

SMART CITIES: LITERATURE REVIEW AND BIBLIOMETRIC ANALYSIS

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Abstract- In an era characterized by rapid urbanization and technological advancements, the concept of smart cities has emerged as a transformative concept in urban development, driven by the integration of technology, data, and innovation. As the global population gravitates towards urban centers, cities face unprecedented challenges related to resource management, infrastructure sustainability, and the overall well-being of citizens. Smart cities represent a visionary response to these challenges, leveraging cutting-edge technologies to create interconnected, intelligent urban ecosystems. This paper conducts a review of the existing literature to provide insights into the historical context, key themes, challenges, and opportunities associated with smart cities. It examines the evolution of the concept, emphasizing the diverse range of applications across various urban domains. The paper also examines the challenges and opportunities that smart cities present, including sustainability, governance, technology adoption, and equitable access. As smart cities continue to shape the urban landscape, this review offers a comprehensive understanding of their conceptual and practical dimensions, informed by the insights from a wide array of scholarly works.

Keywords: Smart City, IoT, Digital City, Scopus, WoS, Bibliometric.

1. INTRODUCTION

In the 21st century, humanity finds itself standing at the precipice of an urban revolution, cities have become the preferred living environment for the majority of the world's citizens, and this trend is set to continue its rapid ascent. Urbanization, driven by factors such as economic opportunities, technological advancements, and population growth, has reshaped the global landscape and brought both unparalleled opportunities and formidable challenges. As cities swell with inhabitants, the demand for resources, services, and infrastructure has intensified. This surge in urbanization necessitates innovative approaches to tackle issues ranging from congestion and pollution to resource allocation and citizen well-being. In response to these challenges, a visionary and transformative concept has taken center stage - the Smart City.

The concept of a Smart City represents a significant change in urban planning and governance, offering a perspective on cities that are not just efficient and sustainable but also responsive and inclusive. A Smart City leverages cutting-edge technologies, data-driven decision-making, and citizen engagement to create a city that is, in essence, intelligent. This paper provides a comprehensive exploration of Smart Cities, covering the conceptual framework and historical evolution of this paradigm, the core components that enable its functionality, the benefits it offers to society and the obstacles and ethical considerations that need to be addressed. It provides a bibliometric analysis about the state of art of the smart city by using two databases. By the end of this journey, readers will have a deeper understanding of the concept and its potential to reshape our cities and improve our lives.

Our exploration begins with the historical evolution of Smart Cities, tracing their roots from the early visions of urban planners to the present-day realization that the integration of technology and data is no longer a luxury but a necessity in our increasingly complex urban environments. The paper will then delve into the fundamental components that constitute a Smart City, including data-driven, decision-making, Internet of Things (IoT) infrastructure and community engagement. In conclusion, the emergence of Smart Cities represents a pivotal moment in human history, where technology and innovation converge to redefine the urban experience. The contents of this paper are divided into four parts: the first discusses the smart cities definition and dimension in the literature. The second covers the bibliometric as a research methodology used in this paper. After that, the third part explains the results obtained from the two databases and a conclusion is given in the last part.

2. LITERATURE REVIEW

2.1. Smart City Definition

Numerous studies have provided varying definitions for smart cities, indicating a lack of consensus in the academic community regarding their precise characterization. According to (Nam, Pardo, 2011) [1] smart cities are based on some special elements:

Technology as software infrastructure and hardware, education, policy institution, human contributions and governance. However, there are other studies which offer a various definition about smart cities without a fully comprehension of the concept. As mentioned by (Anthopoulos and Vakali, 2012 and Lazaroiu and Roscia, 2012) [2] The city's smartness lies in focusing on financial resources, which can advance economic growth and high quality through the proper management of natural resources. Moreover, Lee and authors (2013) in [3] define that Smart cities are derived from the concept of information cities and cover a lot of fundamental dimensions such as: smart economy, mobility, environment, people, quality of life, and governance. These dimensions serve as the foundation for comprehensive and sustainable urban development. Otherwise, (Lee, et al., 2014) [4] mentioned that smart cities combine green and sustainable resources which define relationship between environment and urban life.

