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# Social smart city research: interconnections between participatory governance, data privacy, artificial intelligence and ethical sustainable development

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Social aspects constitute both concerns and opportunities in smart city development, as evidenced by a rapidly increasing body of research. This article presents the first-ever review of all the existing research on social focus in smart cities, delineating the distribution of topics, knowledge bases, and research frontiers that constitute the existing body of knowledge. A bibliometric review was performed to pinpoint publication trends, influential authors, their institutions, and prevalent subject areas within the literature since 2000. Using the Web of Science database, an amalgamation of major indexes (SCI-EXPANDED, SSCI, AHCI, ESCI) were applied to consider the research pattern and citation impact in different disciplines. 1,030 selected articles were subjected to bibliometric mapping using VOSviewer. The results show an almost exponential growth in the number of publications from 2015 onwards. Four interconnected thematic clusters cropped up: (1) participatory governance, (2) data privacy and security, (3) artificial intelligence and social media, and (4) ethics and sustainable development. A deeper analysis of key terms used in recent research revealed the following hot topics: (1) governance and citizen participation, (2) artificial intelligence technologies such as machine learning, (3) blockchain, and (4) Internet of Things. Co-authorship and geographical analyses underpin a solid international collaboration for leading institutions. The results underscore the rising significance of social smart city research by emphasizing the interconnectedness of governance, technology, citizen engagement, and ethics for a comprehensive approach to smart city initiatives. Furthermore, they recommend integrating social equity into these frameworks and enhancing geographic studies through greater international collaboration.

## KEYWORDS

bibliometric analysis, interdisciplinary collaboration, smart cities, social research, VOSviewer

## 1 Introduction

The unprecedented urbanization in the 21st century has necessitated a critical reassessment of how cities are designed, managed, and experienced by their increasingly diverse populations. The data from 2020 reveals that urban population exceeds 4.4 billion, representing over 56% of the global population. Projections indicate that this percentage could rise to 68% by 2050

(United Nations, 2019), highlighting a dramatic shift towards urban living. This rapid increase in urban dwellers intensifies the pressures on existing infrastructure, challenging cities to accommodate growing transportation, housing, energy, and public service needs. Moreover, the surge in urban populations exacerbates critical issues concerning sustainability, governance, and social equity (Jiboye, 2011; Rice and Hancock, 2016). These challenges require urgent attention, as the strain on resources often leads to environmental degradation, decreased quality of life, and widening disparities among urban residents.

The “smart city” concept is a pivotal framework for rethinking urban life in response to these complex challenges. Smart cities leverage advanced information and communication technologies (ICT) and sophisticated data analytics to enhance urban living quality (Caragliu et al., 2011). These technologies enable more efficient management of city services (Marsal-Llacuna et al., 2015), improve connectivity, and provide real-time data, which can inform better decision-making processes (Albino et al., 2015). For instance, smart transportation systems can alleviate traffic congestion, while energy management solutions can optimize resource consumption, contributing to environmental sustainability and economic efficiency (Airaksinen et al., 2016).

Implementing smart technologies in urban settings signifies a complex evolution beyond simply upgrading physical infrastructure; it marks a fundamental shift in social interactions, participatory processes, and governance structures that form the basis of urban life (Caputo et al., 2023; Kitchin, 2014). As cities increasingly adopt these advanced technologies, it is crucial to intentionally embed social perspectives into the planning and execution of smart city initiatives (Carvalho, 2015). Neglecting this aspect can lead to the unintended consequence of turning technological advancements into tools that reinforce exclusion and marginalization instead of fostering genuine empowerment for all community members (Söderström, 2014).

Previous smart city research emphasizes social aspects, including opportunities related to governance, citizen engagement, education, and innovation, as evidenced by theory (Ahvenniemi et al., 2017) and practice (Ahvenniemi and Huovila, 2021). Recently, it was also suggested that social smart city research primarily relates to social media, social networks, social innovation, and social inclusion (Ebrahiem et al., 2024). More importantly, related research is dominated by studies addressing various risks, including the digital divide (Shayan et al., 2020), lack of inclusiveness (Makkonen and Inkinen, 2024), public acceptance (Mutambik, 2023), privacy concerns (Xia et al., 2023), cybersecurity threats (Kitchin and Dodge, 2019), and technocratic governance (Viitanen and Kingston, 2014) with risks of vendor lock-in (Komninos et al., 2013). The risk of the technocratic, top-down corporate model is that the needs of citizens and local communities are neglected (Kummitha and Crutzen, 2017; Townsend, 2013). Therefore, human needs must guide technology deployment so that technology does not become more important than related urban development needs (Huovila et al., 2019). Despite the wide variety of studies, the present research identifies a gap in research on the social aspects of smart cities (Colding et al., 2024), which this study aims to address.

Consequently, while the allure of advanced technology continues to dominate public discourse and policy agendas, it is essential to acknowledge that the quintessence of truly successful smart cities entails a steadfast commitment to prioritizing the social dimensions

of urban existence. This commitment encompasses a concerted effort to enhance inclusivity (Colding et al., 2024; Tekin and Dikmen, 2024), facilitate meaningful social participation (Levenda et al., 2020), and promote social equity (Buttazzoni et al., 2020). By doing so, smart city initiatives can avoid deepening existing socio-economic divides and work to bridge these gaps, fostering a more just and equitable urban environment for all inhabitants (Graham and Marvin, 2002). In this context, it becomes evident that the successful realization of smart cities requires an integrative approach that harmonizes technology with human experience and social dynamics, ultimately ensuring that technological progress uplifts and empowers communities rather than perpetuates disparities.

Such an approach recognizes that successful urban environments rely on cooperation between stakeholders—including government entities, the private sector, local communities, and academia—to realize the shared vision of equitable and sustainable urban spaces (Anthony, 2024; Rani et al., 2021). The smart city paradigm aims to create urban areas that are efficient and responsive and aligned with sustainability principles (Bibri, 2021; Yigitcanlar and Kamruzzaman, 2018) and social equity (Lee et al., 2023), ensuring a better quality of life for present and future inhabitants.

The imperative for comprehensively addressing the social dimensions inherent in the development of smart cities has emerged as a pressing concern for policymakers, urban planners, and community leaders alike, as articulated in Castelnovo et al. (2016). In this context, research emphasizing social perspectives illuminates the potential ramifications of emergent technologies on society's most vulnerable populations and advocates for an inclusive and participatory framework in urban development initiatives. This socially focused research can effectively foster a more equitable urban landscape by ensuring that no demographic is marginalized in the evolution of smart cities (Hunter et al., 2021). Moreover, a critical examination of urban experiences alongside the technological impacts on prevailing social structures underpins the interdisciplinary research that draws insights from social sciences, geography, and environmental studies, thereby enhancing our comprehension of the intricate dynamics among technology, society, and urban space as highlighted in Kandt and Batty (2021) and Sharifi et al. (2021).

Over the past 25 years, many studies have delved into different social facets of smart cities, scrutinizing how technological advancements influence urban social practices and governance frameworks, with significant contributions documented in Bibri and Krogstie (2020). Despite these significant strides in understanding the social implications of smart city development, a discernible gap persists in the form of a systematic review and comprehensive synthesis of the extant literature. The current scholarly discourse appears fragmented (Mora et al., 2017), with research outputs disseminated across diverse domains, such as urban studies, sociology, information systems, and public administration (Bibri, 2018). This fragmentation not only complicates the ability of stakeholders to navigate the expansive intellectual territory but also underscores the necessity of identifying which theories, methodologies, and empirical findings have exerted the most profound influence, thereby informing future research trajectories in this evolving field (Glanzel, 2003).

