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An Analysis of Sustainable Urbanism in Europe: Unveiling Trends and Key Contributors

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Abstract

Also referred to as green cities or eco-cities, sustainable urban centres have arisen from the imperative to harmonise economic, ecological, and social agendas, aimed at fostering resilient environments for the benefit of both present and future generations. This global interest in transitioning cities and communities towards sustainability is exemplified by the 11th Sustainable Development Goal, which encompasses objectives such as ensuring safe housing and infrastructure, enhancing air quality, managing waste efficiently, and bolstering disaster resilience. The main objective of this article was to identify publications investigating the issue of sustainable cities in Europe in order to observe research trends on this topic. This study conducts a bibliometric analysis encompassing all published literature within the Web of Science database pertaining to this subject. The earliest documented studies trace back to 1994, with a marked escalation in scholarly interest observed from 2016 onwards. Employing the Biblioshiny package in R, 245 articles were identified wherein both the terms "sustainable cities" and "Europe" appeared in the titles, abstracts, or keywords. Key recurring themes identified in the authors' discourse on sustainable urbanism include sustainable development, urban planning, smart cities, urban sustainability, climate change, urban development, and energy efficiency. Additionally, this analysis identifies noteworthy sources, prolific authors, and highly cited papers, thus shedding light on prevailing research trends within this domain. Among the topics researched by the most cited articles is the reduction of energy consumption, since 80% of energy consumption is generated by cities and their supply chains. Among the solutions provided by them is the integration of local stakeholders in the decision-making process regarding long-term sustainability.

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JEL Classification: O18, O30, Q01, Q20, Q55.

1. Introduction

Given the upward trend of population growth and their desire to live in the city, the agglomeration of urban areas leads, among other things, to pollution, the alteration of the natural course of the ecosystem, and the high increase in energy consumption. In addition to the environmental aspects, the sustainability of cities must also be viewed from the social point of view. Thus, according to Haughton and Hunter (2004), a sustainable city is one in which citizens and stakeholders try to improve the natural environment, culture, and architecture at the micro (local and regional) level, but with the aim of helping to achieve global sustainability.

The aim of the current study is to determine current trends in researchers' interest in sustainable cities in Europe. The objective of the study is to identify the most productive sources and authors and to discover the countries that have conducted the most intensive studies of this phenomenon. It was also intended to observe the research trends, the most common topics studied together with sustainable cities, as well as the study themes addressed by the most quoted article in this field.

The paper is divided into three large important sections, the first being dedicated to explaining the concept of sustainable cities. The second section is dedicated to the research methodology where the steps to extract the investigated dataset are explained. The results start with general information about documents such as the number of authors, the rate of collaboration between authors from different countries, continuing with information about the journals in which the articles were published, presenting Bradford's Law and H index to show the impact of the most representative sources. It also provides information about the authors, about the most productive countries and the collaborations between them, together with the presentation of the networks between the top 20 authors, as well as affiliations. Information is also presented regarding the most cited articles in the field, showing the main topics addressed by them, as well as the most used keywords.

2. Problem Statement

For several decades, the population's tendency has been to move to cities because they are considered places with great economic impact, offering significantly more jobs than in the countryside. But in order to support a rising number of individuals, increasingly significant amounts of resources are consumed, generating a greater degree of pollution. As the surface of cities remains the same and the population in these areas is growing, the issue of ensuring sustainability in such areas arises (Phillis et al., 2017). Due to the excessive pollution produced by cities and their supply chain (Harris et al., 2020), management and design policies of city infrastructure are needed, as well as the involvement of local stakeholders in

discovering long-term solutions to support sustainability (Carlsson-Kanyama et al., 2008). To evaluate the degree of sustainability of cities, methods such as hierarchical algorithms (Akande et al., 2019a), fuzzy evaluation (Phillis et al., 2017), and the INVAR method (Kaklauskas et al., 2018) were implemented.

To ensure that the urban environment is sustainable, it is necessary to cover economic, social, and ecological needs. Among the ways to achieve a sustainable city are energy efficiency, the use of renewable sources, but without aiming only at the creation of ecocities, but also at addressing social and economic problems (Hassan & Lee, 2015). The debate on sustainable cities revolves around the sphere of transport solutions, the generation of renewable energy sources, and the provision of resource-efficient buildings, without taking into account the social sphere and the ability of individuals to change their mindset regarding the sustainable approach. The most important factors that can ensure sustainability are the very people who live in the urban environment (Stieninger Hurtado, 2018). Circular economy may have an impact in attaining a sustainable city, according to Rogers (1998), that proposed an approach of a circular metabolism by which to minimise the inputs and maximise the recycling capacity.

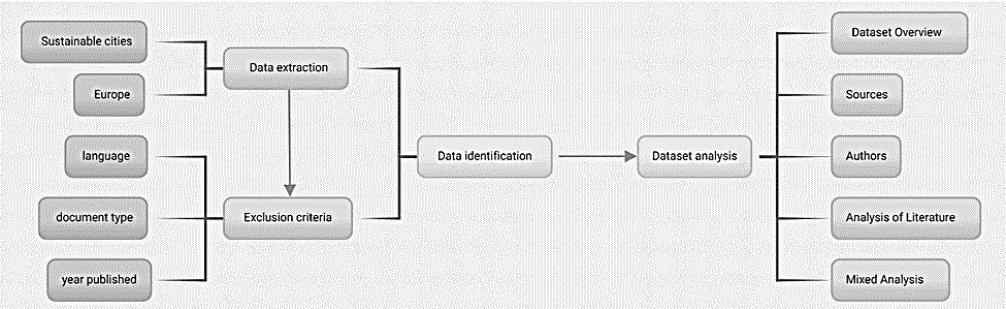
Buildings consume approximately 40% of energy and produce 21% of CO2 globally. Thus, the identification of intelligent and sustainable building planning methods is essential. A new method of building houses refers to the use of shipping containers, which are cheaper, innovative, and easier to make compared to traditional methods (Abrasheva et al., 2013). Another way in which we can test the sustainability of a city refers to resilience in case of natural hazards, such as earthquakes, as it is necessary for the authorities to take into account the vulnerability of cities in case of risk situations (Aguilar-Meléndez et al., 2019).

Among the most intensively analysed topics are energy consumption (Azurza-Zubizarreta et al., 2021; Napoli et al., 2020; Villamor et al., 2020) and energy efficiency (García-Fuentes & De Torre, 2017; Pardo-Bosch et al., 2019), as well as the concern for climate change (Bayulken & Huisingh, 2015; Yang et al., 2020), the modification of the transport system (Marcucci et al., 2017; Ramirez-Rubio et al., 2019), urban planning (Bibri & Krogstie, 2020; Bottero et al., 2019) and greenhouse gas emissions (Andersson & Andersson, 2019; Stolfi & Alba, 2018).

