BIBLIOMETRIC REVIEW OF LITERATURE ON SUSTAINABLE, SMART, AND GREEN CITIES

JYOTI PAUL*, RAJESH KUMAR ABHAY**[1], GAURAV SIKKA***

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Abstract. Sustainable, smart, and green cities are developed to improve residents' quality of life through various approaches. They stress the application of the Internet of Things in various fields. A green smart city tries to combine digital and technology-based advanced solutions in urban areas with sustainable practices. The present study employs a Bibliometric analysis to examine scientific publications in the field of smart, sustainable, and green cities based on various parameters such as publications, authorship, citations, journals, and countries. The data is collected from the Web of Science database. The terms used to extract data were 'Green Smart Cities' and 'Sustainable Smart Cities'. Using the search keyword, 5,393 documents were obtained in the initial run, whereas 3,089 publications which include the most relevant areas were finally selected for the analysis. The study identifies that the work of Smart Cities in Europe by Caragliu (2011) is the most cited research in the field. The study also found that '*Sustainable Cities and Society*' and '*Sustainability*' are the most significant Journals in the area along with '*Cities*' and *'Journal of Cleaner Production*'. Researchers in China are doing their utmost best regarding smart and sustainable cities in the different cities of the world. It is expected that this scientometric analysis complement the researchers in understanding and monitoring the direction of research in the field of sustainable and smart cities.

1. INTRODUCTION

Building Sustainable, smart, and green (SSG) cities is becoming increasingly popular as a solution to problems with unsustainable urbanization, population expansion, environmental concerns, and unplanned development (Bai *et al.*, 2017; Nuissl and Siedentop, 2021). This is evident in the cities of both developed and developing countries. The ideas of SSG cities have been formed in accordance with planning approaches in different parts of the world in order to unfold new ways of urbanization (Kotb *et al.*, 2021; Breuste *et al.*, 2023).

Over the years, the process of urbanization has been haphazard due to which cities experienced disorganized sprawl at the cost of their natural environment. Agricultural land was converted into different land uses, forests were cut to develop infrastructure, river courses shrunk due to encroachment, and many more. Currently, most of the cities of the world are experiencing environmental problems, particularly in the developing world. In response, the planners and decision-makers came up with the idea of planned urbanization through green development along with technological-oriented smart urbanization leading to sustainable cities. Here, a sustainable city is a broad concept that is socially inclusive, economically viable and environmentally-sustainable.

Sustainable cities have been defined in many ways. UN-Habitat (2009) defined the sustainable city as the city that contributes to the improvement in quality of life along with services and

* Ph.D., Associate Professor, Department of Commerce, Dyal Singh College, University of Delhi, New Delhi, India, jyotipaul@dsc.du.ac.in.

** Ph.D., Assistant Professor, Department of Geography, Dyal Singh College, University of Delhi, New Delhi, India, rkabhay@dsc.du.ac.in.

*** Ph.D., Assistant Professor, P.G. Department of Geography, A.N. College, Patliputra University, Patna, Bihar, India, gauravsikkageo@gmail.com.

[1] Corresponding Author

opportunities. It is also stated that sustainable cities are socially inclusive, economically productive and environmentally liveable cities. The European Commission (2015) stated that sustainable cities not only better the quality of life, but also enhance the socio-economic, cultural, and politico-institutional aspects of life without increasing the burden on future generations. Sustainable cities are thought of as locations that are developed and run with a primary emphasis on the socio-economic and environmental effects while also considering the needs of coming generations (ARCADIS, 2018; Kotb *et al.*, 2021). In certain ways, it is obvious that sustainable cities are those that are designed with the socio-economic and environmental components to achieve a better quality of life, as well as the opportunity for future generations to grow and develop. They also promote human interaction by attracting people, culture and trade (Cohen, 2018).

The goal of creating smart cities is to give their citizens an improved quality of life. They emphasize the effective use of technology to provide essential urban services in a sustainable manner, as well as the use of technology and the Internet of Things (IoT) across various fields (Silva *et al*., 2018). The European Commission (2024) states that a "smart city" includes interactive city management, safer public areas, effective water supply and lighting systems, and efficient urban transit networks. In other words, a smart city makes good use of ICT to improve the standard of living for urban dwellers. The future form of urbanization will have components of SSG cities. Addas (2023) states that a smart city is one that has a smart economy, people, environment and governance.

A green city is based on the principle of being 'in balance with nature' (Breuste, 2023). It aims to have more green spaces within the cities. The concept believes in promoting urban nature in the form of urban parks, forests, trees etc. According to Breuste *et al.*, (2023), the green city concept incorporates solutions based on nature to report global issues like biodiversity loss, climate change etc. A green smart city is an innovative concept that has an network of digital and technology-based advanced solutions in urban areas. These cities act as ideas for future urban forms that will solve environmental issues on a global scale and will contribute by improving living conditions for people in the cities of developed and developing countries.

The most recent developments, leading themes, and existing gaps in a certain field of study could be visually and geographically represented using bibliometric techniques (van Eck and Waltman, 2010). The literature indicates that bibliometric research in the field of smart cities is sparse, with few studies conducted on this topic. The current study encompasses both smart cities and a synthesis of smart, sustainable and green cities within its search query, which is crucial for the SSG literature to obtain bibliometric results. Jainik *et al*. (2020) have done a bibliometric review on smart and sustainable cities by compiling studies from 2015–2020. Shao and Min (2025) have performed similar work and reviewed the sustainable development framework in smart cities from studies using Biblioshiny. Pérez *et al.* (2020) have performed a bibliometric review on smart cities literature from the publications issued between 1991–2019. Valencia-Arias *et al.* (2025) analysed research trends regarding sustainable development in smart cities, reinforcing the concept of an expanding, interdisciplinary domain centred on the integration of sustainability indicators and policy effects. However, all the studies have used the Bibliometric analysis; the keywords have changed the analysis. Our study focuses on SSG literature and is bibliometric on the top three domains in the area, while the period we focused on was 2002–2024, with 3,089 publications. This paper is an extension for the growing research in the bibliometric analysis of SSG cities.

The primary motivation for the study is the sparse literature on SSG cities and the emphasis on the aspects of research in this domain. In the study, Bibri (2018) outlines all three elements and emphasizes green and sustainable smart cities. A knowledge gap persists in the domain, necessitating this investigation to ascertain the methodologies employed by diverse researchers in the subject. The paper also takes a new methodology of scientometric analysis to find out the answers to the following research questions:

1. What are the major sources of publication in the area of sustainable, smart, and green cities?

2. Which research articles are the most cited in this area?
3. Who are the major contributing scholars in this area?
4. Which countries are doing major research in this area?
5. What are the realms of research of SSG literature in which future research can be undertaken?

This work contributes to the sparse current literature by offering a scientometric review and revealing new research themes in the field of smart cities. This paper sheds light on the extensive multidisciplinary literature on SSG, guiding future research endeavours.