The primary objective of this study was to comprehensively delineate the existing social research on smart cities while simultaneously identifying the critical factors, including the distribution of topics, knowledge bases, and the research frontiers in

the field that constitute the existing body of knowledge as documented in Zhao et al. (2019). To achieve this aim, a bibliometric analysis was conducted, addressing several pivotal research questions essential for understanding the landscape of this evolving field. Specifically, the analysis investigated the trends in publication activity related to social focus in smart city research since 2000, thereby providing insights into the growth and development of this area of inquiry. Furthermore, this study identified the key authors and institutions that have significantly contributed to this body of literature, highlighting the collaborative networks and intellectual leadership that shape the discourse. In addition, the research explored the prevalent subject areas within the literature. It examined how these themes have evolved over time, offering a nuanced understanding of the shifting focus within the field. Finally, by identifying existing gaps in the current literature, this analysis proposed directions for future research, thereby contributing to advancing knowledge and formulating effective strategies for implementing socially-oriented smart city initiatives.

## 2 Materials and methods

This study presents a bibliometric review of smart city research from a social perspective, addressing its evolution, thematic focuses, dissemination patterns, significant works, authors, and relevant journals (Rejeb et al., 2022). A bibliometric review is a subset of systematic reviews (Hallinger and Kovačević, 2022). It is a quantitative method that uses statistical and mathematical tools to analyze bibliographic data from a large set of documents (Marvi and Foroudi, 2023; Mulay et al., 2020) to identify patterns, trends, and impact of major work within a certain field (Passas, 2024). It does not focus on the detailed examination of individual studies or the synthesis of research findings but rather on identifying patterns and trends in literature (Hallinger and Kovačević, 2022). This methodology shows the state of the art of the literature by using quantitative methods for exploring topics in the literature as a starting point for understanding the literature in depth and in more detail (Marvi and Foroudi, 2023). Thus, this study aimed to identify trends and patterns in social smart city research, relationships among research constituents (authors, institutions, major works, thematic topics), and recommendations for future research, not to analyze individual studies.

We chose the Web of Science database for bibliometric analysis due to its reputation for quality indexing of peer-reviewed research, comprehensive bibliometric information that enhances analysis accuracy with tools like VOSviewer (RRID:SCR\_023516), and the substantial number of available publications on smart cities sufficient to achieve our research objectives (Sharifi et al., 2021). For this bibliometric analysis, we utilized four key indexes—SCI-EXPANDED, SSCI, A&HCI, and ESCI—to comprehensively examine research trends and citation impacts across a variety of scientific disciplines, including social science, arts, and humanities (Rejeb et al., 2022).

Inclusion and exclusion criteria were established to focus more on the subject and limit the data. A preliminary literature review was performed to carefully select the most relevant search terms for literature on social smart city research. The first criterion was the simultaneous presence of keywords along with the keyword “smart city,” which was only searched in the article titles using the Boolean operators “AND” and “OR.” For example, the command AND socia\* (Title) “smart cit\*” (Title) OR communit\* (Title) indicates that both

keywords “smart city” and “social” or “community” must be present in the article title to be selected. The asterisk “\*” at the end of keywords was used to ensure that all variations of the keywords could be included (Romanelli et al., 2021). For instance, instead of the term “smart city,” the term “smart cit\*” was used also to capture the concept of “smart cities.” The presence of the search terms in the article title was considered necessary to exclude articles that would be out of scope. Other criteria for selecting articles included the year of publication, language, and source type, meaning only articles published after 2000, published in English, and published as review and research articles were selected (Agarwal et al., 2016). Based on these criteria, sources published before 2000, those published in a language other than English, or those presented as books or reports were excluded. The literature search was performed on July 22, 2024. Ultimately, 1,030 articles were selected for analysis. The PRISMA flow diagram is included in Supplementary Figure S1.

After preparing the dataset, it was analyzed using VOSviewer, a software tool for constructing and visualizing bibliometric networks. This analysis aids in identifying the sections with the highest citations and can serve as a roadmap for future research (Pérez et al., 2020). Furthermore, changes in the number of publications over time indicate shifts in topics and new social smart city research issues, including subjects such as digital governance and the impact of big data on urban policy (Allam et al., 2022). The study also examined authorship patterns to determine which authors and institutions are most active in this area (Zhao et al., 2019). By mapping co-authorship networks, researchers can gain insights into the collaborative patterns within specific fields and the overall structure of academic relationships that drive knowledge development in areas such as smart cities (Bindu et al., 2019). This analysis, therefore, serves as a valuable tool for identifying key contributors, understanding collaborative dynamics, and assessing the growth and influence of research communities over time.

Analyzing citation relationships among leading publications provides a better understanding of the intellectual foundation of smart city research from a social perspective. It demonstrates which theories and methods have influenced this field (Mora et al., 2017). This citation network offers a history of intellectual growth and guides future researchers (Rossetto et al., 2018). Finally, we identified prominent journals active in this area to assist researchers in making a more significant impact on discussions on the social implications of smart urbanism (Bibri, 2020).

## 3 Bibliometric analysis of social smart city research

### 3.1 Evolution of social smart city research

Preliminary observations of publication trends reveal a notable increase in research output, particularly after 2015 (Figure 1). This aligns with the growing global discourse surrounding smart city initiatives and the enhanced funding from governmental and international organizations focused on urban innovation (Joss et al., 2019; Meijer and Bolívar, 2016).

In Europe, the smart city concept gained high importance in the policy context in 2012 when the EU launched a research and innovation funding program for smart cities and communities

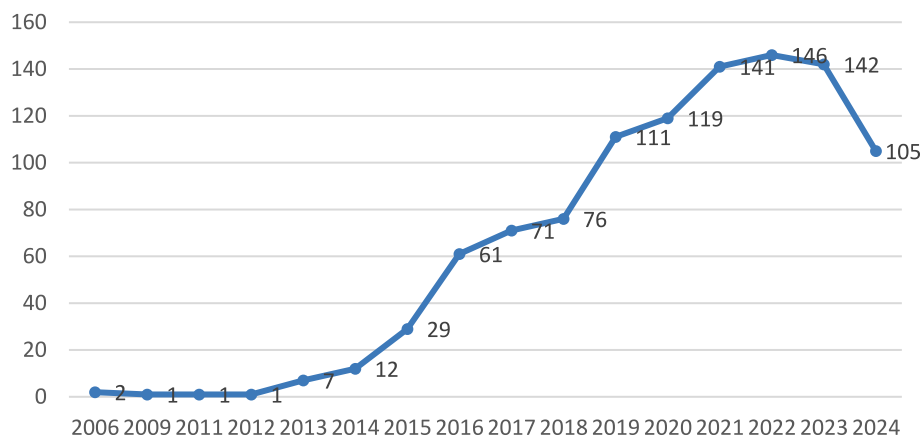


FIGURE 1  
The evolution of social focus in smart city research.

(European Commission, 2012). Since then, abundant funding has been awarded to European smart city research (Vanolo, 2014), which explains the increase in the number of related publications (Huovila, 2024). For example, the Smart City Lighthouse projects have demonstrated close-to-market smart city solutions in the real city environment of 48 frontrunner cities, received €420 million in co-funding since 2015 (European Commission, n.d.), and allegedly leveraged more than €1 billion associated urban investments (European Union, 2024). 2015 is also a significant milestone in relevant global policies, as the United Nations Sustainable Development Goals were launched in 2015 (UNSDG, 2015) and the New Urban Agenda in 2016 (United Nations, 2017).

A year-by-year analysis of publication volumes (Figure 1) shows that social research on smart cities has gained significant momentum, reflecting both heightened academic interest and practical relevance. Overall, the trend in article publication has been upward, although there have been periods of slight slowdown before renewed growth. For instance, between 2016 and 2018, the increase in publication volume was slower; however, this trend reversed in 2019, when 111 articles were published, marking a nearly 50 percent increase compared to the previous year. From 2016 to 2024, an average of 108 articles has been published annually. This growth in articles addressing the social dimensions of smart cities suggests that, over time, the challenges and social issues inherent in urban environments have become increasingly evident, prompting greater interdisciplinary attention to the field (Lytras and Visvizi, 2018; Zheng et al., 2020). Overall, the timeline of research output reflects a dynamic response to evolving urban challenges and the pressing need for innovative solutions within the context of smart city development.

