

## Public Communication in Smart Cities: A Bibliometric Analysis

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### **Abstract**

This study scrutinizes the development of research on public communication in smart cities during the 2016–2024 period through a bibliometric approach. Drawing on bibliometric analysis, it identifies the mapping of publication trends, knowledge structures, thematic developments, and the transformation of research paradigms related to public communication within smart city studies. It shows that research on public communication in smart cities has grown significantly since 2016. Early studies were primarily dominated by themes related to information and communication technologies (ICT), the Internet of Things (IoT), big data, digital platforms, and smart governance systems. Over time, research trends shifted toward issues of citizen participation, transparency, digital inclusion, sustainability, privacy, cybersecurity, and ethical governance. The bibliometric analysis also reveals that the United States, China, and the United Kingdom are the countries with the highest publication contributions. Furthermore, the thematic synthesis identified five major research clusters: Digital Communication Infrastructure, Smart Governance and Citizen Participation, Sustainability and Urban Communication, Security and Privacy, and Human-Centered Smart Cities. This study confirms that public communication in smart cities is no longer limited to the dissemination of digital information but has evolved into a multidimensional governance approach that integrates citizen engagement, transparency, sustainability, digital ethics, and participatory communication within the broader framework of smart urban transformation.

**Keywords:** Bibliometric Analysis; Public Communication; Smart Cities;

## 1. Introduction

Global urbanization, the increasing complexity of urban governance, and sustainability challenges have driven the development of the Smart Cities concept as a strategic approach to modern urban transformation. Smart Cities utilize digital technologies such as the Internet of Things (IoT), Big Data, cloud computing, and artificial intelligence (AI) to improve the quality of public services, enhance resource management efficiency, and support the sustainability of urban systems (Anthopoulos and Kazantzi 2022; Moolngearn and Kraiwanit 2024). The development of AI in smart cities functions not only as an instrument for the automation and optimization of urban systems but also influences patterns of public communication, interactions between governments and communities, and data-driven decision-making within digital governance. The integration of AI in smart cities represents not only a technological transformation but also a transformation of governance and public communication within modern urban ecosystems.

Research on AI in smart cities has shown significant growth since the increasing integration of digital technologies after 2016. Early studies primarily focused on the development of smart homes, energy efficiency, intelligent transportation systems, and AI-based infrastructure optimization (Yang & Cho, 2016). Subsequent research developments demonstrate a shift in attention toward issues of digital governance, data security, algorithmic ethics, community participation, urban sustainability, and AI-based public services (Renukappa et al. 2024). This shift indicates that the implementation of AI in smart cities is no longer understood merely as a technological innovation, but also as part of a broader social and institutional transformation that affects the relationship between governments, technology, and society. The implementation of AI also creates new forms of digital communication spaces that influence transparency, accountability, and social interaction within urban governance.

Previous studies have examined the development of artificial intelligence and smart cities from various technological perspectives. Earlier research has mapped the development of smart cities through themes such as the Internet of Things (IoT), machine learning, cybersecurity, blockchain, digital infrastructure, and sustainable urban systems (Ahad et al. 2020; Alharbi, Attiah, and Alghazzawi 2022). Several studies have also highlighted the relationship between AI and energy efficiency, smart mobility, and data-driven urban system optimization (Abdel-Razek et al., 2022; Alanazi, 2023). The dominance of technological and digital infrastructure themes indicates that research on AI in smart

cities has largely focused on technical aspects, system automation, and the optimization of urban infrastructure.

Attention to the dimensions of governance, public communication, ethics, community participation, and socio-institutional transformation in the implementation of AI within smart cities remains relatively limited (Duncan and Sterling 2023). Most studies position AI primarily as part of the automation and optimization of urban systems, while transformations in the relationship between governments, technology, and society through AI-based digital platforms have not yet been systematically explored (Gaozhao, Wright, and Gainey 2024; Romberg and Escher 2024; Saura, Ribeiro-Soriano, and Palacios-Marqués 2022). These limitations have resulted in the thematic development and knowledge structure concerning the relationship between AI, governance, and public communication in smart cities remaining insufficiently mapped, particularly from the perspective of governmental governance and urban social transformation.

This study aims to analyze the development of artificial intelligence in smart cities through a bibliometric approach during the 2016–2024 period. The study maps publication trends, knowledge structures, thematic developments, and the transformation of AI research paradigms in smart cities from a techno-centric orientation toward human-centered smart cities that emphasize governance, public communication, sustainability, ethics, and community participation. In addition, this study provides a conceptual contribution to understanding the development of AI governance and the transformation of digital communication within modern smart city ecosystems.

From the above, the research question was found:

RQ1. How have publication trends, country contributions, author productivity, and citation impact developed in artificial intelligence and smart cities research during the 2016–2024 period?

RQ2. How are the knowledge structure, intertopic relationships, and thematic development of artificial intelligence and smart cities research represented through bibliometric analysis and thematic synthesis?

RQ3. How has the development of artificial intelligence research in smart cities demonstrated a paradigm shift from techno-centric approaches toward human-centered smart cities in the context of governance, public communication, sustainability, ethics, and social transformation during the 2016–2024 period?

## **2. Method**

### **2.1 Research Design**

This study employed a bibliometric approach using a quantitative descriptive method to analyze the development of artificial intelligence and

smart cities research during the 2016–2024 period. The bibliometric approach was utilized to map publication trends, knowledge structures, thematic developments, and inter-keyword relationships based on scientific publication data indexed in the Scopus database (Gan et al., 2022). Meanwhile, the quantitative descriptive method was employed to describe the distribution of publications, authors, countries, and citations in artificial intelligence and smart cities research.

## 2.2 Data Source

The data for this study were obtained from the Scopus database because it provides broad international publication coverage and is widely used in bibliometric studies (Donthu et al. 2021). In addition, this approach enables researchers to identify dominant research themes, influential authors, and emerging trends related to governance communication, ethics, and citizen-oriented dimensions in AI-driven smart city research.

## 2.3 Data search strategy

The search process in this study was conducted using the following combination of keywords: TITLE-ABS-KEY (“Artificial Intelligence”) AND TITLE-ABS-KEY (“Smart City”). These keywords were applied to the title, abstract, and keywords to ensure that the retrieved documents were directly relevant to the research topic. Several filtering stages were subsequently implemented to ensure that the obtained data were specific and valid. Although the primary search terms focused on Artificial Intelligence and Smart City, communication-related dimensions emerged organically through governance, participation, digital interaction, and public communication themes identified in the bibliometric network. Table 1 summarizes each stage of the search process in the Scopus database, including the inclusion criteria, exclusion reasons, search queries, and number of articles.

