ISSN: 2710-0588

Research on the Impact of Digital Infrastructure Construction on Urban Innovation Quality

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Abstract

Digital infrastructure construction is advancing rapidly around the world and has become an important force in promoting urban innovation and economic development. Digital infrastructure includes technologies such as 5G networks, data centers, the Internet of Things, and cloud computing, which provide cities with efficient information transmission and processing capabilities. Modern cities are gradually relying on these technologies to enhance their innovation capabilities and competitiveness. Digital infrastructure is not only a technical support for urban development, but also a key factor in improving the quality of urban innovation. my country is in a stage of rapid urbanization and digitalization. With the in-depth advancement of new infrastructure construction, many cities have made significant progress in the field of digital infrastructure. However, there are still large differences in the level of digital infrastructure construction and application among different cities, which directly affects the innovation quality and overall development of cities. Cities such as Shenzhen and Hangzhou have shown strong innovation capabilities and economic vitality through the vigorous development of digital infrastructure, becoming models of the digital economy. Studying the impact of digital infrastructure construction on urban innovation quality is not only of great theoretical significance, but also of practical application value. From a theoretical perspective, exploring how digital infrastructure affects urban innovation quality through information circulation, knowledge sharing, enterprise R&D support, and optimization of the innovation ecosystem will help enrich and deepen the theoretical system in the field of digital economy and innovation management. From a practical perspective, the research results can provide a scientific basis for policymakers, and at the same time provide practical guidance for urban planners and managers, promoting the sustainable development of cities and improving their innovation capabilities.

Keywords

Digital infrastructure, innovation quality; digital economy; urbanization.

1. Introduction

1.1. Research background

With the rapid development of global science and technology, digital infrastructure construction has become an important means for countries to promote economic growth and enhance competitiveness. Digital infrastructure covers key technologies such as 5G networks, data centers, the Internet of Things, and cloud computing, providing a solid technical foundation for the efficient transmission, storage, and processing of information. At present, many developed and developing countries are increasing their investment and construction in digital infrastructure in order to seize the initiative in the digital economy era. For example, the United States has vigorously promoted nationwide high-speed Internet access through the

ISSN: 2710-0588

"National Broadband Plan", and Europe has promoted the integrated construction of digital infrastructure in member states through the "European Digital Strategy". Under this global trend, my country has also actively promoted the construction of new infrastructure and issued a series of policies and measures to promote the development of digital infrastructure.

Correspondingly, the quality of urban innovation has become an important indicator for measuring the comprehensive competitiveness of a city. The quality of urban innovation not only affects the level of economic development of the city, but is also directly related to the quality of life of residents and social progress. In recent years, with the intensification of global competition, cities in various countries have taken improving the quality of innovation as the core strategy of urban development. Shenzhen, Hangzhou and other cities in my country have become well-known innovative cities at home and abroad by continuously improving the level of digital infrastructure, attracting a large number of high-tech companies and innovative talents. However, there are still large differences in digital infrastructure construction and innovation quality among cities across the country, and this difference has further aggravated the problem of unbalanced regional development. Therefore, it is of great practical significance to study the impact of digital infrastructure construction on urban innovation quality.

1.2. Research significance

This study is of great significance in both theory and practice. From a theoretical perspective, this paper aims to deepen the understanding of the relationship between digital infrastructure and urban innovation quality. Although some studies have focused on the role of digital infrastructure in promoting economic development, there is still a lack of systematic research on the specific impact mechanism on urban innovation quality. By combing and analyzing relevant literature, this paper will reveal how digital infrastructure affects urban innovation quality through information circulation, knowledge sharing, corporate R&D support, and optimization of the innovation ecosystem, thereby enriching and improving the theoretical system in the field of digital economy and urban innovation.

From a practical perspective, the research results of this paper will provide a scientific basis for decision-making for policymakers and urban planners. Digital infrastructure construction requires a large amount of capital and resource investment. How to efficiently and reasonably allocate these resources to maximize innovation benefits is a major challenge facing policymakers and urban managers. Through typical case analysis and comparative studies, this paper will summarize the successful experiences and lessons of digital infrastructure construction, and provide practical guidance for governments at all levels to formulate digital infrastructure construction plans. In addition, enterprises also play an important role in the construction of digital infrastructure. The research results will provide a reference for enterprises in the formulation of digital transformation and innovation strategies, help them better integrate into the urban innovation ecosystem, and jointly promote the sustainable development of cities and the improvement of their innovation capabilities.

