long waiting times, low efficiency, overcrowded conditions, and poor spatial experiences. This effect is particularly pronounced among individuals residing in densely populated cities. Longer waiting times and inconveniences in processing government affairs often lead to administrative disputes and complaints, resulting in more negative perceptions and experiences of government

service spaces among residents. To address the inefficiency of government service spaces, China has initiated reforms in its government service system, promoting the "Internet + Government Services" approach [3]. In recent years, some major Chinese cities (including Guangzhou and Foshan) have introduced e-government services and established 24 h self-service spaces to implement a government self-service system. E-government services and government self-service systems aim to reduce traditional manual service queue times, enhance the efficiency of government service spaces, and subsequently drive economic development [4]. According to reports from the China Internet Network Information Center, as of December 2022, the user base for online government services in China reached 926 million. In fact, government services and the spaces where they are provided have undergone reconstruction through the innovative application of digital technology. The emergence of e-government services and government self-service systems has provided urban residents with fair and reasonable means of utilizing urban public service resources, compressing urban temporal-spatial resources, reducing residents' time costs, minimizing inefficient spatial movement, and enhancing the efficiency of urban spatial operations [5].

As the main participants in urban activities, urban residents often form their impressions and feelings about cities based on the construction of spatial perception. Specifically, spatial perception refers to an inherent understanding of physical spatial entities and relationships, reflecting residents' cognition of spaces [6]. The advancements and application of digital technology have led to the trend of urban residents' daily lives becoming more intelligent, which is evident in the changes in spatial behavioral patterns and the emergence of new spatial perception behaviors.

The advancement of digital technology in government services reflects its impact on cities, particularly in the intelligent and humanized transformation of government services. However, the spatial reconstruction of resident behavior as a consequence of digital technology's influence requires further discussion and analysis. Meanwhile, while research on the gradual transition of government services toward digitization has predominantly focused on e-government services [7–9], there remains a lack of comprehensive studies on the effectiveness of digital governance, particularly concerning the integration of online and offline government self-service spaces. Particularly in the Global South, including countries like China, where digital governance is relatively underdeveloped [10,11], this issue warrants closer monitoring and deeper investigation.

As a part of urban physical spaces, government self-service spaces not only impact the effectiveness but also influence the urban experience of digital governance. Therefore, to investigate residents' usage experiences of new technologies, such as self-service systems in government service spaces, and the factors influencing these experiences, a re-examination of the interaction between individuals and digital technology concerning spatial perception and its impact on digital governance is crucial. To address this research gap, this study employs a bottom-up approach using a structural equation model to investigate the public perception of digitally embedded government self-service spaces. Specifically, this study contains the following questions: (1) Has the governmental self-service system changed the behavior of Guangzhou and Foshan residents' governmental business handling? How did it change? (2) Are residents satisfied with this change? What are the influencing factors of satisfaction or dissatisfaction? This research contributes to the existing literature in several aspects. Firstly, as a case study investigating the nexus of digital technology and urban public services, this article enriches the current literature on the impact of digital technology on cities and provides a significant bottom-up empirical research case. Secondly, our findings indicate that government self-service systems significantly reshape the spatiotemporal behaviors and perceptions of urban residents through temporal compression. This not only represents the restructuring of residents' daily life practices by digital technology but also reveals the immense potential of digital technology for urban governance. Lastly, this study not only re-examines the interaction between individuals and technology but also offers a more comprehensive perspective to explore the interplay effects among humans, technology, and cities in the process of smart city development.

The rest of this article is structured as follows. The research background and hypotheses analyze and summarize the relevant literature, presenting the research hypotheses of perceived usefulness, perceived ease of use, attitude toward usage, task characteristics, technology characteristics, task-technology fit, and actual usage. The research methodology introduces the research region and data. Empirical results and discussion analyze the model results. Conclusions summarize this article.

2. Literature Review and Research Models

2.1. Digital Technology and Spatial Perception in Cities

The accelerated penetration of digital technology continues to drive the development of spatial governance systems like smart cities [12,13]. The construction of smart cities is seen as a process that centers around digital technology to facilitate urban development planning [14]. It is even considered a crucial field for addressing current global urban challenges [15]. The discourse surrounding smart cities emphasizes how development logic based on digital technology can make regional development more predictable and certain. For instance, digitalized public management tools are seen as capable of promoting innovation in social governance models [16]. Simplified urban topologies also contribute to rapidly enhancing the operational efficiency and sustainability of cities [17]. However, as the construction of smart cities progresses, this idealized urban spatial imagination lacks sufficiently compelling evidence in the real world. Despite the widespread adoption of convenient digital services to enact digital governance, it has not fundamentally resolved long-standing urban issues such as social justice [18,19]. It reveals a significant disparity between the conceptual framework of smart cities and their practical applications to some extent [20]. In recent years, scholars have called for a re-evaluation of the top-down logic of smart city planning [21]. Simultaneously, advocating for a deeper understanding of micro-level digital practices suggests that the purpose of building smart cities should not focus solely on enhancing urban competitiveness and attracting investment. Instead, more attention should be paid to optimizing the overall urban environment and how residents' daily life practices in digitized urban spaces can propagate digital technology to grassroots levels. This approach aims to fully consider residents' perceptions and experiences in an urban environment [22,23]. Therefore, going beyond the current dominant discourse and exploring how residents perceive and experience urban digital governance from a humanistic perspective is of significant importance.

From a humanistic perspective, research on urban spatial digital governance primarily focuses on citizen subjects [24], community groups [25], and macro-level governance [26], covering topics such as bottom-up governance models and social justice. The interaction between individuals and digital technology has an intuitive perception; as end users of digital technology, citizens have the most authentic embodied experiences [24]. If these end users are not involved in urban governance design, digitized spatial governance often fails to achieve its goals optimally and struggles to institutionalize citizen participation in technology space construction as a form of civic rights [27,28]. The embedding of digital technology in spatial governance is the result of public participation, and the interaction between humans and technological objects has gradually become a research hotspot in this field [29,30]. Although various scholars have established assessment frameworks [31] and provided participatory platforms [32] to facilitate public involvement, the genuine collective participation of different groups still requires further discussion. Simultaneously, spatial and experiential effects are closely related to digital governance. With the development of time, the latter is increasingly playing a decisive role [33].

Therefore, digital governance aims to improve the urban living environment by leveraging information and communication technology to enhance human collaboration, leading to better outcomes and a more transparent governance process. Although the bottom-up technological governance model has received considerable attention, there are still notable gaps in our understanding of how subjects' experiences and feedback are integrated within

digitally embedded urban spaces. This highlights the need for more in-depth research to explore these aspects and address existing knowledge gaps.