**Table 1.** Stages of Data Identification, Inclusion, and Exclusion in Scopus Database Search.

No.	Criteria / Filter	Inclusion Criteria	Query (Scopus)	Exclusion Reason	Number of Documents (n)
1	Initial Search (All Years)	All documents containing the keywords “Artificial Intelligence” and	TITLE-ABS-KEY("Artificial Intelligence") AND TITLE-ABS-KEY("Smart City")	-	5,569

No .	Criteria / Filter	Inclusion Criteria	Query (Scopus)	Exclusion Reason	Number of Documents (n)
2	Publication Year Filter (2014–2024)	“Smart City” without limitations on publication year, language, or document type. Articles published between 2014 and 2024.	(...) AND PUBYEAR > 2014 AND PUBYEAR < 2025	1,050 documents were excluded because they were published before 2015 or after 2024.	4,519
3	Subject Area Filter (Social Sciences)	Articles categorized within the Social Sciences (SOCI) subject area.	(...) AND (LIMIT-TO(SUBJAREA, "SOCI"))	3,646 documents were excluded because they originated from other subject areas, such as Engineering, Computer Science, or Energy.	873

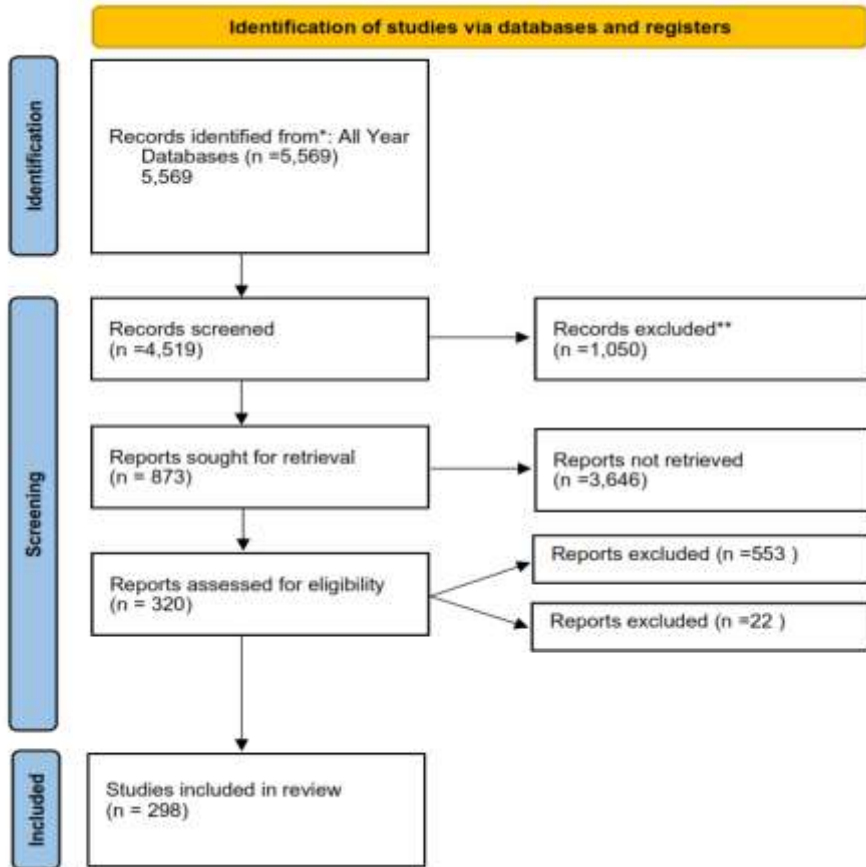
No .	Criteria / Filter	Inclusion Criteria	Query (Scopus)	Exclusion Reason	Number of Documents (n)
4	Document Type Filter (Article)	Only scientific articles (Article – DOCTYPE: ar) published in academic journals were included.	(...) AND (LIMIT-TO(DOCTYPE, "ar"))	553 documents were excluded because they consisted of conference papers, reviews, book chapters, or editorials.	320
5	Language Filter (English)	Articles published in English.	(...) AND (LIMIT-TO(LANGUAGE, "English"))	22 documents were excluded because they were written in languages other than English.	298
6	Metadata Extraction	Articles that passed all filtering stages were exported in CSV format containing complete metadata, including	-	No exclusions were applied; all 298 articles were used as the final dataset.	298 (Final Dataset)

No	Criteria / Filter	Inclusion Criteria	Query (Scopus)	Exclusion Reason	Number of Documents (n)
.		titles, abstracts, keywords, citations, and affiliations			

The absence of publications in 2014 and 2015 indicates that studies on artificial intelligence within the context of smart cities had not yet developed significantly during that period.

#### **2.4 Data Collection Strategy**

Data collection in this study employed a bibliometric analysis approach guided by the PRISMA 2020 framework to ensure that the article identification and selection processes were conducted systematically, transparently, and accountably. (Valérie and Pierre 2010)



**Figure 1.** Stages of Data Collection.

This figure illustrates the systematic article selection process used in the literature review or bibliometric study. The diagram explains how the number of articles was reduced from the initial search stage to the final set of articles included in the analysis.

### 2.5 Data analysis technique

The data analysis technique in this study was conducted using VOSviewer software. Bibliographic data obtained from the Scopus database in CSV format were analyzed to map intertopic relationships, thematic developments, and research trends related to artificial intelligence and smart cities. VOSviewer was utilized to generate three primary forms of visualization, namely Network Visualization, Overlay Visualization, and Density Visualization. Network Visualization was used to identify thematic clusters and inter-keyword relationships within the research network. Overlay Visualization was employed to analyze temporal developments and identify emerging topics based on publication years.

Meanwhile, Density Visualization was used to demonstrate the density and intensity of topic occurrences within the research literature.

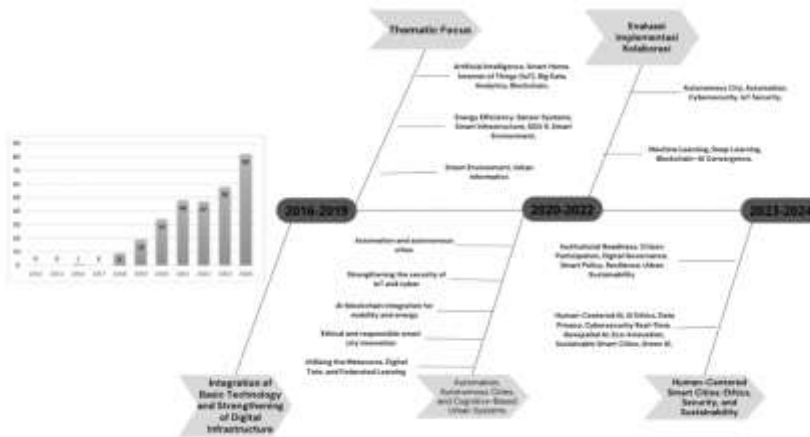
In addition, RStudio was used to generate word cloud visualizations to illustrate the dominance and frequency of word occurrences in Artificial Intelligence and Smart Cities research. Through this combination of visualizations, the study provides a bibliometric mapping of thematic developments and research directions in the field of Artificial Intelligence and Smart Cities.

