

The Pulse of Progress: Technological Innovations Shaping China's Smart Cities

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ABSTRACT

With the rapid digital transformation of China's industrial economy, smart city construction has achieved significant milestones yet faces persistent challenges. This study examines the interplay of technological innovation, policy frameworks, and talent development in driving sustainable and human-centric urban transformation. Between 2018 and 2023, China's smart city initiatives saw a 67% increase in IoT device deployment and a cumulative investment exceeding \$200 billion, enabling intelligent management of traffic, energy, and public services. For instance, the IDPS (Intelligent Decision and Planning System) Urban Mobility Brain Project in Xuancheng reduced average traffic stops by 22%, increased travel speeds by 25.4%, and cut travel time by 10%, directly enhancing citizens' daily commutes. Similarly, the Mushroom Auto Alliance's 5G-enabled smart transportation initiative optimized 200+ kilometers of urban roads in Hengyang, integrating autonomous public transit and environmental monitoring to elevate residents' safety and convenience. However, challenges remain: 78% of surveyed cities report data security vulnerabilities, while 65% cite talent shortages in IoT and big data fields. Over 91.6% of sub-provincial cities prioritize smart city plans, yet interoperability gaps due to fragmented technical standards hinder 40% of cross-departmental collaborations. Privacy concerns persist, with 34% of citizens expressing distrust in data-sharing platforms like the Gantong 5.0 system, despite its blockchain-enhanced security measures. To address these issues, this paper advocates for policy reforms aligned with international frameworks like GDPR (General Data Protection Regulation), alongside investments in workforce development. Case studies from Shenzhen (traffic congestion reduced by 18% through AI-driven systems) and Hangzhou (City Brain improving public service efficiency by 30%) underscore the potential of people-centered innovation. The study concludes with actionable strategies: scaling R&D investments by 15% annually, establishing 50+ regional smart city talent hubs by 2025, and mandating green infrastructure in 70% of new urban projects to harmonize technological progress with environmental and social equity. By prioritizing citizen well-being, China's smart cities can serve as a global model for resilient, inclusive, and sustainable urban ecosystems.

KEYWORDS: Smart city, Technological innovation, Policies and regulations, Talent training

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1. INTRODUCTION

China's smart city development, propelled by rapid urbanization and digital transformation, presents unprecedented opportunities and challenges. This study explores how people-centered technological innovations, such as the Internet of Things (IoT), big data, and cloud computing, drive sustainable economic growth and enhance the quality of life for urban residents. The rapid pace of urbanization in China, with over 60% of the population living in urban areas by 2023, has intensified demands for efficient urban management, sustainable resource allocation, and robust data privacy frameworks. These challenges

are compounded by the need to integrate advanced technologies while addressing unique social, economic, and regulatory constraints, such as managing large-scale urban populations and ensuring cybersecurity in data-intensive environments.

Through a mixed-methods approach, including literature reviews and case study analyses, this paper examines how smart city technologies enable intelligent, precise, and efficient urban governance and services. Successful case studies, such as Xuancheng's Urban Mobility Brain Project and Hengyang's intelligent transportation initiative, were analysed to demonstrate the practical impacts of these technologies. However,

China's smart city initiatives face significant hurdles, including data security risks, inconsistent technical standards, and a shortage of skilled professionals, which necessitate innovative solutions in technology, policy, and talent development.

To contextualise China's efforts, its smart city strategies are compared with those of global leaders such as Singapore and Barcelona. Unlike Singapore's public-private partnership model, which leverages advanced data analytics for urban planning, or Barcelona's citizen-driven open-data platforms, China's approach is characterized by a top-down, government-led framework tailored to its unique demographic and economic landscape. This study aims to provide a theoretical foundation and practical guidance for advancing China's smart cities, promoting their sustainable transformation, and ensuring technological advancements benefit all citizens.

2. THE APPLICATION OF INDUSTRY TECHNOLOGY IN CHINA'S SMART CITIES

To deepen the development of smart cities and promote the city-wide digital transformation, the National Development and Reform Commission of China, the National Bureau of Data, and other ministries and commissions jointly issued the Guiding Opinions on Deepening the Development of Smart Cities and Promoting the City-wide Digital Transformation, proposing that by 2027, the city-wide digital transformation of the country will achieve obvious results. Several liveable, resilient, and smart cities with their own characteristics will be formed through horizontal and vertical connectivity to strongly support the goals of digital China (Guo, 2024). Leveraging artificial intelligence (AI), big data, and 5G, China has emerged as a global leader, boasting the largest number of smart cities worldwide. These cities address urban challenges through informatization and intelligence, enhancing

governance, quality of life, resource allocation, and sustainability while reducing energy consumption and pollution, and fostering industrial innovation and economic growth. **Figure 1** shows the growth trends in the number of smart cities, the number of IoT devices, and smart city investments in China between 2018 and 2023. These data reflect China's rapid development and huge investment in smart city construction, as well as the rapid application and popularization of advanced technologies in construction.