2.2. Digital Transformation of Government Service in China

With the rapid development of digital technology, mobile devices and interconnected tools have pervaded various aspects of daily life [34], showing immense potential in enhancing government services [35,36]. As Michael Estates in his book Digital Governance: "The application of digital information and communication technologies (ICTs) to reform governmental structures, politics, and public administration is widely and perhaps naively viewed as the twenty-first century's 'savior', the enlightened way to reinvigorate democracy and improve the quality of citizen services [37]". The transition from electronic government (e-gov) to digital or d-governance, emphasizing the importance of citizen participation and information technology to accomplish the change, which indicates the interaction between digital technology and government services is a multi-layered process. Burak Erkut suggested that one of the challenges of digital government to digital governance is to create governance structures to involve people in decision-making [38]. R. Silcock revealed that the emergence of e-government has reshaped the way government serves its citizens by offering citizen-centric services and information [39]. S. Jayashree revealed the potential of e-government to transform the physical society into an electronic one [40]. Meanwhile, social media platforms in the form of mobile applications (such as WeChat, Facebook, and Twitter) have significantly altered residents' approaches to accessing government services and constructing interactions with these services, providing individuals with a medium to address governmental affairs [41]. Moreover, societal demand for government service spaces continues to drive technological innovations in government service provisions. This demand is reflected not only in the improvement of service technologies and methods but also in the process of accessing government services, thereby fostering a more equitable and efficient experience in the government service space. Consequently, urban residents' direct experiences with government services mainly stem from the enhanced accessibility of these services, thereby reshaping their perceptions of government service experiences and the perception of these service spaces. Compared to the Global North countries that adopted digital governance approaches in public services earlier [10], Global South countries, including China [11], have long been lagging in digital governance. In recent years, with the Chinese government's implementation of digital transformation strategies, digital governance has played an increasingly important role in urban governance in China, especially in the digital transformation of government services [42].

China has been implementing reforms through the "Internet + Government Services" initiative, employing digital technology as a strategy to address issues prevalent in traditional government service space [3], such as long waiting times and inefficiencies. Particularly, the introduction of e-government and self-service systems has contributed to enhancing the quality of government services, improving residents' experiences, and more effectively meeting their needs while reducing waiting times [4]. As a vital component of urban public spaces, the governance of government service spaces plays a crucial role in maintaining fairness and sustainability in urban resource allocation. The optimization of service space and the balance of government service resources have been significant topics in urban governance. Hence, applying digital technology to government services can enhance efficiency, facilitate fair and equitable access to government resources [35], and significantly redefine social space due to the shift from traditional power structures to new network relationships under digital governance [43].

However, the existing literature lacks analysis from the perspective of urban residents' cognition and behavior regarding the impact of digital technology on government service space. This study aims to analyze the effects of digital technology on the cognition and interaction of urban residents in government service spaces. Interventionary studies involving animals or humans, as well as other studies that require ethical approval, must list the authority that provided approval and the corresponding ethical approval code.

2.3. Research Model and Hypotheses

Davis proposed the Technology Acceptance Model (TAM), initially aimed at explaining individuals' acceptance of technology, which later expanded to a broader range of studies within the domain of technology acceptance behavior [44,45]. TAM comprises two primary dimensions, perceived usefulness and perceived ease of use, which serve as external variables. Perceived usefulness refers to users' belief in how much new technology can enhance their work efficiency, while perceived ease of use denotes users' perception of the simplicity or difficulty of the new technology [46]. Existing research indicates that due to the complexity of modern technology, TAM might not be a strong predictive model for explaining technology adoption, as it may not handle intricate scenarios unless enhanced with additional structures or other research frameworks [47]. Concerning the actual usage of the government self-service system, if residents perceive that the system can enhance transaction efficiency and is user-friendly, their attitude toward usage will be more positive, increasing the likelihood of system adoption.

Based on the original TAM, the following related hypotheses are proposed:

H1. *Perceived ease of use will significantly positively influence residents' perceived usefulness in using the government self-service system for transactional purposes.*

H2. *Perceived ease of use will significantly positively influence residents' attitudes toward using the government self-service system for transactional purposes.*

H3. *Perceived usefulness will significantly positively influence residents' attitudes toward using the government self-service system for transactional purposes.*

H4. *Perceived usefulness will significantly positively influence residents' actual usage of the government self-service system for transactional purposes.*

H5. *Attitude toward usage will significantly positively influence residents' actual usage of the government self-service system for transactional purposes.*

Goodhue and Thompson proposed the task-technology fit (TTF) model to assess whether new technology can support users in completing tasks, considering individual characteristics, task characteristics, technology characteristics, and task-technology fit [48]. This model has been widely applied in fields such as mobile banking [49], insurance [50], and related areas. Most of the literature using TTF primarily employs task and technology characteristics to assess how information technology impacts user performance [51]. Concerning the usage of the government self-service system, if the technology support provided by the system meets residents' transactional needs, the task-technology fit will be higher. Based on these modifications, the following TTF-related hypotheses are proposed:

H6. *Task characteristics will significantly positively influence task-technology fit for residents using the government self-service system for transactional purposes.*

H7. *Technology characteristics will significantly positively influence task-technology fit for residents using the government self-service system for transactional purposes.*

TAM and TTF are two primary models for measuring the adoption of information technology, focusing on different aspects of technology adoption. However, both models have their limitations. TAM lacks consideration for the match between task and technology characteristics, while TTF, although incorporating task and technology features, does not encompass user beliefs regarding technology acceptance. Hence, integrating them may offer a better way to explain the role of technology. Empirical studies have shown that integrated models offer better explanatory power across various types of information technology adoption [52,53]. Therefore, concerning the use of a government self-service

system, when residents perceive that the technology offered by the system meets their transactional needs, they are likely to perceive the system as useful and easy to use. Based on the above discussion, the following hypotheses are proposed:

H8. *Task-technology fit will significantly positively influence the perceived usefulness of using the government self-service system.*

H9. *Task-technology fit will significantly positively influence the perceived ease of use of the government self-service system.*

In conclusion, this study integrates the Technology Acceptance Model (TAM) and the task-technology fit (TTF) model to develop a model of technological usage influencing factors. This model is developed within the context of utilizing a government self-service system as a technological platform for conducting transactions in the government service space (Figure 1).

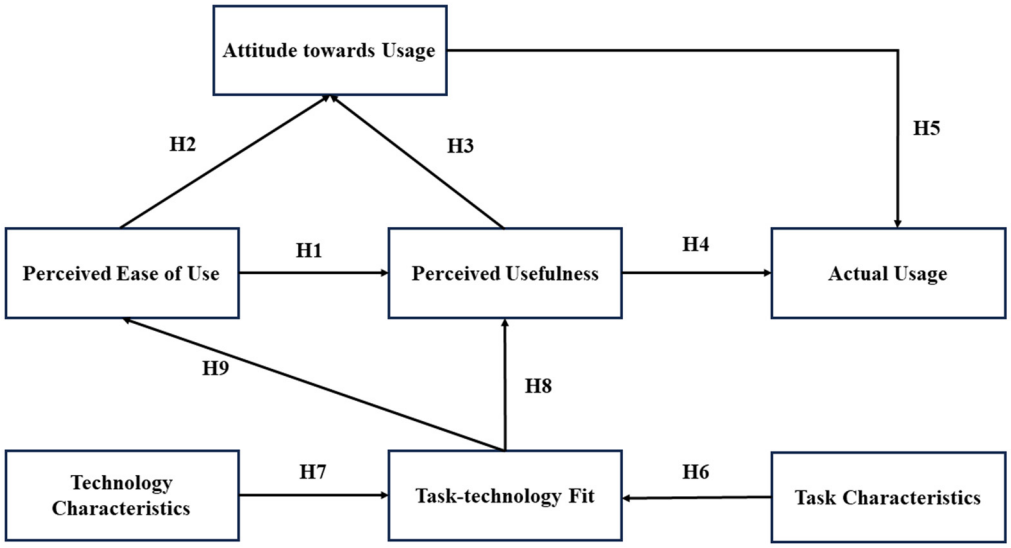


Figure 1. Factors influencing urban residents' actual usage of government self-service systems.