(Hashem, et al., 2015) [5] See that the integration of IoT, cloud and interconnecting devices play an important role to improve ICT infrastructure in smart cities. Also, citizen participation is important to enhance the growth benefits from using ICT even if there is a need to provide assessments tool to all citizen [6]. According to some studies, smart cities are defined as a system that is not homogeneous which bring together different actors sharing resources and knowledge to provide smart [7]. Therefore, smart cities and all involved entities are new sources of success and sustainability (Kiselakova, et al., 2020) [8]. Intelligent cities are facing the growing issues of economic growth, resource exploitation, health and well-being [9].

In accordance to (Kumar, et al., 2020) [10], there are four steps to describe a smart city; the first phase is to establish effective governmental management within smart city structures. In second phase, smart city Internet of Things (IoT) solutions can be provided through ICT infrastructures connecting the population with smart businesses. The third phase is based on IoT to integrate cloud computing, cyber security and devices interconnections to improve ICT infrastructures. And the last phase is based on the three previous phases and their applications in the different domains to make a city smart such as: public transport, health care, quality of life, reduction crime, business, tourism, etc.

2.2. Smart City Dimensions

Based on the literature, there are six dimensions that contribute to the development of smart city: Economic; Governance; Smart living; Mobility; People and Environment [11].

2.2.1. Smart Economy

The concept behind smart economy is to involve technology and innovation to enhance economic growth, foster entrepreneurship, improve overall efficiency, innovation and creativity. Also, (Arroub, et al., 2016) [12] present that smart economy is a result of the integration of communication technology into all aspects of the economy. Table 1 shows some reviewed related to smart economy.

Table 1. Economy aspect of smart city

Form of application	Challenges	Example of reviewed paper
The digital economy encourages citizens to participate and engage in digital activities in various aspects of their lives, and it also encourages digital industries and innovations, such as use of supply chain solutions through IoT devices	Transforming public services into digital services Lack awareness of users in terms of using cybersecurity combining with IoT	Mitigate risks comprehensively, considering all aspects and avoiding a standalone approach. Encourage a thorough understanding of the interconnections and dependencies among various factors
Online platform	Platforms that centralize and control information processing and gathering could lead to a market monopoly Platforms can be useful for individual services and products, but they may not be suitable for acquiring complex products	The Distributed Market Spaces model aims to help facilitate the exchange of complex products at both strategic and operational levels, specifically intended for use in Smart Cities' information technology infrastructure. This model aligns with service ecosystem characteristic of smart cities
Online platforms can be used to coordinate the provision of goods and services through the sharing economy, which encompasses activities	The predominant challenge encountered by the sharing economy is the risk associated with attitudes, particularly in terms of regulating norms and behavior related to sharing	The promotion of positive accountability and responsibility among citizens by the government is crucial for preserving natural resources and advancing sustainability of smart cities
Applications for e-commerce services, including those designed for mobile shopping	Privacy of customer data	The need to prioritize the protection of user data privacy while striking a balance between fostering innovation and safeguarding users' interests

2.2.2. Smart Governance

After examining the characteristics and issues of smart cities, the researchers found that smart city governance is closely linked to decision-making, public social services and transparent administration. The authors underline the fact that governance involves a collaborative effort between resident and public authorities, and that successful governance is crucial in realizing the advantages of smart cities, ensuring reliability, efficiency, and effectiveness in citizen services through the integration of public, private, and civil domains. The value of technical governance in smart governance is stressed by them, as it ensures the comprehensive addressing of all community services and features through advanced technological solutions [13].

Open innovation can be promoted through interactive governance as advocated by Ismagilova, et al. (2019) [14]. E-governance's effectiveness can be increased by integrating 5G technologies, Internet of Things, and Artificial Intelligent. Furthermore, the authors in [14] recommend that cloud-based information services can be utilized to boost decision-making, encourage engagement, and information sharing for collaborative governance. Table 2 outlines research on smart governance.