## 3.2 Thematic focuses of social smart city research

### 3.2.1 Main themes

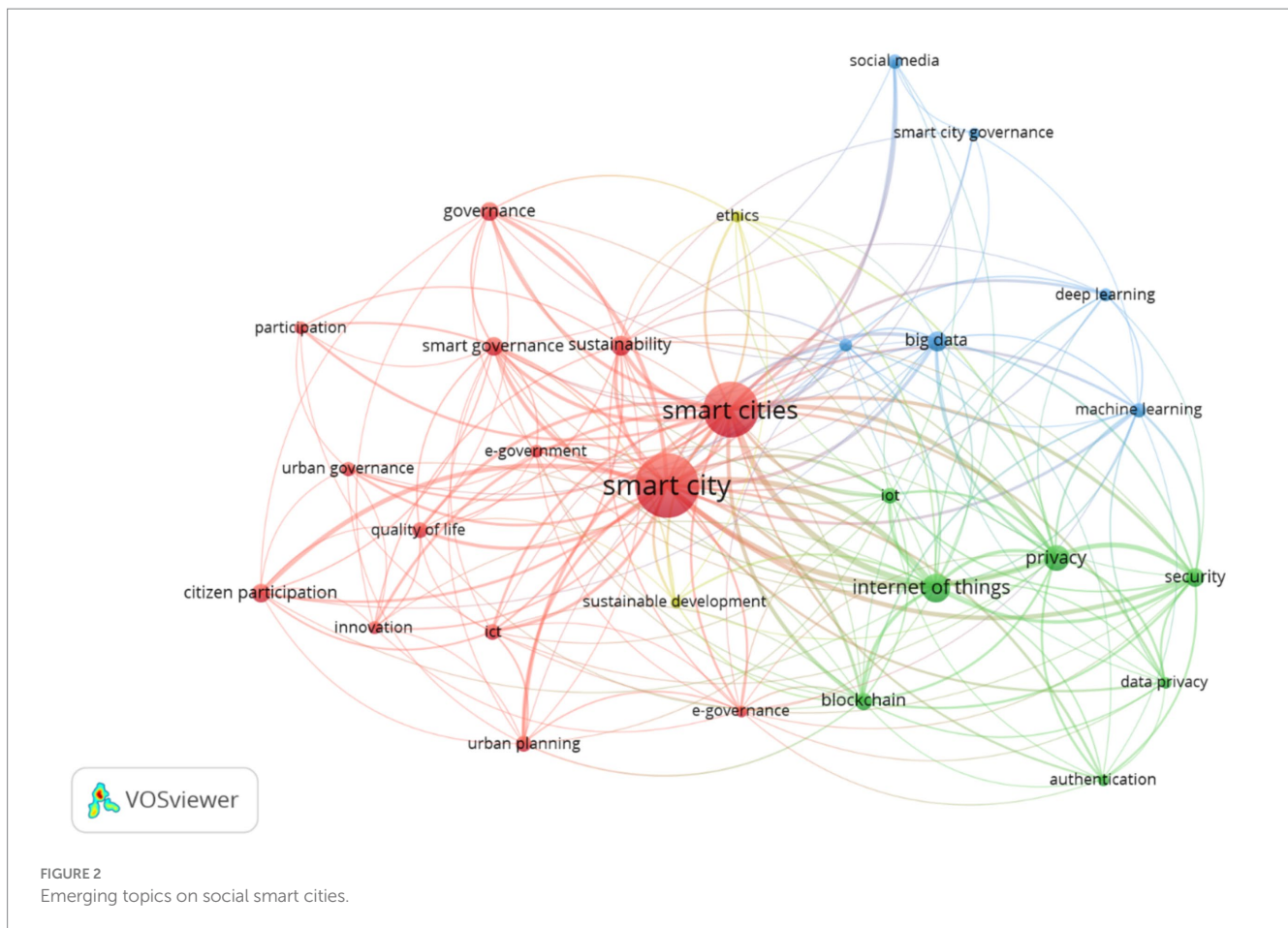
Identifying emerging themes was a central objective of the present study. Therefore, we analyzed keywords from authors that appeared at least ten times in the examined texts. The results of this analysis are

illustrated in Figure 2, revealing the discovered keywords organized into four distinct clusters.

The first cluster, marked in red, primarily focuses on the characteristics of “governance and management” in smart cities. Key concepts such as governance, management, sustainability, urban planning, and innovation are prevalent, reflecting smart city management practices. This cluster also highlights the theme of citizen participation, which exhibits 12 connections with other concepts, underscoring the significant role that citizen engagement plays in the urban governance system of smart cities. Furthermore, the theme of quality of life is also linked with 12 connections to other concepts, suggesting a close relationship between quality of life, governance, and citizen participation. This implies that effective management and governance strategies in smart cities must prioritize citizen involvement and enhance residents’ overall quality of life. Some examples of papers on this topic include studies on open data city dashboards that build transparency of local governance and decision-making and studies on tools engaging citizens in city planning, decision-making, and voting on new projects.

The second cluster, marked in green, centers around the interconnected themes of “security and communication technology.” The security theme encompasses critical concepts such as privacy, security, and authentication, while the communication technology theme includes concepts like the Internet of Things (IoT) and blockchain. The connection between these two themes indicates that attention to both IoT and blockchain technologies is essential for maintaining security and confidentiality in smart cities. This highlights the necessity for robust security measures in deploying smart technologies, ensuring that data privacy and protection are prioritized as cities become increasingly digitized.

The third cluster, marked in blue, presents concepts related to “information management,” emphasizing the crucial role of data management in smart city governance systems. The link between information management and governance suggests that effective governance relies heavily on efficiently collecting, analyzing, and utilizing data. This underscores the importance of establishing comprehensive data management frameworks that can support informed decision-making and enhance the operational efficiency of smart city initiatives.



Finally, the fourth cluster, marked in yellow, includes two concepts: ethics and sustainable development. Although this cluster is smaller, its concepts are interconnected with those in the other clusters, indicating that ethics and sustainable development can connect the other themes. This suggests that ethical considerations and a focus on sustainability are integral to the successful implementation of smart city initiatives, reinforcing the idea that technological advancements should align with ethical standards and contribute to sustainable urban development.

Overall, the analysis of these clusters highlights the emerging themes in smart city literature and underscores the complex interrelationships among governance, technology, citizen engagement, and ethical considerations. The findings from [Zheng et al. \(2020\)](#) in their scientometric review of smart city literature from 1990 to 2019 corroborate that these themes are critical for understanding the evolution and future directions of smart city research and implementation.

### 3.2.2 Emerging hot topics

Additionally, we wanted to identify topics that are becoming increasingly important in current social research on smart cities. Therefore, we examined keywords used in publications over the past 5 years. [Table 1](#) shows the top 10 most common keywords each year, excluding terms such as “smart city,” country names, and methods. To

compare key themes, we grouped different forms of the same word, synonyms, and similar words together.

The analysis presented in [Table 1](#) suggests that the hot topics in social research on smart cities include governance and citizen participation, privacy and security, AI technologies such as machine learning, blockchain, and the Internet of Things. This is logical as the increasing deployment of smart sensing technologies and AI applications raises substantial concerns about privacy, security, and individual freedoms.

### 3.3 Research collaboration

One of the analyses conducted in the present research is the mapping of co-authorship networks, which provides valuable insights into collaborative relationships within the academic community. In this context, a co-authorship network can be visualized as a graph where the nodes represent authors, organizations, or countries, and the adjacent positions symbolize co-authorship between them ([Savić et al., 2019](#)). The weight of these edges can indicate the number of joint publications or the strength of collaboration among authors.

[Figure 3](#) presents the co-authorship network, illustrating the connections among 31 authors forming seven clusters. This network comprises 69 links between authors, with an overall link strength of

TABLE 1 Emerging hot topics.