3. Research Methods

The objective of this research is to identify those papers that addressed the issue of sustainable cities in Europe with the aim of illustrating the most productive sources, authors, as well as the most cited documents, but also the main research topics associated with this subject. To achieve the main objective of this study, the Biblioshiny package (Aria & Cuccurullo, 2017), available in R, was selected. It is frequently chosen by researchers for literary analyses on various subjects (Delcea et al., 2023; Domenteanu et al., 2024; Profiroiu et al., 2024; Nica et al., 2024), including those related to sustainable cities (Janik et al., 2020; Kumar et al., 2023).

Figure 1. Document search algorithm



Source: authors' own work using bubbl.us.

In order to ensure a relevant database, the documents available on the Clarivate Web of Science platform containing information on sustainable cities in Europe were extracted. The next step was to exclude documents that did not meet the language, time, and document type criteria. After the identification criteria were met, it moved on to the next step, which consists of the actual analysis of the documents, discussing general aspects, and then presenting information on the most productive authors, the most relevant sources, together with the analysis of the literature (Figure 1).

Table 1 shows that 5,263 documents on sustainable cities and 1,164,985 on Europe have been published. From the intersection of the two considered concepts, a number of 391 documents can be observed, of which 121 were eliminated by limiting them to articles. The English language criterion reduces the number of documents to 251, and by applying the time restriction (those published in 2024 are not taken into account), the number of articles becomes 245.

Table 1. Data identification steps

Exploration steps	Questions on Web of Science	Description	Query	Query number	Count
1	Title/ Abstract/ Keywords	Contains the specific keyword related sustainable cities	((TI=(sustainable_cit*)) OR AB=(sustainable_cit*)) OR AK=(sustainable_cit*)	#1	5,263
2	Title/ Abstract/ Keywords	Contains the specific keyword related to Europe	((TI=(europe*)) OR AB=(europe*)) OR AK=(europe*)	#2	1,164,985
3	Title/ Abstract/ Keywords	Contains the specific keyword related to both	#1 AND #2	#3	391
4	Document type	Limit to Article	(#3) AND DT=(Article)	#4	270

Exploration steps	Questions on Web of Science	Description	Query	Query number	Count
5	Language	Limit to English	(#4) AND LA=(English)	#5	251
6	Year publisher	Not 2024	(#5) NOT PY=(2024)	#6	245

Source: authors' own work.

4. Findings

The current section provides a complex analysis of the set of documents on sustainable cities obtained by applying the methodology presented previously. The study involves an examination from several perspectives of the articles chosen among them, but not limited to the authors, sources, or the most cited documents in the specialised literature.

4.1 Dataset Overview

General information about the 245 identified documents is presented in this subsection. It should be noted that the period in which they were published, 1994:2023, is obtained by applying the selection criteria mentioned in the methodology, respectively, limiting the documents to articles written in English, not including the year 2024.

In Table 2, the most important information about the selected articles can be found, noting a number of 878 authors who contributed to their writing, noting that 40 articles were written by single authors, while the average number of authors per document was approximately 3.7.

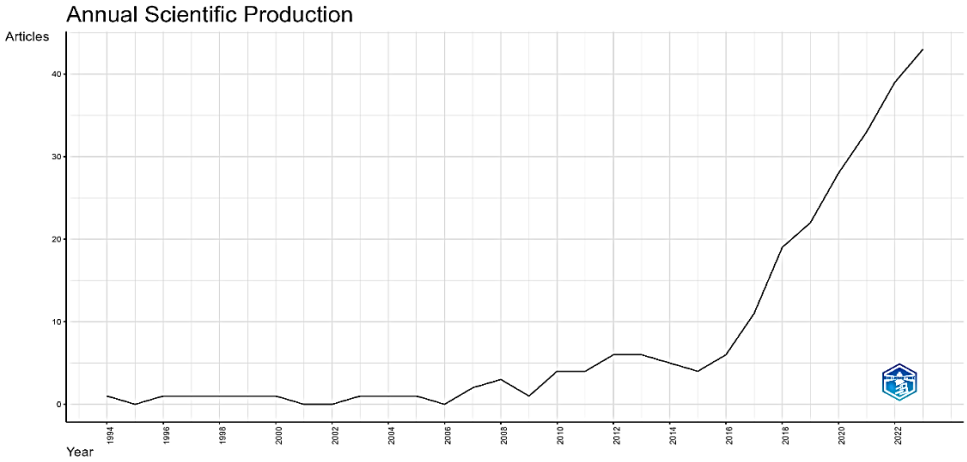
Table 2. Main information

Indicator	Value	Indicator	Value
Timespan	1994:2023	Sources	138
Authors	878	Annual Growth Rate %	13.85
Authors of single-authored docs	39	Average citations per doc	17.45
Single-authored docs	40	References	12,701
Co-Authors per Doc	3.69	Keywords Plus (ID)	579
International co-authorships %	31.84	Author's Keywords (DE)	943

Source: authors' own work.

Furthermore, the collaboration rate between authors from different countries is 31.84%, the authors' interest in this topic being explained by a 13.85% annual increase in the number of articles. The written papers were published in 138 journals, with an average number of 17.45 citations per paper and 12,701 references identified. Additionally, a number of 943 keywords and 579 keywords plus were noticed.

Figure 2. Annual scientific production evolution



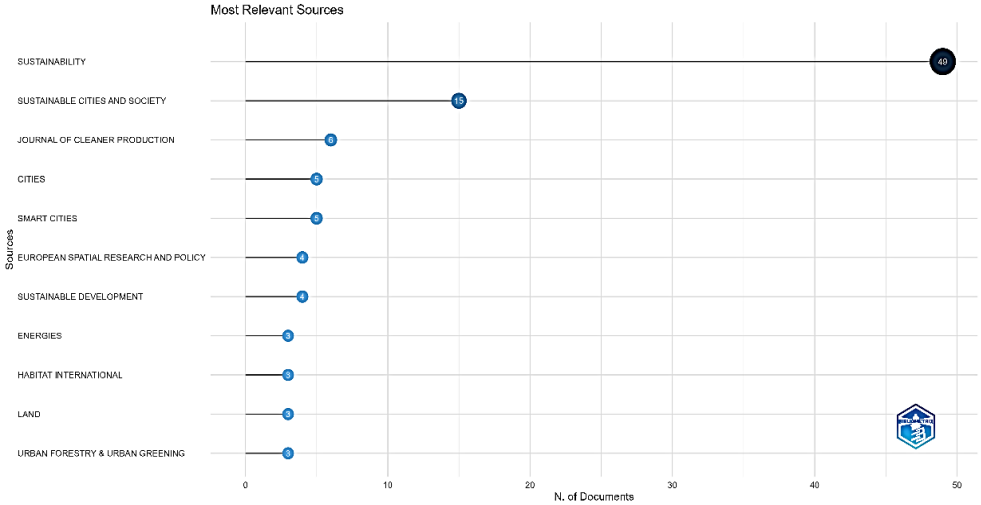
Source: authors' own work using Biblioshiny.