Table 2. Smart city governance

Form of application	Challenges	Example of reviewed paper
Users can manage their devices within a smart city through applications.	Data integrity and confidentiality	Ensure the security of user data privacy by enabling decision-makers to authorize access in accordance with specific policies and guidelines.
Demonstration of social collaboration can be achieved through sharing information and communicating effectively.	Data integrity and confidentiality.	Embracing a national policy that considers the most recent technologies and applications. Implement a robust framework to increase public participation.
e-government projects and services room sharing, and more.	The ability of stakeholders to collaborate and the leadership support to sharing.	The synergy among individuals, policies, resources, culture, and information technology is crucial for ensuring the success of provided services.

2.2.3. Smart Living

Considering the various advancements that have been introduced, individuals are cultivating more intelligent lifestyles through the integration of technology. Virtually everything is now interconnected through devices, leading to increased ease, safety, and cost-effectiveness in numerous tasks. Over the past few years, emerging innovative solutions have been geared towards enhancing the productivity, sustainability, and overall efficiency of individuals' lives. According to (Silva, et al., 2018) [13] awareness is a crucial part in smart living. Healthcare services can be provided with real-time monitoring of specialized care needs and emergency support facilitated by information and communication technology (ICT). Additionally, there has been a rise in home rehabilitation applications, especially during the COVID-19 global epidemic, to aid medical staff in helping during this challenging period [15]. ICT's application is discussed by the authors in [16] as it facilitates networked and automation of living space conditions, lighting, and integrated security systems, resulting in intelligent living. Also, they highlight the widespread use of smart assistance applications in smart homes, which extensively collect personal and private user data. However, the study underscores a lack of transparency in addressing privacy and security risks associated with these applications, drawing from their examination of the transparency levels in smart city products. Additionally [17] (Nitoslawski, et al., 2019) mention that the support of smart living applications comes from empowering new technologies.

Table 3. Smart living applications

Form of application	Challenges	Example of reviewed paper
Smart building	Data privacy	Implementing access control models promotes the use of cryptography and advanced security architecture
Healthcare by using e-health applications	The security and privacy of data	Set specific standards to secure data
Smart tourism	The security and privacy of data	Enhanced security and privacy considerations necessitate the implementation of innovative business models

2.2.4. Smart Mobility

Mention that smart mobility is achieved when intelligent transportation systems, smart traffic management, public transportation, and sustainable and efficient modes of transportation are integrated (Appio, et al., 2019) [18]. The authors highlight that the problem stems from traffic issues, including congestion, extended queues, and delays. According to their proposal, the intelligent system should prioritize the use of private vehicles and offer coordinated alternatives for individuals to improve their commute. The authors in [14] introduce the concept of IoV (Internet of Vehicles) which can to the enhancement of traffic safety and efficiency. To facilitate smart mobility, it is essential to advance technologies like AI, IoT, Big Data, and blockchain (Paiva, et al., 2021) [19].

Table 4. Smart mobility applications

Form of application	Challenges	Example of reviewed paper
IoV for traffic safety	Network availability Sensor's connectivity	Integration of intelligent system to get good service
Road safety and intelligent surveillance system. Mobility as a Service (MaaS) where various modes of transport are integrated into a unified and user-friendly system	Data integrity and confidentiality	Establish an infrastructure, improve connections, implement security measures, and establish policies to control data privacy
Smart applications assisted by crowdsourcing	Big Data analytics and real-time connectivity	Use a wide range of big data analytical tools to anticipate peak times and improve the quality of services delivered

2.2.5. Smart People

Smart people play a crucial role in driving innovation, adapting to technological advancements, and contributing on the whole growth of the city [20]. A smart city's social infrastructure is influenced by two factors, human capital and social capital. Human capital is defined as a person or organization's abilities, while social capital is measured by the quantity and quality of relationships between communities. AI and big data are important to develop smart application in order to enhance education and knowledge. However, they might be challenged by the security and privacy information. In addition to that, (El Haddadeh, Weerakkody) [21] mentioned that the citizens should be engaged on a government application which authorize them to connect with Community services.

Table 5. Smart people applications

Form of application	Challenges	Example of reviewed paper
Engaging people with digital platform such as education, government and social application	Infrastructure security and data privacy	Apply a data protection. Spread the importance of applications and the advantage of using them

2.2.6. Smart Environment

A "smart environment" refers to a physical space that is enhanced and optimized through the integration of various technologies and sensors to improve its functionality, efficiency, and overall user experience.

