Navigating the Complexity: Understanding Social Integration in Smart Communities versus Smart Cities

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Abstract

This study delves into the differentiation between smart community and smart city concepts, employing a comprehensive review of conceptual literature. The aim of this study is to identify and deliberate on the nuanced disparities between these two paradigms. By establishing pivotal distinctions, we aim to scrutinize the integration of social aspects in the development and implementation of smart communities. Our findings will offer insights into the essential factors influencing individual and social behavioral changes, thereby facilitating the development of a conceptual model to guide future empirical investigations.

Keywords

smart community, smart city, behavior, change, social,

1. Introduction

The concept of a smart city is broadly recognized in the literature yet is characterized by a lack of consensus and widely accepted definition [1, 2]. Generally, it emphasizes adopting a technocratic approach to urban management and governance, wherein information and communication technologies (ICT) serve as tools rather than being objectives in urban governance [3]. The concept of a smart city emphasizes the implementation of a wide range of emerging technologies such as Geographic Information System (GIS), Artificial Intelligence (AI), Internet of Things (IoT), edge computing, and more to collect data and provide information, aiming to enhance the delivery of urban services. On the other hand, a smart community encompasses a nuanced understanding that can be delineated into two primary perspectives. The first perspective views smart communities as the cornerstone of smart city (region/district/village) services [4], emphasizing the significance of institutional governance and stakeholders' engagement and participation in fostering the creation and provision of long-term public value and urban sustainable development [5, 6]. Conversely, the second perspective blurs the distinction between

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smart city and smart community, treating both concepts interchangeably as forms of targeted intelligence within smart governance [7, 8].

The social aspects in smart communities and cities are diverse and multifaceted, encompassing environmental, economic, and social objectives of sustainable development, as well as citizens' attitudes, readiness, trust, skills, individual, and social behavior patterns [9, 10]. The theoretical problem lies in the lack of clear conceptual boundaries and a comprehensive framework for organizing these social factors within the context of smart community development. This gap impedes our understanding of how social considerations are reflected in smart community initiatives' design, implementation, and evaluation. From a practical perspective, there is a significant challenge in translating theoretical insights into actionable strategies for smart community development and implementation, addressing and prioritizing social factors, and facilitating inclusive, equitable, and sustainable smart communities.

However, the intersection of social and technological dimensions of research has become vast and indistinct. Consequently, it is challenging to track studies from various academic communities using traditional literature review methods to gain a clear overview. The primary objective is to identify key studies in the field crucial for understanding social determinants in developing and implementing smart communities and cities. Motivated by this need, the study aims to: (a) map the research field, and (b) identify emerging trends and changes over time.

This paper proposes a research method combining ground theory, bibliometric analysis, and visual analysis. It comprehensively shows the state of the art by combining bibliometric analysis and visualizing the network, such as keywords, co-occurrence networks, and clustering networks. Providing these structures supports understanding of the research status, research trends, and dynamic evolution of the knowledge. Bibliometric data are essential to support researchers in establishing the knowledge gap and providing visualizations of the research stages. This paper uses the software CiteSpace to systematically sort out research on the social factors embodied in smart cities and smart communities concepts [11, 12, 13]. This study adopts a combination of qualitative and quantitative analysis. This study contributes to a better understanding of the complex interplay between various social determinants and their implications for urban planning and governance. This research provides insights for integrating social considerations into smart community planning and implementation processes.

The structure of this paper is as follows. In Section 2, we describe the methodology of this study. Section 3 shows findings, while Section 4 provides discussion and conclusions.

2. Methodology

The exponential expansion of literature surrounding smart cities and smart communities, coupled with the extensive range of topics addressed within these publications, presents a formidable challenge for traditional literature reviews seeking to capture the breadth and depth of earlier works. Recognizing the imperative for a rigorous and objective literature synthesis, we employ bibliometric analysis to uphold the scholarly integrity of our review. By integrating both qualitative and quantitative methodologies, we aim to provide a comprehensive research agenda on the influence of social factors in the development and implementation of smart cities and smart communities. Our study combines three approaches: bibliometrics, visualization,

and content analysis.