2.1 The Application of Internet of Things Technology in Smart Cities

The IoT technology plays an important role in the construction of smart cities in China. By realizing the Internet of Everything, the IoT provides accurate and efficient data support for city managers and promotes intelligent and refined urban governance. A smart city realizes real-time monitoring and data analysis in traffic, environment, public safety, and other fields through IoT sensors to improve management efficiency (Yan, 2024). IoT technology has also spawned new business models and industrial ecology, such as smart home, smart security, and other industries, which are booming, improving the life experience of citizens. At the same time, IoT technology promotes industrial integration and innovation, and promotes the transformation and upgrading of the urban economy. For instance, Singapore's Smart Nation initiative uses IoT for real-time water management, a contrast to China's broader urban focus, highlighting differing regional priorities. However, IoT faces challenges in smart city applications, such as data security and privacy protection issues. The promotion and application of IoT technology require the cooperation of the government, enterprises, and all sectors of society. Only through continuous innovation and improvement can the full potential of the IoT in smart cities be realised, thereby promoting the development of China's smart cities to a higher level.

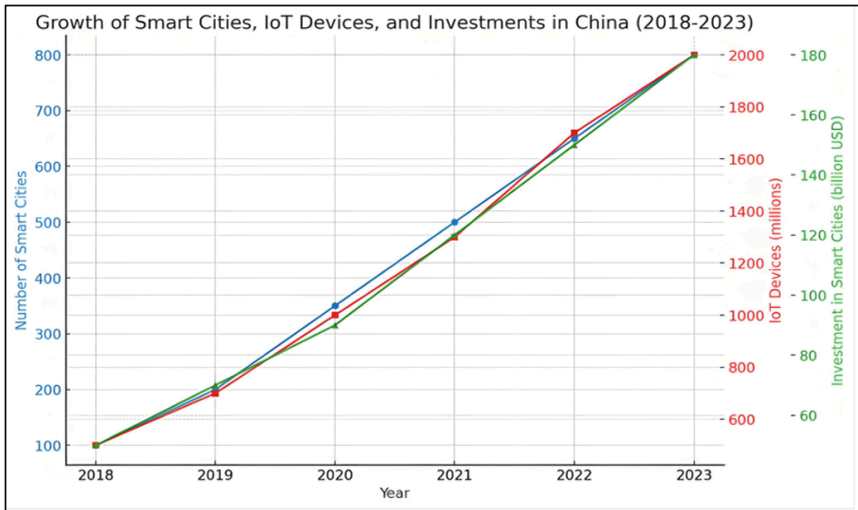


Figure 1: China's smart city growth, increase in the number of IoT devices and investment between 2018 and 2023

2.2 The Application of Big Data Technology in Smart Cities

In the construction of smart cities, big data technology plays a key role. Taking a large city as an example, the big data platform has realized real-time monitoring and data analysis in transportation, energy, environment, and other fields (Zhan, 2023). In the transportation sector, big data platforms collect and analyze traffic data to provide decision support for traffic management departments, optimize traffic layout, and improve efficiency. In terms of energy management, big data technology helps accurately predict and optimize energy allocation. For example, Nanchang, Jiangxi province, has gone a long way in the development of the LED industry. In recent years, Nanchang has successfully grasped the opportunity period of industrial development in the field of silicon substrate LED technology, launched a series of relevant policies, and has become one of the few cities in China with the whole LED industry chain, including epitaxial furnace, chip, display, and lighting application product manufacturing (Han, 2024). In terms of environmental management, big data technology can monitor and analyze environmental data in real time, find pollution problems, and take treatment measures, while providing decision support for environmental protection departments and promoting environmental policy formulation and implementation (Omar et al., 2014). Unlike Barcelona's open-data approach, which empowers citizens to co-create solutions (Stroh, 2018), China's top-down model prioritizes governmental efficiency, a distinction that shapes scalability and citizen engagement.

2.3 The Application of Cloud Computing Technology in Smart City

Cloud computing technology plays a key role in the construction of smart cities. Take a large smart city project as an example; through the introduction of cloud computing technology, the centralized storage and efficient processing of urban data are realized. The cloud computing platform processes terabytes of data every day, which improves the intelligence level of urban management (Liu, 2019). Cloud computing technology promotes the interconnection between smart city systems, breaks information silos, and realizes cross-departmental collaboration. In response to emergencies, various departments can quickly obtain information through the cloud computing platform, coordinate resources, and improve the efficiency of city management and response speed. Cloud computing technology also provides flexible expansion capabilities for smart cities to meet the growing demand for data processing, ensure efficient city operation, and provide a convenient and comfortable living environment for citizens.

3. METHODOLOGY: CASE STUDY

This section presents an analysis of several typical cases

of smart city construction in China. To empirically investigate the implementation, impacts, and challenges of smart city technologies in China, this study adopts a qualitative multiple-case study methodology. This approach is particularly suited for exploring complex, real-world phenomena within their specific contexts, allowing for an in-depth examination of "how" and "why" questions regarding the interplay of technology, policy, and urban outcomes.

Driven by the wave of Industry, successful cases of China's smart city construction have emerged in an endless stream, in which technological innovation and application have played a key role. Smart cities manage city operations in a comprehensive and systematic way by applying the latest information technology, so that various functions in the city can work together, providing excellent development opportunities for enterprises in the city. It also provides citizens with a higher level of quality of life, thus promoting the gradual realization of intelligent, digital, and IoT in the city.