2020	Occurrences	2021	Occurrences	2022	Occurrences	2023	Occurrences	2024	Occurrences
Governance	20	Governance	19	Governance	25	Governance	27	Internet of things	18
Internet of Things	13	Privacy	15	Privacy	17	Privacy	17	Privacy	17
Citizen participation	12	Internet of Things	10	Internet of things	16	Sustainability	17	Sustainability	12
Privacy	8	Security	9	Machine learning	12	Internet of things	16	Blockchain	10
Blockchain	8	Citizen participation	7	Citizen participation	11	Security	9	Citizen participation	10
Data analytics	6	Artificial intelligence	6	Security	10	Artificial intelligence	7	Governance	10
Cyber-physical systems	5	Blockchain	6	Sustainability	8	Citizen participation	7	Artificial intelligence	7
Artificial intelligence	5	Urban planning	5	Artificial intelligence	7	Urban planning	5	Machine learning	7
Sustainability	5	Sustainability	5	Blockchain	6	Digital technologies	4	Social media	6
Public sector	5	Data management	5	Urban planning	5	Public policy	4	Security	5

73, signifying the degree of interconnectedness among the authors through collaborative publications. Each cluster represents a group of nodes (authors) that have established close connections (Anjum et al., 2020). In this figure, red, turquoise, orange, purple, olive, green, and blue represent clusters one to seven.

A notable aspect of this analysis is the identification of central nodes within each cluster; these authors play pivotal roles in their respective clusters. For instance, six connections exist among authors in cluster 1, marked in red, with Gabriela Pereira identified as a central figure. The central members of each cluster serve as crucial connecting points, facilitating collaboration among the authors within their cluster and enhancing connectivity between different clusters.

This structure highlights the importance of central authors in promoting intellectual exchange and cooperation within the network. Such central figures can influence research agendas and foster interdisciplinary collaborations, thereby contributing to the advancement of knowledge in smart city research. Literature on co-authorship networks indicates that these dynamics are vital for understanding the structure and evolution of scientific communities (Mali et al., 2012; Abbasi et al., 2011). Furthermore, the presence of central authors is often associated with higher productivity and impact within the field, underscoring the intertwined nature of collaboration, innovation, and scholarly output.

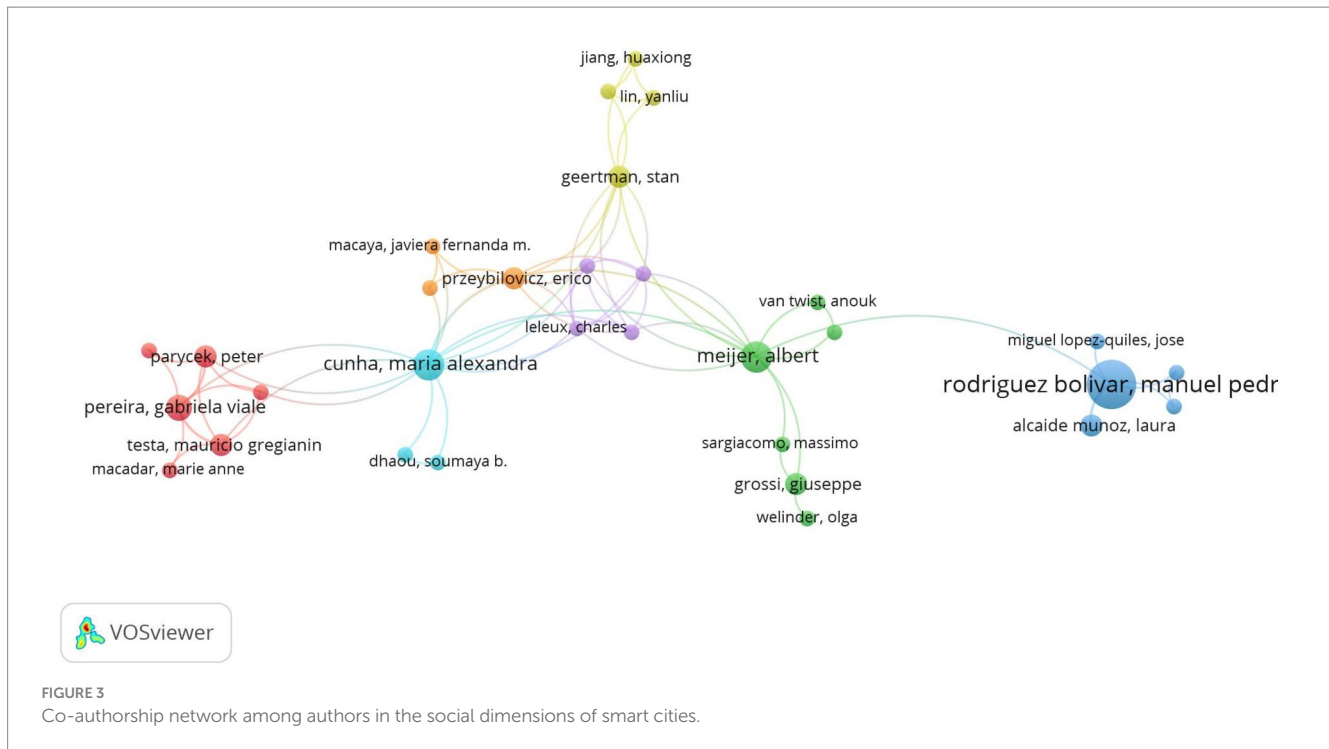
### 3.4 Influential authors

This study conducts a co-authorship analysis to identify key authors in the social smart city literature, examining three critical indices: the number of documents published, citation counts, and the strength of co-authorship links, as illustrated in Table 2.

This multifaceted approach provides a comprehensive perspective on each author's impact within the field. Manuel Pedro Rodriguez Bolivar is the most prolific contributor with ten articles, indicating his active engagement in social smart city research. Anna Visvizi has published six articles, while several authors, including Jesse M. Shapiro, Rob Kitchin, Jennifer Gabrys, Xiaohui Liang, and Dezhi Li, have authored five articles.

Regarding citation counts, Rodriguez Bolivar ranks among the top five authors alongside Albert Meijer, Jesse M. Shapiro, Rob Kitchin, and Jennifer Gabrys, underscoring their research's significant impact on the academic community. High citation counts signify that their work resonates with peers, shaping discussions and advancements in social smart cities. Additionally, the strength of co-authorship links reveals important collaborative dynamics within the discipline. Authors such as Dezhi Li, Mohammad R. Khosravi, Lianyong Qi, Kim-Kwang Raymond Choo, and Shenghua Zhou are instrumental in fostering partnerships that enhance the quality of research and collaboration among scholars. These collaborations enrich the research output and facilitate the exchange of ideas, contributing to the evolution of smart city studies.

These findings illustrate the competitive landscape of research output and collaboration among the main contributors in the social smart city domain and highlight the importance of individual and collaborative efforts in driving the smart city research agenda forward.



### 3.5 Institutional influence

Figure 4 presents a detailed overview of institutional participation in co-authorship within the context of research analyses. It ranks the top eight institutions based on the number of documents they have co-authored, illustrating the collaborative landscape of research on social smart cities. The emphasis on co-authoring reflects the growing recognition of the value of collaborative efforts among institutions, as such partnerships are known to foster diverse perspectives, enhance the quality of research, and generate more impactful findings (Yeo and Lewis, 2019).