Applying bibliometrics methods provides valuable insights into the interconnections and patterns within the literature data [14], facilitating the identification and prioritization of influential papers Wagner et al. [15] on social elements of smart cities and smart communities. Bibliometrics ensure reproducibility of results, enhancing the reliability and validity of literature review findings [16]. Bibliometrics offers a cost-effective and efficient means of analyzing scholarly literature, free from potential researcher bias. The results are internationally accessible, reliable, and available to all interested parties [14, 17]. However, sole reliance on bibliometric analysis has limitations, including the inability to predict future impacts and access the latest knowledge. Additionally, it fails to provide a balanced examination of various types of publications since it is not universally applicable across all disciplines.

We use CiteSpace 6.3.R1 [13], a Java application that integrates information visualization methods, bibliometrics, and data mining algorithms. This tool enables the extraction of citation data and offers comprehensive capabilities for analysis and visualization. The objective of the CiteSpace is to facilitate the analysis of emerging trends in a knowledge domain. Knowledge domains are modeled and visualized as a time-variant duality between research fronts and intellectual bases. Research fronts [18] refers to the citing articles, while intellectual base [19] refers to the cited ones. CiteSpace supports identifying the nature of the research frontier, annotating the research field, and identifying emerging trends and shifts over time [13]. The data format CiteSpace software processes is a Web of Science (WoS) data download format.

We opted for WoS, a high-quality and comprehensive bibliographic indexing database. We use keyword-based search. We searched for the following keywords: “smart city”, “smart community”, “social”, “societal” and “society”. The sources of the subject words in WoS include titles, abstracts, and keywords. We include all publications revealed by the search keywords to provide comprehensiveness of the created network and duplicability.

The research design in bibliometrics application is as follows: 1) we analyze the primary data of the literature samples to understand the rate and time distribution of papers published, the source and volume of journals; 2) we identify which are emergent topics on societal elements of smart cities and communities; 3) the knowledge map is summarized to understand current research status and future research avenues. The intellectual structure of a research domain is achieved through cluster analysis. Table 1 presents the data settings for the search.

The expected outcome of this study is to identify publications that address the societal elements of smart city and smart community concepts and identify future research steps.

3. Findings

3.1. Analysis of most cited articles

The most cited articles are those that shape the state-of-the-art in a particular domain [12]. Table 2 shows the top 10 most cited papers with a co-citation frequency of over 90 times. Respectively, 4 papers are from cluster #0- sustainable cities, 3 papers are from cluster #2 citizen engagement, 2 papers are from cluster #3- smart citizenship, and 1 paper is from cluster #1 - inclusive city. The most cited article with 193 citations is the study of Albino et al. entitled “ Smart Cities: Definitions, Dimensions, Performance, and Initiatives”. The paper underscores that the smart

Table 1
Data settings for the search

Search Settings	Elements	Parameter Settings	Elements
Data source	WoS	Time slicing	2015 Jan-2024 Dec
Search keywords	(smart city OR smart community) AND (social OR societal OR society)		
Type of Literature	articles, journals, book chapters, reviews, early access		
Number of documents	3897	G-index	k=25
Time interval	2 years	TopN	50
Date of search	14/03/2024	TopN%	10%

Table 2
Top 10 most cited papers with co-citation frequency

Rank	Frequency	Label	Cluster
1	193	Albino V (2015)	citizen engagement
2	139	Silva BN (2018)	sustainable cities
3	136	Neirotti P (2014)	citizen engagement
4	129	Kitchin R (2014)	smart citizenship
5	128	Ahvenniemi H (2017)	sustainable cities
6	107	Meijer A (2016)	citizen engagement
7	104	Vanolo A (2014)	smart citizenship
8	99	Cardullo P (2019)	inclusive city
9	94	Bibri SE (2017)	sustainable cities
10	91	Yigitcanlar T (2019)	sustainable cities

city concept encompasses multifaceted dimensions, increasingly incorporating the role of citizens and communities alongside technological aspects. It emphasizes the necessity for tailored assessments considering diverse city visions while highlighting the limitations of universal ranking systems. The second-ranked paper by [21] is entitled "Towards sustainable smart cities: A review of trends, architectures, components, and open challenges in smart cities". The paper discusses the evolution of smart cities as a response to urbanization challenges, emphasizing sustainable practices to minimize environmental impact and enhance citizen well-being. It provides an overview of smart city features, architecture, and real-world implementations while addressing barriers to global adoption, underscoring the importance of sustainable urban development. Finally, the third most cited paper presents a comprehensive Smart City (SC) application domain taxonomy. It investigates the influence of various economic, urban, demographic, and geographical factors on the evolution patterns of SC initiatives. It underscores the importance of local context factors in shaping SC strategies and offers valuable guidance for policymakers and city managers in defining and implementing SC initiatives.