3.1 IDP's Urban Mobility Brain Project

The IDPS urban traffic brain provided by Jiadu Technology for Xuancheng traffic police makes Xuancheng a city that can clearly recognize every vehicle, every section, every intersection and every parking lot, thus achieving a 22% decrease in the average number of stops on the whole network, 5% reduction in average congestion time, an increase in average speed of 25.4%, and a reduction in average travel time of about 10%. IDPS Urban Traffic Brain combines the traffic perception, cognition, and empowerment system, uses the two core technologies of "computable road network" and "individual behavior model" to build a digital twin system, comprehensively empowers traffic planning, design, management, and service, and finally realizes a highly integrated new traffic management model (Zhao, 2023). Jadu's IDPS Urban Traffic Brain has achieved remarkable results in Xuancheng, but the system is complex and expensive to maintain and needs to be continuously optimized to cope with the rapidly changing traffic environment and potential cybersecurity threats. Further strengthening the stability and security of the system to ensure its long-term efficient operation is the direction of future efforts.

3.2 Mushroom Car Alliance Intelligent Connected Vehicle (5G Intelligent Transportation) Project

Hengyang plans to create an intelligent travel demonstration zone with the Mushroom Car Alliance and the Hunan Provincial government, aiming to promote the large-scale deployment of driverless vehicles in a wide range of cities and explore new paths for commercial operation (Li, 2023). The core area of the project covers the urban main road and its surrounding areas, and the urban road network of more than 200 kilometers has been fully updated with

automation technology. This technology has been applied to public transportation, such as buses and taxis, and has been extended to environmental health inspection and other fields to improve the scientific and technological content of the public domain. The vehicle networking information construction project adopts the artificial intelligence big data centre of "vehicle-road-air integrated holographic information interaction new traffic management comprehensive integration solution" to realize in-depth information sharing with administrative agencies in Hunan Province. This not only brings huge economic benefits to the local area, but also improves the standard of social welfare treatment, promotes the steady improvement of the efficiency of overall economic development, and effectively accelerates the pace of local social progress. Although the "City of Wisdom" Hengyang program has made a breakthrough in the deployment of self-driving vehicles, the policy aspect still needs to be improved. Current regulations and standards have not fully caught up with the development of driverless technology, limiting large-scale application and promotion. In the future, relevant policies and regulations need to be improved to provide more powerful support and guarantees for the popularization and application of unmanned driving technology.

3.3 Gantong Version 5.0 Project

From November 2018 to November 2022, Dahan Software provided technical support for "Ganfu Tong" and completed the iterative upgrade of version 1.0 to 5.0, of which version 5.0 was put into operation in November 2022. As the technical service provider of "Ganfu Tong", Dahan Software has been working hard to improve the service capability and user experience of "Ganfu Tong". In terms of improving service capabilities, Dahan Software integrates digital intelligence technology, uses artificial intelligence technology to create digital people "small Gan thing", and provides multi-functional services such as "voice broadcast", "intelligent search service", "multi-round dialogue + asking while doing", so as to improve the digitization and intelligence level of "Gan Service". At the same time, with the help of blockchain technology and data trust authorization technology, the digital trust interaction of "Gannan Service Tong" is strengthened, data asset management is realized, and the cross-departmental, cross-level, and cross-regional use of data is promoted among departments, levels, and regions, and the use of security is ensured. The use of data intelligence technology, big data sharing, and intelligent processing technology, for different types of individual and enterprise users, to establish the connection between events and scenes, services and people, build a dynamic portrait of users and data space, to achieve more accurate and efficient services (Jiangxi Provincial People's Government, 2022). With the security and encryption technology of information data, it provides a more secure guarantee for users' privacy

and data applications.

The challenge facing Gantong is in terms of data security and privacy protection. With the expansion of functions and the increase in the number of users, the pressure on the system to protect sensitive information is also increasing. Despite the adoption of encryption technology and data capitalization management, security measures need to be continuously upgraded to protect against potential cyber-attacks and data leaks. In addition, although the application of blockchain technology enhances the credibility of data, its complexity and high cost also put forward higher requirements for the maintenance and optimization of the system. In the future, data security policies and technologies need to be further strengthened to ensure the absolute security of user information.

3.4 "City Sense" Big Data Intelligence Project

The big data service platform of "City Sense" was used in the second exhibition of the first National Consumer Products Exhibition to assist the organizer and its public relations team in dealing with the management of media-related digital data. The service uses more than \$50 billion of daily data updates to run its tool, called the City Hot Spot Detector, which can quickly identify news coverage of the event (Zhao, 2023). The core function of this system is to perform standardized numerical operations based on artificial intelligence technology to determine the source location of information and the nature of the content. It also tracks user interactions and evaluates the enthusiasm for the information, and finally generates a statistical report on the enthusiasm of the Internet for people to view. By combining comprehensive digital resources with advanced artificial intelligence algorithms, organizers and their public relations teams can capture the main media focus every 24 hours, week, or even month.

Although "City Sense" successfully applied its big data service platform at the National Consumer Product Exhibition, advanced artificial intelligence and big data technology require high-level professionals to operate and optimize, but there is a relative shortage of professionals in related fields at present. Improving the technical training and professionalism of existing employees and attracting more talent with a big data and artificial intelligence background is an important direction for the future. In addition, the establishment of a sound talent training mechanism and incentive system to ensure the continuous innovation and development of the technical team is crucial to maintaining the leadership and efficiency of the platform.

Technological innovation and application drive smart city construction. Continuous introduction and application of new technologies enhance intelligent city management, fulfilling public demands for quality living

(Liu & Zou, 2024). Local governments and companies must collaborate. Governments should formulate regulations for steady smart city implementation. Companies should intensify technological innovation, providing technical support and solutions. Cultivating and attracting talent with professional skills is vital for smart city sustainability.