3. Research Methodology

3.1. Research Region

This study selected Guangzhou and Foshan as case cities for their exemplary roles in China's smart city initiatives. Located in the core area of the Pearl River Delta, both cities are known for their advanced economic development and robust government service capabilities. These cities have been at the forefront of China's broader push to streamline governance and enhance national governance efficiency. In this context, Guangzhou and Foshan have transitioned from traditional governance models to 'smart governance,' which has been marked by the integration of digital technologies into public administration. A defining characteristic of both cities is their development of "Internet + Government Services", a model that blends online platforms with traditional government functions. In recent years, they have introduced 24 h self-service spaces equipped with cutting-edge digital systems, allowing citizens to access a wide range of government services independently and efficiently. These spaces are a testament to cities' commitment to technological integration, operational efficiency, and the breaking of traditional time-space constraints. Moreover, they enhance government-citizen interaction and foster greater public participation in governance processes. Given their pioneering efforts in embedding self-service systems within governmental service spaces, Guangzhou and Foshan stand out as representative cases in the study of smart urban governance. Their selection as case cities is based on their demonstrated success in integrating digital technologies into public

services, making them ideal subjects for analyzing the impact of such systems on urban governance.

3.2. Data Source and Processing

The study collected data through a combination of questionnaire surveys and semi-structured interviews. The design of the research scale referred to previous research achievements (Table 1), which were then revised and perfected by scholars and professionals in this field, resulting in a final survey questionnaire. Initially, questionnaires were distributed to respondents (residents of Guangzhou and Foshan) to analyze the impact of 24 h government self-service space on urban residents. The respondents varied in terms of age, sex, educational level, and physical condition. To ensure the reliability and representativeness of the questionnaire, it was pre-distributed and adjusted based on the issues encountered during the process, both in terms of content and distribution. All questions were presented using a 7-point Likert scale ("7 = strongly agree, 1 = strongly disagree") to assess the respondents' opinions or attitudes on specific issues. The official distribution of the questionnaires comprehensively covered major residential areas. The distribution process was entirely randomized and focused particularly on the structure of the respondents to ensure a basic similarity with the demographic structure of Guangzhou and Foshan cities. Through this method, the sample could effectively represent the overall population. The distribution of questionnaires and interviews took place from April 2021 to April 2024. Questionnaires were distributed online through electronic formats (via Questionnaire Star, China's largest online questionnaire platform with 16.39 million active users in various demographic characteristics). A total of 321 questionnaires were collected, of which 314 were considered valid, resulting in an effective response rate of 97.82%. The interviewees included residents from Guangzhou and Foshan, as well as personnel from government service spaces, totaling 21 individuals (Table 2). The respondents primarily included residents conducting business and staff at government service centers aged between 20 and 50 years old. The interviews were mainly conducted at the Guangzhou Government Service Center and the Foshan Government Service Center. The interviews with the residents covered the process of interaction with digital technologies and changes in spatial and temporal behavior, with specific questions such as 'Do you often use the self-service system at the government service center, and are you able to complete your business? Will you continue to use it in the future?' 'About how long does it take to learn to use the self-service system? Is it smooth to use?' 'What do you think of the reliability and flexibility of the self-service system? How efficient is it?' How did you conduct government business before there was a self-service system? What is it like now? 'What is the experience brought by each of the two? Any impact on daily life?' etc. Staff interview questions included 'What kind of services do government service center generally provide? What are your main responsibilities? How difficult is the work?' 'What is the general flow of people in the government service center? What kind of business do you mainly handle? Is there any difference in the age of the people handling business?' 'When was the 24 h government self-service system set up? Why was it set up? How is it used on weekdays? How does the staff manage it?' 'Has the launch of the self-service system had any impact on your work?' etc. The study utilized SPSS 26.0, and AMOS 24.0, for questionnaire data analysis and model construction (Figure 2).

Table 1. Variables measurements.

Variables	Items	Measurements	Sources
Perceived Usefulness	PU1	Using the self-service system can assist me in completing transactions or inquiries	Davis [54], Yen [55]
	PU2	Using the self-service system can enhance the efficiency of my transaction processing	
	PU3	Using the self-service system helps me save time and money	
	PU4	Using the self-service system at the Government Service Center enhances my transactional experience	
	PU5	Overall, utilizing the self-service system is beneficial for me	
Perceived Ease of Use	PEOU1	I can use the self-service system without spending a significant amount of time learning	Davis [54], Yen [55]
	PEOU2	Becoming proficient in using the self-service system is easy	
	PEOU3	Through the self-service system, I can easily access the content I am interested in	
	PEOU4	My interaction with the self-service system is clear and understandable	
	PEOU5	Overall, using the self-service system is easy	
Attitude toward Usage	ATU1	I believe that using the self-service system is a good idea	Davis [54], Venkatesh [46]
	ATU2	I believe that using the self-service system is advisable	
	ATU3	I believe that it is better for me to use the self-service system rather than using only manual service, and I will recommend it	
Task Characteristics	TKC1	I need to use the self-service system to complete transactional procedures	Zhou [49]
	TKC2	I can use the self-service system for transaction processing and inquiries	
	TKC3	I can efficiently complete transactional procedures through the self-service system	
Technology Characteristics	TYC1	Many government services can be completed using the self-service system	Goodhue, Thompson [48]
	TYC2	The services provided by the self-service system are flexible	
	TYC3	The self-service system is simple and convenient for me	
	TYC4	The self-service system is reliable	
	TYC5	I need human assitance when l am using self-service	
Task-technology Fit	TTF1	During the business transaction process, the self-service system is what I need	Lin, Huang [56]
	TTF2	The self-service system meets my requirements	
	TTF3	For specific procedures, I can quickly find the necessary self-service options	
	TTF4	The self-service system is applicable to me	

Table 1. *Cont.*

Variables	Items	Measurements	Sources
Actual Usage	AU1	I frequently use the self-service system	Venkatesh [46], Davis [54]
	AU2	I extensively utilize the self-service system	
	AU3	In the future, I will continue to use self-service to handle government affairs	

Table 2. Respondent Information.