In a smart environment, devices, systems, and infrastructure are interconnected to gather and analyze data, enabling automation, real-time monitoring, and intelligent decision-making. New tools are employed to enhance green areas, monitor biodiversity, and create urban designs that promote walkability and eco-friendliness [14, 18]. Nizetic, et al. (2020) [22] present on their study that Internet of Things (IoT) plays a crucial role in creating a smart environment. Sensors and devices are deployed throughout the city to collect and transmit data on various parameters such as air quality, pollution, and energy.

Table 6. Environment aspect of smart city

Form of application	Challenges	Example of reviewed paper
Smart forestry applications	Connectivity and IoT devices	Developing framework in order to share infrastructure to reduce cost
Electronic Plants app for plant monitoring	Connectivity and IoT devices	Developing a strategic plan for smart cities to enhance connectivity solutions
Collaborative applications between public and private sectors	Connectivity and IoT devices	Developing applications to provide better data analysis and efficient performance

3. BIBLIOMETRIC AND ITS APPLICATION IN RESEARCH

Recently, bibliometric analysis has gained popularity in scientific research. It becomes a rigorous technique for analyzing a large volume of data. Bibliometric analysis aims to offer information about the publication performance of an individual, a scientific group, or an institution. It not only furnishes details on the impact of publications within professional circles but also delves into aspects such as integration into the scientific landscape and international recognition in comparison to other facets of scholarly output. Bibliometrics encompasses various types of analyses that offer insights into the quantitative aspects of scholarly publications and their impact.

3.1. Previous Bibliometric Studies in Smart Cities

Bibliometric approaches use mathematical and statistical methods to examine the structural characteristics of knowledge domains. These methods are helpful for surviving the development of smart cities as a domain that has grown over the years, and many researchers are interested in this topic. Taking a bibliometric analysis approach, Duran Sanchez, et al., 2017 [23] gives scientific research of bibliometric analysis in smart cities by using two databases Scopus and Web of Science. Ruhlandt, (2018) [24] has studied 62 papers which focus on e-governance. The purpose of this study is to demonstrate that research on smart city governance is more significant than the work being done on smart cities. On the other side, Yigitcanlar, et al. (2019) [25] find that the city cannot be intelligent without being sustainable and thus by reviewing 38 researches published up to June 2018. Margarida Rodrigues mentioned on [26] by reviewing 102 publications, the concept of smart city is based that smart city should relate to the creative culture and network. Beside of F. Zhao, et al. [27] which give a comprehensive

approach of smart city researchers through multidisciplinary perspective such as: Technologies, governance, supply chain. P. Hajek, et al. [28] by its literature study, there have been 1000 projects deployed in smart cities since 2017, and they are projected to double by 2025. The demand and urgency for efficient smart cities are increasing rapidly.

3.2. Methodology

The data used for this study was extracted from Web of Science (WOS) and Scopus in order to make a comparative study between the two databases in term of publication about smart city.

