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RESEARCH STATUS AND EVOLUTIONARY TRENDS OF SMART CITY STUDIES IN CHINA: A CITESPACE-BASED KNOWLEDGE MAPPING ANALYSIS

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Abstract: To systematically clarify the developmental trajectory and knowledge structure of smart city research in China, this study uses CiteSpace to conduct a visual bibliometric analysis of 824 core journal articles indexed in CNKI from 2014 to 2025. The results show that annual publications in this field have generally increased, with research hotspots concentrating on smart cities, the digital economy, urban governance, big data and digital twins. Universities constitute the dominant research force, whereas inter-institutional collaboration remains relatively loose. The evolution of the field can be divided into three stages: conceptual emergence, rapid development and deepening expansion. Research attention has shifted from technological infrastructure and top-level design to governance innovation, empirical measurement, interdisciplinary integration and practical application. On the basis of identifying current limitations, this study further discusses future directions, including the convergence of emerging technologies, human-centred governance and cross-disciplinary collaboration. The findings provide a structured reference for smart city research, planning and implementation in China.
Keywords: Bibliometric analysis; CiteSpace; Digital governance; Knowledge mapping; Smart city; Urban digital transformation

1 INTRODUCTION

Accelerated global urbanisation has enabled cities to concentrate development factors, but it has also intensified governance pressures related to transport, the environment, resources and public safety. The rapid penetration and integration of new-generation information technologies, including the Internet of Things (IoT), big data and artificial intelligence (AI), into urban governance have provided new technological pathways for addressing the limitations of traditional urban management. Against this background, the smart city, as a product of the deep integration of informatisation and urbanisation, has become an important strategic choice for cities worldwide to transform development models and modernise governance capacity. Since the launch of national smart city pilots in China in 2012, and under the impetus of the Digital China strategy and the 14th Five-Year Plan, China's smart city construction has moved from conceptual exploration to large-scale implementation.

With the deepening of urban digital transformation, smart cities have become an important research direction in urban governance and regional development. In essence, a smart city is supported by information and communication technologies; through the sensing, analysis and integration of core urban operational processes, it enables intelligent adaptation and efficient responses to diverse governance needs such as livelihood security, ecological protection, public security prevention and control, and public services [1]. As research outputs have continued to increase, a systematic review of the field's academic development trajectory and an accurate identification of research hotspots and thematic evolution at different stages can help capture the academic frontier and provide theoretical support and practical reference for smart city planning and implementation in China. Therefore, this study selects core journal articles indexed by CNKI as the research sample and applies scientific knowledge mapping to analyse publication output, institutional collaboration, hotspot themes and evolutionary pathways in smart city research, with the aim of presenting the field's research status and development trends in an accurate and intuitive manner.

2 MATERIALS AND METHODS

2.1 Data Sources

To construct a knowledge map of research on smart city construction, and to ensure the continuity, standardisation and comparability of the sample while objectively reflecting the field's development trend, this study follows common practice in domestic knowledge-mapping studies on urban economic resilience and smart cities and selects 2014-2025 as the time window [2]. The year 2014 represents a key point at which China's smart city pilots were advanced comprehensively and academic research shifted from preliminary exploration to systematic deepening. Before 2014, the number of relevant core articles was relatively small and research themes were scattered, making it difficult to support robust bibliometric and knowledge-mapping analysis. Taking 2014 as the starting point enables the study to cover the full cycle of emergence, growth and rapid expansion in smart city research and thereby improves the objectivity and

reliability of the conclusions. Accordingly, this study uses Peking University Core and CSSCI journal articles from the CNKI Chinese database published between 2014 and 2025 as the data source.
The core search terms were ‘smart city’, ‘digital twin’, ‘digital city’ and ‘urban resilience’, with a focus on related disciplines such as urban planning, public administration, information science and geography. After manually excluding conference notices, calls for papers, book reviews and literature with low relevance, 824 valid journal articles were retained as the sample for quantitative analysis.

2.2 Bibliometric Analysis

Bibliometrics is a quantitative analytical approach that integrates mathematical and statistical methods to conduct systematic measurement and analysis of the literature in a specific field or on a specific research topic [3]. In this study, bibliometric methods are used to calculate the annual distribution of publications retrieved from the database, revealing changes in the field’s development trend and academic attention. Frequency statistics are also applied to authors and research institutions in order to identify the core research forces with relatively high productivity and influence.