2. DATA SOURCE AND METHODS

The present study represents a thorough bibliometric analysis of the Smart, Sustainable and Green cities work undertaken to this date. SSG is viewed as a comprehensive idea, and an analysis of it makes it evident where research in the SSG literature is headed. The search keywords were selected after reading related works on green cities, smart cities, and sustainable cities literature. A set of pertinent keywords was meticulously selected to aptly encapsulate the essential information. The keywords used to extract data from the Web of Science (WoS) database were “Green Smart Cities” and “Sustainable Smart Cities”. These search terms were selected in order to retrieve articles about combining the study of smart cities with that of sustainable and green cities so that a thorough analysis of these studies can be summarized by reviewing them.

Using the search keyword, 5,393 documents were obtained from the Web of Science database, which was chosen as 99.11% of the journals indexed in WoS are also indexed in Scopus (Singh *et al.*, 2021) in the initial run (Fig. 1). After the initial query, the search was narrowed down to WoS categories of Green Sustainable Science Technology, Environmental Science, and Environmental Studies, which were the top three domains having the highest publications in the area. Subsequently, we narrowed the search to include the most relevant areas and Urban Studies, Regional Urban Planning, Geography, Management, or Business were the only ones included. Then, other criteria were applied to the date of publication, selecting articles from 2002 to 2024. In 2002, the World Summit on Sustainable Development was held in Johannesburg, South Africa, also referred to as Earth Summit 2002, which marks an important watershed in the discourse on sustainability and environment conservation. Finally, 3,089 publications were selected for the analysis. This initial extraction was carried out on January 22, 2024. The study represents an innovative effort to determine the trend of growth in this field and identify future research directions. The study uses VOS viewer software to visually analyse relevant journals, top authors, domains of research and countries doing research in the area.

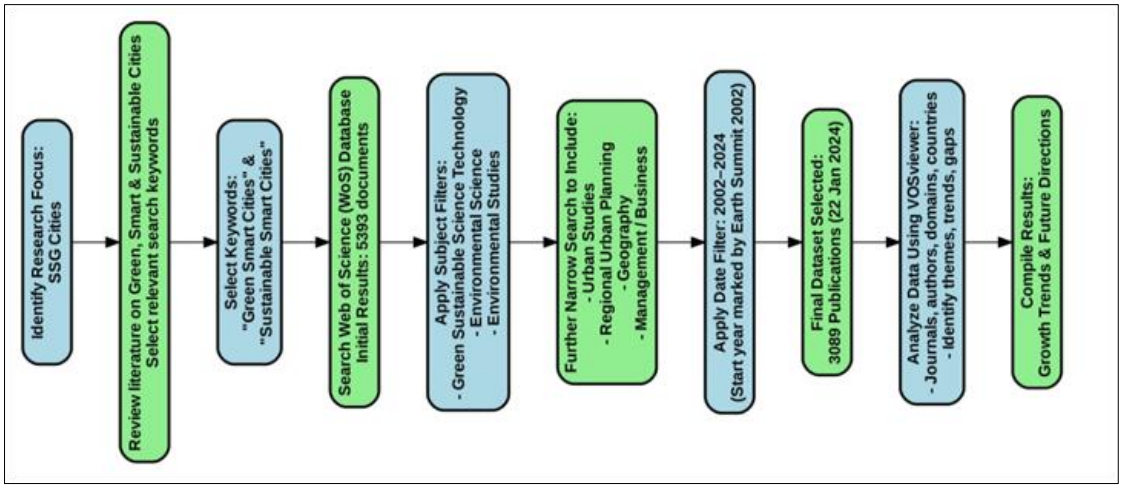

Fig. 1 – Systematic representation of the adopted methodology for bibliometric analysis.

Table 1 presents a profile of research papers being used for the scientometric analysis in this paper. There are a total of 3,089 publications spanning over the 2002–2024 period. There were already 314 review papers with different dimensions and fields of study related to Green Smart cities. According to the study's preliminary results, 9,843 authors have worked in this area.

Table 1

Major information about data

Particulars	Results
Time period	2002–2024
Total sources	269
Total number of documents	3,089
Average citation of each document	26.44
Keywords	4,590
Total Authors	9,843
Single Authors documents	190
Co-authorship in %	39.79%

3. RESULTS AND DISCUSSION

3.1. Annual Scientific Production

Research on Green smart cities is a relatively new area and, based on our dataset, we found that the first article was published in 2002, as per our data query (Fig. 2). The concept "smart city" was established in 1994 when examining the subject of how to change a slumbering city into a smart city using telecommunication services. Since 2010, there have been projects of smart cities which were supported by the European Union (Guo *et al.*, 2019). The research area has been stagnant during the first 10 years and has started growing steeply since 2015. There has been a 12.5% growth rate in research publications in this domain. The reason for such a progressive trend has been the importance of smart cities, since it has also been recognised as a goal by the United Nations in its Sustainable Development Goals (SDGs). Since 2015, authors from diverse fields, from environment to urban studies, and from IT to management, have been working on different aspects of smart cities. The year 2023 shows the highest number of publications and the publications across the globe have exceeded 200 in the 2023.

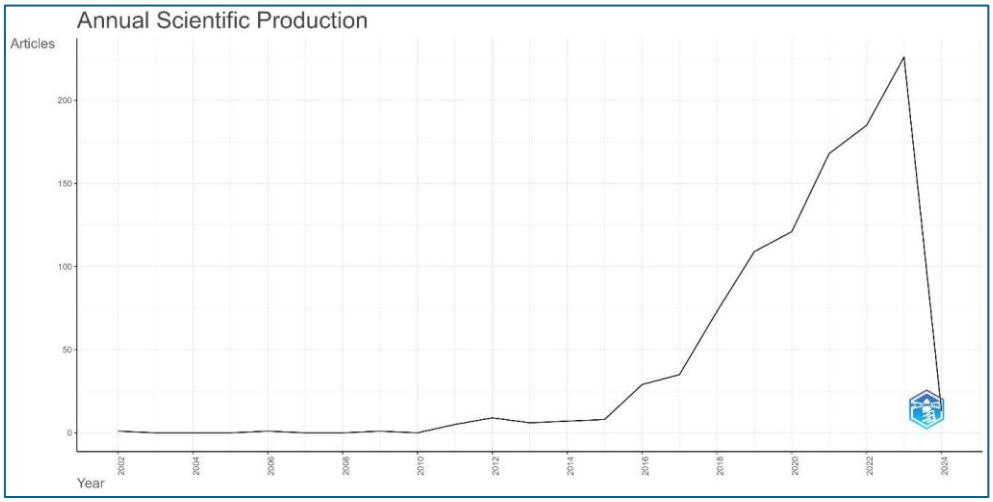

Fig. 2 – Annual scientific production of research on sustainable smart and green cities.