2. Literature Review

2.1. Concept and measurement of digital infrastructure construction

At present, the measurement research on digital infrastructure construction mainly focuses on single indicator measurement and comprehensive system evaluation. Direct indicator measurement. Chao Xiaojing et al. (2021) collected the frequency of relevant words related to digital infrastructure construction in the work reports of provincial and municipal governments in China, and used Python software to summarize and calculate the digital infrastructure construction capacity; Pan Yaru and Gu Hengda (2022) used the relevant data sets of information transmission, software and information technology service industry

ISSN: 2710-0588

investment flows to measure the investment in new infrastructure construction through the perpetual inventory method. Comprehensive indicator evaluation. Fan et al. (2022) used the four-dimensional indicator system of long-distance optical cable lines, mobile phone switch capacity, industrial robot installation, and number of Internet access ports based on the entropy weight method to comprehensively calculate the digital infrastructure construction index; Tang and Yang (2023) used the entropy weight method to quantify the overall development level of China's digital infrastructure from three dimensions: construction degree, usage cost, and coverage rate.

2.2. Related research on factors affecting innovation quality

The earliest research on the factors affecting innovation quality started from the enterprise level. The internal factors mainly involved R&D investment, company stock price, corporate innovation culture, overseas mergers and acquisitions, and employee knowledge hiding behavior. Some scholars have explored the impact of external factors on the quality of corporate innovation, mainly focusing on national strategies and policies, such as the national innovation catch-up strategy and R&D value-added tax preferential policies. Mao Wenfeng and Lu Jun (2020) found that changes in urban spatial form will cause significant changes in urban innovation quality. Yang Jun et al. (2022) found that the pilot policy of innovative cities distorted the effect of innovation policies by strengthening government innovation investment, stimulating urban entrepreneurship, and strengthening talent introduction, thus causing urban innovation to fall into the dilemma of "quantity increase and quality reduction". Yu Liping (2022) pointed out that technological accumulation will also have a certain impact on regional innovation quality. From the existing literature, it can be seen that the research on the factors affecting innovation quality is mostly produced in the micro field, and still needs further discussion and in-depth study.

2.3. Research on the impact of digital infrastructure construction on innovation quality

Many scholars have explored the impact of digital infrastructure construction on innovation quality from the enterprise level, confirming the positive promotion effect of digital infrastructure construction on innovation quality; at the regional and urban level, Li Xiaolong and Ran Guanghe (2021) used panel data from Chinese prefecture-level cities to empirically test the impact of digital financial development on technological innovation quality, and found that digital financial development significantly improved technological innovation quality by expanding market potential and promoting industrial structure upgrading. Liang Qi et al. (2021) focused on the spatial effect of digital infrastructure construction on innovation quality, and found that the spatial spillover effect of digital infrastructure construction on innovation quality in other regions was different under different weight matrices. They believed that economic factors played an important role in the process of digital infrastructure construction affecting regional innovation quality. The smaller the economic gap between cities, the easier it is to produce positive spillover effects. It is not difficult to see that the current research on digital infrastructure construction at the urban level on innovation quality is rarely involved, and most of it is centered on the field of digital finance. In the context of the era when cities are stepping up their digital strategic layout, the impact and mechanism of digital infrastructure construction on urban innovation quality need to be further explored.

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3. The Impact of Digital Infrastructure Construction on Urban Innovation Quality

3.1. Promoting information circulation and knowledge sharing

The construction of digital infrastructure has significantly promoted information circulation and knowledge sharing, which plays an important role in promoting urban innovation activities. Efficient information circulation can accelerate the dissemination and feedback of information, reduce information asymmetry, and improve the speed and accuracy of information acquisition. For example, the widespread application of 5G networks has greatly increased the speed of data transmission, greatly improving the efficiency of information exchange between enterprises and scientific research institutions. At the same time, digital infrastructure provides technical support for the construction of knowledge sharing platforms. Through cloud computing and big data technologies, cities can establish integrated knowledge sharing platforms to bring together innovative resources and knowledge achievements from enterprises, scientific research institutions and governments. These platforms not only promote knowledge exchange and cooperation among all parties, but also promote the open sharing of innovative resources, provide a broader vision and rich resource support for innovation activities, and thus improve the quality of innovation in cities.