Although the time period analysed is a very long one, it is noteworthy that, only since 2012, more than five articles per year have been written, and in 2017 the threshold of 10 articles was exceeded, from then until the end of the analysed period there is a significant increase in the number of published articles.

4.2 Sources

In this subsection, you can find information about the main sources that chose to publish articles about sustainable cities, focusing on the most productive journals, Brandford's Law or journals' impact based on H-index.

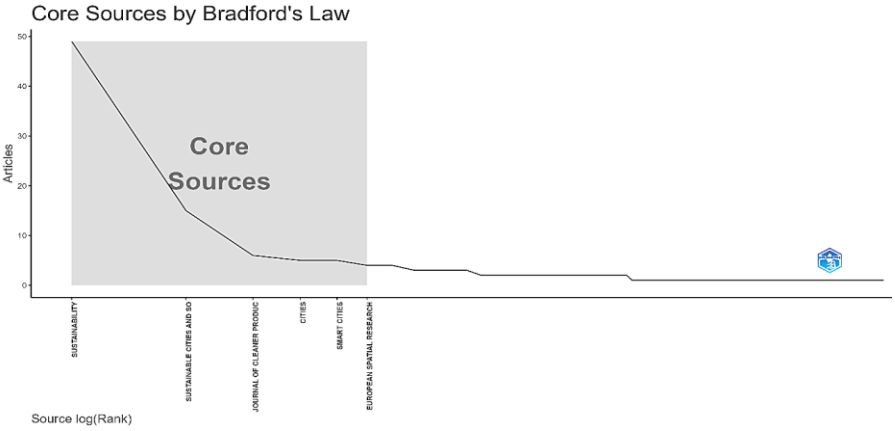
Figure 3. Journals with three or more published articles



Source: authors' own work using Biblioshiny.

Figure 3 shows the journals that have the most articles published on the topic of sustainable cities, at the top of the ranking is Sustainability with 49 articles, the next ranked journal (Sustainable Cities and Society) having three times less articles related to the analysed topic. Next, the Journal of Cleaner Production published six articles during the analysed period, followed by Cities and Smart Cities with five publications each, European Spatial Research and Policy and Sustainable Development publishing four articles each. The following four journals, respectively Energies, Habitat International, Land and Urban Forestry & Urban Greening each published three articles containing the phrase sustainable cities in the abstract, title, or keywords.

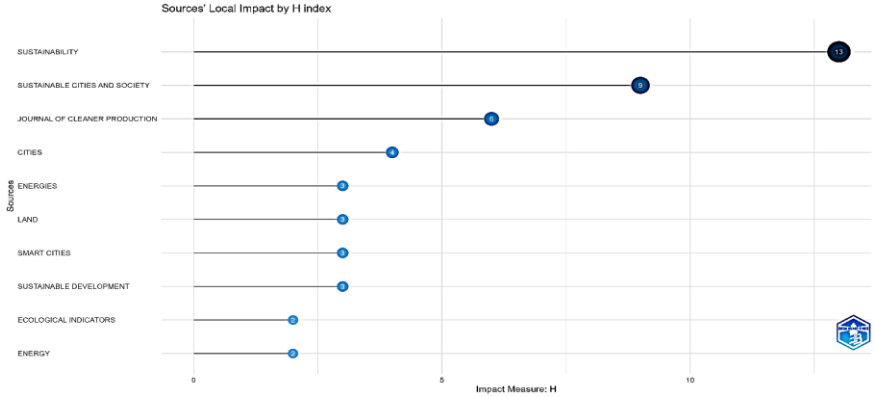
Figure 4. Bradford's Law on source clustering



Source: authors' own work using Biblioshiny.

Figure 4 shows the most productive and cited sources from the specialised literature. Thus, Sustainability, Sustainable Cities and Society, Journal of Cleaner Production, Cities, Smart Cities, and European Spatial Research encapsulate a third of all published articles.

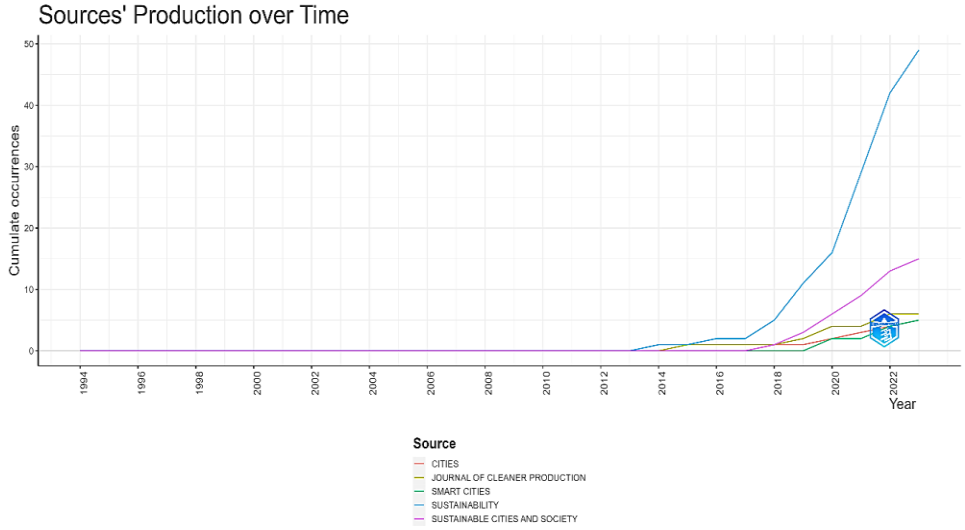
Figure 5. Journals' impact based on H-index.



Source: authors' own work using Biblioshiny.