### 3. Results

#### 3.1 Publication trends by year

Publications by year illustrate the development in the number of research publications on artificial intelligence and smart cities based on publication year during the 2016–2024 period.

#### THREE RESEARCH TREND CLUSTERS OF ARTIFICIAL INTELLIGENCE IN SMART CITIES (2016–2024)



**Figure 2.** Publication by Year  
*Source: Authors' elaboration based on Scopus database.*

The figure illustrates the development of research trends on Artificial Intelligence in Smart Cities during the 2016–2024 period, which can be divided into three major phases. During the 2016–2019 period, research primarily focused on strengthening basic digital infrastructure through the integration of Artificial Intelligence, the Internet of Things (IoT), smart homes, Big Data, and blockchain within urban systems. Research during this phase was dominated by themes related to system automation, energy efficiency, cybersecurity, and the development of autonomous cities based on digital technologies.

The 2020–2022 period demonstrates a broader development of research, marked by increasing attention to machine learning, deep learning, digital governance, institutional readiness, and smart policy. During this phase, research was no longer solely oriented toward technological development but also began to address urban governance, community participation, urban sustainability, and the integration of AI into data-driven decision-making processes. In addition, greater attention emerged toward issues of data security, privacy, and the integration of technologies such as blockchain–AI convergence and digital twins within Smart City ecosystems.

Entering the 2023–2024 period, research trends demonstrate a shift toward a human-centered smart cities approach that emphasizes ethics, security, sustainability, and AI-based public services. Research during this phase began to address AI ethics, privacy, cybersecurity, geospatial AI, eco-innovation, green AI, and sustainable smart cities as integral components of modern urban governance transformation. Overall, the figure indicates that the development of Artificial Intelligence research in Smart Cities has evolved from a predominantly technological orientation toward a more multidimensional, participatory, and human-centered approach.

### 3.2 Distribution of Publications by Country

The distribution of publications by country refers to the distribution of research contributions on artificial intelligence and smart cities from various countries based on the number of indexed publications during the study period.



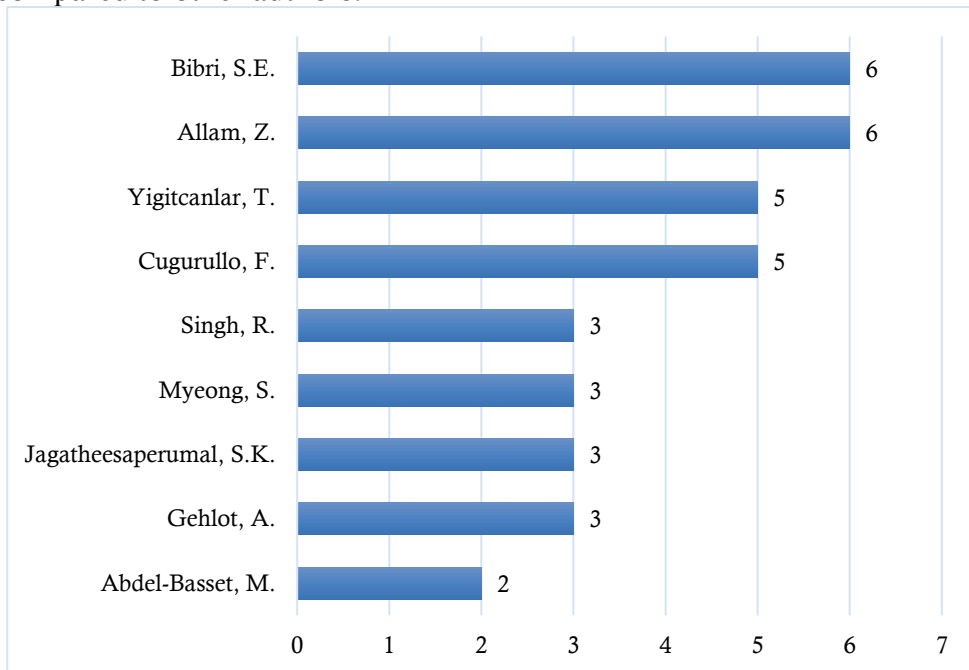
**Figure 3.** Global Distribution of Publications on Artificial Intelligence in Smart Cities by Country

*Source:* Authors' visualization based on Scopus data using MapChart.

The figure illustrates the distribution of research publications on artificial intelligence and smart cities by country during the 2016–2024 period. The United States recorded the highest number of publications with 42 documents, followed by China with 39 documents and the United Kingdom with 38 documents. In addition, Saudi Arabia and India each produced 31 publications. These findings indicate that research contributions related to artificial intelligence and smart cities are distributed across several countries with varying levels of research productivity. Overall, countries with the highest number of publications demonstrate greater research intensity in the development of artificial intelligence and smart cities during the study period.

### 3.3 Author Analysis

Author analysis illustrates the contributions of authors to artificial intelligence and smart cities research during the 2016–2024 period. The analysis results indicate that several authors have higher publication counts compared to other authors.



**Figure 4.** Most Productive Authors in AI and Smart City Research  
*Source: Authors' analysis based on Scopus database.*

The figure presents the most productive authors in artificial intelligence and smart cities research during the 2016–2024 period. Bibri, S.E., and Allam, Z. were identified as the authors with the highest number of publications, each contributing 6 documents. This was followed by Yigitcanlar, T., and Cugurullo, F., with 5 publications each. Meanwhile,

several other authors, including Singh, R., Myeong, S., and Jagatheesaperumal, S.K., each produced 3 publications. These findings indicate variations in author productivity levels in the development of artificial intelligence and smart cities research. Overall, authors with the highest publication counts demonstrate more dominant contributions to the advancement of research in this field.

### 3.4 Citation Analysis

Citation analysis demonstrates the level of article influence based on the number of citations received in artificial intelligence and smart cities research during the 2016–2024 period. Accordingly, the table below presents the articles with the highest citation counts in the development of artificial intelligence and smart cities research.

**Table 2.** Top-Cited Publications in Artificial Intelligence and Smart City Studies

Rank	Author/Year/ Title	Source	SJR/ Quar tile	Cita tion	Key Finding
1	(Allam and Dhunny 2019), On big data, artificial intelligence, and smart cities. <a href="https://doi.org/10.1016/j.cities.2019.01.032">https://doi.org/10.1016/j.cities.2019.01.032</a>	Cities	1.839 /Q1	880	The integration of artificial intelligence (AI) and big data has become a key driver in the development of sustainable smart cities; however, its implementation must be accompanied by a balance between technological, social, and governance dimensions to ensure that it remains oriented toward improving the quality of life of urban communities.