Code	Gender	Age	Identity	Location
A01	male	20–30	resident	Guangzhou Municipal Government Service Center
A02	male	20–30	resident	Guangzhou Municipal Government Service Center
A03	female	20–30	resident	Guangzhou Municipal Government Service Center
A04	male	20–30	resident	Guangzhou Municipal Government Service Center
A05	male	20–30	staff	Guangzhou Municipal Government Service Center
A06	male	30–40	resident	Guangzhou Tianhe District Government Service Center
A07	male	40–50	resident	Guangzhou Tianhe District Government Service Center
A08	male	40–50	staff	Guangzhou Tianhe District Government Service Center
A09	female	40–50	staff	Guangzhou Yuexiu District Government Service Center
A10	female	40–50	resident	Guangzhou Yuexiu District Government Service Center
B01	male	20–30	resident	Foshan Government Service Center
B02	male	20–30	resident	Foshan Government Service Center
B03	female	20–30	resident	Foshan Government Service Center
B04	female	20–30	staff	Foshan Chancheng District Government Service Center
B05	female	20–30	staff	Foshan Chancheng District Government Service Center
B06	male	30–40	staff	Foshan Chancheng District Government Service Center
B07	male	30–40	staff	Foshan Chancheng District Government Service Center
B08	female	40–50	resident	Foshan Chancheng District Government Service Center
B09	male	40–50	resident	Foshan Nanhai District Government Service Center
B10	male	40–50	staff	Foshan Nanhai District Government Service Center
B11	female	40–50	resident	Foshan Nanhai District Government Service Center

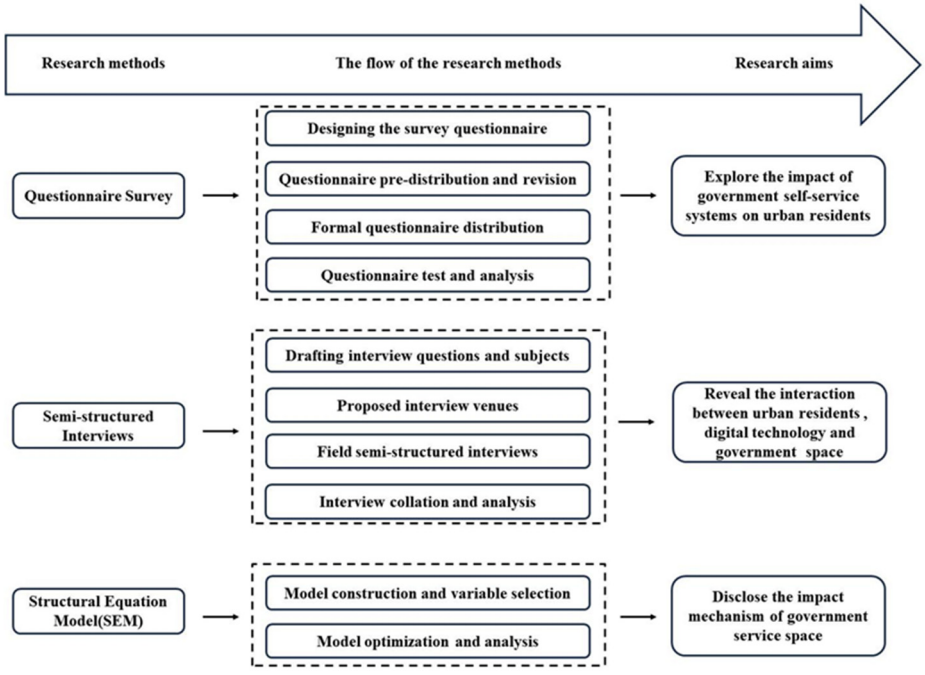


Figure 2. Flow and roles of the research methods.

3.3. Descriptive Statistics

Descriptive statistics results are presented in the table (Table 3). Within the sample, males constitute 43% and females 57%. The age distribution is primarily concentrated among individuals below 40 years old, with 18–25 years old accounting for 46.20%, 26–40 years old for 20.70%, 41–60 years old for 29.30%, and above 60 years old for 3.8%. This reflects a predominantly youthful demographic of technology adoption. In terms of education, those with a college degree or higher account for 81.8% of the sample, which is in line with the average educational attainment in Guangzhou and Foshan.

Table 3. Characteristics of respondents (n = 314).

Variable	Item	Number	Percentage (%)
Gender	Male	135	43
	Female	179	57
Age	18–25	145	46.20
	26–40	65	20.70
	41–60	92	29.30
	Above 60	12	3.80
Highest level of education	Junior middle school and below	20	6.40
	High school and technical secondary school	37	11.80
	College, undergraduate	230	73.20
	Postgraduate, or above	27	8.60
The frequency of using government self-service systems	1 to 2	115	36.60
	3 to 5	91	29.00
	More than 5	108	34.40

4. Results

4.1. Reliability and Validity Tests

The reliability and validity of the questionnaire were assessed using SPSS26.0. The Cronbach's value for the scale was calculated at 0.980, indicating a strong internal consistency among all items, as each item showed a Cronbach's value greater than 0.8. This suggests the high reliability of the scale within the study. Regarding validity, the Kaiser-Meyer-Olkin (KMO) measure for the overall questionnaire reached 0.97, with all individual indicators showing statistics above 0.7. Furthermore, a discriminant validity test was conducted, indicating that the average variance extracted (AVE) for each variable exceeded the correlation coefficients with other variables (Table 4). This suggests strong discriminant validity for the questionnaire.

Table 4. Square root of the AVE of the questionnaire latent variables and their correlation with other latent variables.

	Perceived Usefulness	Perceived Ease of Use	Attitude toward Usage	Task Characteristics	Technology Characteristics	Task-Technology Fit	Actual Usage
Perceived Usefulness	0.908						
Perceived Ease of Use	0.768 **	0.895					
Attitude toward Usage	0.785 **	0.721 **	0.846				
Task Characteristics	0.865 **	0.809 **	0.772 **	0.915			
Technology Characteristics	0.809 **	0.788 **	0.757 **	0.852 **	0.811		
Task-technology Fit	0.862 **	0.762 **	0.734 **	0.851 **	0.86 **	0.913	
Actual Usage	0.633 **	0.665 **	0.645 **	0.669 **	0.69 **	0.641 **	0.855

Note: ** indicates that the correlation is significant for $p < 0.01$ (two-tailed test). The square root of the AVE value for each variable is diagonal.

Additionally, before constructing the model, Structural Equation Modeling (SEM) was employed to examine the factor loadings in the measurement model and assess how well each observed variable explained the latent variables. The consistency between the hypotheses and test items was examined by measuring the factor loadings for each dimension. The analysis revealed that the factor loadings for each dimension's respective variables were all above 0.7, signifying a strong representation of the variables within their dimensions. Moreover, the AVE values for each dimension exceeded 0.5, while the Composite Reliability (CR) was above 0.8, indicating a good level of convergence (Table 5).

Table 5. Descriptive statistical results and reliability and validity tests.

Variable	M	SD	SE	AVE	CR	Cronbach α
Perceived Usefulness						
PU1	5.764	1.167	0.892			
PU2	5.831	1.147	0.921	0.825	0.959	0.959
PU3	5.841	1.178	0.89			
PU4	5.71	1.176	0.926			
PU5	5.885	1.127	0.913			
Perceived Ease of Use						
PEOU1	5.723	1.247	0.867			
PEOU2	5.494	1.292	0.917	0.801	0.953	0.951
PEOU3	5.357	1.38	0.837			
PEOU4	5.363	1.364	0.919			
PEOU5	5.529	1.292	0.93			
Attitude toward Usage						
ATU1	6.003	1.143	0.875	0.715	0.883	0.876
ATU2	6.121	1.078	0.849			
ATU3	5.793	1.347	0.812			
Task Characteristics						
TKC1	5.697	1.228	0.897	0.837	0.939	0.939
TKC2	5.768	1.194	0.939			
TKC3	5.666	1.21	0.908			
Technology Characteristics						
TYC1	5.646	1.185	0.897			
TYC2	5.497	1.27	0.863	0.658	0.902	0.885
TYC3	5.64	1.223	0.891			
TYC4	5.621	1.18	0.857			
TYC5	5.379	1.412	0.462			
Task-technology Fit						
TTF1	5.774	1.154	0.915			
TTF2	5.653	1.154	0.937	0.833	0.952	0.951
TTF3	5.487	1.264	0.857			
TTF4	5.774	1.143	0.94			
Actual Usage						
AU1	5.255	1.598	0.93	0.73	0.89	0.875
AU2	4.78	1.742	0.879			
AU3	5.71	1.336	0.744			