3.2. Source of Publications

The VOS viewer's minimum document count was set at 10. A total of 37 out of 269 journals that were extracted from the WoS database responded to this requirement. The groups of sources of research and the connections between them are shown in Figure 3. The citation information of the source was used to determine the influence of the journal in the Sustainable Smart Cities research domain (Table 2). It clearly shows that the journal '*Sustainable Cities and Society*' is top-tier and has the highest number of citations. Based on our search query, '*Sustainable Cities and Society*' has 797 articles related to sustainable smart cities research. The number of citations of this journal in total up to the date of the search query is 26,406. '*Sustainable Cities and Society*' is followed closely by the journals '*Sustainability*' and '*Cities*', which rank second and third, respectively. The '*Journal of Cleaner Production*' has more publications than '*Cities*' and 6,666 citations, but the total link strength was 686, so it ranks fourth although it has more publications than '*Cities*'.

Figure 3 also shows that '*Sustainable Cities and Society*' and '*Sustainability*' are the most significant Journals in the field, followed by '*Cities*', '*Journal of Cleaner Production*' and, in fifth place, '*Technological Forecasting and Social Change Journal*'. The paper has quantified the most significant Journals based on Total Link Strength; evidently, '*Sustainable Cities and Society*' and '*Sustainability*' are the most authoritative sources in this field, showing many works in this domain.

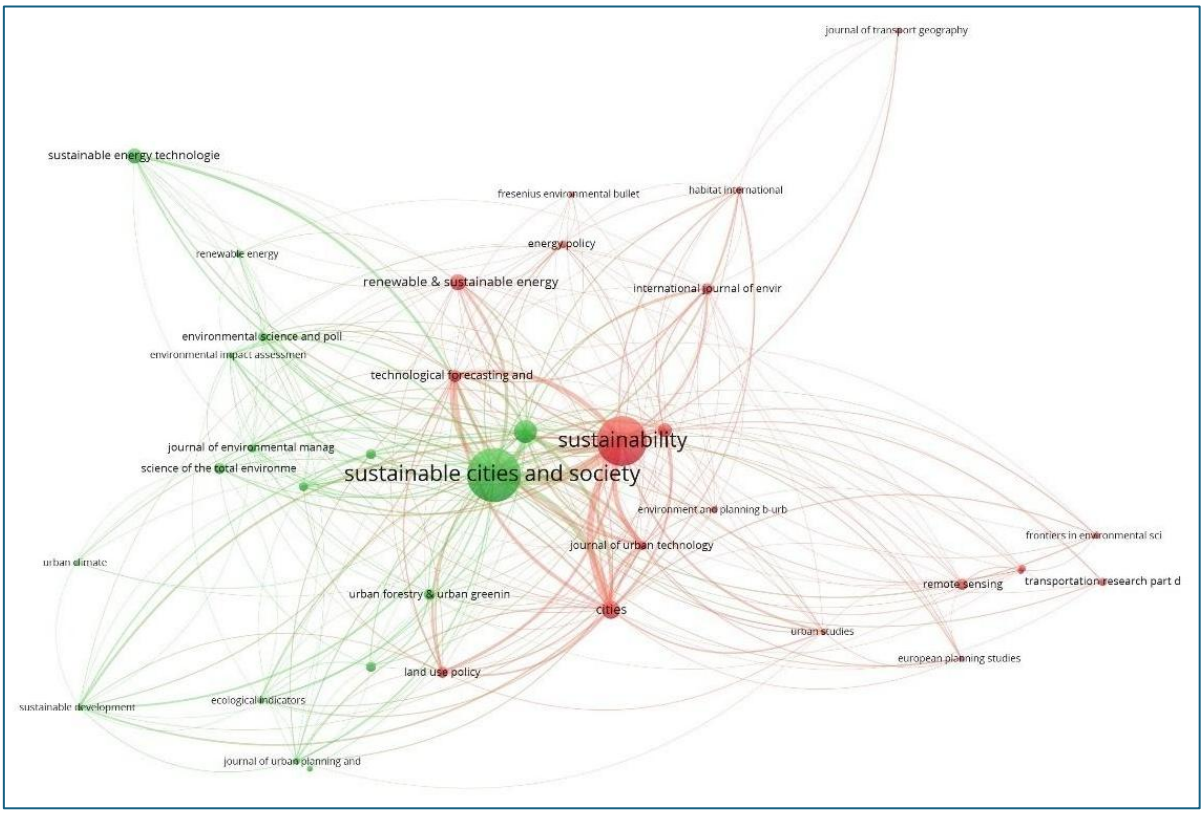

Fig. 3 – Major Sources of Research (Source: VOS Viewer).

Table 2

Major Publication Sources

S. No.	Publication Source	Documents retrieved	Citations	Total Link Strength
1.	Sustainable Cities and Society	797	26,406	1,653
2.	Sustainability	693	8,652	1,552
3.	Cities	97	4,381	875
4.	Journal of Cleaner Production	154	6,666	686
5.	Technological Forecasting and Social Change	40	2,789	484
6.	Journal of Urban Technology	23	3,000	412
7.	Land	56	313	188
8.	Land Use Policy	37	1,052	165
9.	Renewable & Sustainable Energy Reviews	75	3,699	138
10.	Sustainable Development	12	261	104
11.	Environment Development and Sustainability	24	333	90
12.	International Journal of Environmental Sustainability	35	581	89
13.	Sustainable Energy Technologies	69	862	83
14.	Urban Studies	11	835	77
15.	Environmental science and Pollution Research	25	232	73
16.	Habitat International	14	519	68
17.	Environment Impact Assessment Review	12	156	62
18.	Journal of Urban Planning and Development	16	128	61
19.	Ecological Indicators	15	290	58

3.3. Keyword Cooccurrence

Future research directions can be found by conducting a systematic analysis of keywords, which is a primary focus of the research discussion. The keyword analysis is essential to determine keywords and the researchers who employ those keywords from different fields to determine the overall knowledge structure of the domain. The VOS viewer was used to analyse the keywords of published works, with the minimum requirement for keyword occurrences set to 11. 115 keywords out of 9,515 met the threshold limit. The keywords with similar connotations, such as *city/cities*, *IoT/internet of things*, *AI/Artificial intelligence*, and other similar words, were subsequently excluded. The final keywords used for visualization were reduced to 77 of the most relevant words (Table 3).