Rank	Author/Year/ Title	Source	SJR/ Quar tile	Citation	Key Finding
2	(Ahad et al. 2020) Enabling technologies and sustainable smart cities. <a href="https://doi.org/10.1016/j.scs.2020.102301">https://doi.org/10.1016/j.scs.2020.102301</a>	Sustainable Cities and Society	2.869 /Q1	501	Internet of Things, artificial intelligence, blockchain, Big Data, and cyber-physical systems play a crucial role in building sustainable smart cities, as they enable efficient, secure, inclusive, and environmentally sustainable management across various aspects of urban life.
3	(Allam et al. 2022) The Metaverse as a Virtual Form of Smart Cities: Opportunities and Challenges for Environmental, Economic, and Social Sustainability in Urban Futures <a href="https://doi.org/10.3390/smartcities5030040">https://doi.org/10.3390/smartcities5030040</a>	Smart Cities	1.398 /Q1	489	The metaverse has the potential to become a virtual form of smart city that can support environmental, economic, and social sustainability through the implementation of technologies such as AI, Big Data, IoT, and Digital Twins. However, it also raises ethical, social, and cultural challenges related to the quality of human life in urban environments.
4	(Moustafa 2021) A new distributed architecture for evaluating AI-based security systems at the edge, Network	Sustainable Cities and Society	2.869 /Q1	484	This literature introduces a distributed testbed architecture that integrates edge, fog, and cloud layers for IoT networks using the NSX vCloud NFV platform combined with SDN, NFV, and service orchestration technologies. The

Rank	Author/Year/ Title	Source	SJR/ Quar tile	Citation	Key Finding
	TON_IoT datasets. <a href="https://doi.org/10.1016/j.scs.2021.102994">https://doi.org/10.1016/j.scs.2021.102994</a>				architecture produced the TONIoT dataset, which contains heterogeneous data derived from IoT services, Windows and Linux operating systems, and network traffic labeled with authentic attack data from nine types of cyberattacks. Evaluation using four machine learning algorithms demonstrated high attack detection performance. Compared with other datasets, TONIoT is distinguished by the heterogeneity of its data sources, the realism of its scenarios, and its broad coverage of cyberattacks, thereby providing a comprehensive validation foundation for AI-based IoT security solutions, including federated learning applications and digital forensics.
5	(Singh et al. 2020) Convergence of blockchain and artificial intelligence in IoT networks for the sustainable smart city.	Sustainable Cities and Society	2.869 /Q1	453	The convergence of Blockchain and AI is considered a key innovation in building sustainable smart city ecosystems. Blockchain enhances security, decentralization, and privacy, while AI contributes to intelligent decision-making and

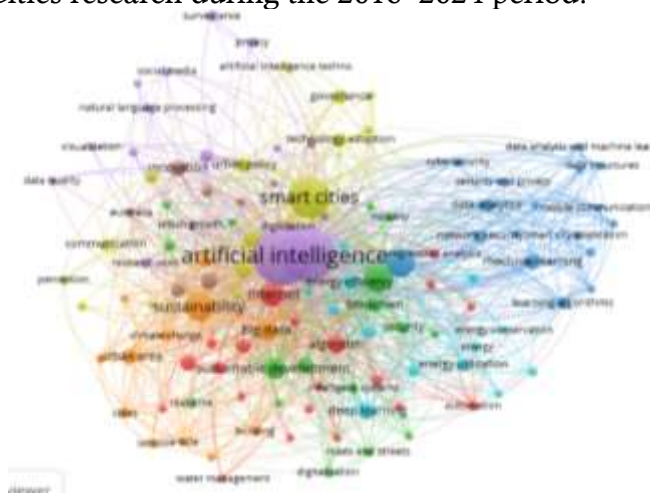
Ra nk	Author/Year/ Title	Sourc e	SJR/ Quar tile	Cita tion	Key Finding
	<a href="https://doi.org/10.1016/j.scs.2020.102364">https://doi.org/10.1016/j.scs.2020.102364</a>				process automation in urban management.

*Source: Authors' analysis based on Scopus database.*

The table presents the articles with the highest citation counts in Artificial Intelligence and Smart Cities research during the 2016–2024 period. The article by Zaheer Allam and S.M.A. Dhunny, published in 2019, entitled *On Big Data, Artificial Intelligence and Smart Cities*, became the most highly cited publication with 880 citations. This was followed by the 2020 article by M.A. Ahad et al., entitled *Enabling Technologies and Sustainable Smart Cities*, which received 501 citations, and the 2022 article by Zaheer Allam et al. concerning the metaverse and Smart Cities, which obtained 489 citations. In addition, the 2021 article related to IoT-based AI system security by Nour Moustafa received 484 citations, while the 2020 study on blockchain and AI convergence in Smart Cities by R. Singh et al. obtained 453 citations. Overall, the most highly cited articles were dominated by themes related to Big Data, sustainability, blockchain, cybersecurity, IoT, and the integration of Artificial Intelligence in Smart City development.

### 3.5 Network Visualization

Network Visualization illustrates the interrelationships among keywords and the formation of thematic clusters in Artificial Intelligence and Smart Cities research during the 2016–2024 period.



**Figure 5.** Network Visualization of AI and Smart City Research

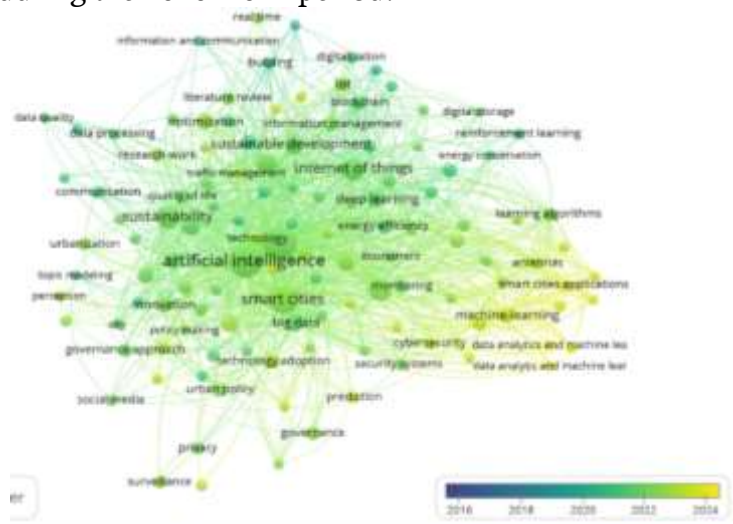
*Source: Authors' analysis based on Scopus database using VOSviewer.*

The figure presents the results of the Network Visualization of Artificial Intelligence and Smart Cities research during the 2016–2024 period using VOSviewer. The visualization results indicate that the keywords “artificial intelligence” and “smart cities” serve as the central nodes within the research network, exhibiting the highest level of connectivity with various other research themes. In addition to their association with technological themes such as machine learning, Big Data, blockchain, and cybersecurity, the visualization also demonstrates linkages with keywords related to governance, communication, urban policy, privacy, and technology adoption.