2.3 CiteSpace Knowledge Mapping

This study employs the CiteSpace knowledge-mapping method for bibliometric and visual analysis. Developed by Chen Chaomei and colleagues, CiteSpace mines associations among documents to visually present research hotspots, knowledge bases and frontier evolution within a field [4]. Its theoretical foundations include Price’s theory of scientific frontiers, co-word analysis and the bridging role of structural holes in knowledge flows [5], which makes it suitable for identifying key turning points and emerging trends in a discipline.

3 RESULTS

3.1 Annual Publication Output

The number and frequency of publications are important indicators for measuring academic attention and development status in a given field. After retrieval and screening, a total of 824 smart city-related articles published between 2014 and 2025 were obtained. These data were used to analyse the temporal characteristics of the field’s development.
Overall, publication output during this period shows a fluctuating upward trend, indicating a sustained increase in research attention. Specifically, from 2014 to 2019, annual output remained in a relatively stable accumulation stage, with an average of 62 articles per year. Research topics in this period focused mainly on the practical exploration of smart city pilots and the preliminary application of information technologies in urban management [6]. The year 2020 marked an important adjustment point, as annual output declined to 58 articles. This change was closely related to the sudden outbreak of COVID-19, which redirected part of the research capacity toward pandemic-related issues [7-9]. From 2021 to 2025, publication output entered a high-level growth stage. The years 2023 and 2024 both reached 89 articles, the highest level in the statistical period, and this rapid growth reflects a clear policy trajectory [10].

3.2 Research Institutions

The institutional co-occurrence map reflects collaboration among different institutions engaged in smart city construction research as well as their influence in the field. The network contains 205 nodes and 231 links, with a network density of only 0.0026, indicating that the overall collaboration network is relatively loose. The modularity index is $Q = 0.9722$, suggesting that collaboration clusters have clear boundaries; the weighted mean silhouette value is $S = 0.2639$, indicating that the internal consistency of some clusters requires further improvement.
Node size represents publication output. The School of Public Administration, Huazhong University of Science and Technology; the School of Public Administration, Xiangtan University; the School of Architecture and Urban Planning, Nanjing University; the School of International and Public Affairs, Shanghai Jiao Tong University; and the School of Public Administration and Policy, Renmin University of China are among the prominent nodes. These institutions constitute core research bases in the field and show substantially higher output and influence than other institutions.
The map reveals several relatively independent collaborative subnetworks. For example, clusters centred on Huazhong University of Science and Technology, Nanjing University and Shanghai Jiao Tong University form locally dense cooperative relationships, but cross-regional and cross-institutional links among clusters are limited; a nationwide collaborative network has not yet taken shape. The participating entities are dominated by university schools related to public administration, urban planning, and economic management, while research institutes and laboratories account for only a small proportion. This pattern indicates that research capacity is concentrated within universities and that the participation of scientific research institutions still needs to be strengthened.
In general, the field has formed a research pattern centred on universities in public administration and urban planning. However, institutional collaboration is characterised by ‘local density and overall dispersion’. Cross-cluster collaboration remains insufficient, network density is low, and an efficient national collaborative system has not yet been established. In the future, cross-regional collaboration platforms should be developed to promote interaction between core and emerging institutions, optimise the research network and enhance the overall capacity for collaborative innovation.

3.3 Keyword Clustering

Keyword clustering is an important method for revealing the internal structure and thematic distribution of a research field. It helps researchers systematically grasp the field's knowledge framework and the division of subfields.

The keyword cluster map contains N = 803 nodes and E = 857 links, with a network density of 0.0025. The modularity index is Q = 0.5441 (> 0.3), and the weighted mean silhouette value is S = 0.9639 (> 0.5), indicating a significant clustering structure, high internal consistency and reliable mapping results. The map forms 10 thematic clusters. Excluding 'smart city'. Overall, the field takes the smart city as the core carrier and has formed a clear research system that links technological support, scenario application and multi-actor governance. Cluster boundaries are clear and cross-cluster connections are close, while research hotspots are diverse and strongly practice-oriented. Future studies may pay closer attention to the deep integration of cross-cluster topics, such as the synergistic pathways between the digital economy and low-carbon cities and the balancing mechanisms between information security and smart city construction.

3.4 Keyword Co-occurrence

Keyword co-occurrence analysis is one of the important methods for identifying development trends and hotspot themes in a research field. The co-occurrence map contains N = 805 nodes and E = 857 links, with a network density of 0.0025. The largest connected component accounts for 95% of the network, indicating a strong overall association within the research network and a relatively concentrated set of core issues. 'Smart city' is the absolute core node, with the thickest ring and the densest links, and constitutes the research centre of the entire field.