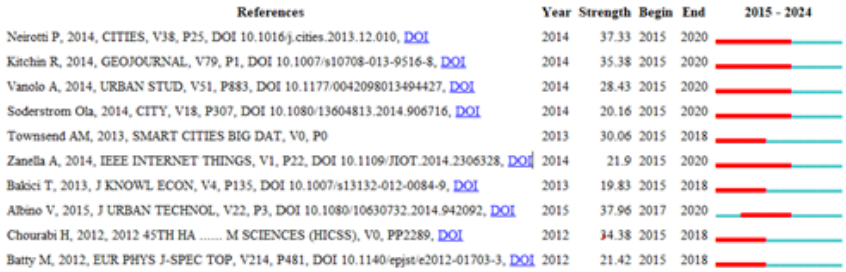

Figure 1: Top 10 references with the strongest Citation Burst

3.2. Analysis of the emergent topics

A citation burst refers to a sudden increase in the number of citations received by a particular academic paper or work within a short period, typically due to heightened interest or recognition in the academic community. Figure 1 presents the top 10 references with the strongest citation burst sorted by the duration of the burst with a minimum duration of 3 years. As observed, the earliest citation burst started in 2012, consistent with the period of the emerging smart city discipline. As shown in Figure 1, most of the issues raised have a very long burn time (till 2020), which indicates the high relevance and timeliness of the issues raised. From 2014-2020 researchers focused on investigating current trends in smart cities [22], IoT and big data applications [23, 24], and the issue of smartness [25, 20]. Keywords analysis over time involves tracking the usage and relevance of specific terms or phrases within a dataset or context across different periods. This analysis helps identify evolving trends, shifts in interest, and the impact of various factors on the prevalence and significance of keywords over time. Figure 2 presents keyword analysis for the first five clusters, each aligning closely with distinct themes. Focusing on the period close to 2023, we observe that in cluster #0, centered on sustainable cities, emerging topics include citizen science. In cluster #1, indicative of an inclusive city, keywords highlight research topics such as attitudes, smart homes, planned behavior, and environmental sustainability. Cluster #2, revolving around citizen engagement, emphasizes terms like digital twin, protocol, and smart city planning. Meanwhile, cluster #3, focusing on smart citizenship, features keywords related to urban resilience, research and development, and carbon emissions. Lastly, cluster #4, highlighting the citizens' perspective, underscores ongoing research trends, including stakeholder engagement, corporate social responsibility, helix, transition, and tourism.

3.3. Analysis of burst keywords

Research hot spots are based on burst strength. Figure 3 presents the top 5 keywords with the strongest citation burst between 2015 and 2024. Each red bold rectangle shows the keyword's occurrence at a minimum duration of 4 years.

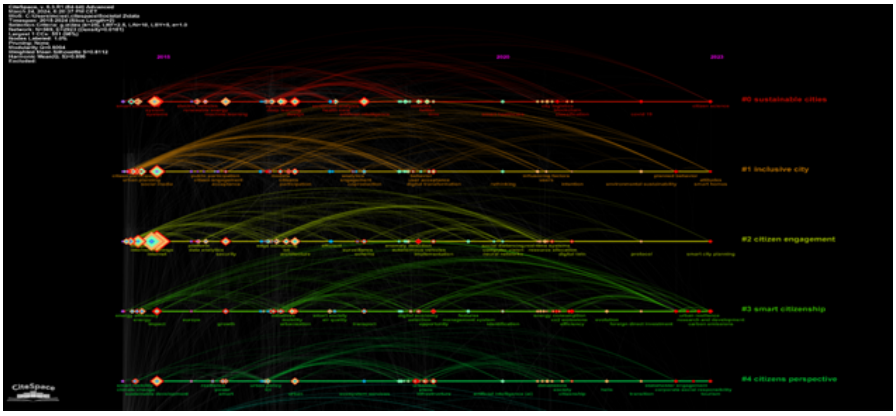

Figure 2: Keywords analysis over time

Keywords	Year	Strength	Begin	End	2015 - 2024
smart grid	2015	7.34	2015	2018	
open innovation	2015	6.13	2015	2020	
gis	2017	2.76	2017	2020	
smart campus	2015	2.69	2015	2018	
civic engagement	2017	2.51	2017	2020	

