



Research on the Development of Smart Cities in China

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Abstract. Smart cities are the core vehicle of the digital China strategy and a key pathway to modernizing urban governance and achieving high-quality development. This paper systematically reviews the development trajectory, policy framework, and technological systems of China's smart cities, analyzes current mainstream application scenarios and typical cases, and summarizes successful models from cities such as Hangzhou, Shenzhen, and Shanghai. The study reveals that China's smart city construction has undergone a process from concept introduction and pilot exploration to deepening comprehensive digital transformation, forming development characteristics driven by data, scenario-oriented approaches, and people-centered principles. The research also highlights multiple challenges currently faced, including data barriers, sustainable operations, and security privacy issues. In the future, China's smart cities will evolve toward comprehensive digitalization, deep intelligence, and collaborative governance. The key to success lies in strengthening top-level design, unlocking the value of data elements, and establishing long-term development mechanisms, ultimately serving the goal of building people-oriented cities.

Keywords: Smart City, Comprehensive Digital Transformation, Digital Governance.

1 Introduction

Against the backdrop of escalating global urbanization and the profound revolution brought forth by a new generation of information technologies, the concept of the smart city has emerged as a pivotal paradigm worldwide, offering strategic solutions to intricate urban challenges and enhancing overall competitiveness. China's engagement with this paradigm began in the early 2000s with the initial introduction of the smart city concept. Since then, driven by robust policy frameworks and vigorous market participation [1], its practical development has transitioned from fragmented, localized experiments to a phase of nationwide implementation and deepening sophistication. This trajectory has been significantly shaped and accelerated by key national strategies, most notably the 14th Five-Year Plan and the overarching Digital China Initiative, which have strategically positioned smart city construction as a cornerstone for national digital transformation. Presently, China's smart city development is advancing into a

more mature and comprehensive stage, defined by the goal of achieving "city-wide digital transformation." [2] This new phase aims to transcend isolated technological applications, focusing instead on systemic reforms that holistically reshape and elevate urban governance models, economic structures, and the quality of public services. The purpose of this paper is to systematically examine this evolutionary journey, dissect the core technological architectures and representative application scenarios, synthesize both the accrued successes and persistent obstacles, and project future directions, thereby offering a consolidated reference for ongoing academic discourse and practical policymaking in this dynamic field [3].

2 Development History and Policy Evolution of China's Smart Cities

2.1 Three-Stage Theory of Development History

Building upon the initial adoption of related concepts, China's smart city development formally commenced around 2008, marking the Concept Introduction and Pilot Exploration Phase (2008-2015). This period was primarily guided by the foundational constructions of "Digital Cities" and "Wireless Cities," which focused on establishing basic information infrastructure and connectivity. During this era, selected pioneering cities, often major metropolises or special economic zones, initiated discrete pilot projects targeting specific sectors such as intelligent transportation management and public security surveillance systems. These efforts were largely characterized by isolated, application-specific informatization initiatives. Consequently, development during this phase exhibited a sporadic, point-based distribution pattern without coordinated national strategy. A coherent top-level design framework and unified technical or data standards were generally absent, leading to fragmented systems that operated in silos, which later posed significant challenges for integration and scalability [4].

The experience and challenges accumulated from the initial phase prompted a strategic shift, leading to the Standardized Development and Comprehensive Construction Phase (2016-2020)[5]. During this period, the national framework evolved significantly with the formal introduction and clarification of the "New-Type Smart City" concept. This refined paradigm distinctly emphasized a people-oriented approach, sustainable development, and a core operational principle of being data-driven. Under this strategic guidance, smart city initiatives proliferated rapidly, with hundreds of cities across the country launching comprehensive projects. The construction focus fundamentally shifted from building standalone, vertical information systems to developing integrated, horizontal management and service platforms[6]. This shift was best exemplified by the widespread emergence and adoption of "Urban Brains" or city-level operating systems, which aimed to serve as central command hubs by aggregating and analyzing cross-departmental data to improve overall urban coordination and decision-making efficiency[7].

Entering the 14th Five-Year Plan period, the development agenda advanced into the Deepening Phase of Comprehensive Digital Transformation (2021-present). This

represents a qualitative leap in scope and ambition, moving beyond the pursuit of discrete "smart" projects towards enabling the holistic digital transformation of entire cities[8]. The current focus emphasizes profound restructuring of government and business processes, fostering institutional innovation to support the digital ecosystem, and encouraging multi-stakeholder collaboration. It aims to deeply integrate digital technology with the very fabric of urban economic and social development. The release of the 2024 "Guidelines on Deepening Smart City Development and Promoting City-Wide Digital Transformation" serves as a definitive policy milestone. This document formally marks the transition into this new era, which is characterized by a systematic, coordinated approach and the deep convergence of digital and physical spaces, ultimately targeting the fundamental enhancement of urban governance capacity and modern resilience.