These interconnections indicate that the development of Artificial Intelligence research in Smart Cities is not solely focused on technological aspects, but has also begun to expand toward the dimensions of digital communication and governmental governance. The emergence of keywords such as communication, governance, urban policy, and privacy within the research network reflects growing attention to the transformation of interactions between governments and communities through AI-based digital systems within Smart City ecosystems. Furthermore, the relationship between Artificial Intelligence and themes such as sustainability, security, and public policy demonstrates that Smart City research is evolving toward a more integrated, responsive, and data-driven governance approach.

### 3.6 Overlay Visualization

Overlay Visualization illustrates the temporal development and keyword emergence trends in Artificial Intelligence and Smart Cities research during the 2016–2024 period.



**Figure 6.** Overlay Visualization of AI and Smart City Research  
*Source: Authors’ analysis based on Scopus database using VOSviewer.*

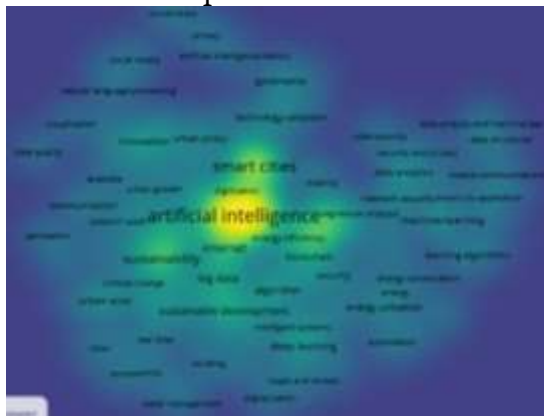
The figure presents the results of the Overlay Visualization of Artificial Intelligence and Smart Cities research during the 2016–2024 period using VOSviewer. This visualization illustrates the temporal development of keywords based on their year of emergence within the research network. Blue to green colors represent research themes that emerged during the earlier period, while yellow indicates more recent and emerging themes in the latest period.

During the early period, research primarily focused on foundational themes such as the Internet of Things (IoT), sustainability, information management, optimization, and digitalization in Smart City development. Subsequently, research developments began to shift toward more complex themes, including machine learning, cybersecurity, blockchain, data analytics, and smart city applications, which became more dominant in the most recent period.

In addition to technological developments, the visualization also demonstrates the emergence of keywords such as governance, policymaking, urban policy, communication, privacy, and social media, which have become increasingly interconnected within the research network. This indicates that Artificial Intelligence research in Smart Cities is evolving from a predominantly technological orientation toward the dimensions of digital communication and data-driven governmental governance. Overall, the results of the Overlay Visualization reveal a shift in research trends toward a more multidimensional approach that integrates technological aspects, governance, digital security, and public communication within Smart City ecosystems.

### 3.7 Density Visualization

Density Visualization illustrates the level of density and intensity of keyword occurrences in Artificial Intelligence and Smart Cities research during the 2016–2024 period.



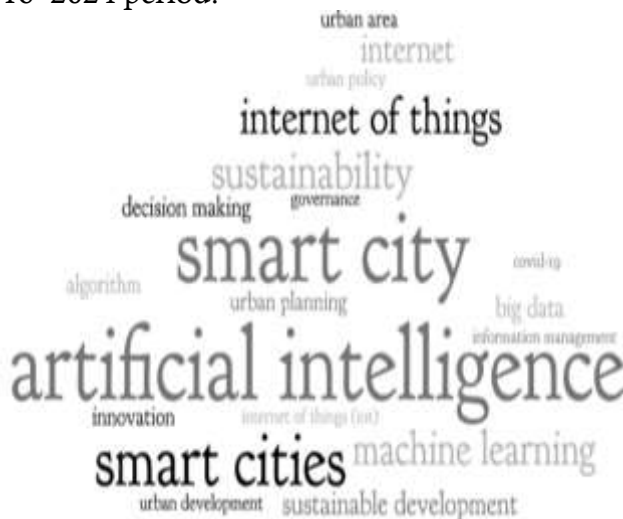
**Figure 7.** Density Visualization of AI and Smart City Research  
*Source:* Authors' analysis based on Scopus database using VOSviewer.

The figure presents the results of the Density Visualization of Artificial Intelligence and Smart Cities research during the 2016–2024 period using VOSviewer. This visualization illustrates the density level of keyword occurrences within the research network, where yellow indicates themes with the highest occurrence intensity, while green and blue represent themes with lower levels of occurrence. The keywords “artificial intelligence” and “smart cities” appear as the central nodes with the highest density within the research network, indicating the dominance of these themes in the development of the Artificial Intelligence and Smart Cities literature.

In addition to technological themes such as machine learning, Big Data, deep learning, and cybersecurity, the visualization also demonstrates interconnections with keywords such as communication, governance, urban policy, privacy, and social media within the research network. The emergence of these keywords indicates that Artificial Intelligence research in Smart Cities is evolving toward the dimensions of digital communication and data-driven governmental governance. The interrelationship between Artificial Intelligence, communication, and governance reflects increasing attention to the transformation of interactions between governments and communities through digital platforms, intelligent information systems, and data management within modern urban ecosystems.

### 3.8 Word Cloud Analysis

Word Cloud Analysis illustrates the dominance and frequency of word occurrences in Artificial Intelligence and Smart Cities research during the 2016–2024 period.



**Figure 8.** Word Cloud Analysis of and Smart City Research  
*Source: Authors’ analysis based on Scopus database using RStudio.*

The figure presents the results of the Word Cloud Analysis of Artificial Intelligence and Smart Cities research during the 2016–2024 period. The visualization indicates that the terms “artificial intelligence,” “smart city,” and “smart cities” are the most dominant words, appearing in the largest font sizes compared to other terms. In addition, several other frequently occurring terms include “internet of things,” “machine learning,” “sustainability,” “big data,” and “sustainable development.”

The emergence of terms such as “governance,” “decision making,” “urban policy,” and “information management” indicates that Artificial Intelligence research in Smart Cities is not solely focused on technological aspects, but has also begun to expand toward the dimensions of digital communication and governmental governance. Furthermore, terms such as “urban planning,” “innovation,” and “urban development” demonstrate the relationship between Artificial Intelligence and the development of policies and the transformation of modern urban systems.

### 3.9 Thematic Synthesis of Artificial Intelligence and Smart Cities Research

Thematic synthesis illustrates the clustering of major themes and the research structure within Artificial Intelligence and Smart Cities studies based on the thematic interpretation of bibliometric analysis results during the 2016–2024 period.