Figure 3: Top 5 keywords with the strongest citation burst

3.4. Analysis of clustering keywords

The analysis of clustering keywords is the technique of using a clustering algorithm to the data displaying closely related words into groups. The clustered data are reliable when Q>0.3 and S≥0.5. The cluster confidence is high as Q=0.6094 and S=0,8112. Within 2015-2024 clustering depicts 12 clusters: #0 sustainable cities, #1 inclusive city, #2 citizen engagement, #3 smart citizenship, #4 citizens perspective, #5 sustainability-enabling configuration, #6 big data analytics, #7 public value, #8 smart city pilot; #9 contextual information; #10 urbanistic viewpoint; #11 smart community; #12 emerging technologies. Table 3 presents detailed clustering information.

Cluster #0 focuses on sustainable cities and underscores the discipline's commitment to integrating smart innovations to promote sustainability, particularly addressing social issues. Within this discipline, smart innovations foster emerging markets that contribute not only to environmental and economic sustainability but also to addressing social concerns. The research within this cluster delves into social representation theories, thereby examining sustainable city development through the lens of societal impact and inclusion. The most cited members in this cluster address the constitution of smart cities, depicting differences between smart and sustainable cities, focusing mainly on social and economic sustainability, and depicting models

of smart and sustainable cities.

Cluster #1, inclusive city, encompasses keywords that are at the forefront of research, where scholars extensively delve into the realms of data-driven societal inclusion and the active engagement of civil society. Their focus extends to re-examining the foundational principles of smart cities while embracing a discourse centered on citizen-oriented perspectives. Notably, the most cited members within this cluster emphasize the imperative shift towards citizen-centric smart city paradigms. They advocate for approaches prioritizing social rights, political citizenship, and the common good, emphasizing that societal concerns and public interests should guide smart cities.

Cluster #2, citizen engagement, shows the discipline's commitment to conceptualizing smartness and its relation to citizens' quality of life, the supportive role of ICT, and local context factors. It is pointed out that smart city descriptions, besides their ICT focus, should include qualities of people and communities. The authors in this cluster advocate for a holistic perspective, asserting that smart city governance entails cultivating novel forms of collaborative human interaction facilitated by ICTs.

On the other hand, Cluster #3 directs scholars' focus toward the intricacies of smart citizenship, smart urbanism, smart citizen participation, and the diverse strategies cities employ to achieve these aims. The most cited references within this cluster delve into the intricate relationship between smart city governance and citizens, leveraging the vast reservoir of big data extracted from digital infrastructures and networks to glean insights into urban dynamics and citizen behavior. Scholarly discourse highlights the potential drawbacks of implementing smart city initiatives, including a tendency towards a purely technocratic approach to urban governance. Consequently, this prompts a reassessment of urban political dynamics and the fundamental definition of what constitutes a "good city".

Finally, cluster #4, focusing on the citizens' perspective, highlights scholars' keen interest in understanding how citizens perceive smart cities, thereby enriching the societal understanding of the smart city concept. This cluster also endeavors to address the contextual disparities between the global North and South regions through comparative analysis. The most highly cited articles within this cluster delve into smart cities' underlying rationale and objectives, particularly emphasizing the importance of empowering citizens to utilize smart city solutions effectively. This shift in focus is evident in the lens of Information Systems (IS) design, which now prioritizes considerations such as ease of use and technology acceptance by citizens. Consequently, enabling technologies are perceived as essential tools to accommodate urban populations' dynamic and diverse requirements.

Cluster #5, related to sustainability-enabling configuration keywords, depicts scholars' attention to practical issues of achieving sustainability in smart cities through developing conceptual models and methodological frameworks of sustainability indices, as well as necessary organizational changes that public administration faces to address. Top citing publications are posing questions about the sustainability of smart city initiatives by juxtaposing theoretical approaches to practical implications based on case studies. These result in a mapping of smart city initiatives and depicting main drivers as well as social criteria of sustainability, which are to be addressed to establish a sustainable-enabling urban ecosystem.

