IJMR | International Journal of Multidisciplinary Research
Международный институт управления и предпринимательства
Research Article Print ISSN 3105-8884 Online ISSN 3105-8892 December 2025, Vol. 1, No. 3
https://doi.org/10.65231/ijmr.v1i3.81

Digital Management of China's Municipal Infrastructure and Challenges: Smart Urban Greening and Sponge City Construction

Wang Bin[1], Gaoyi Sen*

[1'*]Belarusian State University, Nezavisimosti Avenue 220030, Minsk, Belarus

KEYWORDS

Smart Garden;
Sponge City;
Digital intelligence

ABSTRACT

In recent years, the rapid advancement of urbanization in China has placed unprecedented pressure on urban infrastructure management. Digital tools and innovative technologies, including smart city management, the "City Brain," artificial intelligence (AI), and sponge city construction—have provided new opportunities to address these complex challenges. However, the practical implementation of smart urban greening and sponge city initiatives requires not only technological innovation but also a balance among policy coordination, resource optimization, and sustainability goals. This paper analyzes the theoretical foundations, technical requirements, spatial dimensions, current achievements, and challenges of digital municipal management, using the smart urban greening system of Hangzhou's City Brain and Shenzhen's sponge city construction as case studies. It also explores potential directions for future improvement and development.

INTRODUCTION

Research Background： Against the backdrop of the accelerating global urbanization process, traditional municipalmanagement systems have struggled to meet the urgent demands of modern cities for efficiency, intelligence, and sustainable development. As one of the countries wit the fastest-growing urbanization rates worldwide, China faces particularly severe challenges in terms of the carrying capacity of its urban infrastructure and the sustainability of its ecosystems. In this context, smart urban greening and sponge city initiatives, as emerging urban development strategies, are progressively demonstrating their significant potential in ecological conservation, resource optimization, and economic benefits.

Research Significance： This paper aims to explore how digital technologies can drive innovation in municipal management, achieving a balance between improving management efficiency and promoting ecosystem restoration. The study focuses on the remote monitoring and intelligent optimization systems of smart urban greening, as well as the efficient rainfall management and water resource recycling mechanisms in sponge cities. Through an integrated analysis of policy frameworks and technological pathways, this research seeks to provide empirical evidence and theoretical insights for future urban planning and policy formulation.

1.Core Concepts

Smart Urban Greening： Smart urban greening refers to an intelligent urban green space management system based on artificial intelligence and Internet of Things technologies. Its core functions include real-time environmental data monitoring, precise irrigation control, vegetation health analysis, and early warning systems. For example, leveraging sensor networks and drone remote sensing technologies, the system dynamically collects plant growth data, assesses pest and disease risks, and utilizes artificial intelligence models to enable adaptive management and optimized decision-making for urban green spaces, thereby enhancing the precision and intelligence of urban greening efforts [1,2].

Sponge City: The core concept of a Sponge City involves absorbing, purifying, and reusing rainwater to mitigate flood

* Corresponding author. E-mail address:sen026053@gmail.com

Received date: December 01, 2025; Revised manuscript received date: December 10, 2025; Accepted date: December 20, 2025;
Online publication date: December 31, 2025.

risks and enhance water resource efficiency. Key technologies include rain gardens, permeable pavements, and green roofs. It advocates for the intelligent management of rainwater resources through six core functions: infiltration, retention, storage, purification, utilization, and drainage. This concept was initially proposed in response to challenges such as frequent urban flooding and water scarcity in China and has rapidly emerged as a new direction for sustainable

Spatial Dimension: The implementation of smart urban greening and sponge cities requires multi-dimensional spatial optimization, such as connecting urban green spaces with water resources to establish ecological networks [3,4].

Technical Requirements: Both fields rely on advanced information technologies, such as AI and IoT, to achieve precise monitoring and efficient management.

Policy Support: IN the 14th Five-Year Plan and the 2035 Long-Range Objectives, the Chinese government explicitly emphasizes the integration of digitalization with ecological goals as a key measure to promote ecological civilization and sustainable development.

2.Case Study:

2.1.Hangzhou City Brain Case—Smart Urban Greening Project

Project Overview: The Hangzhou City Brain utilizes IoT sensors and real-time data analysis to manage urban public facilities and green spaces comprehensively, with a particular emphasis on water conservation and automation in park irrigation.

Technical Solution: Building on the "City Brain" concept, Hangzhou's smart urban greening extensively employs IoT sensors to monitor environmental parameters of green spaces in real-time, including soil moisture, air temperature and humidity, and light intensity. By analyzing plant health conditions through a data collection network, water irrigation is optimized, and early warnings are issued for potential anomalies. Leveraging AI algorithms and big data analytics, the Hangzhou greening system dynamically adjusts irrigation strategies, improving water resource utilization by approximately 5%–12%. Additionally, drone patrol technology is used to monitor green spaces, enabling timely detection of pest infestations and plant growth issues. Multidimensional datasets, such as water resource usage data and vegetation health indices, facilitate optimized design and dynamic adjustments of green spaces. For example, multi-layered composite green spaces integrated with ecological retention ponds combine environmental transformation with automated irrigation to enhance overall efficiency.

Management Innovation: Hangzhou encourages community members to participate in green conservation activities and report park-related issues through citizen-facing applications, such as WeChat mini-programs, by scanning QR codes. This participatory approach not only fosters a sense of civic responsibility but also broadens the scope of data collection. Managed centrally by the City Brain platform, this system integrates data from transportation, environment, and public services to establish a horizontal collaboration mechanism. Municipal teams can monitor and allocate resources in real-time, reducing response times. By leveraging IOT and AI technologies, the greening project streamlines daily operations, making tasks such as irrigation and vegetation maintenance more efficient and reducing overall costs by approximately 10%–20%.