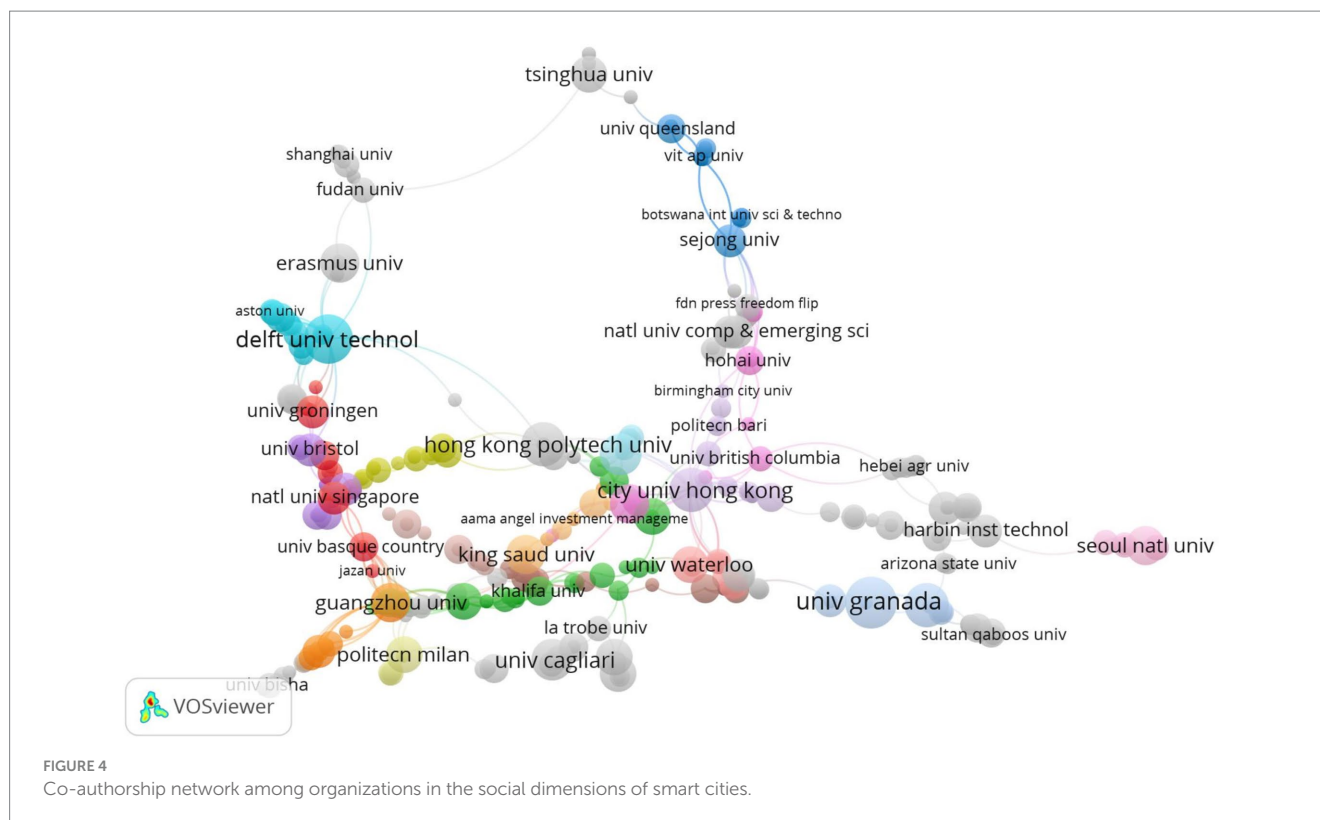
The figure highlights Granada University as the leading institution, with 12 documents attributed to its collaborative research efforts. However, it should be noted that this dominance is primarily affected by one prolific author, Manuel Pedro Rodríguez Bolívar, who, as mentioned earlier, is among the leaders of this field in studies related to the social dimensions of smart cities. Nevertheless, this finding indicates that Granada University plays a pivotal role in producing scholarly work, likely benefiting from a network of researchers that enhances its academic contributions.

Following closely, 11 documents are co-authored by scholars representing Delft University of Technology, which signifies considerable engagement in collaborative research initiatives. This suggests that Delft University is actively involved in interdisciplinary projects, contributing to a broader understanding of the smart city concept. In addition, authors from the City University of Hong Kong and Hong Kong Polytechnic University have each contributed to nine documents. Their involvement exemplifies these institutions' active role in fostering research partnerships, indicating a collective effort to advance knowledge in the smart city domain. Utrecht University and the University of Texas at San Antonio are noted for each contributing to eight documents.

### 3.6 Geographic analysis

The geographic co-authorship analysis presented in Figure 5 provides valuable insights into the collaborative landscape of academic authorship across different countries, revealing that authors from 80 countries have established connections through 419 links, indicating a significant level of international collaboration in research. These connections are organized into 16 distinct clusters, suggesting that certain groups of countries frequently collaborate. The total link strength of 768 reflects the intensity of collaboration among these countries, measuring the number and quality of collaborative interactions. The figure visually represents countries using circles, with larger circles indicating higher levels of co-authorship, allowing for quick identification of the most active nations in collaboration. Notably, the People's Republic of China leads the analysis with 182 documents published, 3,381 citations, and a total link strength of 149, indicating prolific output and significant recognition in the academic community. The USA ranks second with 123 documents, 4,532 citations, and a link strength of 128, suggesting that its works are highly regarded and influential. Spain follows in third place with 85 documents, 2,700 citations, and a link strength of 71, demonstrating a solid level of contribution and collaboration, albeit with fewer documents and citations than the top two countries.

Additionally, Table 3 complements the visual data by providing a detailed overview of the first 20 countries based on the number of documents, citations, and link strength, aiding in further analysis of each country's contributions and co-authorship dynamics. When interpreting these findings, it is essential to notice the differences in the population size and number of scholars in different countries. For example, among the top six countries, the population sizes of Spain, England, and Italy are tremendously smaller than those of China, the USA, or India, suggesting significantly smaller numbers of scholars



per country and, thus potentially, a more significant publication output per scholar in the smaller countries.

Another remark on the country distribution is that social research on smart cities has been primarily conducted in developed countries. This finding corroborates previous research that has claimed that the smart city concept is primarily relevant to developed countries without sufficient attention to the needs of the global South (Estevez et al., 2021). This finding points to a gap in research as developing countries could benefit from smart city approaches due to their quickly increasing urbanization rates and risks of disasters due to the effects of climate change. Some initiatives targeted at developing countries already exist (United Nations Centre for Regional Development, n.d.), and researchers and public organizations are encouraged to investigate further smart approaches to ensuring resilient, inclusive, and safe local communities.

### 3.7 Co-citation analysis

The co-citation analysis tool employed in this study reveals the intricate relationships among authors, sources, and references by examining co-citations within a defined body of literature (Boyack and Klavans, 2010). By establishing an entry criterion that required authors to have a minimum of 20 citations, the analysis focused on 134 influential authors, thereby enhancing the reliability of the results. This rigorous approach identified four distinct clusters, illustrating varying research themes and showcasing a substantial interrelationship among the cited authors with 6,989 lines of connection and a robust connection strength of 50,497 (see Figure 6). Notably, the analysis highlighted 12 authors with exceptionally high citation counts, including Kitchin, Caragliu, and Hollands, positioning them as key figures whose works have significantly resonated within the scholarly

community. This comprehensive co-citation analysis not only underscores the interconnectedness of researchers (Lazzeretti et al., 2017) in the field but also serves as a valuable guide for understanding the research landscape (Gurzki and Woisetschläger, 2017), identifying pivotal contributions (Ferreira et al., 2016), and directing future inquiries and collaborations (Trujillo and Long, 2018).

### 3.8 Source analysis

The co-citation analysis of sources in the social field of smart cities revealed that out of 17,568 potential sources, only 270 had at least 20 citations, highlighting a select group of influential works. The top ten sources identified are notable for their citation volume and interconnectivity, as indicated by link strength (see Table 4). Leading the list is the journal *Sustainability*, which addresses broad environmental, social, and economic issues. It has a significant citation count of 1,164 from 60 citing documents and a link strength of 285. Following closely is *Sustainable Cities and Society*, which focuses on urban sustainability with 30 documents and 914 citations, alongside *Cities*, which explores various urban aspects, garnering 1,023 citations across 25 documents. Other prominent journals include *IEEE Access*, *Technological Forecasting and Social Change*, and *Future Generation Computer Systems*, which emphasize technological innovations and their societal impacts. *Sensors*, *Government Information Quarterly*, *Journal of Urban Technology*, and *IEEE Internet of Things Journal* also contribute to the discourse on technological advancements, smart cities, and policy implications for a sustainable future. This analysis underscores the critical interplay between these sources in shaping the scholarly dialogue around sustainability and urban development.