**Table 3.** Research Clusters of Artificial Intelligence and Smart Cities

Research Cluster	Main Themes	Representative Studies
Technological Infrastructure	IoT, Big Data, Machine Learning, Smart Home, Automation	(Ahad et al., 2020; Heidari et al., 2022; Moustafa, 2021; Yang & Cho, 2016).
Sustainability and Smart Environment	Sustainability, Energy Efficiency, Green AI, Sustainable Development	(Allam and Dhunny 2019; Ghadami et al. 2021; Xia, Semirumi, and Rezaei 2023; Yigitcanlar, Kankanamge, and Vella 2021).
Governance and Public Communication	Governance, Urban Policy, Decision Making, Communication	(Bokhari and Myeong 2022; Braun et al. 2018; Casares 2018; Filiou, Kesidou, and Wu 2023; Louati et al. 2024).

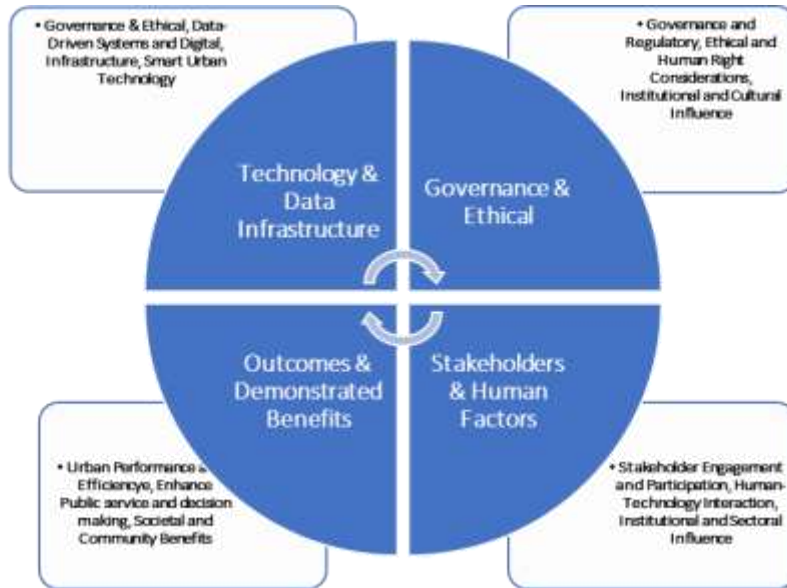
Research Cluster	Main Themes	Representative Studies
Security and Privacy	Cybersecurity, Blockchain, Data Privacy, Federated Learning	(Dong, Wang, and Han 2024; Moustafa 2021; Ramu et al. 2022; Singh et al. 2020) (Allam et al. 2022; Bokhari and Myeong 2022; Louati et al. 2024; Yigitcanlar, Kankanamge, and Vella 2021)
Human-Centered Smart Cities	Ethics, Participation, Social Innovation, Human-Centered AI	(Allam et al. 2022; Bokhari and Myeong 2022; Louati et al. 2024; Yigitcanlar, Kankanamge, and Vella 2021)

The table shows that artificial intelligence and smart cities research during the 2016–2024 period can be classified into five major research clusters: Technological Infrastructure, Sustainability and Smart Environment, Governance and Public Communication, Security and privacy, and human-centered smart cities. The Technological Infrastructure cluster is dominated by themes such as the Internet of Things (IoT), big data, machine learning, smart homes, and automation, which focus on the development of digital infrastructure and intelligent urban systems. Meanwhile, the Sustainability and Smart Environment cluster demonstrates the relationship between AI and sustainability, green AI, energy efficiency, and sustainable development in supporting the development of sustainable smart cities.

The Governance and Public Communication cluster demonstrates the growing body of research related to governance, urban policy, decision-making, and communication within AI-based smart city governance. In addition, the Security and Privacy cluster highlights themes such as cybersecurity, blockchain, data privacy, and federated learning, which are associated with security and data protection in digital urban systems. Meanwhile, the human-centered smart cities cluster reflects increasing research attention toward ethics, participation, social innovation, and human-centered AI in the development of more participatory and community-oriented smart cities.

### 3.9 Conceptual Synthesis of AI Governance in Smart Cities

Conceptual synthesis is the process of integrating various research findings, themes, concepts, and patterns into a more structured and comprehensive conceptual framework or model.



**Figure 9.** Conceptual Framework of AI Governance and Public Communication in Smart Cities

**Source:** Authors' conceptual framework derived from thematic synthesis and bibliometric analysis of Scopus data.

Figure 9 presents the results of the conceptual synthesis regarding the development of Artificial Intelligence (AI) in Smart Cities based on the integration of bibliometric findings during the 2014–2024 period. This framework demonstrates that the development of AI in Smart Cities is shaped through the interconnection of four major dimensions: Technology and Data Infrastructure, Governance and Ethics, Stakeholders and Human Factors, and Outcomes and Demonstrated Benefits. These four dimensions are interconnected and collectively form a digital governance ecosystem that supports AI-driven Smart City transformation.

The Technology and Data Infrastructure dimension demonstrates that the development of Smart Cities is supported by the integration of AI, Big Data, data-driven systems, and smart urban technologies as the primary foundation for data-based urban management. Within this dimension, technology is not only utilized to enhance the efficiency of urban systems but also serves as a key instrument in supporting digital decision-making, urban monitoring, and the integration of AI-based public services.

Furthermore, the Governance and Ethical dimension demonstrates that the implementation of AI in Smart Cities requires governance frameworks that consider aspects of regulation, ethics, digital rights, as well as institutional and cultural influences. The emergence of this dimension

indicates that the development of AI is no longer understood merely as a technological innovation, but is also closely associated with issues of governance, transparency, data security, and the protection of public rights within urban digital spaces.

Within the Stakeholders and Human Factors dimension, the framework highlights the importance of social actor involvement in the implementation of AI-based Smart Cities. This dimension encompasses stakeholder engagement, community participation, human–technology interaction, and institutional influences in the development of urban digital governance. These findings indicate that the successful implementation of AI in Smart Cities is influenced by the relationship among governments, communities, the private sector, and technology in building more participatory and responsive urban systems.

Meanwhile, the Outcomes and Demonstrated Benefits dimension demonstrates that the implementation of AI is directed toward enhancing urban performance, public service efficiency, data-driven decision-making, as well as social and community benefits within Smart City ecosystems. This dimension indicates that the use of AI is not solely oriented toward technological automation, but also toward improving the quality of life of urban communities and the effectiveness of urban governance.

## **4. Discussion**

### **4.1 The development and transformation of artificial intelligence research in smart city**

Based on the publication-by-year analysis, the development of artificial intelligence (AI) research in smart cities has shown significant growth since 2016. During the initial stage, research primarily focused on the development of smart homes through intelligent agent systems designed to enhance the efficiency and convenience of AI-based domestic environments (Yang & Cho, 2016). However, the advancement of digital technologies and the increasing complexity of urban governance have driven the transformation of research toward the application of AI in broader urban management systems.