Table 3

Selected keywords having more than 50 total link strength

Keyword	Occurrences	Total Link Strength
Smart City	451	561
Smart Cities	323	462
Sustainability	256	442
Sustainable Development	115	170
Internet of things	100	157
Urban Planning	68	119
Artificial Intelligence	49	112
Machine learning	71	100
Big Data	50	90
Sustainable Cities	58	90
ICT	37	89

Table 3 (continued)

Keyword	Occurrences	Total Link Strength
Smart Grid	67	89
Sustainable City	45	89
IOT	41	69
Climate Change	47	68
Covid-19	50	68
Governance	33	67
Resilience	31	67
Blockchain	35	66
Sustainable Urban Development	51	66
Technology	25	62
Deep learning	47	61
Energy Efficiency	61	61
Renewable Energy	56	60
Urban Development	30	58
Sustainable Development Goals	39	57
Environment	28	56
Urban Sustainability	49	56
Circular Economy	44	55
Cities	32	54
Innovation	28	54
Smart mobility	36	54

Figure 4 shows the density of the relevant keywords used by authors. *Smart cities*, *sustainability*, *urban planning*, *IOT*, *AI*, *Urban Planning*, *Circular economy*, *Machine learning*, *ICT*, and *big data* were the most frequently used keywords. The strongest keyword connections could be seen between *smart cities* and *sustainability*. The node size shows the frequency of keywords with the larger nodes showing more such occurrences. And the proximity of keywords to each other shows the connection between such keywords. *IoT*, *Big data* and *mobility* are closely connected, as shown in Figure 4. *Similarly*, *smart grid*, *electric vehicles*, and *demand side management* are other close keyword clusters. Additionally, we also found *green infrastructure*, *ecosystem services*, and *air quality* to be closely connected.

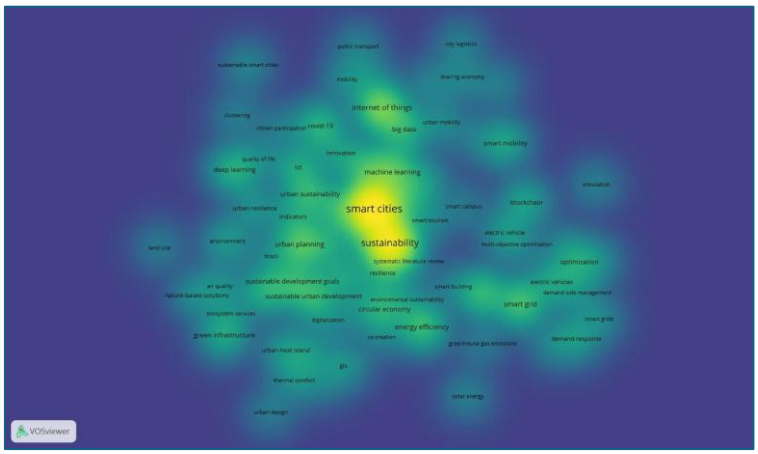

Fig. 4 – Density of keywords used by authors.

3.4. Co-Authorship Analysis

The authorship collaboration analysis reflects the dimensions of research in which different authors are working in collaboration with each other. To analyse this aspect, the minimum number of published works by authors was considered 5, whereas the minimum citations of work settled on as 2 in the software for a better representation of the results of co-authorship. This was set so as to generate a meaningful diagram as per the dataset. Different realms of work have originated in Green or sustainable smart cities.

Figure 5 shows clusters of research in different dimensions of sustainable smart cities. A prominent co-authorship was observed among Joss Simon, Martin De Jong and Schraven Robb. A very prominent research work by Simon coauthored with De Jong (2015) is an article titled "Sustainable–smart–resilient–low carbon–eco–knowledge cities making sense of a multitude of concepts promoting sustainable urbanization" published in the *Journal of Cleaner Production*.

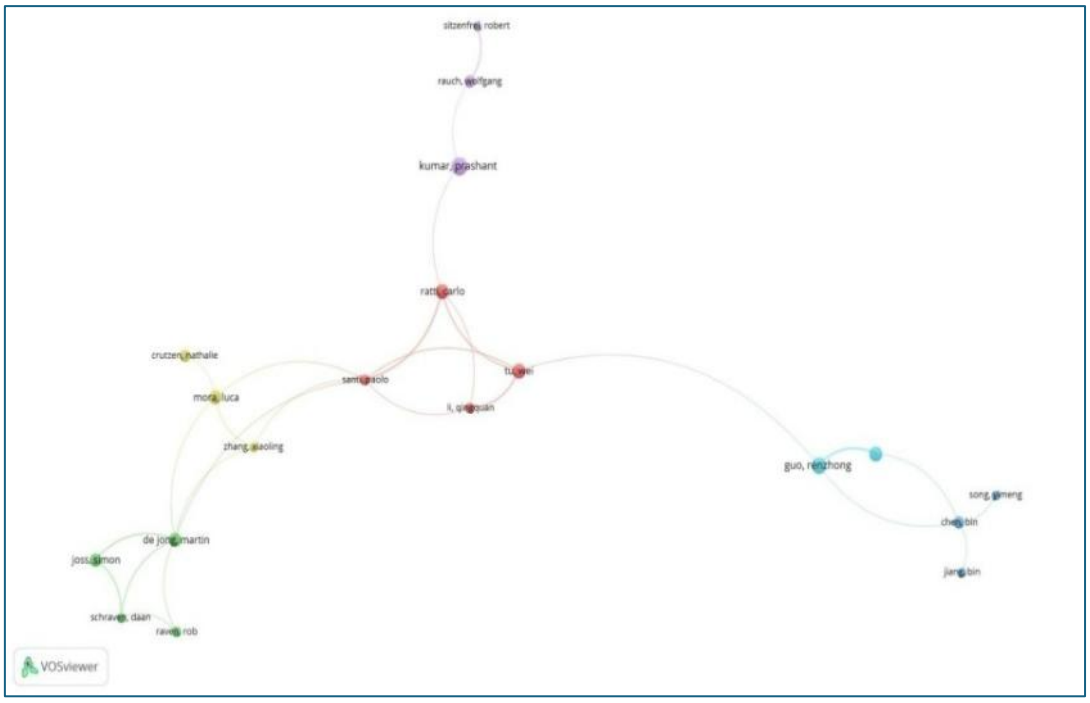

Fig. 5 – Research clusters in different dimensions of sustainable smart cities.

Prashant Kumar has coauthored with various authors from time to time and has made significant contributions in the areas of air quality and air pollution. Some of his famous coauthored works are "A Citizen Science Approach for Enhancing Public Understanding of Air Pollution" in *Sustainable Cities and Society* and "Green Infrastructure for Air Quality Improvement in Street Canyons" in *Environment International* (Mahajan *et al.*, 2020; Tomson *et al.*, 2021).

Guo Renzhong is from Wuhan University in China and has also coauthored many works and has substantial works in smart cities dimensions like roof greening and urban buildings. Because of the criteria set in the VOS viewer, we have received a smaller network of authorship, but many authors have contributed to research in this area and have different collaborations with authors at times; hence, a much narrower map is issued by the VOS viewer search query (Hong *et al.*, 2019).

3.5. Globally-cited Authors

Figure 6 shows the most cited documents, globally. Caragliu's (2011) has been the most cited document of all time. The article has focused on providing an in-depth and operational definition of a smart city in the case of EU27. The second-most cited document globally is Silva and Khan's (2018) which dealt with the review of smart cities while keeping the ICT in focus. Bibri and Krgstie's (2017) have done an extensive review and given in-depth knowledge on the future of smart and sustainable cities. De Jong *et al.* (2015) try to find conceptual differences and interrelationships among twelve dominant city categories, which is a pioneering work using scientometric analyses differentiating closely related terms like *smart*, *green*, *eco-city*, *resilient city* etc. Ahvenniemi *et al.* (2017) analysed various indicators to understand the differences between the concept of smart and sustainable cities, and recommended the use of the term *sustainable smart cities* as more appropriate taking into account environmental, social and economic dimensions.