High-frequency technical keywords include 'big data', 'artificial intelligence', 'Internet of Things' and 'digital twin'. These concepts form the core technological hotspots supporting smart city construction and reflect the mainstream orientation of technology-enabled urban development. 'Urban governance' and 'digital governance' co-occur strongly with the central and technical nodes, forming a triangular structure of technology and governance. 'Digital economy' and 'low-carbon city' are directly connected with 'smart city' and constitute application-scenario clusters. In peripheral areas, 'public participation', 'multi-actor participation' and 'emergency decision-making' co-occur with one another and focus on collaborative governance, while 'information security' is connected across clusters with 'digital twin' and 'Internet of Things'. This pattern shows that security issues are embedded in technological applications and that scholars not only pay attention to public services and collaborative governance, but also emphasise data security, risk response and other supporting issues. The research perspective is becoming increasingly diversified.

Node colours correspond to the 2014-2025 time series from lighter to darker shades. Early studies had relatively simple co-occurrence relationships and concentrated mainly on 'smart city' and foundational technologies. In the middle stage, keywords such as 'digital twin', 'digital governance', 'artificial intelligence' and 'Internet of Things' emerged, and the research focus expanded from single-technology applications to the integration of digital scenarios. Cross-research between technology and governance increased markedly. In recent years, darker nodes such as 'digital economy', 'metaverse' and 'technological innovation' have increased, and their co-occurrence edges with 'digital economy' and 'technological innovation' indicate the emergence of new clusters.

Overall, the field has formed a three-dimensional research pattern centred on the smart city and supported by technological foundations, governance innovation and scenario-based applications. Core issues remain stable, while research hotspots continue to iterate with technological development and social demand. Future research may further examine the deep integration pathways linking emerging technologies, including AI and digital twins, with urban governance and the digital economy.

3.5 Evolution of Research Hotspots

3.5.1 Timeline map

The CiteSpace timeline view clearly displays the temporal evolution path and stage-specific characteristics of smart city research keywords from 2014 to 2025. The map contains 242 nodes and 507 links, with a network density of 0.0086, indicating relatively close relationships among nodes. The modularity index is Q = 0.7604 and the weighted mean silhouette value is S = 0.9934, suggesting a significant clustering structure, high homogeneity and reliable results. The evolution can be broadly divided into three stages.

The first stage, 2014-2018, is characterised by nodes concentrated mainly along the two timelines of #0 smart city and #1 big data. During this period, the main co-occurrence axis was 'smart city-big data-informatisation'. Research focused on defining the connotation of the smart city and exploring the preliminary application of new-generation information technologies in urban operations. Links among keywords were relatively sparse, reflecting an early stage of independent exploration in which dense cross-theme networks had not yet formed. Representative nodes, such as 'information infrastructure' and 'decision support', clearly carried a 'technical tool' orientation and pointed to an efficiency-centred research approach.

The second stage, 2019-2022, saw a significant shift in research focus. The most prominent change was the rapid rise of the #3 urban governance and #4 artificial intelligence timelines. Nodes such as 'urban governance', 'public participation' and 'multi-actor participation', together with 'artificial intelligence', 'digital twin' and 'Internet of Things', appeared intensively. During this period, the co-occurrence network displayed a clear cross-over between technology and governance. For example, strong cross-timeline links appeared between 'artificial intelligence' and

'urban governance', while 'digital twin' formed sequential relationships with nodes such as 'emergency decision-making' and 'public safety'. In addition, the #5 digital economy line began to take shape, and the emergence of related nodes indicated that research was expanding from single technological scenarios to macro-level dimensions such as the economy and industry. Overall, this stage completed a paradigm shift from 'technology-driven' research to 'technology-enabled governance'.

The third stage, 2023-2025, is marked by the independent formation and rapid extension of two new lines: #6 information security and #7 smart governance. Related nodes appear at the end of the timeline, indicating that research has shifted from asking whether technologies are advanced to asking whether technologies serve people. At the same time, 'metaverse' appears as a new node at the end of the #7 smart governance line and forms cross-line co-occurrence edges with 'digital economy' and 'digital twin', suggesting the formation of a new integrated cluster that combines frontier technologies and value orientation. Furthermore, nodes such as 'green and low-carbon' and 'sustainable development' have appeared frequently in the past two years, contrasting clearly with earlier concerns such as 'informatisation' and 'technological efficiency'. The research focus has moved from the simple pursuit of efficiency to inclusiveness, sustainability and human-centred values.

3.5.2 Citation bursts

The keyword burst map intuitively shows the rise, evolution and decline of research hotspots in smart city studies from 2014 to 2025. The burst analysis suggests that the development of smart city construction research can be summarised in three stages.