2.2 Construction of Policy System

Through over a decade of practical exploration and top-level design, China has established and refined a robust, multi-tiered policy framework for smart city development. This structured system can be understood as a three-layer architecture comprising "National Strategy—Specialized Policies—Standards and Regulations," which operates in a cohesive, top-down manner to guide construction. At the highest level, national strategies, most prominently the 14th Five-Year Plan (2021-2025) and the overarching Digital China Initiative, establish the fundamental direction, vision, and key priorities, positioning smart cities as a core component of national modernization and digital transformation[9]. Beneath this strategic layer, a suite of specialized policies and action plans—such as those concerning digital government construction, data element market development, and integrated urban-rural digitalization—translate the broad strategic vision into concrete operational pathways, specific tasks, and implementation guidelines for various sectors and administrative levels. Finally, this framework is grounded by detailed technical standards and specifications, including national standards like the "Smart City Top-Level Design Guide" (GB/T 36333-2018), which provide the essential technical protocols, evaluation metrics, and architectural blueprints to ensure interoperability, quality, and consistency across different projects and regions. Collectively, this hierarchical and interlocking policy system provides comprehensive, stage-by-stage guidance, thereby fundamentally ensuring the systematic planning, standardized implementation, and long-term sustainability of smart city initiatives nationwide[10].

3 Key Technology System Architecture of Smart Cities

The technological foundation of smart cities lies in the integrated innovation of next-generation information technologies, with its framework structured into three tiers:

Perception and Network Layer (Basic Support): Leveraging the Internet of Things (IoT) to achieve ubiquitous sensing of urban elements, utilizing 5G/fiber-optic net-

works for ultra-high-speed, low-latency data transmission, and coordinating cloud computing with edge computing to provide elastic computing power.

Platform and Data Layer (Core Hub): Centered on the urban big data platform and urban information modeling platform, this layer integrates, governs, and analyzes multi-source heterogeneous data to form the urban "data foundation." Artificial intelligence and digital twin technologies empower this layer, enabling intelligent analysis, simulation prediction, and decision support.

Application and Service Layer (Value Delivery): Leveraging underlying capabilities, we develop various intelligent applications for governments, enterprises, and citizens, such as "One-Stop Online Management", "One-Stop Online Services", smart transportation, and smart healthcare, which represent the ultimate manifestation of technological value.

4 Current Challenges and Underlying Issues

"Data silos" and collaboration barriers: Inconsistent data standards and unclear responsibilities across departments and systems lead to difficulties in data sharing and business collaboration, thereby constraining overall efficiency.

Lack of long-term operational mechanisms: Some projects exhibit the phenomenon of "overemphasis on construction, neglect of operation, and difficulty in sustainability." While substantial investments are made during the construction phase, there is insufficient funding and talent for post-construction operation and maintenance, coupled with unclear business models.

Isolation between Technology and Operations: The application of technology is disconnected from the practical needs of urban governance and public services, with some "show-off" applications lacking practicality, resulting in insufficient citizen satisfaction.

Escalation of security and privacy risks: The extensive collection and analysis of massive data have posed severe challenges to data security and personal privacy protection, necessitating urgent improvements in relevant regulations and safeguard systems.

Digital divide issue: Rapid technological advancement may marginalize digitally vulnerable groups such as the elderly and low-income populations, compromising the equity of public services.

5 Future Development Trends and Policy Recommendations

5.1 Development Trends

From "Smart Scenarios" to "Comprehensive Transformation": The focus of development will shift from fragmented smart applications to systematic and holistic digital transformation across urban economic, lifestyle, and governance domains.

From "data aggregation" to "factor circulation": Building upon data aggregation, the core task is to promote the marketization of data factors and unleash their multiplier effects across industries.

Deep Integration of "AI+": AIGC technologies represented by large models will be deeply integrated with urban operation management, giving rise to new forms such as urban intelligent agents and AI-powered government officials.

Profound transformation of governance paradigms: Promoting the shift in urban governance from experience-based judgment to data-driven analysis, and from post-event response to proactive prediction, early warning, and prevention mechanisms.

5.2 Policy Recommendations

Strengthen top-level design and institutional innovation: Establish a higher-level coordination mechanism to break down departmental barriers and promote innovation in laws, regulations, standards, and norms compatible with digital transformation.

Strengthening the integrated intelligent public infrastructure: Unified planning and construction of common capability platforms for urban cloud, network, data, intelligence, and security to avoid redundant construction and resource waste.

Deepening market-oriented reform of data elements: Improve fundamental systems including data property rights, circulation and trading, revenue distribution, and security governance; promote authorized operation of public data; and foster a data industry ecosystem.

Establishing a sustainable operational model: Explore a diversified collaborative operation model characterized by "government guidance, market dominance, and social participation," clarify the rights, responsibilities, and interests of all stakeholders, and ensure the long-term healthy operation of the project.

Strengthening the Bottom Line of Security and Ethics: Improve cybersecurity, data security, and personal information protection systems, develop technologies such as privacy computing that enable "data usability without visibility," and ensure safe, reliable, fair, and inclusive development.

6 Conclusion

The development of China's smart cities results from the dynamic interplay of three core forces: technological advancement, policy initiatives, and practical urban needs. Its evolution shows a clear maturation path—from isolated "point-like" tech applications, to "linear" system integrations, and now toward comprehensive "surface-level" and "volume-level" digital transformation that reshapes urban operations and governance. Future success depends not just on deeper adoption of technologies like AI, but more critically on institutional reforms to break data silos, fully unleashing data value, and genuinely embedding a "people-oriented" approach in all projects. Domestically, this drive supports high-quality urbanization and modernization. Globally, it offers

practical "China solutions" and adaptable insights, especially for cities in the Global South.

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