3.2. Improving the R&D capabilities of enterprises

Digital infrastructure plays a key role in improving the R&D capabilities of enterprises. First, digital infrastructure provides strong technical support, enabling enterprises to use advanced digital tools and technologies for R&D activities. For example, cloud computing platforms can provide enterprises with high-performance computing and massive data storage capabilities to support complex R&D tasks. Second, digital infrastructure plays an important role in data analysis and application in the R&D process. Through big data analysis technology, enterprises can conduct in-depth analysis of massive data in the R&D process, explore potential laws and trends, and optimize R&D processes and decision-making. In addition, Internet of Things technology enables devices and products to collect and transmit data in real time, helping enterprises to understand the operating status and performance of products in a timely manner and make precise improvements and innovations. The application of these technologies not only improves the R&D efficiency and innovation capabilities of enterprises, but also shortens the R&D cycle, reduces R&D costs, and further enhances the market competitiveness of enterprises and the innovation quality of cities.

3.3. Optimizing the innovation ecosystem

The construction of digital infrastructure provides strong support for optimizing the innovation ecosystem. By building a digital ecosystem, cities can achieve efficient integration and optimal allocation of innovation resources. Digital infrastructure makes the interaction and collaboration between different innovation entities more convenient and efficient, forming an open and interconnected innovation network. For example, through digital platforms, enterprises, scientific research institutions and governments can jointly participate in innovation projects, share resources, complement each other's strengths, and promote collaborative innovation. At the same time, digital infrastructure promotes the integration and optimization of innovation resources. Through the integration and analysis of data, it identifies and eliminates bottlenecks and obstacles in the innovation process and improves the efficiency of resource utilization. In addition, the digital ecosystem also supports the development of innovation and entrepreneurship activities, provides start-ups with necessary technical and data support, reduces the threshold and risks of innovation and entrepreneurship, further stimulates the innovation vitality of the city, and improves the overall innovation quality of the city.

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3.4. Improving the innovation environment and policy support

The construction of digital infrastructure is of great significance to improving the innovation environment and policy support of cities. Digital government and smart city construction are important directions for modern urban governance. Through digital means, the efficiency and transparency of government management and services can be improved, and a good external environment can be provided for innovation activities. For example, the intelligent transportation and intelligent energy management systems in smart cities can improve the operating efficiency of cities and the quality of life of residents, and attract more innovative talents and enterprises to settle down and develop. The government's policy support in the construction of digital infrastructure is also crucial. By formulating and implementing policies conducive to the development of the digital economy, providing financial and technical support, and encouraging enterprises and scientific research institutions to increase digital transformation and innovation investment. In addition, policy support is also reflected in intellectual property protection, data security management and other aspects, creating a fair, safe and stable environment for innovation activities. These policy and environmental improvements have further promoted the construction of digital infrastructure and the improvement of innovation capabilities in cities, and promoted the sustainable development and high-quality innovation of cities.

4. Typical Case Analysis

4.1. Case selection and introduction

This article selects two representative cities, Shenzhen and Hangzhou, for case analysis. As a pioneer city of China's reform and opening up, Shenzhen is known for its rapid economic growth and high-level scientific and technological innovation. In recent years, Shenzhen has invested heavily in digital infrastructure construction, established a complete 5G network, data center and Internet of Things applications, and has become a pioneer city in the digital economy in China and even the world. As the leader of China's digital economy, Hangzhou has also made remarkable achievements in digital infrastructure construction by relying on the technology and resource advantages of technology giants such as Alibaba. Hangzhou actively promotes the construction of smart cities and develops digital applications in multiple fields such as smart transportation, smart medical care and smart government affairs. The digital economy has become an important economic pillar.

The achievements of Shenzhen and Hangzhou in digital infrastructure construction have laid a solid foundation for improving the quality of urban innovation. Shenzhen has vigorously developed 5G networks and Internet of Things applications through the "new infrastructure" strategy, providing a superior digital environment for innovation and entrepreneurship; Hangzhou has achieved comprehensive digitalization of urban management and services through the "City Brain" project, improving urban operation efficiency and the quality of life of residents. The basic situation and current status of digital infrastructure construction in these two cities fully demonstrate the profound impact and huge potential of digital transformation on urban development.