4.2. Model Construction and Optimization

AMOS 24 was used to construct the model diagram (Figure 3), and the overall goodness-of-fit of the model was tested and analyzed (Table 6). The χ^2 value of the overall fit index was significantly affected by the sample size. Therefore, the absolute fit index (χ^2/df), goodness-of-fit index (GFI), root mean square error of approximation (RMSEA), root mean residual (RMR), relative fit index (NFI, CFI, IFI, and RFI), and con-

tracted fit index (PNFI and PGFI) were selected to test the goodness-of-fit of the model. In the initial goodness-of-fit index, $\chi^2/df = 3.432$,which was higher than the standard value ($1 < \chi^2/df < 3$). To improve the fit of the model, the modification index provided by AMOS24 was used to modify the model according to the modification criteria. Based on theoretical feasibility, model modifications can make the default model reasonable by adding or deleting the correlation path. Two model modifications were made in this paper, and all indicators meet the ideal criteria (Figure 4). This indicates that the model is well suited to the factors that influence the use of the government self-service system.

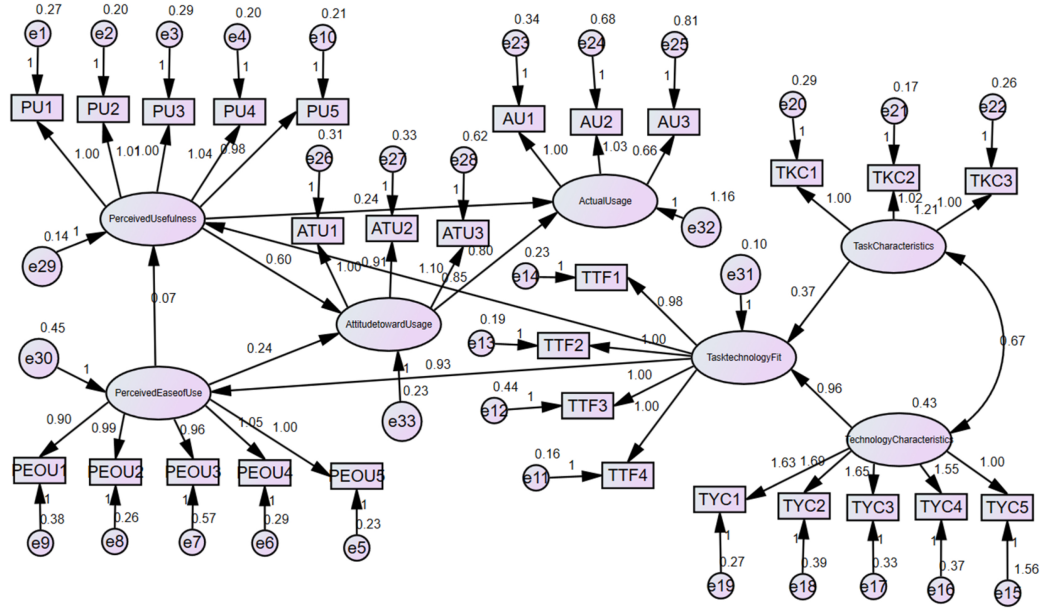


Figure 3. Initial structural equation model of influencing factors (Generated by AMOS24.0).

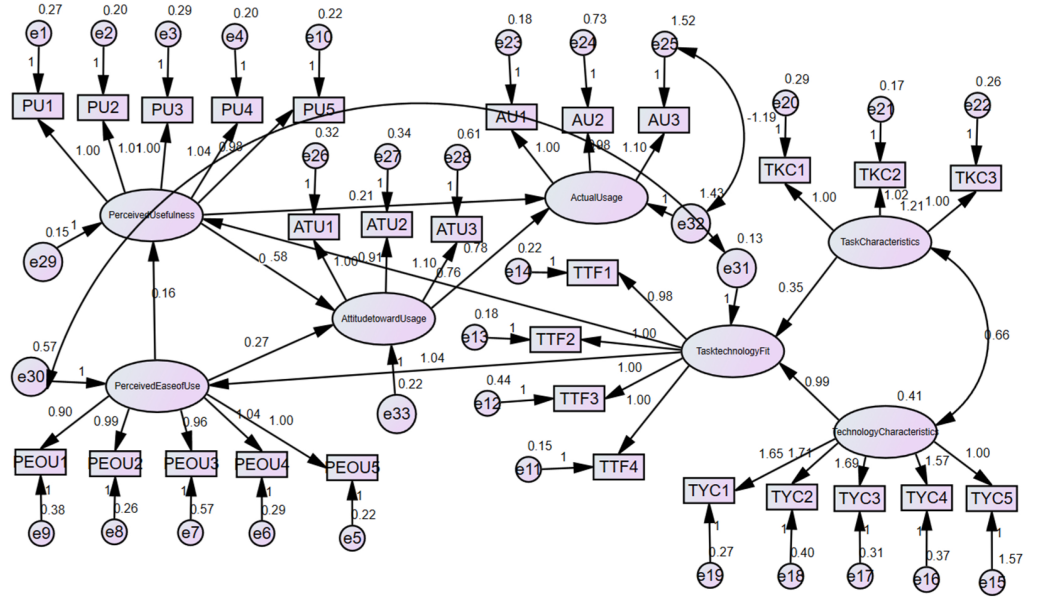


Figure 4. Revised structural equation model of influencing (Generated by AMOS24.0).

Table 6. Test results of the model goodness-of-fit indexes.

	Absolute Fit Index				Relative Fit Index				Parsimonious Fit Index	
Goodness-of-fit index	χ^2/df	GFI	RMR	RMSEA	NFI	RFI	IFI	CFI	PNFI	PCFI
Ideal value	<3	>0.9	<0.5	<0.5	>0.9	>0.9	>0.9	>0.9	>0.5	>0.5
Initial model	3.432	0.788	0.131	0.088	0.895	0.883	0.923	0.923	0.805	0.83
Correction model1	3.214	0.798	0.124	0.084	0.902	0.89	0.93	0.93	0.809	0.834
Correction model2	2.819	0.918	0.078	0.076	0.914	0.904	0.943	0.943	0.817	0.843

4.3. Analysis of Model Results

This research conducted a path analysis of the model and obtained the path coefficients and path examination table (Table 7). When the absolute value of CR is greater than 1.96, and the *p*-value is less than 0.05, we consider the regression coefficient of the assumed path to be significant. According to this criterion, the computation results in the table indicate that eight of the nine assumed paths (H1, H2, H3, H5, H6, H7, H8, and H9) are supported, while one assumed path (H4) is not supported (Figure 5). An explanation of these findings based on the computed results is provided below.