4. RESULTS AND DISCUSSION

Building upon the empirical insights derived from the analysis of representative smart city projects in China, this section synthesizes the key challenges confronting the sustainable development of China's smart cities and proposes targeted strategies to address them. The findings presented here encapsulate the recurring obstacles identified across diverse implementations, encompassing technical, policy, and talent dimensions. Subsequently, the discussion pivots to formulate actionable recommendations, grounded in the case study evidence and broader contextual analysis, aimed at overcoming these barriers and guiding future development. This integrated presentation of results (challenges) and discussion (strategies) provides a comprehensive understanding of the current state and pathways forward for China's urban digital transformation.

4.1 Challenges and Problems Facing China's Smart Cities in the Context

In 2023, cities at the sub-provincial level and above, up to 91.6% of prefecture-level and higher cities, and more than 65.8% of county-level cities nationwide, have clearly indicated the need for the construction of smart cities. All regions are actively exploring and implementing smart city plans, realizing the transformation from a single information management system to the comprehensive application of multiple departments, multiple businesses, and multiple systems, and achieving remarkable results. Many cities have established smart city operation command centers and urban brains to improve governance capabilities and public satisfaction (Su, 2024). However, it faces new challenges, such as insufficient planning and construction, insufficient linkage between industry and city, untapped data potential, and an imperfect long-term mechanism. With the development of digital technologies such as artificial intelligence, the value of data elements has become prominent, promoting smart cities to enter a new stage of global digital transformation.

4.1.1 Technical Challenges and Problems

China's smart city development faces multiple technical challenges. Among them, data security and privacy protection are prominent challenges. With the application of the IoT and big data, smart cities generate a large amount of data, involving multiple sensitive

levels. However, the existing technical mechanism is not perfect, and there is a risk of data leakage (Goh et al., 2017; Yin, 2022). Data security and privacy risks, inconsistent standards, and lagging innovation compared to global leaders like Singapore require urgent attention. In recent years, the economic losses caused by data breaches have been rising, hindering the healthy development of smart cities. Inconsistent technical standards and interoperability issues are another challenge. Smart cities involve multiple fields and technology systems, and the lack of unified standards leads to difficulties in data sharing and system interoperability. This increases construction costs and affects operational efficiency. Therefore, it is an urgent problem to formulate unified standards and norms and promote technology integration and collaboration. Technological innovation, research, and development are also key challenges. Although China has made progress in the field of IoT and big data, there is still a gap with developed countries. In order to promote the rapid development of smart cities, technological innovation and research and development efforts should be strengthened, while the capacity for independent innovation should be improved (Ye & Yang, 2023). At the same time, international exchanges and cooperation should be enhanced to absorb advanced technology and management knowledge, thereby improving the overall quality of smart city construction. Several measures are needed to address these challenges. Strengthen data security technology and privacy protection mechanism research to improve security; Promote the unification and interoperability of technical standards and formulate related policies and norms; Step up technological innovation and research and development efforts, enhance independent innovation capabilities, and promote the rapid development of smart cities.

4.1.2 Policy and Regulatory Challenges and Issues

Under the wave of Industry, China's smart cities face policy and regulatory challenges. In terms of policy-making, smart cities involve multiple fields and departments and need cross-sectoral and cross-sectoral collaboration. However, the policy system is not perfect, and there are many obstacles to implementation. In terms of data sharing, there is a lack of unified standards and limited circulation and sharing. In terms of legal construction, smart cities involve new technologies, applications, and formats, and corresponding laws and regulations need to be formulated. However, the regulatory system is not sound, and there are regulatory gaps and loopholes, which bring security risks (Peng & Cao, 2023). Fragmented policies and regulatory gaps hinder progress, necessitating cohesive frameworks. Lessons should be drawn from successful cases, with attention given to the coordination of policies and regulations. A coordination mechanism should also be established to ensure that regulations are formulated

and adjusted in a timely manner, thereby providing support for the development of smart cities.

4.1.3 Talent Training and Introduction: Challenges and Problems

China's smart cities face the challenge of talent training and introduction. The advancement of technology and the expansion of application fields are in urgent need of professional skills and innovative talents. However, the current talent reserve and supply remain insufficient, resulting in a significant shortage of professionals. In the context of global digital transformation, successful smart cities should place greater emphasis on attracting, developing, and retaining talent. There are shortcomings in the education system; universities and scientific research institutions are out of step with market demand, and enterprises have high recruitment costs and serious brain drain. At the same time, smart cities need interdisciplinary talents, but the existing mechanism lacks cross-border cooperation and exchange. To address these challenges, cooperation among universities, research institutions, and enterprises should be strengthened. Talent development plans and curriculum structures should also be formulated to meet market demand (Lyu, 2022). In addition, talent introduction mechanisms should be established to attract professionals through preferential policies and project-based cooperation. Cross-border cooperation and exchanges should also be strengthened to encourage professionals from different fields and industries to jointly support smart city development. Smart city development requires professionals with a diverse skill set, encompassing knowledge from multiple fields such as information technology, urban planning, and environmental science. However, the current educational and training systems tend to produce specialists in single disciplines, leaving a void in the supply of interdisciplinary talent, which is crucial for the integrated and innovative development of smart cities. These talent-related issues and challenges must be addressed to ensure the sustainable and successful development of China's smart cities.