Additionally, to support the impact brought by these sources on the specialised literature, the H index is also presented, which shows the number of articles published in a journal and which were cited at least H times each (Hirsch, 2005). Therefore, Sustainability published 13 articles with at least 13 citations each, followed by Sustainable Cities and Society with nine articles published at least nine times, in third place is the Journal of Cleaner Production which published six articles cited, each by at least six times. Cities occupies the fourth position in the ranking with four articles cited at minimum four times each, followed by Energies, Land, Smart Cities and Sustainable Development, each with three articles published and cited at least three times, the next ranked being Ecological Indicators and Energy with two articles that have at minimum two citations each.

Figure 6. Journals' growth (cumulative) based on the number of papers



Source: authors' own work using Biblioshiny.

Regarding the production over time of the most productive journals, it can be seen, according to Figure 6, that Sustainability was the first journal that chose to publish, in 2014, articles on this topic, also having the most spectacular growth, being followed by the Journal of Cleaner Production, in 2015, no longer publishing until 2019, and then reaching third place in the list of the most articles published at the end of the period. Sustainable Cities and Society and Cities both started publishing in 2018, with the former occupying the second place in the list of the most articles published. Although Smart Cities started publishing articles about sustainable cities only in 2020, it managed to occupy the fourth place in the list of the most published articles, just like Cities.

4.3 Authors

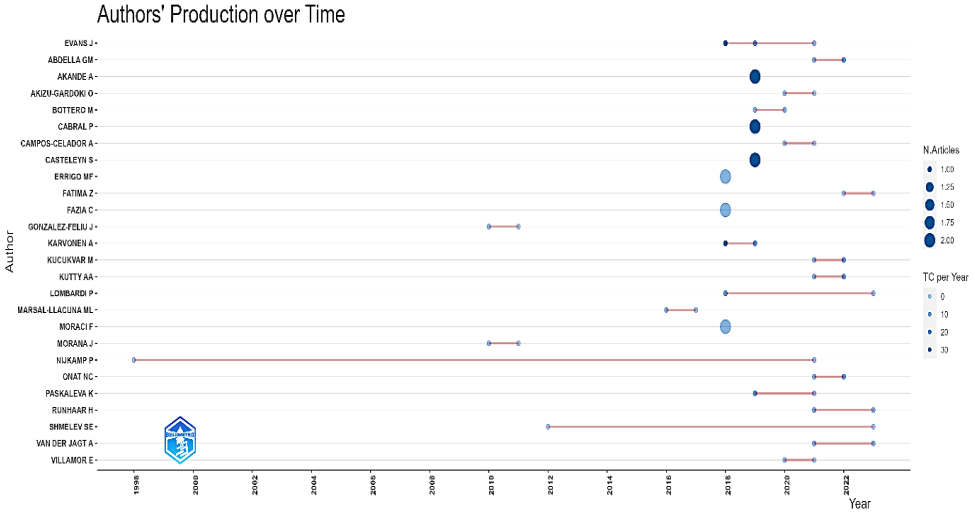
The current subsection details information about the authors of the analysed documents, also referring to the countries from which these authors research, as well as the collaborations between them.

Figure 7. Authors with two or more published articles

Source: authors' own work using Biblioshiny.

Figure 7 shows the authors with at least two articles published on the chosen topic, noting that only Evans J. wrote three articles published on the Clarivate platform.

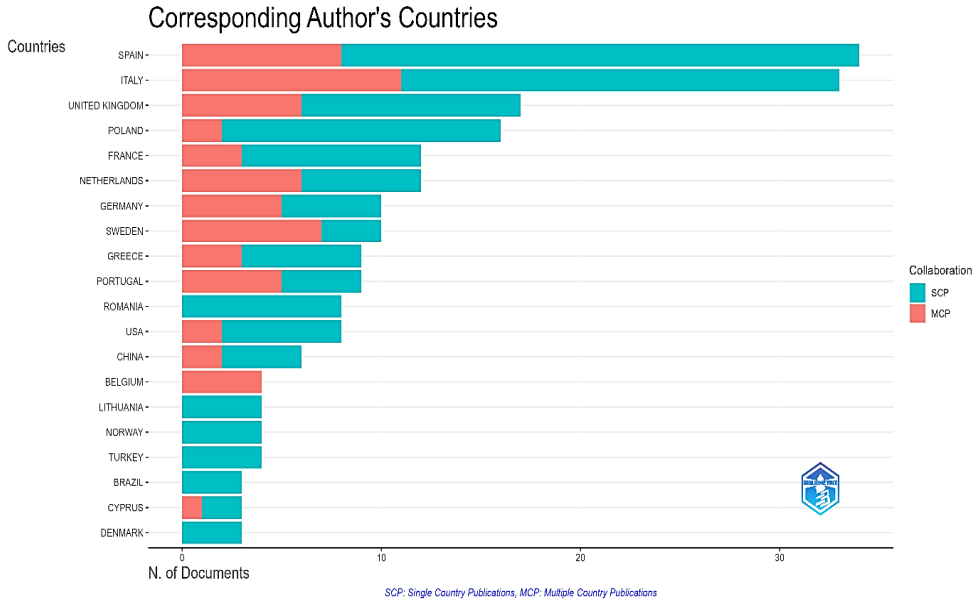
Figure 8. Authors production over time



Source: authors' own work using Biblioshiny.

Figure 20 shows that the three articles written by Evans J. were published in three distinct years between 2018 and 2021, and, as expected, being the oldest, the 2018 article is the most cited of the three. Interesting to note is the time gap between the writing of the two articles by Nijkamp P., one being published in 1994 and the other in 2021. Another author who published two articles a long time apart, but not compared to the one mentioned previously is Shmelev S.E., who chose to address this topic in 2012 and later in 2023.

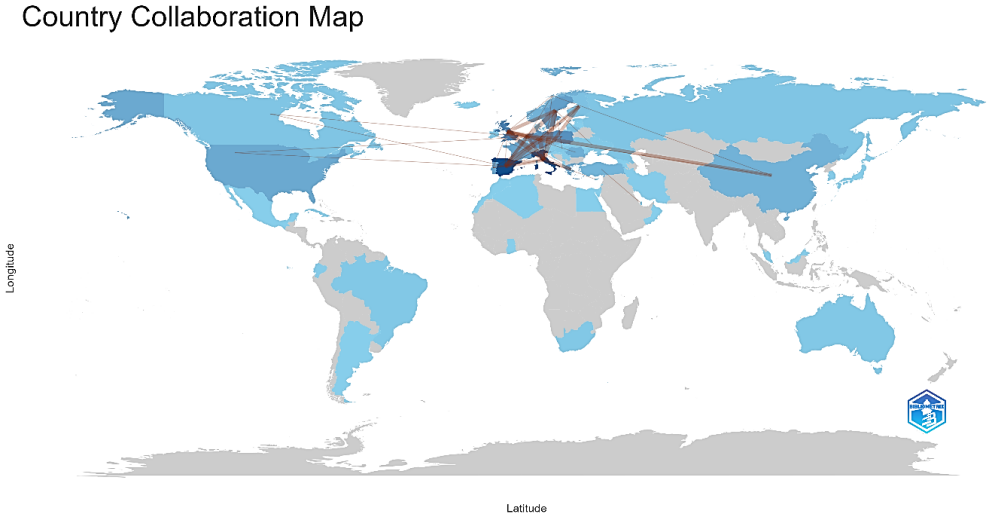
Figure 9. Top-20 most relevant corresponding author's country



Source: authors' own work using Biblioshiny.