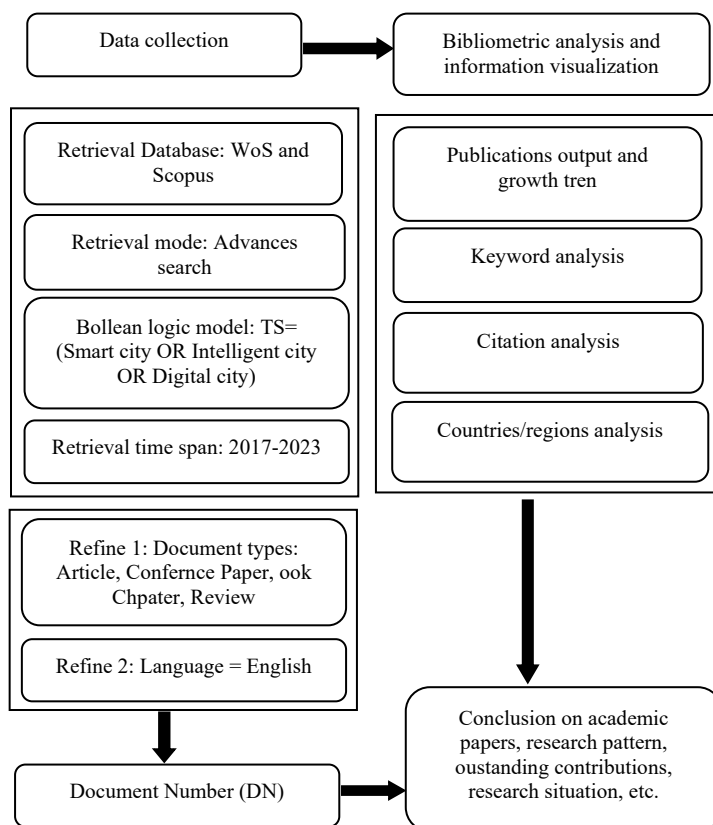


Figure 1. The purpose methodology of the study

Web of Science was selected as the search engine due to its widespread acceptance and frequent utilization as the primary database for analyzing scientific publications. Scopus was selected due to its extensive multidisciplinary coverage, making it well-suited for the analysis of cross-disciplinary phenomena like smart cities. While Web of Science (WOS) and Scopus are recognized as the most commonly used databases for various scientific fields and are frequently used in literature searches. The search term used in this study was “smart city”, “intelligent city”, “digital city”, “smart sustainable city” and “ubiquitous city”, which resulted in publications from 2017 to 2023. The purposed method is illustrated in Figure 1.

4.1. Scopus Database

In stage 1 and after applying filter to identify the range date, exclude duplicate documents which considered as an

important step to have reliable results [29] (Mohadab, et al). 6073 publications were found that were related to smart cities and there were three main types of documents identified: Conference paper (60% $n=3563$) then Article (32.3% $n=2176$) and Review (2.5% $n=175$). From 2017 to 2023, China, India, the United States, the United Kingdom, and Morocco were the top five countries where the majority of publications were created.

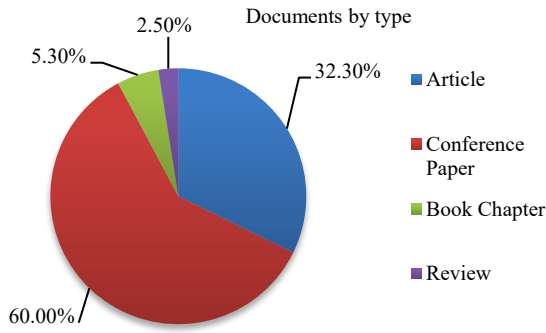


Figure 2. Type of documents published in Scopus

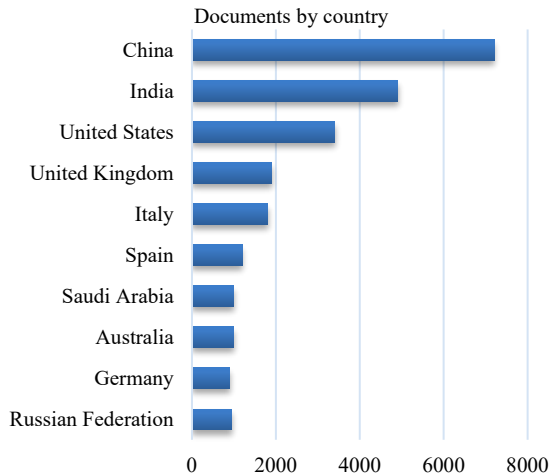


Figure 3. Documents published by country in Scopus

The majority of publications (31.7%) in the Scopus database are related to computer science and engineering, which indicates that most authors prioritize technological aspects. Urban development is founded on multiple IT solutions to manage the resources of the city.