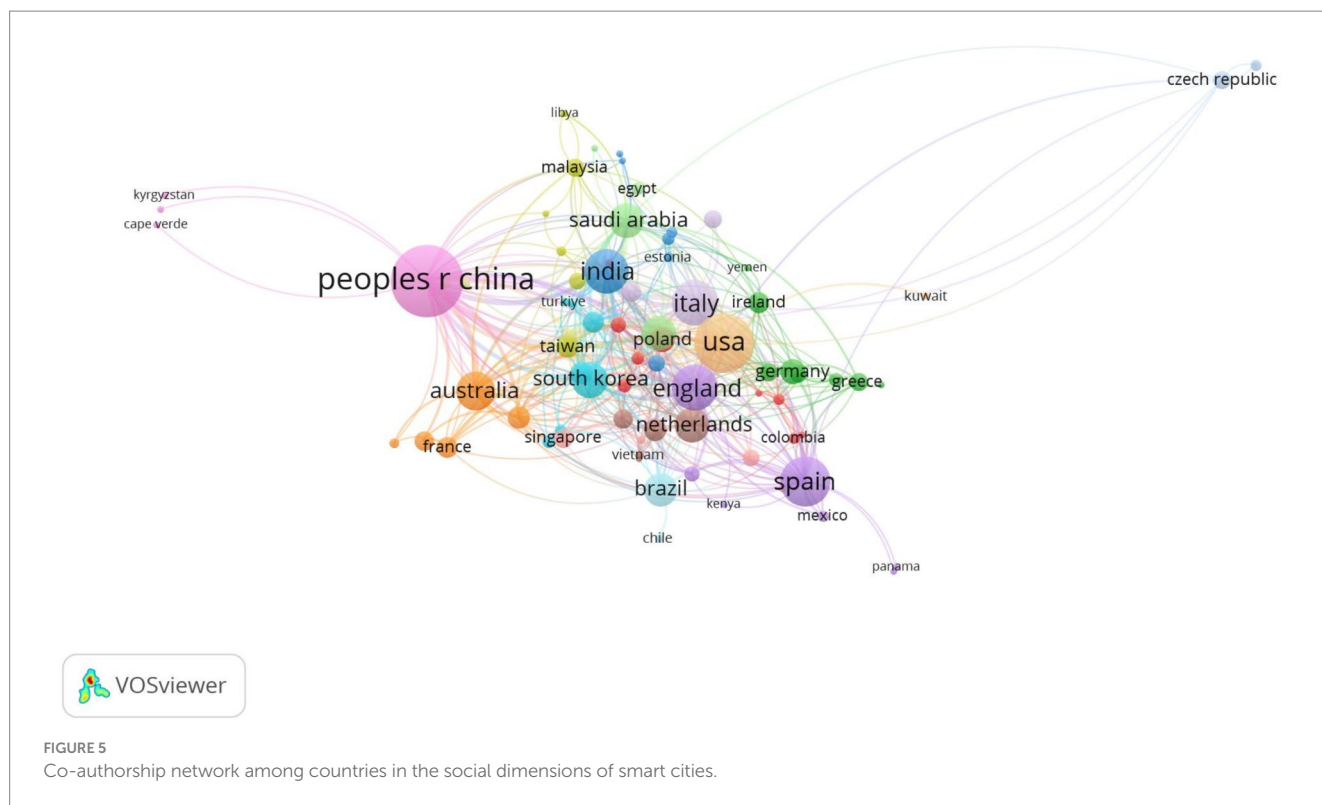


TABLE 2 Distribution of authors' status based on co-authorship indices.

Author	Documents	Author	Citations	Author	Total link strength
Rodriguez Bolivar, Manuel Pedro	10	Rodriguez Bolivar, Manuel Pedro	964	Li, Dezhi	21
Visvizi, Anna	6	Meijer, Albert	795	Khosravi, Mohammad R.	19
Garau, Chiara	5	Shapiro, Jesse M.	611	Qi, Lianyong	19
Kitchin, Rob	5	Kitchin, Rob	459	Choo, Kim-Kwang Raymond	18
Li, Dezhi	5	Gabrys, Jennifer	384	Zhou, Shenghua	17

### 3.9 Influential works

The co-citation analysis of references reveals significant insights regarding the scholarly landscape, identifying 71 influential works out of 34,436 cited references that meet the threshold of at least 20 citations. As illustrated in Figure 7, these essential references are organized into three distinct clusters, with 2,244 interconnections and an overall link strength of 10,941. The first cluster, marked in red, includes central publications such as Caragliu et al. (2011), with 116 citations, and Albino et al. (2015), with 108 citations, both from the Journal of Urban Technology, highlighting innovative urban solutions and the impact of technology on city development and definition of smart cities. The second cluster, displayed in green, features works like Hollands (2008), with 91 citations, and Kitchin (2014), with 73 citations, published in City and GeoJournal, which examine the socio-spatial dynamics and technological implications for urban life. Meanwhile, the third cluster, represented in blue, consists of references such as Neirotti et al. (2014), with 77 citations,

and Angelidou (2014), with 44 citations, both from Cities journal, discussing urban sustainability and the integration of smart technologies in urban management. These clusters showcase thematic concentrations within urban technology and sustainability and illustrate the interconnectedness of these scholarly works.

## 4 Discussion

The unprecedented pace of urbanization causes growing stress on infrastructure, sustainability, governance, and social equity, requiring urgent urban design and management rethinking. The smart city approach has created a constructive foundation for these challenges framed under one concept by incorporating emergent technologies that genuinely enrich urban livelihoods. Nevertheless, social views must be inculcated within smart city planning so as not to exacerbate existing inequalities technologically.

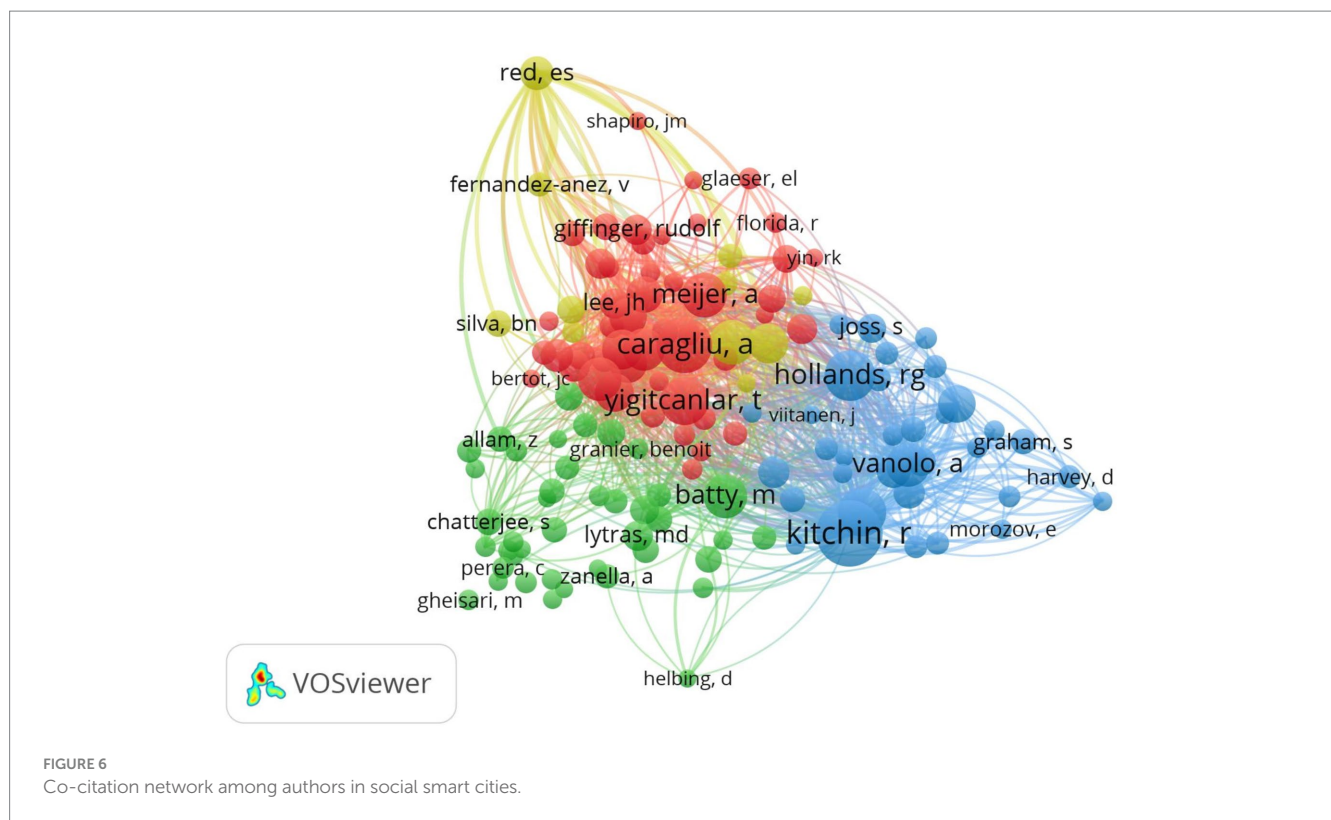


FIGURE 6 Co-citation network among authors in social smart cities.