Regarding the country of the corresponding author, the most productive are Spain and Italy, with more than 30 articles published each, about a quarter of which are written in collaboration with authors from other countries. The countries from which at least 10 papers were written are the United Kingdom, Poland, France, the Netherlands, Germany, and Sweden. At least six articles were published by countries such as Greece, Portugal, Romania, USA and China, Belgium, Lithuania, Norway and Turkey each publishing four articles, while authors from Brazil, Cyprus, and Denmark published three.

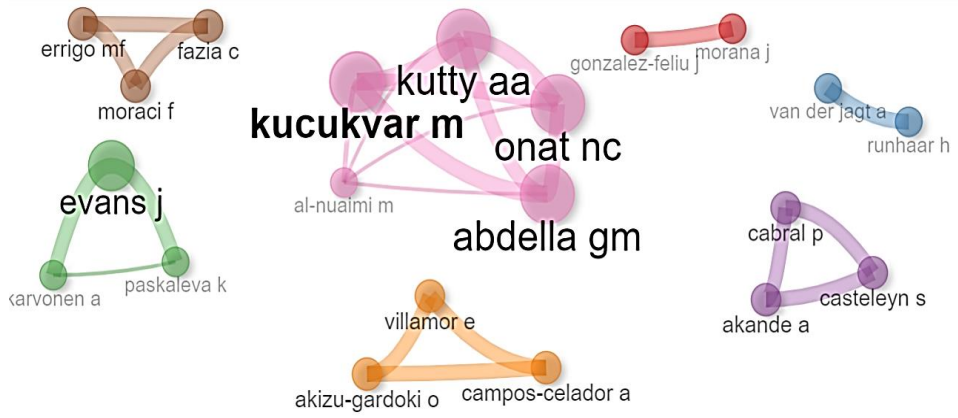
Figure 10. Country collaboration map



Source: authors' own work using Biblioshiny.

Figure 10 shows the countries from which the authors have published research on sustainable cities in Europe, noting that the more intense the shade of blue, the more articles were published in that country. Thus, collaborations between the United Kingdom and China, as well as between Spain and Italy, which are also the most productive countries, are recorded. Other multiple collaborations have been made between Spain and Sweden, Italy and Finland, United Kingdom and Italy, Spain and Finland etc. Since this paper analyses the European sustainable cities, it is obvious that the countries of Europe are the most productive, but it is important to note the collaboration with the other countries outside the European continent, particularly the United States and China.

Figure 11. Top 20 authors collaboration network



Source: authors' own work using Biblioshiny.

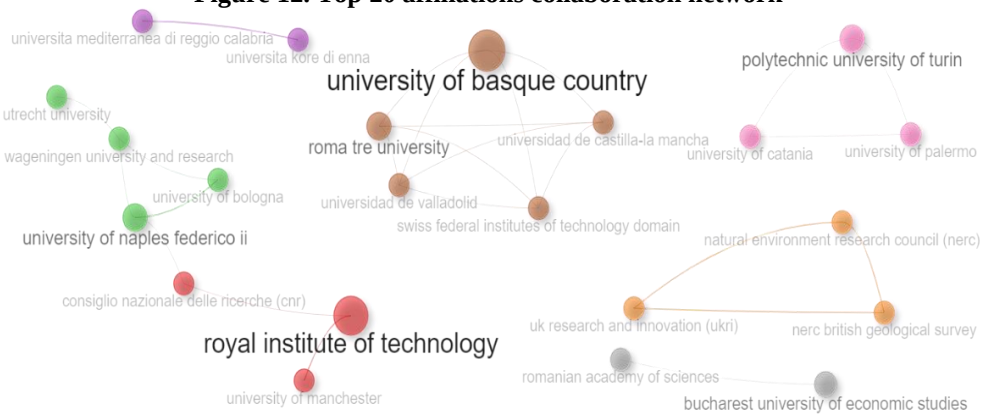
Figure 11 illustrates the collaborations between the authors with the most published articles, noting in green the partnership between Evans J., Karvonen A. and Paskaleva K., who wrote an article about smart sustainability (Martin et al., 2019). Also, Evans J. wrote two other articles in association with each of the other two authors, thus, together with Paskaleva K. studied Quadruple Helix (Paskaleva et al., 2021), while with Karvonen A. they produced a paper on smart-sustainable cities in Europe and North America (Martin et al., 2018).

The next network formed, visualised in brown, is between Errigo M.F., Fazia C., and Moraci F. who published together two articles on resilience cities (Moraci et al., 2018a; Moraci et al., 2018b). Another collaboration between three authors is highlighted in orange between Villamor E., Akizu-Gardoki O., and Campos-Celador A. who studied the energy transition (Azurza-Zubizarreta et al., 2021; Villamor et al., 2020). Moreover, Cabral P., Akande A., and Casteleyn S. joined forces to write two papers, one about ranking of 28 European cities regarding their sustainability (Akande et al., 2019a) and another one regarding the gap between technology and the environmental sustainability (Akande et al., 2019b).

The network with the most nodes consists of Kucukvar M., Kutty AA., Onat NC., Abdella GM. and Al-Nuaimi M. who authored together two articles on eco-efficiency (Onat et al., 2021) and the sustainability performance of European smart cities (Kutty et al., 2022).

There are two networks with two nodes each, the collaboration between Gonzalez-Feliu J. and Morana J. leading to the creation of a study on sustainable solution for city logistics (Gonzalez-Feliu & Morana, 2011), while Runhaar H. and van der Jagt A. published two articles on urban nature (Dorst et al., 2021; Van Der Jagt et al., 2023).

Figure 12. Top 20 affiliations collaboration network



Source: authors' own work using Biblioshiny.