Cluster #6, focusing on big data analytics, #8, emphasizing smart city pilot projects, and #9, centered on contextual information, share a common characteristic: they lack keywords

that directly reflect the social issues addressed in the studies. While cluster #6 expresses the research stream focused on applying big data collected through IoT and its processing using edge computing and analytics, cluster #8 keywords indicate a discipline construction focused on smart city innovations to achieve environmental sustainability and urban resilience.

Cluster #7, focusing on public value, illuminates critical aspects of the public value inherent in smart city initiatives. Scholars emphasize that the construction of smartness serves as a means to address pressing social challenges, such as the concept of the 15-minute city or managing tourism flows, while also adapting smart city concepts to incorporate cultural and historical dimensions. The overarching research emphasis lies in examining sustainable governance frameworks for smart cities.

Cluster #9 highlights the utilization of IoT, GIS, and crowdsourcing techniques for acquiring and disseminating contextual information. Research within this cluster focuses on developing innovative geo-social models and platforms utilizing sensor data from mobile phones and urban activities to implement advanced sensing within the smart city framework.

Cluster #10, from an urbanistic viewpoint, signifies a discipline that delves into human-centric aspects, notably exploring the application of the UTAUT model in web applications, AI, and IoT implementations aimed at enhancing livability. This cluster advocates for promoting bottom-up approaches and the strategic integration of ICT to maximize the potential of eco- and future-cities.

Cluster #11, termed "smart community," focuses on developing smart communities as integral components of achieving economically and energy-efficient smart cities. It delves into the intricacies of measuring and managing technological advancements to foster the realization of sustainable smart cities.

Cluster #12, centered on emerging technologies, signifies the utilization of cutting-edge innovations to transition cities into smarter environments, thereby enhancing the well-being of citizens. The ongoing advancements primarily concentrate on integrating Internet of Things (IoT) networks, blockchain technology, and artificial intelligence (AI) alongside the development of architectural frameworks to safeguard privacy-sensitive data.

4. Discussion

Due to the vast amount of scientific publications regarding the smart city concept and smart community, we opted for a novel approach - bibliometrics analysis on CiteSpace to discover key literature and knowledge clusters around social determinants for the development and implementation of smart community and city. This we consider as the first step of our comprehensive study focused on identifying the most important studies within various domains to provide comprehensive characteristics of social determinants within smart city and community concepts. In the second step, we aim to differentiate between the scientific concepts of a smart city and a smart community regarding social factors embeddedness using qualitative methods.

To achieve the objective, we used various keywords and clustered them accordingly. Analysis of the references reveals that smart communities are catalysts for fostering sustainable behaviors among individuals and communities within urban environments. On the other hand, smart city is the most frequently used keyword among identified search results.

Table 3
Clustering information table

no.	Clustering	Clustered content	Silhouette	Mean (year)	Most citing members
0	sustainable cities	sustainable cities; smart innovation; sustainable mobility; emerging market; social representation theory	0.632	2018	Silva et al. (2018); Ahvenniemi et al. (2017); Bibri and Krogstie (2017)
1	inclusive city	selective inclusion; civil society involvement; smart city; smart city ecology; smart city premises; smart city discourse; multiscalar perspective; data governance	0.681	2018	Cardullo (2019); Cardullo (2019b); Joss (2019)
2	citizen engagement	citizen engagement; citizen participation; smart tourism destination; case study; conceptualizing smartness; governing smart cities	0.884	2013	Albino et al. (2015); Neirotti et al. (2014); Meijer (2016)
3	smart citizenship	smart citizenship; smart urbanism; smart citizen participation; city approaches	0.858	2014	Kitchin (2013); Vanolo (2013); Hollands (2014)
4	citizens perspective	citizens perspective; societal smart city; global whitewashing; developing countries; comparative analysis; case study; employee acceptance	0.782	2020	Ismagilova et al. (2009); Ahad et al. (2020); Lytras and Visvizi (2018)
5	sustainability-enabling configuration	methodological framework; mapping sustainability-enabling configuration; organizational field; conceptual model; social criteria; main driver	0.821	2015	Anthopoulos (2017); Manville (2014); Marsal-Llacuna (2015)
6	big data analytics	using big data analytics; edge computing; smart city transformation; privacy-preserving identity-based file sharing; one-stop smart city app performance; smart city-applications technologies challenge; smart cities context	0.834	2016	Zanella (2014); Hashem (2016); Jim (2014)
7	public value	15-minute city; public value; tourism flow; regional smart city development focus; sustainable smart cities governance; toe framework; risk management	0.848	2019	Appio (2019); Allam (2018); Trencher (2019)
8	smart city pilot	smart city construction; smart city pilot; smart city policy; carbon emission; high-quality economic development; achieving resilience; spatial structure; smart city innovation; haze pollution	0.962	2020	Caragliu (2019); Yigitcanlar (2018); Shen (2018)
9	contextual information	integrating contextual information; technical geo-sensor information; using mobile phone-based sensor data; urban activity; social network; smart city crowdsensing; openstack-powered infrastructure	0.973	2012	Gubbi (2013); Cardone (2013); Hancke (2013)
10	urbanistic viewpoint	utaut model; web application; urbanistic viewpoint; practitioners perspective; future cities; green urban development; case study analysis	0.9	2018	Allam (2019); Angelidou (2017); Cugurullo (2018)
11	smart community	smart technological solution; regulatory measure; technological advancement; smart energy management; city-renewables nexus; green tourism industry; energy-efficient smart city	0.989	2019	ODwyer (2019); Mora (2021); Strielkowski (2020)
12	emerging technologies	iot network; current developments trend; transforming cities; emotional well-being; blockchain framework; smart monitoring	1	2016	Mohanty (2016); Zhang (2017); Sun (2016)