This study systematically analyzed the social focus in smart city research, pinpointing key contributors, trends, and gaps in research that could guide future inquiry in the direction of collaboration among various stakeholders in fostering equitable and sustainable urban spaces that can empower all community members.

We analyzed the research patterns, citation impacts, and authorship dynamics using the Web of Science and other bibliometric tools. Identifying key authors and their affiliated institutions further emphasizes the nature of research collaboration that pervades this area. This implies that the approach to confronting the multidimensional challenges arising from urbanization and smart technologies must be interdisciplinary. Further, the citation network analysis explains which works have been most influential, how they have interacted with each other and formed a blueprint for future research. The quickly increasing number of publications demonstrates the growing importance of social aspects in smart cities, covering key topics such as digital governance and big data's impacts on urban policy. This research contributes to the theoretical foundations of the smart city concept. It opens a dialogue on the social value and risks of smart city projects to be carried by researchers, practitioners, and policymakers.

Preliminary observations about publication trends reveal a substantial increase in research output related to social smart cities, especially after 2015. This can be explained by increased public funding and international policies supporting smart city research, such as the launch of the Smart cities & communities program in Europe in 2014, the SDGs in 2015, and the New Urban Agenda in 2016. Janik et al. (2020) have reached a similar finding regarding smart and sustainable cities, showing that since 2015, the growth trend of articles in this field has gained significant momentum. This would hint that problems and social questions connected with urban

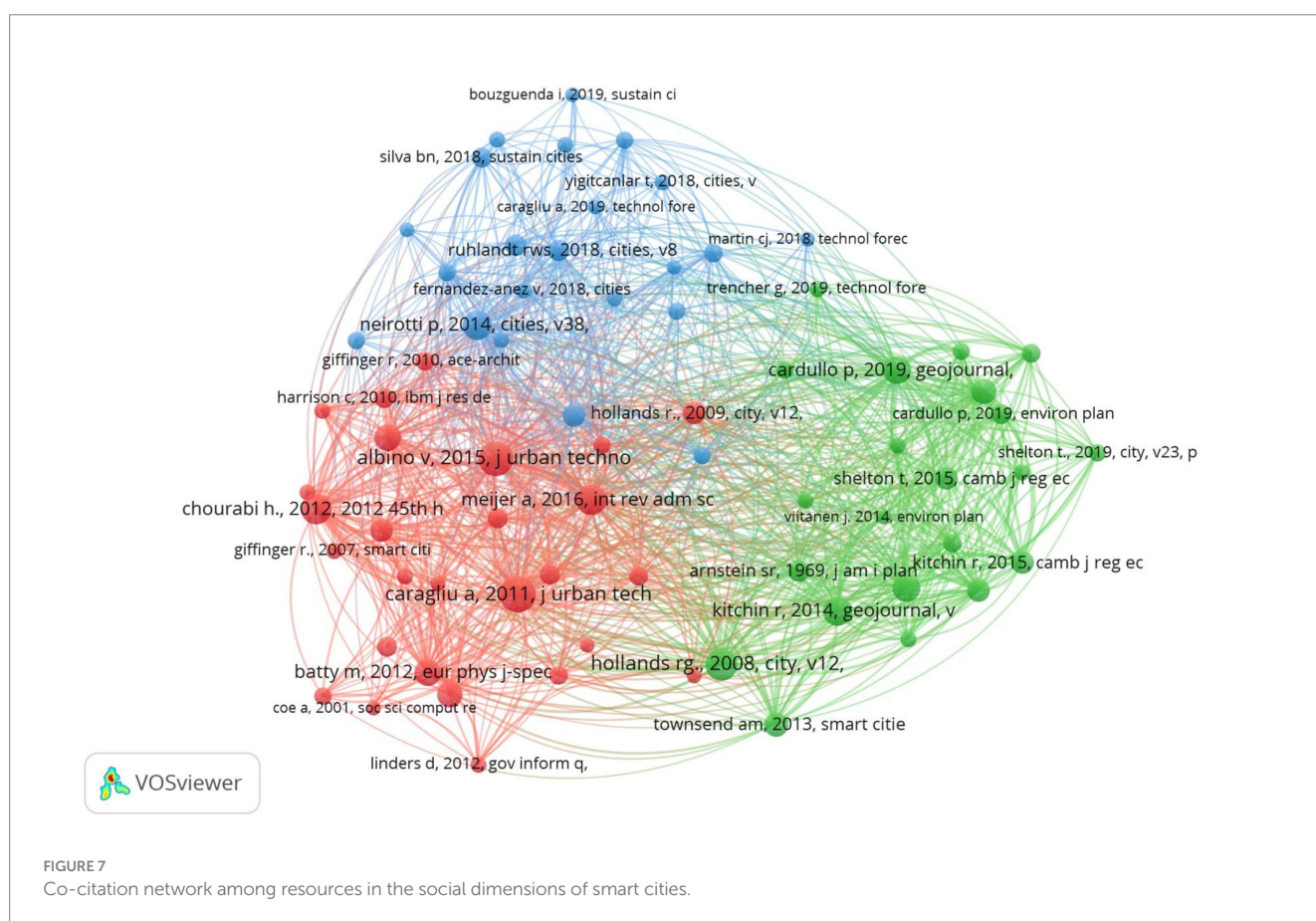
TABLE 3 Distribution of countries' status based on co-citation indices.

Countries	Documents	Citations	Total link strength
China	182	3,381	149
USA	123	4,532	128
Spain	85	2,700	71
England	74	2,518	88
Italy	72	2,006	84
India	70	1,385	77
Australia	52	1,540	59
South Korea	44	835	53
Canada	42	1,572	55
Saudi Arabia	42	555	56
Netherlands	41	2,245	38
Brazil	39	866	32
Germany	23	697	25
Poland	22	321	20
Iran	18	691	34
Taiwan	18	747	26
Portugal	17	227	15
United Arab Emirates	17	388	31
Ireland	16	839	16

environments have become more evident (Yli-Pelkonen and Niemelä, 2005; McHale et al., 2015). Therefore, the interest in studies in this subject area has grown correspondingly and become more

TABLE 4 Distribution of sources' status based on co-citation indices.

Source	Documents	Citations	Total link strength
Sustainability	60	1,164	285
Sustainable Cities and Societies	30	914	156
Cities	25	1,023	155
IEEE Access	25	721	52
Technological Forecasting and Social Change	16	1,191	160
Future Generation Computer Systems	13	486	10
Sensors	12	195	15
Government Information Quarterly	10	847	138
Journal of Urban Technology	10	225	53
IEEE Internet of Things Journal	9	352	9



interdisciplinary. Such ebbs and flows in publication rates signal broader socio-political dynamics, shifting funding priorities, emerging urban challenges, and the ever-changing face of smart city discourse. The renewed growth post-2018 would herald an academically responsive community ready and willing to meet the pressing needs of urbanization, technology integration, and social equity. Overall, the trend in research output evidences a vibrant response to dynamic urban challenges and underlines decisively that there is an imperative need for innovative responses placing technological development in a social perspective on smart city

development (Joss, 2017). It testifies not only to the commitment of the academic community to real-world issues but also to an opportunity for researchers, practitioners, and policymakers to collaborate on making smart city initiatives more effective and inclusive (Kogan and Lee, 2014; Sarker, 2022).