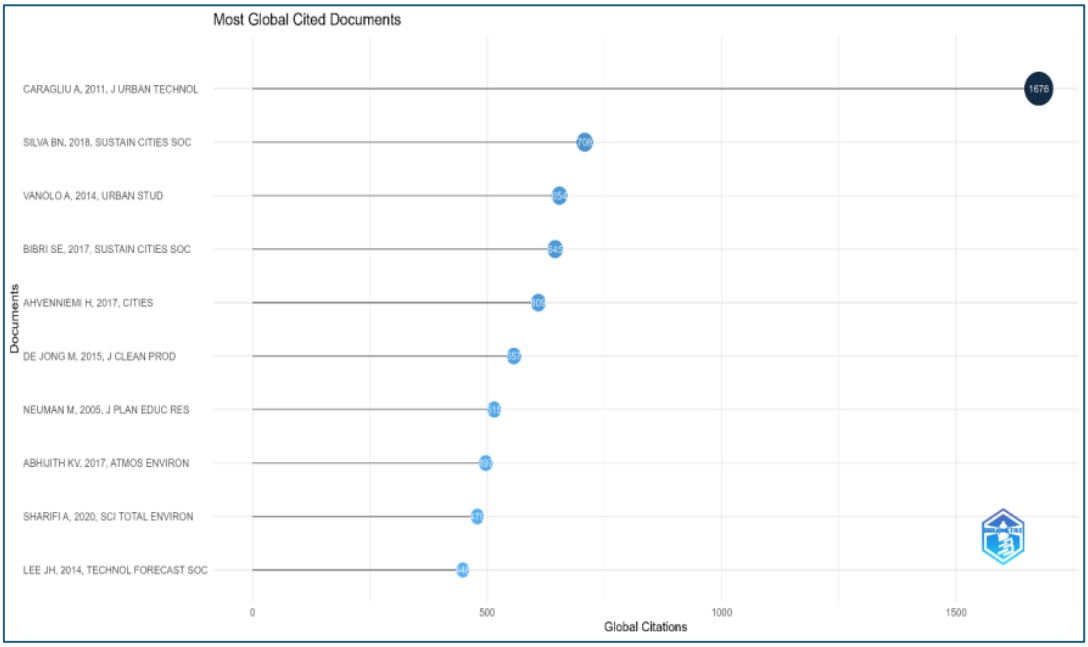

Fig. 6 – Most cited documents, globally.

3.6. Countries Performing Research on SSG Cities

In the VOS viewer, the minimum quantity of publications per nation was set at 25, while the minimum quantity of citations per nation was set at 50. 41 of the 117 nations responded to this requirement (Table 4). Using the VOS programme, these factors were subsequently used to determine and assess each nation's contribution to the global research of green smart cities. Figure 6 shows the most cited documents, globally, related to SSGs.

Figure 7 shows the prominent countries pursuing research in the field of green smart cities. Clearly, three groups can be identified. China, India, UAE, Portugal, Malaysia, Turkey, Iran, Canada, and Denmark are closely working with each other. The other group has prominent European nations like England, the USA, Germany, Netherlands, Switzerland, Ireland, as well as South Africa and Russia collaborating in this group with prominent developed European nations. Another small group in Blue consists of countries like Japan, Norway, Singapore, and France working closely in this domain.

The participation of countries across the globe shows that the awareness and interest of nations regarding this research is significant and not only developed but Asian countries are also doing research in green smart cities.

China, the USA and England have the most citations of their documents. It can be attributed to the level of scientific advancement in these countries. India has 5,035 citations with its 221 documents as per the criteria set in the VOS viewer. We can notice a good mix of developed and developing countries in the Top 10. Moreover, as the clusters show, many developing countries, such as China, India, Pakistan, Brazil, Saudi Arabia, Turkey, etc. are working on the topic of green, sustainable and smart cities.

Table 4

Top 10 countries as per the highest link strength

S. No.	Country	Documents	Citations	Total Link Strength
1	China	745	16,252	3,624
2	England	295	11,253	2,904
3	Italy	255	9,830	2,607
4	USA	379	12,864	2,381
5	Australia	209	8,191	2,091
6	South Korea	190	5,653	1,866
7	Netherlands	154	6,948	1,706
8	India	221	5,035	1,479
9	Brazil	103	3,189	1,351
10	Spain	192	4,674	1,309

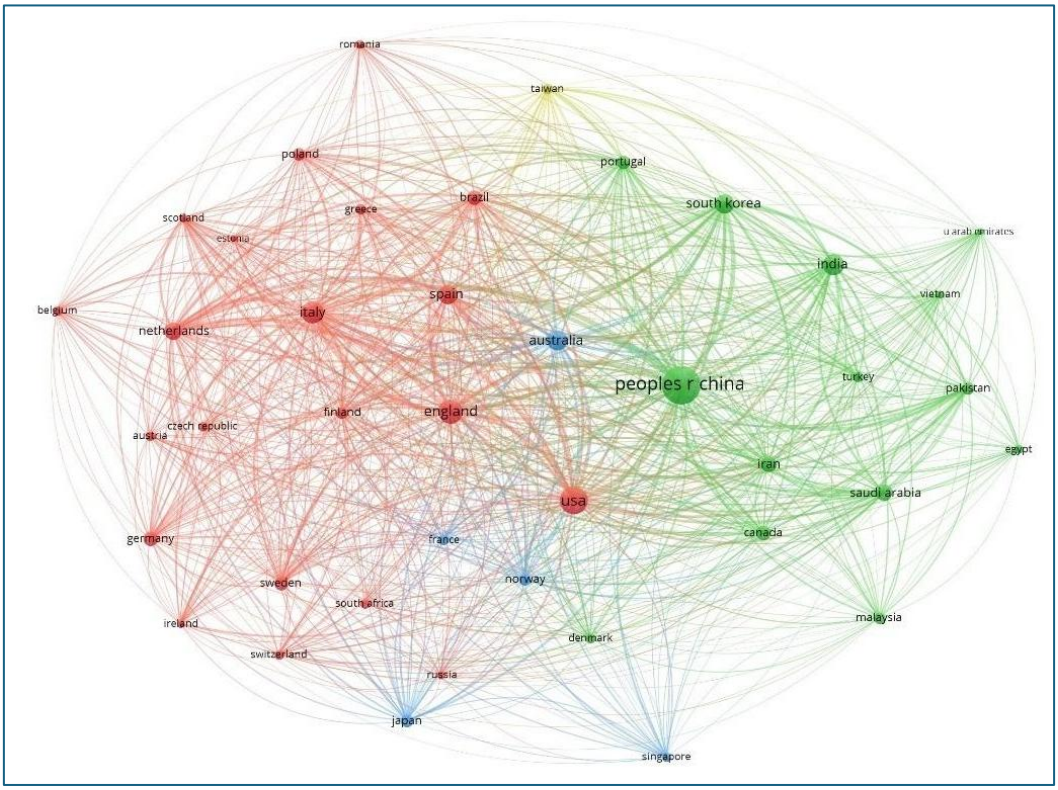

Fig. 7 – Countries with link strength.