Regarding the collaborations between affiliations, the collaboration between the network with the most nodes is noteworthy, which includes two distinct associations linked by the partnership between the University of Naples Federico II and the

Consiglio Nazionale delle Ricerche, which published two papers on sustainable cities in the Mediterranean Basin (Battarra et al., 2020) and sustainable city-port (Cerreta et al., 2020). Thus, in green is illustrated the partnership between Utrecht University, Wageningen University and Research, University of Bologna and University of Naples Federico II who wrote a paper on sustainable city food systems (Vittuari et al., 2021), the last two mentioned universities also publishing a paper on reducing energy consumption from buildings (Ruggiero et al., 2021). The red network is represented by the Royal Institute of Technology and the University of Manchester, whose researchers have jointly published two papers on smart-sustainable cities (Martin et al., 2019; Martin et al., 2018), the Royal Institute of Technology, writing another one paper with the Consiglio Nazionale delle Ricerche on urban metabolism and life cycle assessment (Maranghi et al., 2020).

The second largest network is represented in brown, being composed of the University of Basque, Roma Tre University, Universidad de Valladolid, Universidad de Castilla-La Mancha, and the Swiss Federal Institutes of Technology Domain that have published on greenspace management (Fischer et al., 2020). In orange is represented the partnership between the Natural environment Research Council, UK Research and Innovation, and Nerc British Geological Survey, which published a work on urban groundwater (Ó Dochartaigh et al., 2017). The following three-node network is coloured pink and is made up of Polytechnic University of Turin, University of Catania, and University of Palermo who created a paper on energy efficiency of public building (Napoli et al., 2020).

The last partnerships analysed are composed of two affiliations each, with purple representing the collaboration between Universita Mediterranea di Reggio Calabria and Universita Kore di Enna, which published a paper on smart tools for an energy resilient city (Moraci et al., 2018b). The partnership between the Bucharest University of Economic Studies and the Romanian Academy of Sciences, which wrote about the efficiency of urban development (Maricuț et al., 2023), is highlighted in grey.

4.4 Analysis of Literature

In this subsection, aspects such as the summarisation of the most cited articles, together with the most frequently encountered expressions, but also the grouping of the themes addressed by the authors according to the interest given to them, will be discussed.

Table 3. Brief summary of the content of top 10 most global cited documents

No.	Paper (First Author, Year, Journal, Reference)	Total citations (TC)	Title	Purpose
1	Martin CJ, 2018, Technol Forecast Soc (Martin et al., 2018)	337	Smart and sustainable? Five tensions in the visions and practices of the	It presents a review of the specialised literature on the subject of smart cities, following which differences in vision between smart cities and the SDGs are identified. It also presents ways in

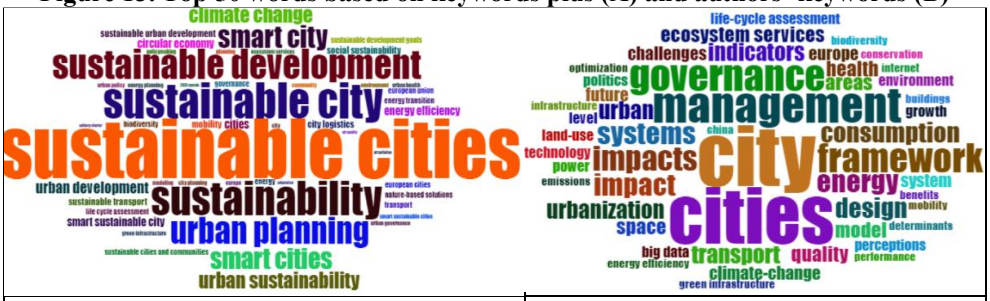
No.	Paper (First Author, Year, Journal, Reference)	Total citations (TC)	Title	Purpose
			smart-sustainable city in Europe and North America	which urban developers, together with municipalities and citizens, can address these differences with the help of digital technology specialists.
2	Akande A, 2019, Sustain Cities Soc (Akande et al., 2019a)	335	The Lisbon ranking for smart sustainable cities in Europe	The paper presents a ranking of a number of 28 European capitals using principal component analysis and hierarchical algorithms for clustering based on a number of 32 indicators regarding their sustainability.
3	Carlsson-Kanyama A, 2008, Futures (Carlsson-Kanyama et al., 2008)	147	Participative backcasting: A tool for involving stakeholders in local sustainability planning	The study involves the identification of some methods to involve local stakeholders in long-term sustainability discussions. Among their proposals were identified the need for local and organic food, an improved public transport in which to find ways of nonmotorised transport, as well as a greener environment.
4	Phillis YA, 2017, Comput Environ Urban (Phillis et al., 2017)	137	Urban sustainability assessment and ranking of cities	The research wants to evaluate a number of 106 cities based on a number of 46 socioeconomic and environmental indicators to measure urban sustainability based on a fuzzy logic.
5	Haarstad H, 2017, J Environ Pol Plan (Haarstad, 2017)	99	Constructing the sustainable city: examining the role of sustainability in the 'smart city' discourse	The article presents the role of sustainability in smart cities starting from the EU and reaching a local setting, the city of Stavanger in Norway. According to what will be illustrated in the paper, smart cities are realised through technology, innovation, and economic entrepreneurialism, without sustainability appearing to be a significant factor.
6	Harris S, 2020, J Clean Prod (Harris et al., 2020)	83	Low carbon cities in 2050? GHG emissions of European cities using production-based and consumption-based emission	The article debates the role of competent authorities in cities to reduce the amount of carbon, because, they say, cities and their supply chains produce approximately 80% of global energy consumption and more than 60% of greenhouse gas emissions. The paper presents, based on ten European cities,

No.	Paper (First Author, Year, Journal, Reference)	Total citations (TC)	Title	Purpose
			accounting methods	two scenarios for the year 2050, with 2010 as the base year.
7	Kaklauskas A, 2018, Cities (Kaklauskas et al., 2018)	70	Quality of city life multiple criteria analysis	The article involves the analysis of the quality of life in European cities comparing the results obtained by applying the INVAR method with the Quality-of-Life Index, also offering recommendations for the cities based on the analysed indicators.
8	Nilsson A, 2018, Energ Buildings (Nilsson et al., 2018)	68	Smart homes, home energy management systems and real-time feedback: Lessons for influencing household energy consumption from a Swedish field study	The research involves studying the impact of Home Energy Management Systems on energy consumption, identifying obstacles to energy consumption behavioural change, and also recommending policies. Following a study of 154 households in a district of Stockholm for a period of one year, the results showed that energy consumption varies significantly from one house to another.
9	Martin C, 2019, Sustain Cities Soc (Martin et al., 2019)	67	Smart-sustainability: A new urban fix?	The study presents the role of urban policy in creating sustainability through smart urban development. Based on the literature on sustainable and smart cities, the authors present ways to integrate environmental and digital initiatives through entrepreneurial forms of urban governance.
10	Torabi Moghadam S, 2018, Sustain Cities Soc (Torabi Moghadam et al., 2018)	64	A GIS-statistical approach for assessing built environment energy use at urban scale	The research presents a geospatial bottom-up statistical model to estimate the energy consumption of an Italian city, analysing approximately 3600 residential buildings.