The first stage is the conceptual emergence period (2014-2018). The main burst terms in this stage were 'big data' (6.62), 'Internet of Things' (5.81) and 'top-level design' (3.23). Research during this period focused on the hardware deployment of 'digital city' and 'e-government', with the purpose of constructing technological frameworks and laying infrastructure. Scholars and practitioners mainly discussed how to establish standards for data collection and sharing and how to build unified cloud-computing platforms to realise the informatisation of urban management. Smart city research was still in the early phase of technological accumulation at this time [11].

The second stage is the rapid development period (2019-2022). 'Digital twin' (4.68), 'difference-in-differences' (3.82), 'urban governance' (3.15) and 'carbon emissions' (3.13) became new high-frequency burst terms. This shift indicates that the research paradigm moved from pure technological construction to empirical analysis and refined management. Scholars began to use difference-in-differences (DID) models to evaluate the actual effects of smart city pilot policies on environmental pollution and economic efficiency [12]. At the same time, the maturation of digital twin technology enabled urban management to move from two-dimensional management to three-dimensional spatiotemporal simulation [13].

The third stage is the deepening expansion period (2023-2025). The map shows that 'digital economy' ranked first with an extremely high burst strength of 10.02, while 'digital governance' (3.87), 'artificial intelligence' and 'industrial structure' became core topics. Research has gone beyond the scope of smart cities in the narrow sense and expanded to microeconomic dimensions such as AI-enabled industries, financing constraints and internal control in enterprises, emphasising high-quality development driven by data elements.

4 DISCUSSION AND CONCLUSIONS

4.1 Main Conclusions

Through CiteSpace knowledge mapping, this study systematically examines the publication characteristics, institutional collaboration patterns and thematic evolution of smart city research in China from 2014 to 2025. The main conclusions are as follows.

First, research capacity is concentrated within the university system, but cross-institutional collaboration networks remain loose, showing a pattern of local density and overall dispersion. This indicates that smart city research in China is still dominated by institution-based independent exploration, and a nationwide collaborative system spanning regions and disciplines has not yet been formed. This may constrain the capacity for joint research on major theoretical and practical issues.

Second, research topics have formed a stable knowledge framework of technological empowerment, governance application and multidimensional integration. The stability of this framework indicates that the academic community has reached a basic consensus on the core issues of smart city research. At the same time, it also suggests that the research paradigm is becoming relatively fixed and that the ability to absorb cross-boundary topics needs to be strengthened.

Third, research hotspots exhibit a clear three-stage evolutionary trajectory. This trajectory is highly synchronised with national strategic deployment and reflects the strong policy responsiveness of smart city research.

4.2 Limitations

Although this study clarifies the research trajectory and hotspot pattern of smart city studies through knowledge mapping, several limitations remain.

First, the literature sample is limited. The study uses only Chinese core journals in CNKI as the data source and does not include foreign-language publications from Web of Science, which prevents a comparative analysis of Chinese and international scholarship.

Second, the research method is relatively singular. The study relies mainly on CiteSpace for bibliometric and visual mapping analysis and therefore emphasises macro-level patterns and hotspot identification. It does not combine deep text mining, case-based empirical research or other methods, which limits the in-depth analysis of the internal mechanisms of specific research themes and the practical pain points of implementation.

Given these limitations, and in light of policy and practical contexts, future research can be deepened in the following directions.

4.3 Future Development Trends

A comprehensive analysis of the literature indicates that over the past decade Chinese smart city research has remained closely aligned with national strategies. The 2025 Central Urban Work Conference clearly stated that urban development is shifting toward a stage of improving quality and efficiency within existing urban stock [14], with the goal of building modern people-centred cities that are innovative, liveable, beautiful, resilient, civilised and smart [15]. The Action Plan for Deepening Smart City Development and Promoting Territory-wide Digital Transformation, released in the same year, deeply integrates the concept of the 'people's city' with territory-wide digital transformation and promotes a comprehensive shift in smart cities from technological orientation to human-centred value [10,16]. Against this historical background, academic research has focused on the deep integration of technological empowerment and governance innovation and has gradually formed an overall smart city research framework driven by technology, data, reform and industry, with territory-wide digital transformation at its core. Theoretical outputs have evolved continuously from the 'urban brain' to the 'urban intelligent agent' and from single-point applications to the integration of 'platform foundation plus scenarios'. This process has nurtured Chinese approaches such as 'people's cities built by and for the people' and 'the city as an organic life form' [14,17], while also exploring governance models such as 'one-network unified management', 'efficiently handling one matter at a time' and 'rapid response to public opinion' [10]. More than a decade of accumulation has promoted a cognitive transformation in smart city research, which is now accelerating toward new stages characterised by AI large models, digital twins and trusted data spaces, thereby laying a solid theoretical foundation for Chinese-style urban modernisation.