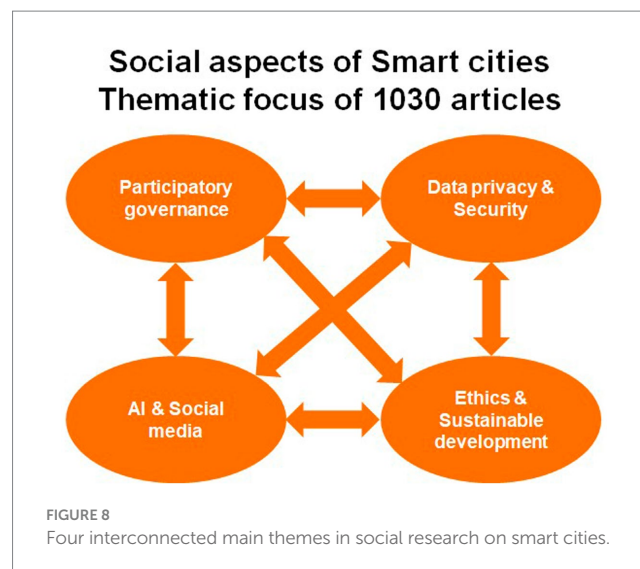
Results emerging from theme analysis of smart city literature indicate nuanced comprehension of the connectedly pertinent dimensions of shaping urban governance and development. Four clear-cut clusters are identified in several shades of variation within smart city research (see Figure 8).

The first cluster depicts the characteristics of management and governance. Governance, sustainability, and citizen participation are examples of keywords underpinning community involvement to enhance the quality of life. Therefore, the most efficient governance strategies should make provisions for citizens to become involved (Mora et al., 2023; Nastjuk et al., 2022). The second cluster points toward security and communication technology, finding the linkage between such critical concepts as privacy and the Internet of Things with the necessity of security in an urban setting that is becoming increasingly digitized (Medaglia and Serbanati, 2010; Sfar et al., 2018). The third cluster, on information management, integrates social media and big data with AI technologies such as machine learning and deep learning. It again illustrates that effective governance depends on effective data collection and analysis, calling for a meaningful data management framework to support informed decision-making (Provost and Fawcett, 2013; Pisa et al., 2020). Finally, the fourth but smallest cluster outpoints the integral role of ethics and sustainable development. It is suggested that ethical and sustainable development considerations should go hand in glove with technological advancements if urban growth is to be sustained (Chaudhary et al., 2024). In sum, such an analysis will not only reveal emerging themes in smart city literature but also detail how governance, technology, citizen engagement, and ethical considerations are interconnected and amplify the holistic approach imperative for smart city initiatives' future evolution and success.

Looking more deeply at research over the past 5 years, four emerging hot topics emerge: (1) governance and citizen participation, (2) AI technologies such as machine learning, (3) blockchain, and (4) the Internet of Things. Recently, also the concept of "societal smart city" was suggested, emphasizing social rights and democratic values with technological innovations, considering social sustainability, citizen-centeredness, e-democracy, social justice, participatory governance, and cultural resilience (Alizadeh and Sharifi, 2023). It should be noted that this study was a bibliometric review using a quantitative method to depict thematic focuses, research trends, and patterns from a large set of articles. Further qualitative reviews are recommended to understand related theories and methods that shape social smart city discourse.

Co-authorship in this paper gives insight into network analysis of collaborative dynamics that typify the academic community of smart city studies. The presence of links between 69 authors with a cumulative link strength of 73 indicates a strong connectedness among authors, facilitating healthy idea cross-pollination. In this respect, Gabriela Pereira is a central author who has enabled collaboration within the cluster and with other network members. Centrality pinpoints these nodes' strategic position in shaping research agendas and nurturing interdisciplinarity as an enabling resource in developing knowledge about smart city studies. Joint network studies reinforce such an idea by stating that such structures of collaboration are vital for spotting how the evolution within the scientific community takes place since it is usual to have central authors who have greater productivity and impact, hence underlining the fact that collaboration is at the very base of innovation and scientific output.

Institutional collaboration can only raise the quality and impact of research into smart cities (Anttila and Jussila, 2018). Granada University is the leading institution with 12 co-authored documents, underlining its centrality in the academic network, mainly due to the scientific output of leading authors such as



Manuel Pedro Rodríguez Bolívar, corroborating previous findings (Dias, 2018). Similarly, Delft University of Technology reflects interdisciplinary research, a characteristic considered necessary but insufficient to tackle the complexity of smart cities (Roche et al., 2012). Further examples of this collaborative spirit of contribution come from the City University of Hong Kong and Hong Kong Polytechnic University. Similarly, in this respect, the participation of Utrecht University and the University of Texas at San Antonio, each with eight documents, underlines the varied range of institutional collaboration needed for knowledge generation and problem-solving in urban areas. This collaborative landscape shows the combined effort required to advance social research on smart cities, as it showcases the interrelated nature of academic institutions toward providing solutions to contemporary challenges in urban areas.

Geographic co-authorship analysis shows that smart city research is an area of solid international collaboration represented by 80 countries and 419 links, which shows a dynamic global network. Besides, 16 clusters were detected, which proved the assumption that some countries often collaborate, which allowed them to develop greater depth and breadth of research output. The leading position of the People's Republic of China, with most documents and citations, signals a significant influence, while the USA and Spain also have a high impact. However, it should be noted that there are differences between the sizes of each country's academic communities, and therefore, analyzing the impact per scholar could lead to slightly different conclusions when considering the influence of scholars from different countries. Overall, the collaborative scenario enriches the research quality and allows multiple visions to approach the complex challenges that smart urban development implies. However, the results also show that developing countries are underrepresented in terms of number of publications. This presents a gap in current research. As those countries are quickly developing economically and technologically, it is recommended that smart and socially inclusive approaches be applied to tackle quick urbanization and the effects of climate change.

The co-citation analysis developed in this study outlines the intellectual landscape related to social smart cities, influential authors, sources, and references connected through complex

relationships. Among 134 key authors with at least 20 citations, four distinctive research clusters are identified with substantial interlinkages: 6,989 lines of connection with a strong connection strength of 50,497. Eminent authors such as Kitchin, Caragliu, and Hollands are also influential in social smart city literature since they were very influential in the general smart city literature (Sharifi et al., 2021; Verrest and Pfeffer, 2019). Selection within the literature was also shown by the 17,568 possible sources, with only 270 sources passing the citation threshold. Journals such as Sustainability and Sustainable Cities and Society show a high number of citations and strong interconnectedness, thereby underlining their position in developing discourses on social smart cities. Reference analysis also identified 71 influential works that, taken together, have demonstrated thematic foci within the broad streams of urban technology and sustainability. This study highlights some of the interlinked research features in this domain, which may provide valuable inputs for further research and collaboration in advancing knowledge on smart cities and their socio-environmental consequences.

Based on this study, several recommendations can be made. Firstly, future research should focus on integrating social equity into smart city frameworks to prevent the exacerbation of societal inequalities. This could involve exploring such methods for community engagement in urban planning that amplify the voices of marginalized populations. Interdisciplinary collaboration among researchers, practitioners, and policymakers will be crucial in addressing the multifaceted challenges of rapid urbanization in the coming years. Analyzing co-authorship networks can reveal significant collaborations and facilitate knowledge sharing across disciplines. Additionally, further investigation into citation patterns and influential works will provide insights into emerging trends and gaps in the literature, particularly concerning the ethical implications of technology use in urban contexts. Finally, expanding the geographic scope of co-authorship studies will illuminate how various regions tackle the challenges of smart cities and promote global collaboration, ultimately enhancing the quality and relevance of research. In this way, academia can be vital in fostering more equitable, sustainable, and innovative urban environments.

## Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding authors.

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## Author contributions

SRA: Conceptualization, Investigation, Methodology, Writing – original draft. BBM: Conceptualization, Investigation, Writing – review & editing. BG: Conceptualization, Methodology, Writing – original draft. MI: Conceptualization, Writing – review & editing. AH: Investigation, Visualization, Writing – original draft, Writing – review & editing.

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## Conflict of interest

BG was employed by Turbulent Magic Limited.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The authors declare that Gen AI was used in the creation of this manuscript. To translate some text from Persian to English and improve the manuscript's readability during the editing phase. After using AI, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/frsc.2024.1514040/full#supplementary-material>

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