3.7. Publications

Publications in any area display the direction and scope of research. The top 99 items can be divided into seven clusters depicting the realms of research in the area of Smart cities. The Red cluster has publications by Heidari *et al.* (2022), Chen *et al.* (2021), Wu *et al.* (2023), and Laufs *et al.* (2020) have all dealt with new technologies, cyber security and smart cities. The second group of research, as reflected in dark green, has dealt with the subject of Smart and Sustainable cities. The studies by Yigitcanlar and Kamruzzaman (2019), Yigitcanlar and Kamruzzaman (2018), Yadav *et al.*, (2019) and de Jong *et al.* (2015) have dealt with sustainability and its interconnectedness with smart cities, and the multidimensionality of smart cities. The third cluster, depicted in dark blue, deals mainly with urbanisation and smart city literature. Prominent works are that of Caragliu *et al.* (2011), Haarstad (2016), and Cowley *et al.* (2017) (Fig. 8).

The fourth cluster deals with the issue of energy management and smart cities. The prominent research in this field is Calvillo *et al.* (2016), Hoang *et al.* (2021), and Hui *et al.* (2023). These studies deal with the environmental aspect of smart city literature. The fifth cluster of publications (in purple) deals with smart city assessment frameworks and indicators. Different authors have worked on the various dimensions of smart city assessment tools, and this cluster is marked by studies from this area, such as famous works by Ahvenniemi *et al.* (2017), Sharifi (2020), Dall'O' *et al.* (2017), and Akande *et al.* (2019).

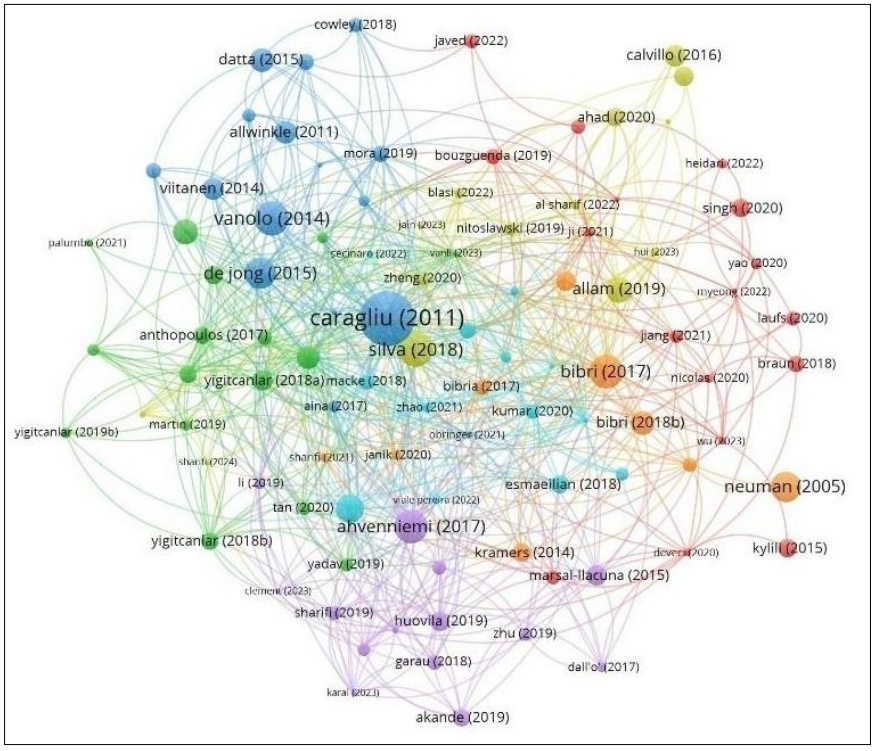

Fig. 8 – Publication clusters.

The sixth cluster, indicated in light blue, has studies by Kumar *et al.* (2020), Dai *et al.* (2024), Camboim *et al.* (2019), Shamsuzzoha *et al.* (2021), and Pereira *et al.* (2022). These studies have discussed the smart city transformation process, using technology as a mediator. Most of the studies in this group deal with different dimensions of how to make cities smart and their future trajectories.

All the studies in this cluster have tried to find ways to develop smart, sustainable cities. The last group, the seventh cluster, is depicted in orange. Those in this cluster have reviewed studies and foundational studies on Smart city literature. The famous studies in this group are Bibri and Krogstie (2017), Bibri (2018b), and Janik (2018).

4. CONCLUSIONS

The present study employed a bibliometric analysis to visualize a comprehensive picture of research on SSG over time, countries and domains. The full records were extracted from the WoS database between 2002 and 2024 during the bibliometric search, resulting in a sample size of 3,089 articles after excluding certain domains based on their relevance to the theme. The science map was created and data on keywords, co-authorships, citations, and nations with active research were analysed using the scientometric method.

This bibliometric review is an attempt to identify the underlying dimensions in which authors and nations are working in the field of Sustainable Smart Cities research. The primary analysis of publications shows that this research area is evolving and has significant contributions, particularly after 2015, which was the year when SDGs were announced and one such goal focused on Smart cities. The number of authors working in this area is staggering, as proven by the 9,843 articles. The variety of publications shows the authors are working in different fields. The authors are still working on the distinction between smart, sustainable, green, intelligent, cities, or urban areas. The keyword analysis also emphasized that authors are using *sustainability*, *smart cities*, *urban planning*, *ICT*, *resilience*, as well as newer keywords, such as *deep learning*, or *solar energy* to explore the smart cities concept from all perspectives. The points of view vary, from air quality, air pollution, to net zero emissions, to the impact of solar energy in smart city research, and the role of ICT in making cities smarter.

China is clearly at the top in terms of publications in sustainable smart cities research. China has become a global leader in smart city initiatives over the past 10 years, proving the importance of smart city development to the point that it has been integrated into national strategy (Janus, 2021). The USA has the second most numerous publications but the gap between China and the USA is wide. The USA is closely followed by England, Italy, Australia and India. But a positive sign in smart cities research is that countries across the globe, be they Vietnam, Pakistan, Taiwan or even Czechia, Japan etc. countries from Europe, Asia, Australia, or the USA, each are contributing to sustainable smart cities research. China has 16,252 citations to its publications, showing its authority in the area.

The study provides subtle differences in the terms *sustainable cities*, *smart cities* and *green cities*. Papers like Bibri (2018a), which came out as one of the significant papers using bibliometric analysis, reveal their distinctions clearly. The review paper compiles these definitions and gives authors a way forward for future research. The literature reveals that these terms are often conflated, leading to conceptual ambiguity. An in-depth, clear knowledge of SSG cities is required for policy-making and the development of standardized metrics for city performance.