Table 1 displays the talent situation of technical positions related to China's sponge city (MOHURD, 2025). It covers data such as job types, the current number of talents, demand forecasts for 2027, and salary increase rates from 2023 to 2025. Specific job positions include

hydrological model engineers, permeable material R&D experts, smart operation and maintenance system architects, and ecological landscape designers. From the data, it can be seen that the current number of talents in each position is relatively small, but the demand is expected to increase significantly by 2027. At the same time, the salaries of each position have also increased significantly, with the smart operation and maintenance system architect having the largest salary increase rate of 260%.

In the context of China's rapid urbanization and the increasing emphasis on smart city development, the issues and challenges related to technical talent have become prominent. The shortage of technical talent in the field of smart cities is acute, as evidenced by the significant gap between the current number of professionals and the projected demand in related positions, such as those in sponge city - related fields. This shortage has an impact on the implementation and progress of smart city projects.

4.2 Strategies and Suggestions to Promote the Development of Smart Cities in China

4.2.1 Strengthen Technological Innovation and Research and Development

In addition to the typical cases mentioned above, China's smart city construction has also achieved a series of innovative technological achievements. Several first-tier core cities in China have implemented notable smart-city initiatives. In Shenzhen, the intelligent transportation system enables the smart control of traffic signals and the real-time collection of vehicle information, which helps alleviate traffic congestion. The city has also introduced electronic payment and bike-sharing services to improve citizens' travel experience (Zhang, 2019). In Hangzhou, the City Brain system enables real-time monitoring and intelligent analysis of the city's operations, thereby improving the efficiency and quality of traffic management, environmental monitoring, and public services (Caprotti & Liu, 2022). In Shanghai, the smart medical system supports the optimal allocation and intelligent management of medical resources by integrating electronic medical records, telemedicine, and intelligent diagnostic services, thus improving the quality and efficiency of healthcare delivery (Zhu, 2019).

Table 1: China Sponge City technical talent

Position Type	Current Talent	Demand Forecast (2027)	Salary Increase (2025 vs 2023)
Hydrological Model Engineer	12,000	180,000	+ 220%
Permeable Material R&D Specialist	8,000	90,000	+ 190%
Smart O&M System Architect	5,000	120,000	+ 260%

Data source: White Paper on Sponae City Construction Talent. (MOHURD, 2025).

To further strengthen technological innovation and research and development, China should increase investment and encourage cooperation among enterprises, universities, and research institutions. By comparing data on the technologies adopted, investment scale, and implementation outcomes of smart city construction in different cities, the advantages, limitations, and scope of application of various technical solutions can be more clearly identified. This comparison also helps clarify their effectiveness and challenges, thereby guiding future technology research, development, and application.

Increase R&D investment and international collaboration, e.g., by adopting Singapore's IoT standards. At the same time, establish and improve the technological innovation system, improve the mechanism, learn from international experience, introduce foreign advanced technology, and improve the technological innovation level of China's smart cities (Yin, 2022). With the continuous innovation and application of technology, smart cities will promote the rapid development of industries such as the IoT, big data, and cloud computing, forming new economic growth drivers.

4.2.2 Improve the System of Policies and Regulations

Improving the policy and regulatory system is crucial to the development of smart cities in China. Although China has introduced a series of policies to ensure the construction of smart cities, with technological progress and market development, the existing system needs to be further improved. For example, more stringent data security and privacy protection regulations should be formulated, and cross-departmental collaboration policies should be introduced to clarify the responsibilities of various departments and promote resource sharing (Sun, 2022). Through the formulation of policy documents, the objectives and measures of smart city construction are clearly defined, and supervision and evaluation are strengthened to ensure that the project achieves the expected effect (Zhang, 2023). These initiatives have raised the level of smart city construction and also provided experience for other cities.

In the context of globalization, the construction of smart cities has become a global task. In formulating policies, international standards and best practices should be taken into account, such as the data privacy protection experience of Europe's General Data Protection Regulation (GDPR) and the successful practice of Singapore in cross-sectoral collaboration, to formulate regulations and policies that are suitable for China's national conditions (Yin, 2022). Comprehensive data governance needs to include multiple layers of security. Encryption methods such as end-to-end encryption ensure that data is not stolen during transmission, and anonymization technology protects personal privacy

through de-identification processing. In addition, strict regulatory measures need to be developed and implemented, such as compliance with data protection regulations, regular security audits, and risk assessments, to ensure that data processing is transparent and lawful, and to protect the data security and privacy of individuals and businesses (Hoofnagle et al., 2019). By combining these technologies and measures, China can further improve its policy and regulatory framework, including data governance, to ensure smooth progress and efficient operation of projects.

4.2.3 Strengthen Personnel Training and Introduction

According to the statistics in **Figure 2**, the demand for talent in the smart city sector is growing rapidly, especially in key areas such as the IoT, big data, and cloud computing, where the talent shortage is particularly prominent. To address this challenge, more comprehensive education and vocational training programmes should be developed by drawing on advanced international experience and establishing a sound training system based on China's actual conditions. For example, dedicated smart city colleges or research institutes could be set up to provide systematic courses and practical opportunities to train highly qualified people with interdisciplinary knowledge and innovation. At the same time, it is also necessary to strengthen school-enterprise cooperation, promote the deep integration of industry, university, and research, and create more practical opportunities and employment paths (de Carvalho Montalvão, 2021).