Since 2018, research has increasingly integrated artificial intelligence (AI) with the Internet of Things (IoT), big data, and digital governance to support more adaptive and responsive urban systems. (Braun et al. 2018; Casares 2018; Chatterjee, Kar, and Gupta 2018). This shift indicates that smart cities are no longer understood merely as technological modernization projects but also as part of broader transformations in governance and sustainability within urban management. Research conducted between 2019 and 2024 further reinforced this orientation through discussions on the Sustainable

Development Goals (SDGs), green AI, energy efficiency, digital twins, and institutional readiness in Smart Cities (Allam & Dhunny, 2019; Dong et al., 2024; Yigitcanlar, 2021). This condition confirms that “This indicates a transformation of smart cities toward the integration of social, ecological, and governance dimensions.”

In addition, the development of publications also demonstrates how AI has increasingly been positioned as an urban management system that supports data-driven decision-making, predictive analytics, and the automation of public services. The integration of AI with predictive systems, smart mobility, and digital infrastructure indicates that the development of Smart Cities is evolving toward a more adaptive, efficient, and sustainability-oriented model of urban governance (Jamarani et al. 2024; Ramu et al. 2022).

#### **4.2 Paradigm Shift from Techno-Centric toward Human-Centered Smart Cities**

Techno-centric smart cities refer to an approach that positions technology as the primary solution for addressing various urban problems through automation, data integration, and the optimization of digital systems. In contrast, human-centered smart cities emphasize people, public participation, ethics, sustainability, and social interaction as the central focus of urban digital transformation (Alizadeh and Sharifi 2023; Hu, Wang, and Zhai 2023).

Based on the results of the Network Visualization, Word Cloud, and Overlay Visualization analyses, Smart City research has experienced a paradigm shift from techno-centric toward human-centered Smart Cities. During the initial phase, research was dominated by technical issues such as machine learning, IoT, Big Data, and data analytics. However, recent developments indicate increasing attention toward governance, privacy, surveillance, citizen participation, sustainability, and human–technology interaction.

Figure 5 demonstrates that issues of governance and sustainability have become important components within the knowledge structure of Smart Cities. This indicates that the development of smart cities is no longer solely oriented toward technological efficiency, but also toward how technology is utilized to create urban governance systems that are inclusive and responsive to societal needs (Sha and Taeihagh 2024). Furthermore, the emergence of themes such as privacy and surveillance reflects increasing attention to the social and ethical implications of AI implementation within digital urban spaces (Biesaga et al. 2023; Chen et al. 2024).

The word cloud in Figure 6 demonstrates that the interconnection between AI, smart cities, and IoT has become increasingly linked with

themes of governance, sustainability, and social dimensions. This condition indicates that Smart City development is moving toward a multidisciplinary integration that places humans at the center of urban digital transformation. The overlay visualization in Figure 7 also reveals that more recent topics are increasingly associated with sustainability, cybersecurity, and human-centered governance rather than merely technological automation. Therefore, this study confirms that “research on smart cities is not solely oriented toward technological development, but also positions AI as a strategic instrument for creating urban governance.”

#### **4.3 Artificial Intelligence as the Foundation of Smart City Governance**

The results presented in Figure 3, Figure 7, and Figure 9 demonstrate that AI is increasingly developing as a fundamental foundation of Smart City governance. The integration of AI with digital twins, predictive systems, and Big Data analytics illustrates how these technologies are utilized to support real-time data-driven decision-making in urban management (Kahawala et al. 2024; Ramu et al. 2022).

Figure 7 demonstrates that the development of AI in Smart Cities has strong relationships with machine learning, deep learning, monitoring systems, and sustainability. This indicates that AI functions not only as an automation tool, but also as a predictive system that supports adaptive governance across various urban sectors, including transportation, energy, security, and public services (Hammoumi, Maanan, and Rhinane 2024; Heidari, Navimipour, and Unal 2022). In this context, “AI is increasingly positioned as a cognitive decision-making system within Smart City ecosystems.”

Furthermore, Figure 9 demonstrates that the implementation of AI in Smart Cities requires the integration of technology and data infrastructure, governance and ethical considerations, stakeholder engagement, as well as outcomes and demonstrated benefits. This indicates that the success of AI governance is determined not only by technological readiness but also by institutional readiness, regulatory frameworks, and the capacity of governments to manage sustainable urban digital transformation.

#### **4.4 Sustainability and Urban Intelligence in Smart City Development**

Based on Figure 3, Figure 5, and Table 2, sustainability has become one of the primary orientations in the development of AI and Smart Cities research. Various studies position AI as an important instrument for supporting the Sustainable Development Goals (SDGs), green development, energy efficiency, and sustainable urban systems (Ahad et al. 2020; Allam and Dhunny 2019).

Figure 5 demonstrates a strong interconnection between AI, sustainability, climate change mitigation, and environmentally friendly

urban resource management. This condition reflects a “research tendency to integrate smart technologies to support energy efficiency, climate change mitigation, and environmentally friendly urban resource management.” Studies from China also demonstrate how AI is utilized for green growth, carbon emission prediction, and urban sustainability through data-driven approaches. (Dong, Wang, and Han 2024; Zhong et al. 2024).

Furthermore, Table 2 shows that the most highly cited articles predominantly discuss sustainable smart cities, green AI, blockchain, and the integration of Big Data in urban management (Ding et al. 2022; Yigitcanlar et al. 2021). This indicates that sustainability has become an integral component of AI-based urban intelligence development. Consequently, Smart City research is not only oriented toward technological efficiency, but also toward environmental sustainability, energy efficiency, and the quality of life of urban communities.

#### **4.5 Governance, Ethical, and Digital Security Challenges**

The development of AI in Smart Cities has also introduced various challenges related to governance, ethics, and digital security. Based on Figures 5, 7, and 8, issues such as privacy, surveillance, cybersecurity, algorithmic bias, and social inequality have become increasingly dominant themes in the development of Smart City research.

Figure 5 demonstrates that privacy and surveillance have become important components within the research structure of Smart Cities, particularly in relation to the use of facial recognition, data monitoring, and digital surveillance in public spaces (Chen et al. 2024; Mobilio 2023). Meanwhile, Figure 7 illustrates increasing attention toward cybersecurity and data security as consequences of the growing use of AI and IoT within digital urban systems (Braun et al., 2018; Xia et al., 2023).

Figure 8 also reveals the existence of research gaps related to urban social justice, algorithmic bias, and participatory governance (Bradley 2022; McCrory 2024) This indicates that the implementation of AI has the potential to exacerbate social inequalities if it is not accompanied by inclusive regulations and governance frameworks. Therefore, this study confirms that “the implementation of AI in smart cities cannot be separated from regulatory, ethical, and environmental sustainability considerations.”