The analysis of reference numbers within clusters reveals that sustainable cities, as well as inclusive cities, have been an ongoing research field since 2015 and continue to maintain significant impact. Furthermore, the cluster analysis over time suggests a notable shift in research focus from citizen engagement, progressing through smart citizenship, towards the citizens' perspective. The latest reference points to: 1) revisiting the domains of smart city quality of life and varying impact of citizens' attitudes and support to smart city development [26]; 2) citizens' dissatisfaction with technology, democracy, and societal impact [27], and dehumanization of citizens [28, 29]; 3) citizens needs [30] [31]; and 4) policies for incorporating a civic perspective [32]. Starting in 2020, scholars have increasingly focused on the concept of public value within the contexts of smart cities and smart communities [33, 34, 35]. An analysis of the most frequently cited references within clusters refers to the ongoing development of the complexity between smartness, sustainability, and the social aspect, while the latter is becoming increasingly recognized by researchers [20, 21, 22, 23].

The second objective is to understand how social factors influence smart community implementation. Therefore, we searched for the keywords "smart city" and "smart community" combined with "social", "societal", and "society" keywords. The search results allowed us, via CiteSpace software, to denote 12 clusters, each characterized by social component keywords. The top 5 keywords burst depict "civic engagement" as the current research hot spot. The cluster keywords analysis through the perspective of social components indicates the following keywords to shape current research trends on social aspects of smart cities and smart communities: "social representation theory", "selective inclusion", "civil society involvement", "citizen engagement", "citizen participation", "smart citizenship", "smart citizen participation", "city approaches", "citizens perspective", "societal smart city", "global whitewashing", "developing countries", "social criteria", "emotional well-being", "urban activity", "social network", "smart city crowdsensing", "spatial structure", and "public value".

The results aim to expand the understanding of social elements in smart city and smart community concepts. Due to the exploratory nature of this study, the detailed analysis of emerging topics is to be continued by delving into the particular revealed references and qualitative analysis of social component interplay with smart city and smart community concepts. Hence, further studies are to be continued by adopting: 1) socio-technical theory to analyze the design of a smart city and smart community; 2) social theories to understand drivers, barriers, and policies to implement social perspective into smart city and smart community initiatives; 3) behavioral theories to depict triggers to achieve sustainable individual and social behavior of citizens.

This study, like any other, has its own limitations. While we incorporated a blend of technical concepts such as 'smart city' and 'smart community', alongside keywords like 'social,' 'societal,' and 'society,' the distinction of social elements requires further exploration through content analysis of identified references and subsequent summarization. To broaden the breadth and depth of this study, additional research avenues could be pursued: (1) analyzing a wider range of articles, including those in non-English languages, pertaining to smart city and smart community themes, and comparing findings with those of this study; (2) addressing self-citation, (3) integrating diverse knowledge domain visualization techniques to generate a comprehensive map visualizing socio-technical research domains.

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