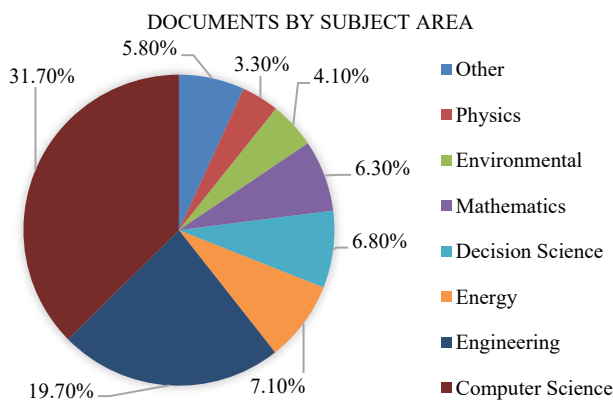


Figure 4. Documents published by subject area in Scopus

4.2. Web of Science Database

The data retrieved from WOS by applying the same filter in Scopus database. We are founded 6500 academic publications about smart city concept. As we can see in the figures below, in WOS most of publication concern article ($n=5600$), most of the publication were created in China, followed by USA and then India. However, the researchers are interested to computer science subject area, engineering and telecommunication, which mean that the world become focused on new technologies and IT domain.

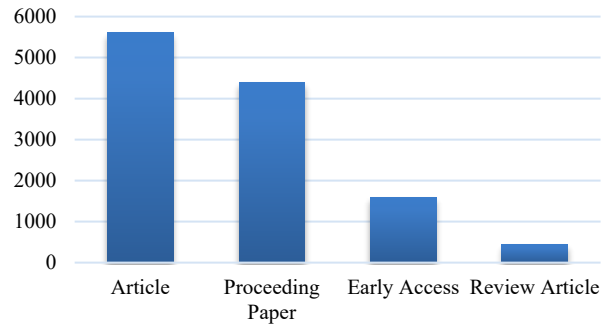


Figure 5. Document type published in WOS

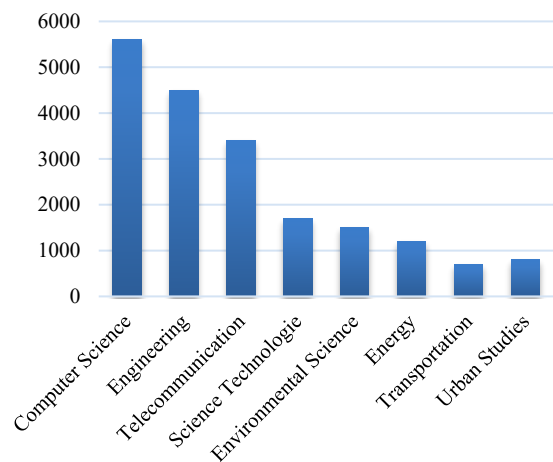


Figure 6. Document published by subject area in WOS

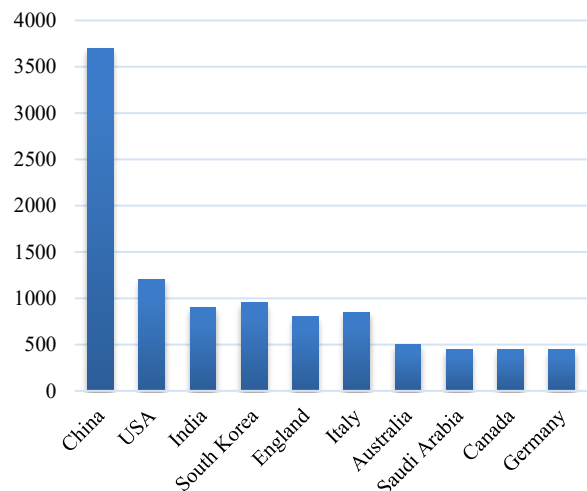


Figure 7. Document published by country in WOS (Source Web of Science)