Source: authors' own work.

Even if Table 10 analyses the situation of the 10 most cited articles, it is noted that the topics discussed in them are consistent with those found in Figures 13 and 14, energy consumption and its planning being the subject of discussion in several of the analysed articles. Furthermore, sustainable urban planning is debated, as well as the quality of life found in these cities, along with the role of governance and technology in the adoption of sustainable cities.

Figure 13. Top 50 words based on keywords plus (A) and authors' keywords (B)



(A) Top 50 words based on authors' keywords	(B) Top 50 words based on keywords plus

Source: authors' own work using Biblioshiny.

As expected, the most frequent keywords are those chosen when retrieving the dataset of articles, so that sustainable cities is the most common keyword, followed by sustainable city, sustainability, sustainable development, urban planning, smart cities, and climate change. While Figure 13 (B) shows that the most frequent keywords-plus are city and cities, followed by management, governance, systems, impact, energy, etc. Regarding the most common expressions found in the abstracts, it is noted that sustainable cities and sustainable development appeared more than 100 times each, followed by phrases such as climate change, smart or sustainable city, urban development or urban planning, sustainable urban, smart cities, and European cities.

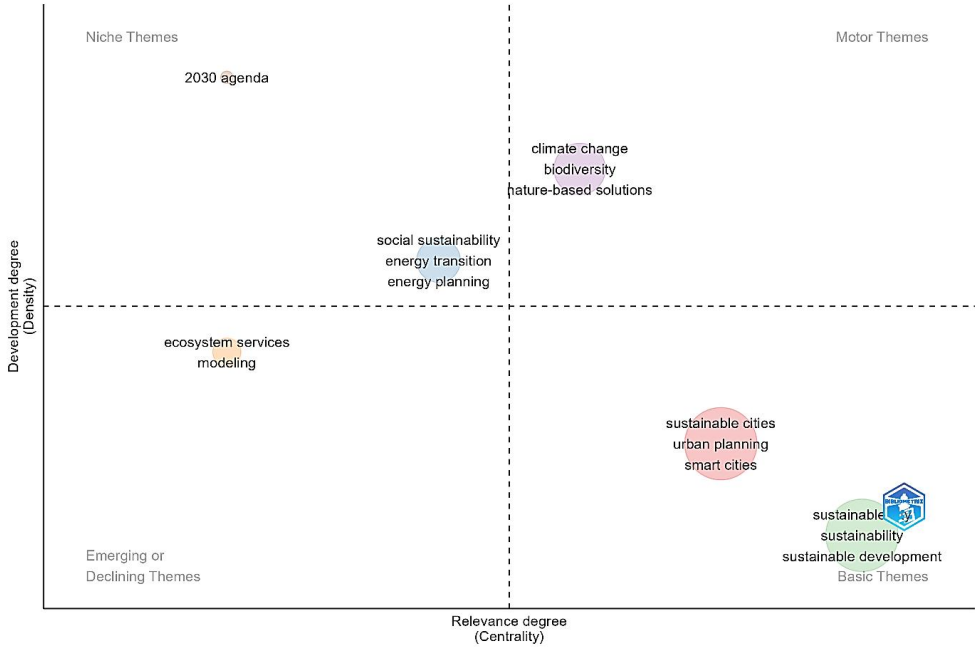
Table 4. Top 10 most frequent bigrams and trigrams in abstracts

Bigrams	Occurrences	Trigrams	Occurrences
sustainable cities	128	sustainable development goals	30
sustainable development	116	sustainable urban development	15
climate change	62	development goals sdgs	12
smart city	61	greenhouse gas emissions	12
sustainable city	60	european green deal	9
urban development	55	smart sustainable cities	9
european cities	52	nations sustainable development	8
smart cities	49	sdg sustainable cities	8
urban planning	48	smart sustainable city	8
sustainable urban	42	united nations sustainable	8

Source: authors' own work.

Table 4 also shows the most used trigrams, namely sustainable urban development, greenhouse gas emission, European green deal etc.

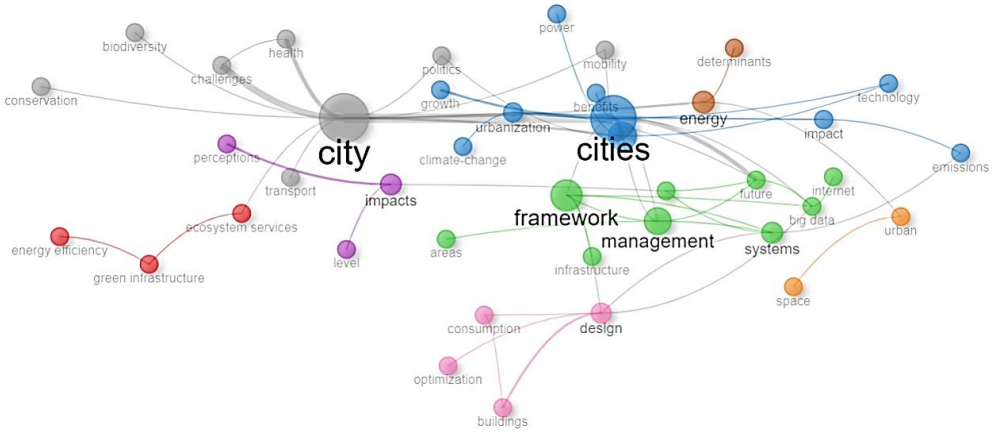
Figure 14. Thematic map – keywords



Source: authors' own work using Biblioshiny.

Regarding the framing of the themes addressed by the authors' keywords in the analysed articles, it is found that the basic themes are related to sustainable development and sustainable cities, while the motor themes focus on climate and environmental actions. Niche themes address topics such as Agenda 2030, social sustainability, and energy transition. As for the emerging themes, according to Figure 14, ecosystem services and modelling can be found.