Accordingly, the development of Smart Cities requires governance frameworks capable of maintaining a balance between technological innovation, the protection of public rights, and social justice.

#### **4.6 Multidisciplinary Evolution in Smart City Research**

Based on Figures 4 and 5, Smart City research has evolved toward a multidisciplinary approach that integrates technological aspects, governance, sustainability, urban policy, and social dimensions. This

development is reflected in the contributions of leading authors who discuss AI not only from a technical perspective, but also from social, ethical, and urban governance perspectives.

The contributions of Allam, Bibri, and Cugurullo demonstrate that the development of Smart Cities has increasingly shifted toward discussions on surveillance capitalism, adaptive governance, urban autonomy, and the interaction between humans and technology within urban digital spaces (Bibri and Allam 2022; Cugurullo 2020). Furthermore, Figure 5 demonstrates the interconnection between governance, sustainability, and policy-oriented research, which has become increasingly dominant within the research structure of Smart Cities.

This condition indicates that “smart city research has evolved into a multidisciplinary field that integrates technological, social, environmental, and policy perspectives.” Consequently, Smart City research is no longer limited to the development of digital infrastructure, but also encompasses social, political, cultural, and sustainability dimensions within AI-driven urban transformation.

#### **4.7 Global Inequalities in the Development of AI and Smart Cities**

Figure 3 demonstrates the existence of global inequalities in the development of AI and Smart Cities research, which is dominated by countries with high levels of digital capacity and institutional readiness. The United States emerged as the largest contributor, with research focusing on governance, digital twins, public trust, and AI-driven public governance (Hartley and Aldag 2024; Yigitcanlar et al. 2024).

China demonstrates a strong research orientation toward green AI, carbon emissions, and sustainable urban transformation through data-driven approaches and AI-driven green development (Dong, Wang, and Han 2024; Zhong et al. 2024). Meanwhile, Saudi Arabia places greater emphasis on the integration of socio-cultural values in Smart City development, including smart campuses and socio-cultural sustainability (Sepehri et al. 2024). India tends to focus on e-governance, smart water management, road safety, and AIoT-based public service innovation (Jagatheesaperumal et al. 2024; Kuberkar, Singh, and Singhal 2024).

These differences in research orientation indicate that Smart City development is strongly influenced by each country’s digital capacity, policy direction, and social needs. Developed countries tend to possess greater capacity in the development of AI governance and digital infrastructure, whereas developing countries continue to face challenges related to institutional readiness, regulatory frameworks, and equitable access to technology.

#### **4.8 Research Gaps and Future Agenda**

Based on Figure 8, AI and Smart Cities research still demonstrates several research gaps that require further development. One of the major gaps is the limited amount of research related to urban social justice, algorithmic bias, and the impact of AI on vulnerable social groups. These issues are important to ensure that the implementation of Smart Cities does not exacerbate social inequalities within urban digital spaces.

Furthermore, participatory governance and digital democracy have not yet emerged as dominant themes within the research structure of Smart Cities. This condition indicates that the use of AI is still more frequently directed toward improving administrative efficiency rather than strengthening public participation in urban decision-making processes. Research related to AI ethics, co-creation, and human-centered governance also remains relatively limited compared to themes associated with technology and digital infrastructure.

Therefore, future research agendas need to expand their focus toward ethical dimensions, public participation, and social justice in the implementation of Smart Cities. The development of more inclusive AI governance is essential to ensure that “smart city development becomes more holistic and inclusive.” Accordingly, future directions in Smart City research should position human-centered approaches, digital democracy, and social sustainability as fundamental components of AI-driven urban transformation.

#### **4.9 Conceptual Implications of AI Governance in Smart Cities**

Based on Figure 9, this study demonstrates that AI governance in Smart Cities is shaped through the interrelationship between technology, governance, stakeholders, and outcomes. The conceptual framework illustrates that the implementation of AI cannot be understood solely from a technological perspective, but must also be viewed as a system involving regulation, social interaction, and the objectives of sustainable urban development

The technology and data infrastructure component demonstrates that AI, Big Data, digital twins, and smart urban technologies constitute the primary foundation for supporting data-driven urban management. However, the success of their implementation is strongly influenced by governance and ethical considerations, including regulatory frameworks, digital rights, data security, and institutional influence. At the same time, stakeholder engagement and human–technology interaction indicate that communities, governments, and the private sector play important roles in determining the success of Smart City transformation.

Furthermore, the outcomes and demonstrated benefits component demonstrates that the implementation of AI is directed toward improving

public service efficiency, energy optimization, security, and the quality of life of urban communities. Accordingly, this framework illustrates the interrelationships among themes and categories within Smart City research, while also emphasizing that AI governance must be developed through an integrative approach that connects technology, governance, social actors, and the objectives of urban sustainability.

## **5. Conclusion**

This study demonstrates that the development of Artificial Intelligence (AI) research in Smart Cities during the 2016–2024 period reflects a significant transformation from techno-centric approaches toward more human-centered urban governance. AI is no longer positioned solely as a technological instrument for automation and infrastructure optimization, but increasingly as part of a broader governance ecosystem that integrates sustainability, ethics, digital security, public communication, and citizen participation. The bibliometric findings indicate that themes such as governance, privacy, cybersecurity, urban policy, and sustainability have become increasingly interconnected within Smart City research, reflecting the growing complexity of AI-driven urban transformation.

Conceptually, this study contributes to the Smart City literature by proposing an integrative framework of AI Governance and Public Communication in Smart Cities. The framework highlights the interrelationship between technology and data infrastructure, governance and ethical considerations, stakeholder engagement, and urban outcomes within AI-based Smart City ecosystems. These findings confirm that the success of Smart Cities is not determined solely by technological readiness, but also by institutional capacity, adaptive governance, regulatory frameworks, and inclusive public participation. In this context, AI governance should be understood as a socio-technical process that requires a balance between innovation, public accountability, and social sustainability.

This study also provides practical implications for policymakers and urban institutions. The increasing integration of AI into urban governance creates opportunities to improve public service efficiency, data-driven decision-making, and sustainable urban management. However, it simultaneously raises challenges related to surveillance, algorithmic bias, cybersecurity, digital inequality, and the protection of public rights. Therefore, the implementation of AI in Smart Cities requires governance frameworks that are transparent, ethical, participatory, and socially inclusive to ensure that technological transformation does not exacerbate urban inequalities.

Nevertheless, this study is limited by its reliance on Scopus-indexed English-language publications within the Social Sciences field. Future research should expand the analysis through multidatabase approaches and empirical studies that explore AI governance, digital democracy, participatory governance, and urban social justice in different regional and institutional contexts. Such efforts are important for developing a more inclusive and sustainable understanding of AI-driven Smart City transformation.

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