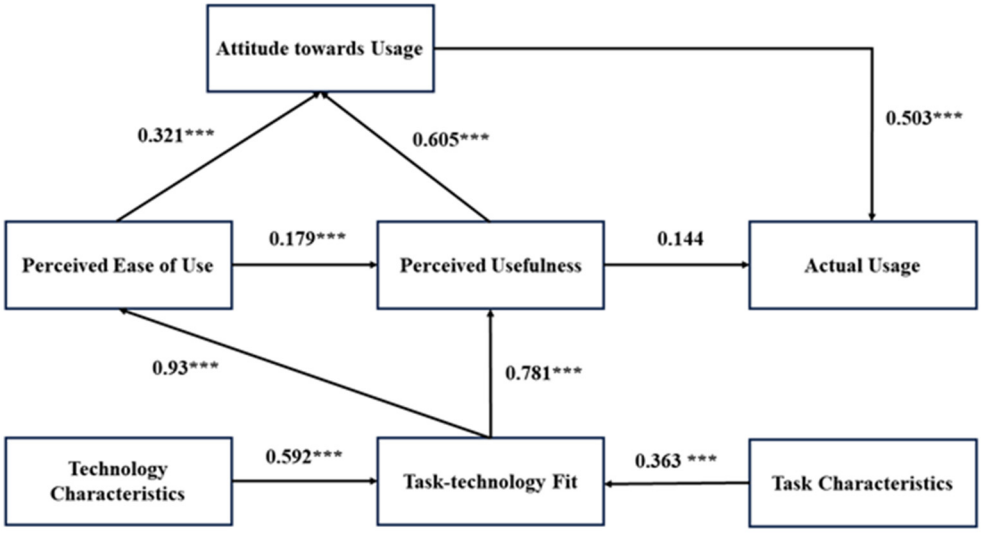


Figure 5. Model test result. *** indicates that the correlation is significant for $p < 0.01$ (single-tailed test).

Table 7. Path coefficient test of the model.

Paths	Assumptions	Unstandardized Regression Coefficients	Standardized Regression Coefficients	SE	CR	P	Test Results
Perceived Ease of Use to Perceived Usefulness	H1	0.156	0.179	0.04	3.868	***	Supported
Perceived Ease of Use to Attitude toward Usage	H2	0.265	0.321	0.052	5.143	***	Supported
Perceived Usefulness to Attitude toward Usage	H3	0.575	0.605	0.062	9.207	***	Supported
Perceived Usefulness to Actual Usage	H4	0.212	0.144	0.104	2.044	0.041	Supported
Attitude toward Usage to Actual Usage	H5	0.78	0.503	0.124	6.275	***	Supported

Table 7. *Cont.*

Paths	Assumptions	Unstandardized Regression Coefficients	Standardized Regression Coefficients	SE	CR	P	Test Results
Task Characteristics to Task-technology Fit	H6	0.355	0.363	0.078	4.536	***	Supported
Technology Characteristics to Task-technology Fit	H7	0.988	0.592	0.174	5.682	***	Supported
Task-technology Fit to Perceived Usefulness	H8	0.758	0.781	0.051	15.004	***	Supported
Task-technology Fit to Perceived Ease of Use	H9	1.038	0.93	0.054	19.138	***	Supported

Note: *** indicates that the correlation is significant for $p < 0.01$ (single-tailed test).

4.3.1. Perceived Ease of Use, Perceived Usefulness, Attitude toward Usage and Actual Usage

The analysis reveals significant positive impacts among the factors influencing the usage behavior of the government self-service system by residents. Perceived ease of use significantly and positively influences perceived usefulness, with path coefficients of 0.175 and 0.316, respectively ($p < 0.01$), confirming H1 and H2. Moreover, both perceived usefulness and attitude toward usage significantly and positively influence actual usage, with path coefficients of 0.118 and 0.489 ($p < 0.05$), confirming H4 and H5. These findings indicate that the streamlined and efficient design of the government self-service system has played a crucial role in facilitating residents' administrative transactions. It not only expands their options for transactional activities but also fosters a more positive attitude toward usage, consequently promoting actual usage with the system. Hence, the government's self-service system has the potential to broaden the space for residents' transactional activities.

4.3.2. Task Characteristics, Technology Characteristics and Task-Technology Fit

The analysis indicates that among the factors influencing the actual usage of the government self-service system, task characteristics have a positive impact on task-technology fit with a path coefficient of 0.363 ($p < 0.05$). Therefore, H6 passed the test. Meanwhile, the technological characteristics of the government self-service system significantly and positively impact task-technology fit, with a path coefficient of 0.945 ($p < 0.01$). Thus, H7 is confirmed. The task characteristics and technological characteristics provided by the government self-service system satisfied the requirements and enhanced convenience for residents, making the transactional process more convenient and expedited.

4.3.3. Task-Technology Fit, Perceived Usefulness, Perceived Ease of Use

The analysis indicates that among the factors influencing the actual usage of the government self-service system, task-technology fit significantly and positively impacts residents' perceived usefulness and perceived ease of use. The path coefficients are 0.769 ($p < 0.01$) and 0.923 ($p < 0.01$), respectively. Hence, both H8 and H9 have passed the test, demonstrating that higher task technology fits in the government self-service system, which leads residents to perceive the system as more usable and effective.

5. Spatial Perception and Technology Interaction among Urban Residents

As a novel technology, the impact of the 24 h government self-service space primarily manifests in reshaping urban residents' perceptions of government service space. This reconceptualization of spatial perception is achieved through the compression of time and space and interactive engagements with digital technology.

The Technology Acceptance Model indicates a close connection between the perception shaping of government service space under digital technology integration and the degree of acceptance and usage of the self-service system, showcasing the time-space compression

effect resulting from the adoption of new technology. Specifically, in terms of residents' perception of government service space, compared to the past practice of relying only on manual services, enduring long queues, and conducting transactions at fixed times and locations, self-service systems offer notably higher transactional efficiency, operate round-the-clock, and eliminate location restrictions. Considering the time and effort costs, residents generally prioritize this system. Consequently, the impact of digital technology transformation is evident in temporal and spatial dimensions, compressing transaction time, expanding transactional spaces, and enriching the diversity of temporal and spatial choices. This diversity highlights the operability and convenience of government self-service systems in cultivating new practices in terms of temporal and spatial perceptions. As mentioned by the respondents:

> *"...I took a number and had to wait for quite a while before it was my turn. Seeing the self-service space here without any queue, I decided to give it a try. The experience was great; I quickly completed my tasks. Next time, I won't go to the manual service. It saved me a lot of time" (A03)*

> *"...It's basically a few key aspects, 24 h, 5 + 2, day and night. Essentially, whenever you come, you can go in and get things done. The self-service space integrates various services related to people's livelihoods or some governmental applications. In fact, it's a consolidation into a service space, probably a centralized one. Whatever you want to do, as long as it's available here, you can do it." (B06)*

These statements highlight how the convenience and efficiency of self-service systems have led to a positive shift in residents' spatial behaviors and attitudes. Residents appreciate the reduction in time spent and the flexibility of accessing services, which has not only improved their experiences but also fostered a sense of autonomy in managing their affairs. Moreover, the interaction between residents and self-service systems has influenced their spatial experience by meeting their specific needs. For instance, residents increasingly prefer to use self-service options for tasks like property changes or driver's license renewals, as these systems are perceived to be reliable and efficient. As one respondent noted:

> *"...I think the driver's license renewal physical examination space is well organized. Now, it can be completed in a separate small room, saving the hassle of another trip to a medical institution for the examination. The current space is secluded, with a peaceful environment, offering an all-in-one service, which is really convenient." (B09)*

However, some residents also highlighted areas for improvement. For example:

> *"I think there are two points that could be improved. First, it is more convenient to use the system with a mainland ID card, but it would be better if the system could also optimize the process for foreign passports, Hong Kong's return permits, or Taiwan's travel permits. Second, for young people, using the internet and system is relatively simple, but it might be difficult or inaccessible for older people. Although there are volunteers to provide guidance, considering the cost of manpower, it would be good to see if more volunteers can be added. After all, systems can't handle all situations like people can, and when using systems, you need to understand your specific situation, which can distribute responsibilities differently." (A06)*

> *"I hope that more services can be handled through self-service. Also, it would be great if some services could be processed nationwide across regions. For people from other provinces, it's still very inconvenient that many services must be handled manually." (B11)*

Additionally, the staff at government service centers have observed a noticeable shift in residents' behaviors, with many choosing self-service options over manual services. This shift has also reduced the workload of staff, leading to a more harmonious environment within service centers. As staff members remarked:

> *"...Sometimes work on weekdays can not find time to do business, leave to come because of the long queue time can not take their turn, the need to come again let a person is very annoying. In the past, this situation to deal with business will be very impatient, it will lead to some conflicts such as quarrels, complaints." (A04)*

> *"...I think this (the creation of the self-service area) is actually having a big impact. Firstly, our staff, we don't have to face their negative emotions all the time, because the self-service reduces the burden of the residents, and the residents' sense of access will actually be very high. Because residents don't have to run from various departments, they can do their business, finish it and then they can go, the staff saves time they also save time." (B07)*

Overall, according to the results of the interviews, the establishment of the 24 h government self-service space has positively changed the spatial behavioral patterns and emotional attitudes of both citizens and staff. For residents, the self-service system relies on the efficiency and convenience of technology and a reduction in business processing costs. It solves the problems of difficult queuing and time constraints for business processing, making sense of the experience of the government service space that continues to rise in interaction with technology, thus creating an atmosphere of better city life and facilitating urban governance. For the staff, the self-service system effectively reduces the mechanical repetition of workload and reduces the possibility of conflict with the public in the process of daily business. Technology embedded in the government service space has achieved a good social effect, reflecting the organic connection between individuals, technology, and the city, indicating the correctness of technology sinking into the digital governance of urban social public space.

6. Discussion

With the rapid development and widespread application of information and communication technology, as well as the Internet, digital technology has permeated various aspects of modern life, thereby altering people's perceptions, interactions, and experiences within spaces. Understanding the interaction between space, technology, and human beings is crucial for analyzing spatial transformations and comprehending new spatial phenomena. The impact and role of the 24 h self-service space and its self-service system on urban residents highlight the spatiotemporal and interactive nature of digital geography, emphasizing the interaction between space, technology, and human beings. Research findings indicate that employing a self-service system as a technological intervention has improved the efficiency of government service processes to some extent and expanded the scope of services. The application of digital technology has enhanced urban residents' satisfaction and overall perception of the quality of the government service space. Through the self-service system within the 24 h service space, residents gain access to more government service spaces and resources while reducing the need for unnecessary on-site operations such as appointments and queuing. The intervention of digital technology strengthens residents' perceptions of space in terms of its spatiotemporal dimensions. The 24 h government self-service system enables more flexible and controllable handling of government tasks, effectively reducing entry barriers to government service spaces.

It is noteworthy that the implementation of the government self-service system has led to a compression of time and space, reshaping urban residents' perceptions of government service spaces. The convenience of the system has shaped new subjective perceptions to a significant extent. People's changed perceptions of government service spaces are largely due to the diversity of choices available. Individuals are no longer confined to fixed timeframes and spaces; they now have the flexibility to arrange their schedules. This study found that approximately 90% of the respondents believed that the 24 h self-service space extended the hours for handling tasks, allowing for personalized scheduling. The government self-service in this space has reduced the actual time taken for the entire transaction process, thereby enhancing the convenience of handling government affairs in terms of spatiotemporal perception. Analyzing residents' perceptions and interactions

with government service spaces under the intervention of digital technology responds to the core issue of digital geography by exploring the relationship between space, digital technology, and humanity. It offers a new perspective for understanding various changes in digital society and their impact on how we perceive physical spaces, such as government service spaces, and interact with them [57,58].

In terms of the interaction between humanity, digital technology, and space, the research results indicate that urban residents' acceptance and usage of digital technologies (such as government self-service systems) and the widespread availability of the self-service system have expanded their opportunities to use government service spaces. Moreover, the convenience offered by these digital technologies further increases their willingness to use them. This enhanced willingness to use digital technologies positively impacts the efficiency of government service processes, perception of service quality, and scope of services. Additionally, the convenience and compression of time and space provided by digital technologies makes residents inclined toward their usage. This increased willingness and frequency of usage further strengthens the impact of digital technologies on individuals and spaces, enhancing their applicability and utilization while interconnecting digital technologies with spatial aspects. These findings underscore the importance of digital technologies in the outcomes of government services. In urban spaces, the spatiotemporal costs of residents' engagement with government affairs often increase owing to slow manual services and cumbersome processes. Taking Guangzhou and Foshan as examples, both regions rank among the nation's leaders in terms of government services. However, due to factors like dense population and a highly aging demographic, challenges persist in the efficiency of government services. Supported by digital technology, optimizing government service spaces represents a breakthrough in addressing conflicts between spaces and residents. The spatial perceptions formed by urban residents under the influence of digital technology offer an intuitive understanding of the allocation of urban government service spaces and resources. This perception directly impacts the formation of residents' emotions and their recognition and expectations of smart cities, digital governance, and digital government services.

Considering the interaction between digital technology, space, and humanity offers a dialectical view of urban digital governance and valuable insights into the construction of smart cities. Ultimately, this enhances the intelligence and humanization of urban digital governance and urban spaces. Improving government service spaces and the convenience and efficiency of urban residents' transactional activities are critical issues in digital governance [59]. However, to realize intelligent utilization of government service spaces and resources in smart cities, enhance the interaction between digital technology and individuals, and optimize space utilization, a technological platform system capable of Internet access is indispensable [60]. The construction of a digital governance space is based on the convenient and efficient delivery of urban government services. Spatial configurations in government services need to adapt flexibly to residents' actual time schedules, constructing a perceptually intelligent and convenient space. Reducing queue times and streamlining processes shapes residents' positive perceptions of government service spaces. Urban digital governance not only concerns the acceptance and use of digital technology by urban residents but also focuses on their perception and experience of technology embedded within spaces. With the widespread adoption of self-service systems in government service spaces, residents' perceptions and experiences of spaces undergo changes, making the creation of digital governance spaces a crucial aspect of the increasing demand for digital governance. Considering the reshaping of urban government service spaces by digital technology, reinforcing the optimization of digital technology services within spaces and resource allocation represents another layer of meaning in the interaction between people and technology.