The study reveals early research centred on sustainability, urban planning, and ICT. More recent works incorporate keywords like *resilience*, *blockchain*, *solar energy*, and *net-zero emissions*, indicating a broadening scope. While multidimensionality is valuable, the field risks fragmentation if clear conceptual frameworks are not established. Research sometimes becomes siloed (e.g., focusing only on technology or only on environmental aspects) rather than integrative. Future research should aim to clarify and integrate these overlapping concepts, possibly through unified frameworks that address environmental, technological, social, and economic dimensions. Collaboration between urban planners, technologists, environmental and social scientists is essential to addressing the full spectrum of urban challenges.

While the research work provides a detailed view, its certain limitations must be acknowledged. Firstly, this paper uses only one research database, which is WoS, and secondly, the VOS software only includes studies published in the English language and other regional languages, and therefore, excludes studies conducted in other languages. In the future, more comprehensive studies using Scopus, Dimensions and other databases can be conducted to enhance conclusions. Furthermore, as the research areas in Sustainable Smart cities are very wide and deal with areas of ICT, Urban studies, management, architecture, and sciences, a detailed review of works in the particular areas can be undertaken to bring out contributions, challenges and opportunities in each area to help practitioners in making cities sustainable, smart and green.

REFERENCES

Addas, A. (2023), *The concept of smart cities: a sustainability aspect for future urban development based on different cities*, Frontiers in Environmental Science, **11**: 1241593, DOI: https://doi.org/10.3389/fenvs.2023.1241593.

Ahvenniemi, H., Huovila A., Pinto-Seppä I., Airaksinen M. (2017), *What are the differences between sustainable and smart cities?*, Cities, **60**: 234–245, DOI: https://doi.org/10.1016/j.cities.2016.09.009

Akande, A., Cabral P., Gomes P. et al. (2019), *The Lisbon ranking for smart sustainable cities in Europe*, Sustainable Cities and Society, **44**: 475–487. DOI https://doi.org/10.1016/j.scs.2018.10.009.

ARCADIS (2018), *Citizen centric cities: sustainable cities index-2018*. *Citizen Centric Cities: The Sustainable Cities Index 2018*, Retrieved July 27, 2024, from https://www.arcadis.com/campaigns/citizencentriccities/images/%7B1d5ae7e2-a348-4b6e-b1d7-6d94fa7d7567%7Dsustainable_cities_index_2018_arcadis.pdf.

Bai, X., McPhearson T., Cleugh H. et al. (2017), *Linking urbanization and the environment: conceptual and empirical advances*, Annual Review of Environment and Resources, **42**: 215–240, DOI: https://doi.org/10.1146/annurev-environ-102016-061128.

Bibri, S.E. (2018a), *Conceptual, Theoretical, Disciplinary, and Discursive Foundations: A Multidimensional Framework*. In: Smart Sustainable Cities of the Future. The Urban Book Series. Springer, Cham. https://doi.org/10.1007/978-3-319-73981-6_2.

Bibri, S.E. (2018b), *A foundational framework for smart sustainable city development: theoretical, disciplinary, and discursive dimensions and their synergies*, Sustainable Cities and Society, **38**: 758–794, DOI: https://doi.org/10.1016/j.scs.2017.12.032.

Bibri, S.E., Krogstie J. (2017). *Smart sustainable cities of the future: an extensive interdisciplinary literature review.* Sustainable Cities and Society, **31**: 183–212. https://doi.org/10.1016/j.scs.2017.02.016.

Breuste J. (2017), *The green city: general concept*. In J. Breuste, M. Artmann, C. Ioja, and S. Qureshi (eds.) Making Green Cities: Concepts, Challenges and Practice. Cities and Nature. 2nd eds. Cham: Springer, pp. 3–18. DOI: https://doi.org/10.1007/978-3-030-73089-5_1.

Calvillo, C.F., Sánchez-Miralles A., Villar J. (2016), *Energy management and planning in smart cities*, Renewable and Sustainable Energy Reviews, **55**: 273–287, DOI: https://doi.org/10.1016/j.rser.2015.10.133.

Camboim, G.F., Zawislak P.A., Pufal N.A. (2019), *Driving elements to make cities smarter: evidences from European projects*, Technological Forecasting and Social Change, **142**: 154–167, DOI: https://doi.org/10.1016/j.techfore.2018.09.014.

Caragliu, A., Del Bo C., Nijkamp P. (2011), *Smart cities in Europe*, Journal of Urban Technology, **18**(2): 65–82. https://doi.org/10.1080/10630732.2011.601117.

Chen, D., Wawrzynski P., Lv Z. (2021), *Cyber security in smart cities: a review of deep learning-based applications and case studies*, Sustainable Cities and Society, **66**: 102655, DOI: https://doi.org/10.1016/j.scs.2020.102655.

Cohen, S. (2018), *The sustainable city*. New York: Columbia University Press.

Cowley, R., Joss, S., Dayot Y. (2017), *The smart city and its publics: insights from across six UK Cities*, Urban Research & Practice, **11**(1): 53–77, DOI: https://doi.org/10.1080/17535069.2017.1293150.

Dai, Y., Hasanefendic S., Bossink B. (2024), *A systematic literature review of the smart city transformation process: the role and interaction of stakeholders and technology*, Sustainable Cities and Society, **101**: 105112, DOI: https://doi.org/10.1016/j.scs.2023.105112.

Dall'O', G., Bruni E., Panza A. *et al.* (2017), *Evaluation of cities' smartness by means of indicators for small and medium cities and communities: a methodology for northern Italy*, Sustainable Cities and Society, **34**: 193–202, DOI: https://doi.org/10.1016/j.scs.2017.06.021.

DeJong, M., Joss S., Schraven D. *et al.* (2015), *Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization,* Journal of Cleaner Production, **109**: 25–38, DOI: https://doi.org/10.1016/j.jclepro.2015.02.004.

European Commission (2015), *Science for environment policy: indicators for sustainable cities*, (Revised March 2018). Retrieved July 27, 2024 from https://op.europa.eu/en/publication-detail/-/publication/cbaa6e59-437c-11e8-a9f4-01aa75ed71a1/language-en.

European Commission (2024), *Smart cities*, Retrieved July 27, 2024 from https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/city-initiatives/smart-cities_en

Guo, Y.-M., Huang, Z.-L., Guo, J. *et al.* (2019), *Bibliometric analysis on smart cities research*. Sustainability, **11**(*13*), 3606. https://doi.org/10.3390/su11133606.

Haarstad, H. (2016), *Constructing the sustainable city: examining the role of sustainability in the 'smart city' discourse*, Journal of Environmental Policy & Planning, **19**(*4*): 423–437, DOI: https://doi.org/10.1080/1523908X.2016.1245610.