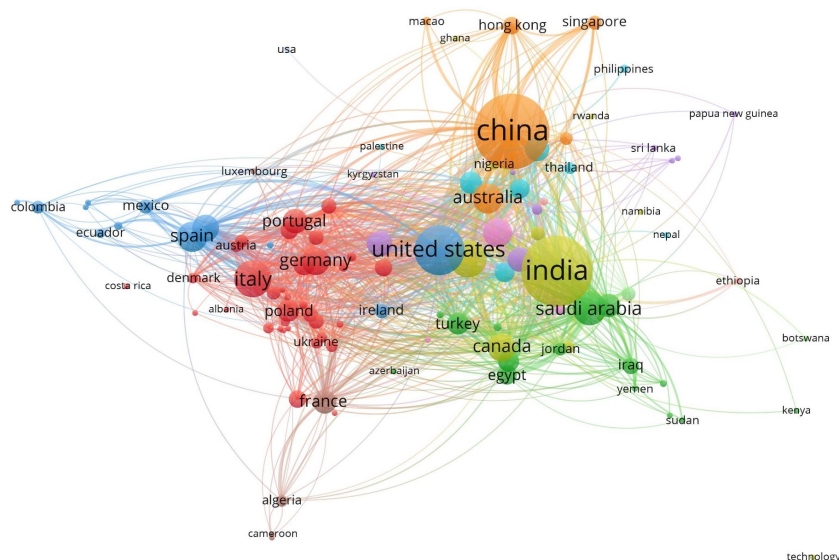


Figure 12. Citation visualization by countries in Scopus

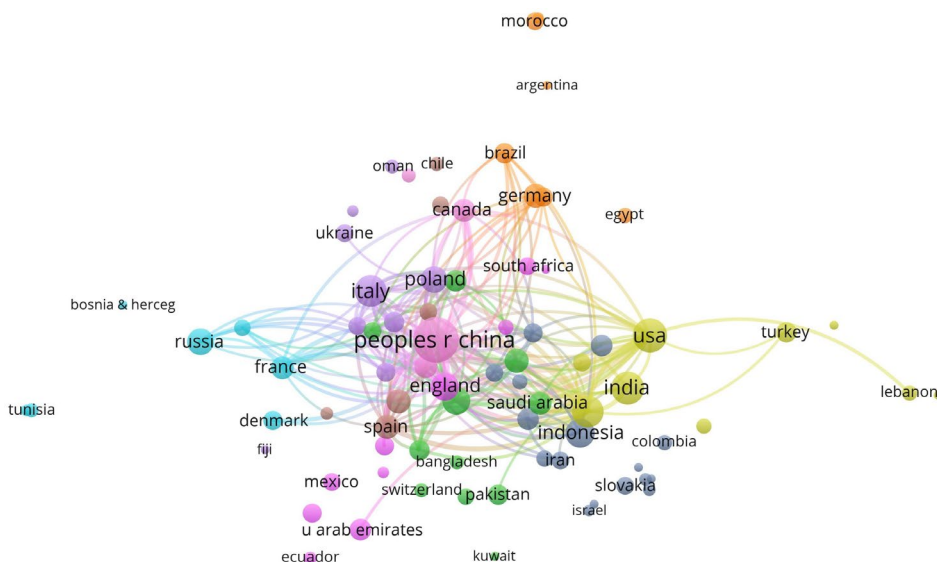


Figure 13. Citation visualization by countries in WOS

5. CONCLUSION

This study investigates the dynamic shifts in global research on smart city publications spanning the years 2017 to 2023. During this period, the topic of smart cities has garnered increasing significance, evidenced by an exponential surge in scholarly publications. This heightened interest is closely aligned with the urgent imperatives surrounding urban development and the quest for an elevated quality of life within cities worldwide. Employing a rigorous bibliometric analysis based on two prominent databases, Scopus and WOS, the study not only elucidates the remarkable growth in smart city literature but also offers valuable insights into the state and trajectory of this research domain.

By comprehensively surveying the landscape of smart cities research, the study contributes to a nuanced understanding of its evolution. The findings underscore the pivotal role that smart cities can play in addressing the challenges posed by burgeoning urban populations.

As cities continue to expand, smart city initiatives emerge as a promising avenue for fostering sustainable development and enhancing the overall well-being of millions of urban residents globally. In recognizing the potential of smart cities, it becomes apparent that further research in this field is imperative for successful development and implementation. This study serves as a stepping stone, highlighting the current state of smart cities research and emphasizing the continued need for exploration and innovation to fully harness the transformative potential that smart city initiatives hold for the future of urban living.

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