Figure 15. Co-occurrence network - keywords plus



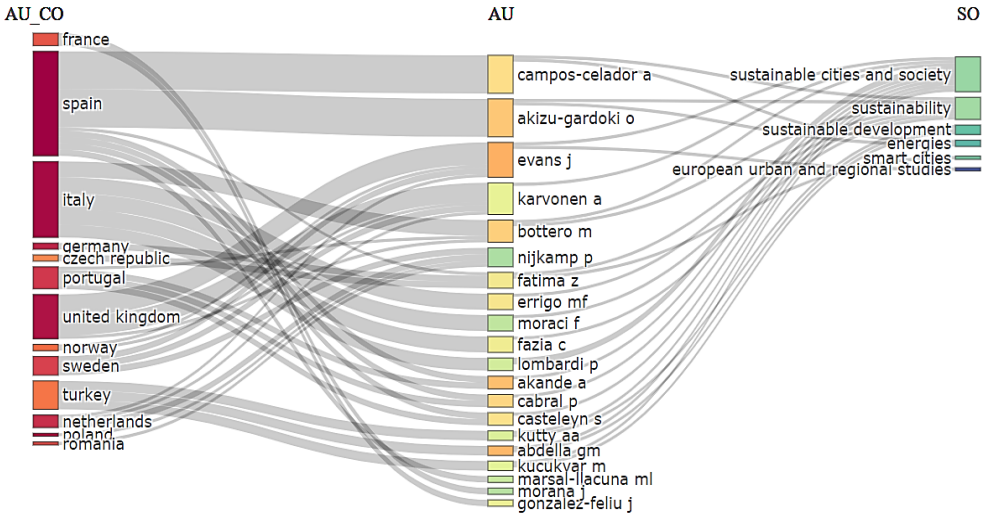
Source: authors' own work using Biblioshiny.

Concerning the appearance of the keywords plus in the problematisation of sustainable cities, notions such as biodiversity, health, policies, transport are discussed. Another focus is on energy efficiency and green infrastructure, while the impact on the future focuses on systems, the internet, and big data. An additional approach is represented by optimising the design of buildings to limit the consumption of resources.

4.5 Mixed Analysis

The last subsection of the chapter dedicated to the results represents a cross-analysis between the 20 most productive authors and the country from which they are affiliated, together with the names of their affiliations and the main sources in which they chose to publish their papers, as well as the keywords selected by them to describe his research.

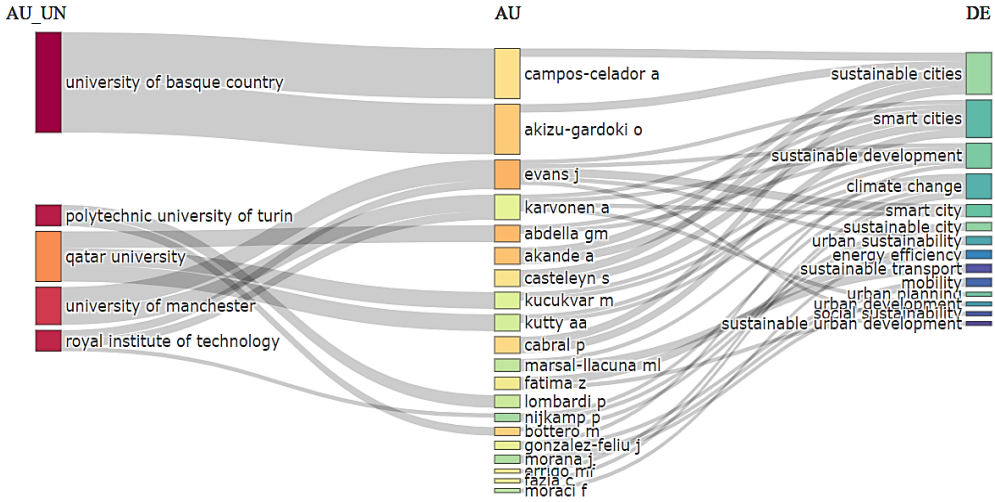
Figure 16. Three-fields plot: countries (left), authors (middle), journals (right)



Source: authors' own work using Biblioshiny.

According to Figure 16, most of the most productive authors come from countries such as Spain, Italy, United Kingdom, and Turkey. Other representative countries for these authors are France, Germany, the Czech Republic, Portugal, Norway, Sweden, the Netherlands, Poland, and Romania. The sources in which these authors have chosen to publish their work are Sustainable Cities and Society, Sustainability, Sustainable Development, Energies, Smart Cities, and European Urban and Regional Studies.

Figure 17. Three-fields plot: affiliations (left), authors (middle), keywords (right)



Source: authors' own work using Biblioshiny.

Figure 17 shows the affiliations of the 20 most productive authors, noting the University of the Basque Country, Qatar University, University of Manchester, Royal Institute of Technology, and Polytechnic University of Turin. Furthermore, among the most used keywords are sustainable cities, smart cities, sustainable development, climate change, smart and sustainable cities etc.

Throughout the current research, data has been highlighted regarding: the sources with the greatest inclination to publish such topics, the authors who have studied the phenomenon of sustainable cities in Europe, the most used keywords to describe these researches, thus noting some practical implications that should remain in the readers' minds. First of all, the tendency of the authors to introduce local stakeholders into the discussions about the sustainability of the cities they are part of was observed. Another element refers to the use of digital innovations, big data, and IoT in capitalising on solutions regarding the creation of sustainable and resilient cities. The impact of cities on the environment and their high energy consumption is also highlighted, discussing finding solutions to reduce pollution and reduce the use of resources, but also the mentality of citizens because change must start from those who live in the environments urban.

5. Conclusions

The role of the current research consisted of studying the specialised literature on the topic of sustainable cities in Europe in order to identify the sources that issued the most papers related to this topic, observing that Sustainability journal presents the leading position with 49 published articles, being followed by Sustainable Cities and Society with 15 papers. Moreover, among the countries whose researchers have studied this phenomenon most intensively are Spain, Italy, the United Kingdom, Poland etc., while the countries outside the continent that collaborated

in the writing of the most articles related to sustainable European cities are United States and China. With regard to the studies presented by the 10 most cited articles, the authors pointed out their inclination towards reducing pollution and energy consumption, as well as improving the quality of life, or integrating local stakeholders in decision-making processes to promote long-term sustainability in the urban environment. The connection between sustainable cities and climate change, greenhouse gas emissions, urban planning, and energy planning was found to facilitate the transition to a green economy, studying nature-based solutions and using technology, the Internet, and big data to preview the future of infrastructure cities. Like any other study, there are certain limitations in this case as well. For the current research, the limitations appear based on the choice of words by which the articles were searched, but also based on the exclusion criteria; thus, any changes to them would have represented a different dataset. However, we chose to study only those articles that debate the issue of sustainable cities in Europe because the number of published works on sustainable cities exceeded 5200 documents, which is a much too large amount of information to be examined in detail.

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