This study primarily focuses on how urban residents perceive and interact with urban government service spaces under the intervention of digital technology. Specifically, it analyzes the impact of digital technology, represented by the government's self-service

system, on urban residents' spatial perceptions and interactions. The aim of this study is to unveil the linkage mechanism between digital technology, space, and human behavior, offering theoretical and practical implications for future research. In the digital era, the role of technology within a space is undeniable. Innovative applications of digital technology have brought about changes in spatial utilization, behaviors, and perceptions. Particularly, by altering the temporal and spatial patterns of behavioral subjects, digital technology propels transformation in government service spaces. Admittedly, digital technology cannot fundamentally solve these issues in urban government service spaces. Indeed, its role in enhancing efficiency and perceptual emotions, such as trust within this space, can contribute to the optimization and improvement of government service space efficiency under the influence of digital technology, subsequently fostering digital governance in urban spaces (Figure 6).

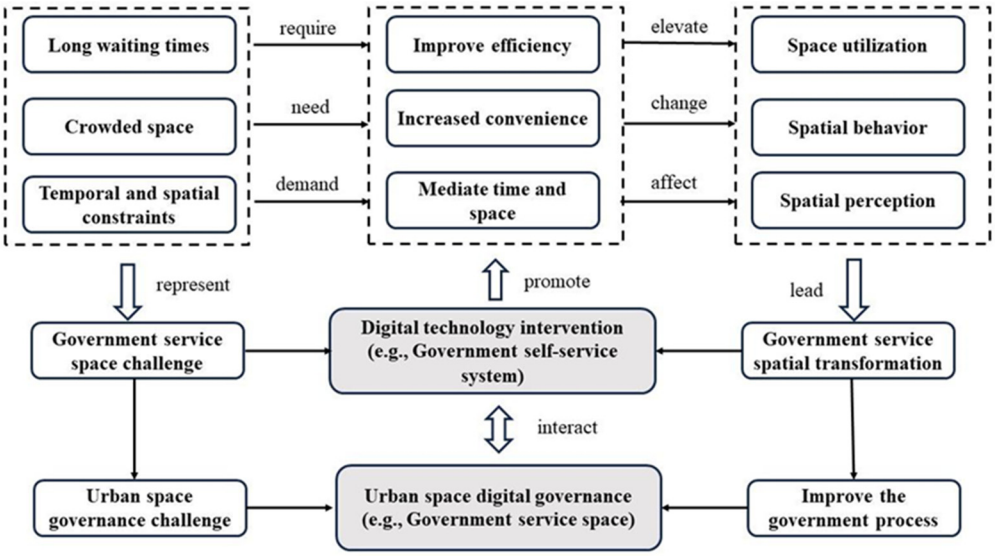


Figure 6. The logical mechanism of digital governance and transformation in urban government service space.

Previous studies in various regions and countries, such as Switzerland and India, have explored the impact of digital governance on urban and rural governance, with mixed results. For instance, Reissig. L found that in Switzerland, the integration of digital technologies into public services (e-government services) led to an administrative burden for farmers, which contrasts with our findings in China [61]. Similarly, Datta. A observed that India has experienced an identity challenge in its digital governance efforts [28]. Meanwhile, our findings are consistent with those of Michael. E: Digital governance is the next step for governments at all levels to reduce costs, meet citizen expectations, and achieve economic recovery goals [37]. These comparative insights highlight the diverse ways in which digital governance is implemented across different sociopolitical contexts and suggest that, while our findings are particularly relevant to China's unique environment, there may be broader implications for other countries undergoing similar digital transitions.

7. Conclusions and Limitations

From the perspectives of digital geography and smart cities, this article uses Guangzhou and Foshan as examples to explore the impact of government self-service systems on the spatial perception and behavior of urban residents, as well as their influence and interactive mechanisms on government service spaces, through a mixed-method approach that combines questionnaire surveys and semi-structured interviews analyzed using a structural equation model. As an emerging digital technology service, the government self-service system liberates residents from constraints during their business processing, offering round-the-clock availability and real-time access, thereby reshaping residents'

perceptions of government service space. Conversely, the reshaping of spatial perception leads to the restructuring of urban residents' spatial behaviors. As a new technology, the government self-service system predominantly influences urban residents through temporal compression and technological interaction, which manifests in the reduction of time spent and changes in spatial behavior. Urban residents' access to government services extends from physical spaces to the digital realms. These interactions illustrate the negotiation and mutual promotion between urban residents and technology. Confronted with the introduction of new technology, urban residents often perceive changes in both temporal and spatial dimensions. Moreover, at the temporal and spatial levels, government self-service systems impact residents' daily lives, breaking through the temporal and spatial limitations of their business processing by leveraging online platforms.

It is worth noting that while digital technology enables online transaction processing and cross-regional information flow, urban development still relies on the balanced allocation of governmental resources and physical environments. Additionally, in the process of constructing a more humane and intelligent city, paying closer attention to changes in urban government service spaces becomes crucial, as it will lead to shifts in residents' spatial perceptions. The influence of digital technology on urban subjects' spatial perception not only indicates the direction of urban spatial issues, but also serves as a vital reference for building harmonious and humanized cities. This study also focuses on the interaction between digital technology and humanity, thus contributing valuable empirical research in digital geography.

One significant limitation of this study is the use of a random sample that may not be fully representative of the broader population. Although random sampling can help mitigate selection bias, it does not necessarily capture the diversity and complexity of the entire population in Guangzhou and Foshan. As a result, the findings derived from this sample may not be fully generalizable to all residents of these cities or other urban areas with different socioeconomic or cultural contexts. This limitation introduces a degree of uncertainty in the results, making them potentially fragile from a scientific standpoint. The implications of this are twofold: first, the conclusions drawn about the impact of government self-service systems on residents' spatial perception and behavior should be interpreted with caution; second, the reproducibility of these results in different samples or contexts remains an open question. To address this, Future research could address this by utilizing a more statistically representative sample, which would allow for more generalizable conclusions. Moreover, this study focuses on Guangzhou and Foshan, cities known for their advanced integration of digital technologies into governance. Future research could explore similar studies in cities with varying levels of technological integration and different governance structures to enhance the generalizability of these findings. For instance, investigating cities in less developed regions or those in the early stages of digital governance adoption could provide a comparative perspective on how different levels of technological maturity affect urban governance outcomes. Additionally, as digital technologies continue to advance, future studies could explore the integration of emerging technologies, such as artificial intelligence and blockchain, into urban governance. Assessing the impact of these technologies on resident interaction and spatial perception could help identify new opportunities and challenges in the ongoing digital transformation of urban spaces. Despite these limitations, this study offers valuable initial insights into the interaction between digital governance systems and urban spatial perception, which can serve as a foundation for further investigation.

Author Contributions: Conceptualization, L.L. and X.L.; methodology, L.L.; software, L.L.; validation, L.L., X.L. and Z.L.; formal analysis, L.L.; investigation, L.L., X.L., Z.L. and X.Y.; resources, X.L.; data curation, L.L.; writing—original draft preparation, L.L. and X.L.; writing—review and editing, Z.L. and X.Y; visualization, L.L.; supervision, M.W.; project administration, L.L. and X.L.; funding acquisition, M.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China (grant number: 42271241).

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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