In terms of talent development, public-private partnerships and internship programs are key. By partnering with businesses, schools can provide internships for students so they can gain valuable experience in real projects. Enterprises can also participate in school curriculum design and teaching activities to ensure that the educational content is consistent with the needs of the industry, so as to cultivate professionals who meet the needs of the market. At the same time, more attractive policies and measures need to be developed. For example, a special fund can be set up to support the introduction and team building of high-level talents in the field of smart cities; A flexible talent flow mechanism should be established to encourage the free flow of talents between different regions and enterprises to realize resource sharing and complementary advantages (Li, 2023). In addition, by holding international exchange activities and establishing scholarships, more international talents can be attracted to China. Through comprehensive education and vocational training programs, as well as the implementation of public-private partnerships and internship programs, China's smart city construction will receive sustained talent support and promote the long-term development of the industry.

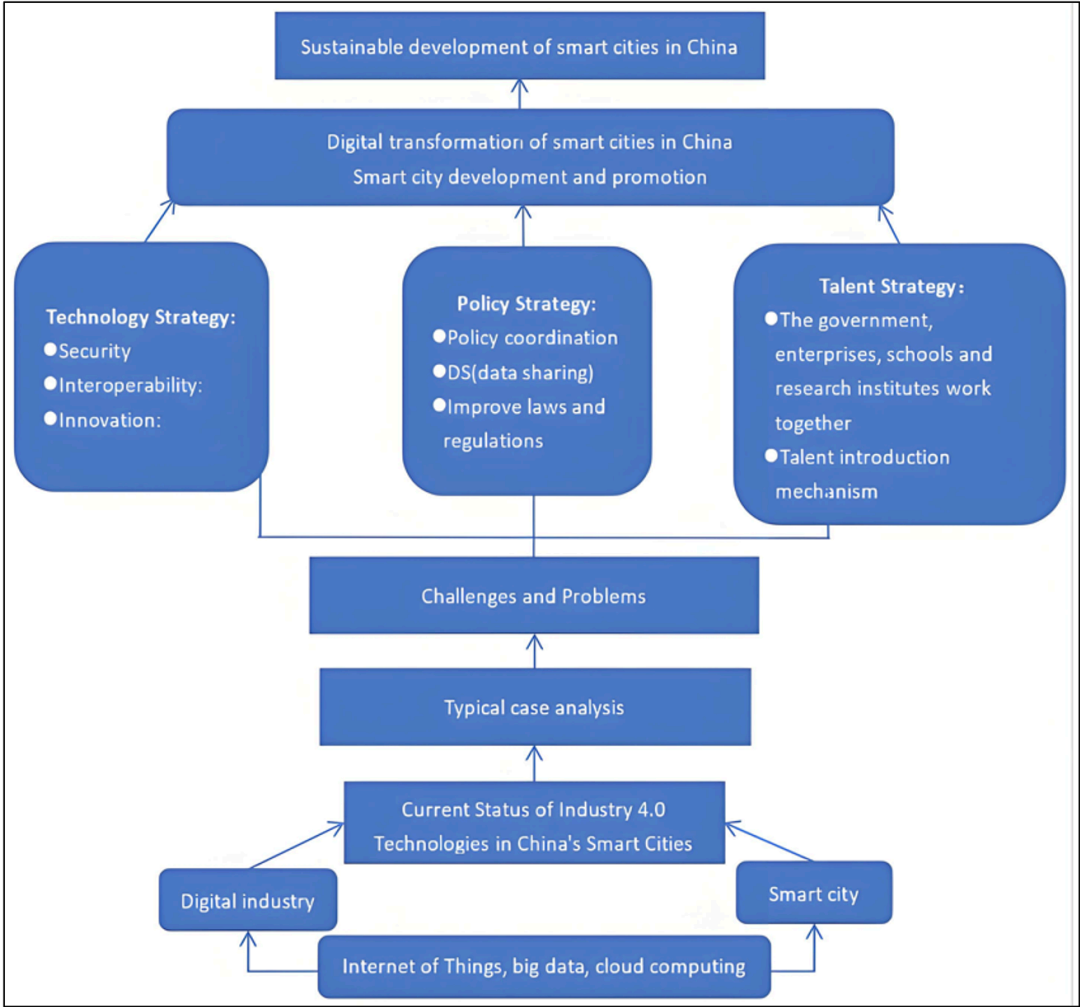


Figure 2: Theoretical framework

4.3 The Development Trend of Smart Cities in China

4.3.1 Digital Transformation and Development Promotion of Smart Cities in China

With technology's continuous progress and innovation, China's smart cities are becoming more diversified and intelligent. IoT, big data, and cloud computing are deeply integrated to provide comprehensive, accurate, and efficient urban management and service solutions (Li & Xu, 2024). Emerging technologies like AI and blockchain are creating broader opportunities. Policies and regulations are focusing on standardization and normalization, improving the standard system, promoting standardized development, and strengthening supervision to ensure quality and safety. With international cooperation, policies are also emphasizing international standards to promote China's smart city construction's internationalization (Yan & Wang, 2024). In talent introduction, China's smart city development trends towards diversification and internationalization. Domestic talents are improving their skills and visibility through projects and competitions,

attracting enterprise attention. Overseas talents are also coming to China to contribute their advanced technology and management experience, injecting new vitality into China's smart city development.