4.2. The specific impact of digital infrastructure construction on innovation quality

Through the case analysis of Shenzhen and Hangzhou, we can clearly see the significant impact of digital infrastructure construction on the quality of urban innovation. First, before the construction of digital infrastructure, the innovation activities of these cities were limited by problems such as poor information flow, insufficient technical support and scattered resources, and the innovation efficiency and quality were relatively low. By vigorously building 5G

ISSN: 2710-0588

networks, the Internet of Things and big data platforms, Shenzhen and Hangzhou have achieved efficient transmission and sharing of information, greatly improving the innovation capabilities of enterprises and scientific research institutions. For example, Huawei in Shenzhen has achieved world-leading results in 5G technology research and development based on its strong digital infrastructure, promoting the level of scientific and technological innovation in the entire city. Through the construction of smart cities, Hangzhou has optimized urban management and services, improved the overall innovation ecology of the city, and provided a good environment for innovation and entrepreneurship.

In terms of summarizing successful experiences and lessons, the experience of digital infrastructure construction in Shenzhen and Hangzhou shows that the government's active guidance and policy support are key factors. The two governments have formulated and implemented a series of support policies, such as providing financial subsidies, technical support and intellectual property protection, to encourage enterprises and scientific research institutions to increase investment in digital transformation and innovation. At the same time, digital infrastructure construction needs to be closely integrated with industrial development and urban planning to form a synergistic effect. For example, in the process of promoting the construction of smart cities, Hangzhou has cooperated with local Internet companies such as Alibaba to make full use of their technology and data advantages to improve the efficiency and effectiveness of smart city construction. However, it should also be noted that the construction of digital infrastructure requires continuous investment and long-term planning, and cannot be achieved overnight. In the future, Shenzhen and Hangzhou need to continue to improve digital infrastructure construction, optimize the innovation ecosystem, and further enhance the city's innovation quality and competitiveness.

5. Conclusion and Outlook

5.1. Research conclusions

This paper systematically analyzes the impact mechanism of digital infrastructure construction on urban innovation quality and reveals the key role of digital infrastructure in promoting urban innovation. The study shows that digital infrastructure construction has significantly promoted information circulation and knowledge sharing, enhanced the R&D capabilities of enterprises, optimized the innovation ecosystem, and improved the innovation environment and policy support. Specifically, the widespread application of digital technologies such as 5G networks, data centers, the Internet of Things, and cloud computing has enabled cities to transmit information and integrate resources more efficiently, and enterprises and scientific research institutions can obtain and use data more quickly, thereby improving R&D efficiency and innovation capabilities. At the same time, the construction of a digital ecosystem and the government's active policy support have provided a solid foundation and a good environment for urban innovation activities. Typical case analysis further proves that cities such as Shenzhen and Hangzhou have achieved significant improvements in innovation quality through digital infrastructure construction, and their successful experiences and lessons provide valuable references for other cities.

5.2. Future research directions

Although this paper has explored the relationship between digital infrastructure construction and urban innovation quality in detail, there are still many potential areas worthy of further research. Future research can focus on the following aspects: First, the differential impact of cities of different sizes and types in digital infrastructure construction requires more detailed comparative studies to reveal digital infrastructure construction strategies that adapt to the characteristics of different cities. Second, study the impact of digital infrastructure construction

ISSN: 2710-0588

on urban long-term innovation performance and sustainable development, and evaluate its role in environmental protection, social responsibility, etc. Third, deeply explore the challenges and risks in digital infrastructure construction, such as technical bottlenecks, data security and privacy protection issues, and propose countermeasures and solutions. Future research can adopt a variety of research methods and tools, such as case studies, questionnaires, data analysis and system dynamics models, etc., to further reveal the deep-seated impact of digital infrastructure construction on urban innovation quality through a combination of quantitative and qualitative methods, and provide more scientific and practical guidance for governments and enterprises.

Acknowledgements

This work is supported by Innovation and Entrepreneurship Training Project for College Students of Anhui University of Finance and Economics in 2024, Project number: S202410378649.

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