Sustainability: The efficient irrigation system of smart urban greening reduces water wastage while increasing green space coverage, enhancing capacity by 5%–12%. Through precise monitoring of vegetation health, the need for additional care due to plant diseases and pests is minimized, thereby reducing agricultural inputs and carbon emissions. The successful implementation of Hangzhou's smart urban greening demonstrates the potential of technology-driven ecological restoration and provides a model for promoting efficient greening management technologies nationwide.

Future Prospects: More effective cross-regional collabora tion models will help expand the boundaries of this tec hnology’s application across the country.

2.2.Shenzhen Sponge City

Project Overview： Shenzhen is one of the leading cities in policy innovation for sponge city construction. It has developed a system covering millions of square meters, achieving a synergistic integration of social, economic, and ecological benefits through coordinated policy efforts.

Technical Features： Shenzhen’s sponge city initiative emphasizes low-impact development technologies, including permeable pavements, rain gardens, and green roof designs. These technologies enable the city to absorb rainwater rather

than rapidly discharge it, reducing flood risks through rainwater purification and recycling. Shenzhen utilizes GIS (Geographic Information Systems) and artificial intelligence to optimize water flow and spatial capacity allocation, intelligently adjusting drainage timing and locations. This dynamic optimization process, supported by real-time data feedback, has significantly reduced water pollution discharge rates. Additionally, Shenzhen implements rainwater harvesting and reuse technologies to support the intelligent allocation of water for industrial and agricultural purposes, enhancing regional water resource sustainability and substantially reducing potable water consumption.

Management Approach： The construction of Shenzhen's sponge city involves collaborative management across different departments, such as the Water Resources Bureau and the Urban Planning Bureau. By establishing an integrated database, real-time information sharing and policy coordination are achieved, improving the efficiency and implementation of project decision-making. Shenzhen also adopts a Public-Private Partnership (PPP) model to secure funding for sponge city infrastructure, attracting private sector participation and alleviating some of the economic burdens. Furthermore, the city promotes educational activities within communities to raise public awareness of sponge city concepts and technologies, such as involving residents in the design and maintenance of rain gardens.

Sustainable Outcomes： Through technologies like rain gardens, Shenzhen's sponge city has reduced annual pollutant discharge by approximately 50%–60%. This design has significantly improved water quality and promoted water recycling. Dynamic water management techniques have directly mitigated flooding issues while increasing urban water efficiency by about 20%–25%. With the construction of rainwater retention infrastructure, Shenzhen's natural ecosystems are gradually recovering, and community awareness of ecological importance has notably increased.

3.Analysis of Challenges and Countermeasures

3.1.Challenges

Data Fragmentation and Management Complexity: The absence of fully established data standards and information-sharing mechanisms across different technology platforms is a common pain point in the digital management of municipal facilities. Although multiple departments recognize the importance of data, differences in software systems and data formats hinder collaboration and reduce efficiency [5].

Technical Security: With the advancement of smart cities, risks related to privacy breaches and data misuse are becoming increasingly apparent. For instance, the collection of surveillance footage and resident behavior data in urban management raises urgent concerns about ensuring lawful and ethical use [6].

Economic Pressure: The higher initial investment required for smart solutions and Low-Impact Development (LID) systems poses a significant challenge for small and medium-sized cities.

Insufficient Public Participation: Low public awareness of smart urban greening and sponge city initiatives hinders their widespread adoption.

3.2.Countermeasures

The government should promote cross-regional data standardization, enhance system compatibility, strengthen relevant policy guidance, and improve the corresponding standard framework. Additionally, it should increase investment in science and technology.

In smart city budgets, fiscal incentive mechanisms should be introduced to provide special subsidies for small and medium-sized cities, boost investment in related scientific research and technologies, encourage collaboration among enterprises, universities, and the government, and facilitate the introduction of advanced domestic and international technologies.

Publicity efforts should be intensified to encourage community participation. By integrating civic education with the promotion of digital applications, organizing public lectures, and developing exhibitions, the engagement of all citizens can be fostered, thereby enhancing public awareness and recognition of smart green spaces and sponge cities.

Conclusion

The construction of smart urban greening and sponge cities is not merely a short-term solution to address rapid urbanization and environmental pressures. It represents a critical practice for advancing China's cities toward green and intelligent development, contributing to global climate goals. In the future, more efficient integration of digital infrastructure and emerging technologies will require

enhanced policy guidance and research support. While the successful cases of Hangzhou and Shenzhen demonstrate the potential of digital technologies in green infrastructure management, challenges such as technical barriers, social acceptance, and funding mechanisms must be addressed to achieve scaled-up implementation.

REFERENCES

1. Torresani M, Kleijn D, De Vries J P R, et al (2023). A novel approach for surveying flowers as a proxy for bee pollinators using drone Images. Ecological Indicators, 149: 110123.
2. Tang Y, Fu H, Xu B (2024). Advanced design of triboelectric nanogenerators for future Eco-smart Cities. Advanced Composites and Hybrid Materials,7(3).
3. Lu Y, Huang M, Xiao H, et al (2025). Keyword Analysis and Systematic Review of China's Sponge City Policy and Flood Management Research . Atmosphere,16(9): 1090.
4. Qi Y, Shun Chan F K, Griffiths J, et al (2021). Sponge City Program (SCP) and Urban Flood Management (UFM)—The Case of Guiyang, SW China . Water, 13(19): 2784.
5. Krasilnikova P, Lapshina S (2021). Digitalization of Citizen Participation in Urban Development Management. SHS Web of Conferences, 93: 05013.
6. Hatuka T, Toch E, Birnhack M D, et al (2020). The Digital City: Critical Dimensions in Implementing the Smart City. SSRN Electronic Journal.