4.3.2 Sustainable Development of Smart Cities in China

Based on the realization, application, and promotion of digital transformation, the sustainable development of China's smart cities requires continuous technological innovation while achieving coordinated development of the environment, economy, and society. For example, energy efficiency can be improved through the use of smart grids and the integration of renewable energy sources. These measures can reduce energy waste and dependence on fossil fuels. Waste management can also be enhanced through smart waste-sorting and recycling systems, which optimize waste treatment, reduce landfill use, and support the development of a circular economy. In addition, green infrastructure can be strengthened by constructing green buildings, promoting green transportation, and creating more

green spaces to improve the quality of the urban environment (Goh et al., 2019). Green buildings use energy-efficient materials and technologies, while green transportation encourages the use of public transport and electric vehicles. Urban parks and other green spaces can also improve residents' quality of life. Overall, digitalization and intelligent technologies can enhance productivity while promoting environmental sustainability.

In addition, smart cities will also improve residents' quality of life and happiness through smart medical care, smart education, smart community, and other services, and promote social harmony and progress. The government will formulate stricter and more detailed standards and regulations, drawing on advanced foreign experience, to ensure that all parties' requirements for sustainable development are met. Through continuous education and training, improve the technical level and management ability of existing personnel, attract more outstanding talents with cutting-edge technologies and sustainable development concepts, so that smart cities continue to innovate and maintain vitality (Li & Xu, 2024).

The overall research framework is shown in **Figure 2**. Through technological innovation, policy improvement, and talent gathering, smart cities will gradually realize the goals of intelligent, digital, and sustainable development and provide a reference for the construction of smart cities around the world. In addition, in terms of cultural and social considerations, the preservation and presentation of local cultural heritage through digital technology involves the use of intelligent platforms to promote community interaction and cultural activities. From an international perspective, learn from the experience of European smart cities in data privacy protection, learn from the successful practices of cross-departmental collaboration, and optimize their own smart city construction strategies.

5. CONCLUSION

This study analyzes the opportunities and challenges facing the construction of smart cities in China, with a special focus on how people-centered technologies can drive sustainable economic growth and improve the quality of life of urban residents. Despite significant achievements, issues such as data security, inconsistent technical standards, and talent shortages remain to be addressed. Looking ahead, the construction of smart cities in China must pay more attention to digital transformation and sustainable development, with a particular emphasis on human well-being and economic prosperity. In short, the construction of China's smart cities must adhere to the people-oriented approach, prioritizing the needs of citizens, while promoting sustainable economic and environmental development. By strengthening technology research and development,

improving policies and regulations, and cultivating skilled personnel, China can become a global model for sustainable urban development. The ultimate goal is to create urban environments where technology enhances the quality of life for all residents, promotes equitable economic growth, and ensures a sustainable future for future generations.

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ARTIFICIAL INTELLIGENCE (AI) USE AND DISCLOSURE

The authors declare that no artificial intelligence (AI) tools were used in the preparation of this manuscript.

REFERENCES

- Caprotti, F., & Liu, D. (2022). Platform urbanism and the Chinese smart city: The co-production and territorialisation of Hangzhou City Brain. *Geo Journal*, 87(3), 1559–1573. <https://doi.org/10.1007/s10708-020-10320-2>
- de Carvalho Montalvão, D. C. (2021). *The maturity of smart cities in Portugal: A study about the urban growth of Portuguese municipalities on becoming truly smart and sustainable cities* [Master dissertation, Universidade NOVA de Lisboa, Portugal].
- Goh, H. H., Sim, S. Y., Mohamed, M. A. H., Rahman, A. K. A., Ling, C. W., Chua, Q. S. & Goh, K. C. (2017). Fault location techniques in electrical power system: A review. *Indonesian Journal of Electrical Engineering and Computer Science*, 8(1), 206–212. <https://doi.org/10.11591/ijeecs.v8.i1.pp206-212>
- Goh, K. C., Goh, H. H., & Chong, H. Y. (2019). Integration model of fuzzy AHP and life-cycle cost analysis for evaluating highway infrastructure investments. *Journal of Infrastructure Systems*, 25(1), Article 04018045. [https://doi.org/10.1061/\(ASCE\)IS.1943-555X.0000473](https://doi.org/10.1061/(ASCE)IS.1943-555X.0000473)
- Guo, Z. (2024). The coordinated development of large and small models facilitates the digital transformation of the entire urban area. *Informatization of China Construction*, 24, 32–33. <https://qikan.cqvip.com/Qikan/Article/Detail?id=7200039340>
- Han, H. Y. (2024). The application of big data technology in the lighting industry. *China Light & Lighting*, 8, 66–68. <https://doi.org/10.3969/j.issn.1002-6150.2024.08.017>
- Hoofnagle, C. J., Van Der Sloot, B., & Borgesius, F. Z. (2019). The European Union general data protection regulation: What it is and what it means. *Information & Communications Technology Law*, 28(1), 65–98. <https://doi.org/10.1080/13600834.20>