Heidari, A., Navimipour N.J., Unal M. (2022), *Applications of ML/DL in the management of smart cities and societies based on new trends in information technologies: a systematic literature review*, Sustainable Cities and Society, **85**: 104089, DOI: https://doi.org/10.1016/j.scs.2022.104089.

Hoang, A.T., Pham V.V., Nguyen X.P. (2021), *Integrating renewable sources into energy system for smart city as a sagacious strategy towards clean and sustainable process*, Journal of Cleaner Production, **305**: 127161, DOI: https://doi.org/10.1016/j.jclepro.2021.127161.

Hong, W., Guo R., Tang H. (2019), *Potential assessment and implementation strategy for roof greening in highly urbanized areas: a case study in Shenzhen, China*, Cities, **95**: 102468, DOI: https://doi.org/10.1016/j.cities.2019.102468.

Hui, C.X., Dan G., Alamri S. *et al.* (2023), *Greening smart cities: an investigation of the integration of urban natural resources and smart city technologies for promoting environmental sustainability,* Sustainable Cities and Society, **99**: 104985, DOI: https://doi.org/10.1016/j.scs.2023.104985

Janik, A., Ryszko A. (2018), *Scientific landscape of smart city concept: a bibliometric analysis*, International Business Information Management Association Conference (IBIMA) – Vision 2020: Sustainable Economic Development and Application of Innovation Management from Regional Expansion to Global Growth, Seville, Spain 15–16 November 2018, pp. 6254–6266.

Janik, A., Ryszko, A., Szafraniec, M. (2020), *Scientific landscape of smart and sustainable cities literature: a bibliometric analysis,* Sustainability, **12**(3): 779, https://doi.org/10.3390/su12030779.

Janus, D. (2021), *Smart cities in China: sustainable or surveyed*. Sprawy Międzynarodowe. **74**. 149–170. 10.35757/SM.2021.74.1.04.

Kotb, H., El-Menshwy A., Beah T.H. (2021), *Sustainable cities*, The Egyptian International Journal of Engineering Sciences and Technology, **34**: 38–44. DOI: https://doi.org/10.21608/eijest.2021.66307.1054.

Kumar, K., Singh, M.K., Gupta M.P. et al. (2020), *Moving towards smart cities: solutions that lead to the smart city transformation framework*, Technological Forecasting and Social Change, **153**: 119281, DOI: https://doi.org/10.1016/j.techfore.2018.04.024.

Laufs, J., Borrion, H., Bradford B. (2020), *Security and the smart city: a systematic review,* Sustainable Cities and Society, **55**: 102023, DOI: https://doi.org/10.1016/j.scs.2020.102023.

Mahajan, S., Kumar P., Pinto J.A. *et al.* (2020), *A citizen science approach for enhancing public understanding of air pollution*, Sustainable Cities and Society, **52**: 101800, DOI: https://doi.org/10.1016/j.scs.2019.101800.

Nuissl, H., Siedentop S. (2021), *Urbanisation and land use change*. In T. Weith, T. Barkmann, N. Gaasch, S. Rogga, C. Strauß, J. Zscheischler, *ed*. Sustainable Land Management in a European Context. Human-Environment Interactions. Cham: Springer, pp. 75–99, DOI: https://doi.org/10.1007/978-3-030-50841-8_5.

Pereira, G.V., de Azambuja L.S. (2022), *Smart sustainable city roadmap as a tool for addressing sustainability challenges and building governance capacity*, Sustainability, **14**(*1*): 239. DOI: https://doi.org/10.3390/su14010239.

Pérez, L.M., Oltra-Badenes, R., Oltra Gutiérrez, J.V., Gil-Gómez, H. (2020), *A Bibliometric Diagnosis and Analysis about Smart Cities*, Sustainability, **12**(*16*): 6357. https://doi.org/10.3390/su12166357.

Shamsuzzoha, A., Nieminen J., Piya S. *et al.* (2021), *Smart city for sustainable environment: a comparison of participatory strategies from Helsinki, Singapore and London*, Cities, **114**: 103194, DOI: https://doi.org/10.1016/j.cities.2021.103194.

Shao, J., Min, B. (2025), *Sustainable development strategies for Smart Cities: review and development framework, Cities*, **158**: 105663. https://doi.org/10.1016/j.cities.2024.105663

Sharifi, A. (2020), *A typology of smart city assessment tools and indicator sets*, Sustainable Cities and Society, **53**: 101936, DOI: https://doi.org/10.1016/j.scs.2019.101936.

Silva, B.N., Khan M., Han K., (2018), *Towards sustainable smart cities: a review of trends, architectures, components, and open challenges in smart cities*, Sustainable Cities and Society, **38**: 697–713, DOI: https://doi.org/10.1016/j.scs.2018.01.053.

Singh, V.K., Singh, P., Karmakar, M. *et al.* (2021), *The journal coverage of web of science, scopus and dimensions: a comparative analysis*, *Scientometrics*, **126**: 5113–5142. https://doi.org/10.1007/s11192-021-03948-5.

Tomson, M., Kumar P., Barwise Y. *et al.* (2021), *Green infrastructure for air quality improvement in street canyons*, Environment International, **146**: 106288, DOI: https://doi.org/10.1016/j.envint.2020.106288.

UN-HABITAT (2009), *Planning sustainable cities: global report on human settlements 2009. united nations human settlements programme*, Earthscan, London. Retrieved July 27, 2024 from https://unhabitat.org/sites/default/files/download-manager-files/Global%20Report%20on%20Human%20Settlements%202009%20Planning%20Sustainable%20Cities.pdf.

Valencia-Arias, A., Martínez Rojas, E., García Pineda, V. *et al.* (2025), *Research trends on sustainable development in smart cities*. Discov Sustain, **6:** 369 https://doi.org/10.1007/s43621-025-01210-z.

van Eck, N.J., Waltman, L. (2010), *Software survey: VOSviewer, a computer program for bibliometric mapping, Scientometrics*, **84**: 523–538. https://doi.org/10.1007/s11192-009-0146-3.

Wu D., Xie Y., Lyu, S. (2023), *Disentangling the complex impacts of urban digital transformation and environmental pollution: evidence from smart city pilots in China*, Sustainable Cities and Society, **88**:104266, DOI: https://doi.org/10.1016/j.scs.2022.104266.

Yadav, G., Mangla S.K., Luthra S. *et al.* (2019), *Developing a sustainable smart city framework for developing economies: an Indian context,* Sustainable Cities and Society, **47**: 101462, DOI: https://doi.org/10.1016/j.scs.2019.101462.

Yigitcanlar, T., Kamruzzaman M. (2018), *Does smart city policy lead to sustainability of cities?*, Land Use Policy, **73**: 49–58, DOI: https://doi.org/10.1016/j.landusepol.2018.01.034.

Yigitcanlar, T., Kamruzzaman, M., Foth M. *et al.* (2019), *Can cities become smart without being sustainable? A systematic review of the literature*, Sustainable Cities and Society, **45**: 348–365, DOI: https://doi.org/10.1016/j.scs.2018.11.033.

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