Looking ahead, although significant progress has been made in smart city research, several directions still warrant deeper exploration in the new stage of territory-wide urban digital transformation.

First, emerging technologies will become more deeply integrated. AI, digital twins, the metaverse, large models and other emerging technologies will continue to converge with smart city development. Future research will no longer be limited to single-technology applications but will move toward multi-technology integration, full-scenario intelligent sensing, and real-time mapping between digital and physical spaces. This direction is likely to remain a long-term frontier.

Second, governance models will become more collaborative and human-centred. Existing studies suggest that research will shift from a technology-centred orientation to a human-value orientation, paying more attention to public participation, multi-actor collaborative governance and the equalisation of public services. Issues of livelihood security, social equity and inclusive development in smart city construction will become increasingly important.

Third, cross-domain research will become normalised. Intersections between smart cities and topics such as the digital economy, low-carbon cities, carbon emissions, emergency management and information security will continue to intensify. Research will focus on practical problems such as upgrading industrial structures, advancing green and low-carbon transitions, and preventing and controlling urban security risks. Interdisciplinary and cross-domain research will become a mainstream direction.

Fourth, quantitative research and mechanism exploration will become more refined. Future studies will move beyond descriptive accounts and hotspot mapping by applying empirical methods such as spatial econometrics, threshold-effect models and mediation-effect models. These approaches will enable deeper exploration of the influencing factors, mechanisms and spatiotemporal differentiation characteristics of smart cities. At the same time, studies should strengthen differentiated pathway analysis across regions and city types to provide theoretical foundations and practical references for targeted smart city construction in different localities.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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REFERENCES

[1] State Administration for Market Regulation and Standardization Administration of China, GB/T 37043-2018 Smart City: Terminology. China Standards Press, Beijing, 2018.

[2] Hong J Q. Analysis of the current status and trends of urban economic resilience based on knowledge mapping. Architecture & Culture, 2026(1): 94-96. DOI: 10.19875/j.cnki.jzywh.2026.01.028.
[3] Chen C. CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. J. Am. Soc. Inf. Sci. Technol., 2006, 57(3): 359-377.
[4] Chen C. Searching for intellectual turning points: progressive knowledge domain visualization. Proc. Natl. Acad. Sci. USA, 2004, 101(suppl. 1): 5303-5310.
[5] Burt R S. Structural holes and good ideas. Am. J. Sociol., 2004, 110(2): 349-399.
[6] Ministry of Housing and Urban-Rural Development. National Smart City Pilot List. Ministry of Housing and Urban-Rural Development, 2019.
[7] Costa G D, Peixoto J P J. COVID-19 pandemic: a review of smart cities initiatives to face new outbreaks. IET Smart Cities, 2020, 2(2): 64-73.
[8] National People's Congress, Outline of the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives through the Year 2035 of the People's Republic of China, 2021.
[9] National Development and Reform Commission, National Data Administration, Ministry of Finance and Ministry of Natural Resources, Guiding Opinions on Deepening Smart City Development and Promoting Territory-wide Urban Digital Transformation (NDRC Data [2024] No. 660), 2024.
[10] National Development and Reform Commission, National Data Administration, Ministry of Finance, Ministry of Housing and Urban-Rural Development and Ministry of Natural Resources, Action Plan for Deepening Smart City Development and Promoting Territory-wide Digital Transformation (NDRC Data [2025] No. 1306), 2025.
[11] Li D R, Shao Z F, Yang X M. From digital city to smart city: theory and practice. Geospatial Information, 2011, 9(6): 1-5, 7.
[12] Shi D Q, Ding H, Wei P, et al. Can smart city construction reduce environmental pollution? China Industrial Economics, 2018(6): 117-135. DOI: 10.19581/j.cnki.ciejournal.2018.06.008.
[13] Zhang X C, Hua S Z, Qi J, et al. Construction and prospects of new smart cities: AI-based big data, large models and computing power. Journal of Geo-information Science, 2024, 26(4): 779-789.
[14] Jiang X P, Cao X Q, He Y L, et al. Promoting the construction of modern people's cities (symposium). Administrative Tribune, 2025, 32(5): 5-29. DOI: 10.16637/j.cnki.23-1360/d.2025.05.012.
[15] Zhang A Q. Building modern people's cities. China City News, 2025.
[16] Guo J, Wang J, Jiang L, et al. From technocentrism to humanism: progress and prospects in smart city research. Progress in Geography, 2022, 41(3): 488-498.
[17] Feng S Z, Building an organic urban life form in the new era. Guangming Daily, 2025.