- 19.1573501
- Jiangxi Provincial People's Government. (2022). *Notice of the General Office of the People's Government of Jiangxi Province on printing and distributing the construction work plan of Ganfu Tong Version 5.0*. Jiangxi Provincial People's Government Gazette.
- Li, D. X. (2023). *Research on the collaborative governance model of smart transportation in Suzhou City*. <https://link.cnki.net/doi/10.27061/d.cnki.ghgdu.2023.003702>
- Li, H., & Xu, J. (2024). Impact of digital government on digital transformation of enterprises from the perspective of urban economic sustainable development. *Sustainability*, 16(7), Article 2667. <https://doi.org/10.3390/su16072667>
- Liu, T. Y. (2019). Master of supervision process optimization in smart city engineering infrastructure. *Jilin University*, 16–49.
- Liu, T., & Zou, Q. (2024). AI empowers key technologies and typical applications of smart city digital governance. *Science and Technology Intelligence*, 5, 56–62. <https://doi.org/10.19881/j.cnki.1006-3676.2024.05.08>
- Lyu, C. (2022). *Sustainable smart city in the United States: Citizen-centered collaboration and value creation in urban transformations* [Doctoral dissertation, University of La Verne].
- Ministry of Housing and Urban-Rural Development (MOHURD). (2025). *White paper on Sponge City construction talent*. The Ministry of Housing and Urban-Rural Development of China.
- Omar, M. F., Nursal, A. T., Nawi, M. N. M., Haron, A. T. & Goh, K. C. (2014). A preliminary requirement of decision support system for building information modelling software selection. *Malaysian Construction Research Journal Volume 15*(2), 11–28.
- Peng, H. Z., & Cao, L. P. (2023). Research on the operation mode of 2023 real estate project — Taking Changde Zhongjian Eco-Smart City as an example. *Real Estate World*, 12, 31–33. https://oversea.cnki.net/kcms2/article/abstract?v=wTY03cmeYFpvlmhkaydHw3EJilYE335uF-A3XdzKGPz8u75FOhujlb-hALGJPH_VTJfuzEtm4Fo4qeNphFRgfc9MUE1s2F0yv845ZQAQMgqODM6NNvMT_BiDfo8SagHTWFKAj2iuQgee4qmBAaUlpyQXi9ATYKWe603LTIIXIY68cl eE3tQ==&uniplatform=OVERSEA&language=EN
- Stroh, F. (2018). *The new role of citizens as co-creators of socio-digital innovations and urban development* [Master dissertation, Tübingen, Univ.].
- Su, Y. L. (2024). *Research on digital intelligence empowering public service demand management*. <https://link.cnki.net/doi/10.27204/d.cnki.glzhu.2024.000065>
- Sun, S. N. (2022). Key points of cost management in the whole process of intelligent construction project of communication construction enterprises in 2022. *Investment and Cooperation*, 12, 135–137. https://oversea.cnki.net/kcms2/article/abstract?v=wTY03cmeYFrlWjxc3NAmMVfqmIlg8GW3OCrvP67RWuSl2HuZ8VAsCbdjlemGjSIVNlsiqjlp3nTXkmlpl8RzoZGkx4YEBRdZohrrE3Q9_ngsOV3Rh45_XbzdizRDg24z8K-a65Pr88mrnpBE3n9bARxF9fvktAUlJmklmdai7JUTP9Pi7hM6OA==&uniplatform=OVERSEA&language=EN
- Yan, F. J., & Wang, Y. Y. (2024). *Build an upgraded version of smart city — National Data Bureau interprets the digital transformation of cities across the globe*. Xinhua Net. http://news.china.com.cn/2024-05/21/content_117201450.shtml
- Yan, Z. (2024). The application and challenges of the internet of things in smart city construction. *China Broadband*, 20(03), 61–63. <https://doi.org/10.20167/j.cnki.issn1673-7911.2024.03.021>
- Ye, S. D., & Yang, J. Q. (2023). GOD Analysis of PPP model applicability of 2023 project — Taking smart city construction project as an example. *Journal of Beijing Jiaotong University (Social Sciences Edition)*, 22(02), 117–124. <https://doi.org/10.3969/j.issn.1672-8106.2023.02.013>
- Yin, J. W. (2022). The practice and enlightenment of citizen participation in the construction of smart cities in foreign countries in 2022 — A case study of the British smart City Project OPHC. *Journal of Sichuan Normal University (Social Science Edition)*, 49(05), 111–119. <http://doi.org/10.13734/j.cnki.1000-5315.2022.05.013>
- Zhan, G. F. (2023). Analysis on the new mode of municipal construction under the concept of smart city in 2023. *Smart City*, 9(07), 111–113. <https://link.oversea.cnki.net/doi/10.19301/j.cnki.zncs.2023.07.036>
- Zhang, L. (2019). *Traffic congestion reduction and smart city strategy: A case study in Shenzhen, China* [Master dissertation, University of Twente].
- Zhang, Y. H. (2023). Analysis of the construction of a county smart city e-government cloud platform project. *China Cable Television*, 2, 42–45. https://oversea.cnki.net/kcms2/article/abstract?v=wTY03cmeYFoDfFDRRZVU-qidTtQBpCHhyEx4LdD80LAMKmmz1QGe9-ZML0FV--ElKgLP7C4ZexaRmt8JQFtdlyNBz5FchjBZQwV4UjhKC3dP1lofwhUfrm8scDLvLENOq87-JaCVJaCVbvnv_qU7kg0706PBjsWgrIEh2gSVCZuZ9AQT OXdXTwejZA==&uniplatform=OVERSEA&language=EN
- Zhao, G. (2023). Strive to advance the comprehensive development of the urban lifeline perception system in Beijing. *Urban Management and Science Technology*, 24(06), 10–12. <https://doi.org/10.16242/j.cnki.umst.2023.06.002>
- Zhu, X., & Zhu, X. (2019). *Case VI: Children's Hospital of Shanghai: A pioneer in smart healthcare. In Emerging champions in the digital economy: management for professionals*. Springer, Singapore. https://doi.org/10.1007/978-981-13-2628-8_8