Smart City: A Bibliometric Analysis of Conceptual Dimensions and Areas

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Abstract: In recent years, cities are expected to develop in line with the smart city (S.C.) idea. Cities, perceived as attractive places for people to live, must now meet many conditions. A city's duty is, among others, to meet the needs and expectations of both, its residents and newcomers, offering a wide range of opportunities for entrepreneurs, caring for the natural environment, constantly taking on new challenges, and meeting them for its further development. Thus, the management of a city involves undertaking activities in line with the smart city idea. However, to implement them, they use widely available means, defined as intelligent solutions, e.g., modern ICT technologies. In line with the smart city idea, a city is a center inhabited by people who create a civic and participatory society, having the ability to use the latest ICT solutions and having access to a range of services and solutions offered by the city. Since the smart city idea is considered at many levels, it is still unknown what dimensions or areas related to this concept are the most valuable and stimulating for its implementation. Therefore, the purpose of this article is to study what dimensions or areas related to this idea are the most valuable and stimulating for its implementation. The applied methodology is based on a critical analysis of the available literature in the form of bibliometric and citation analysis and analysis of the keyword characteristics of S.C. co-occurrences. The result of the research is a set of keywords that enable identifying the key dimensions and main areas of the implementation of S.C.

Keywords: smart city; keyword occurrences; sustainable development; ICT; bibliometric analysis; citation analysis

1. Introduction

A city is a product of human beings, and its space is a place where new ideas, technologies, and innovative ventures emerge and spread [1]. On the other hand, urbanization is a feature of modern civilization, and the manner of this process is shaped by globalization and technological progress [2]. Currently, in times of very dynamic and rapid socio-economic and technological changes, cities are the centers that play the main role. This has rendered the smart city concept very popular in recent years. The smart city concept is a modern idea of city development and a response to the ongoing urbanization processes. In 2018, 55.3% of the world's population lived in cities. By 2030, this percentage is expected to increase to approximately 60%, and 68% by 2050 [3,4]. Projections indicate that urbanization, i.e., the gradual transfer of people from rural to urban areas, combined with the overall growth of the world population, may result in another 2.5 billion people living in urban areas by 2050 [5]. This will cause many countries to face the challenges of meeting the needs of their growing urban population in housing, transport, energy systems, other infrastructure, employment and basic services such as education and healthcare [6]. The concept of smart cities tries to answer problems that have not occurred before on such a large scale, assuming that a smart city is a city inhabited by a creative-thinking society that can use technical and technological innovations in its activities. Additionally, it is assumed that this society can use information and communication technologies (ICT) [7], enabling, among others, consolidating the freedom of expression and access to public information

and services [8]. On the one hand, the solutions used by smart cities focus on innovative technologies, such as cheap IoT sensors with a long battery life, which collect data at the consumer, enterprise or industry level [9]. On the other hand, a smart city does not always integrate the entire new infrastructure and includes improving the technology already used by analyzing the accumulated big data [10].

This article focuses on the smart city idea. However, since it is still unknown what factors, key dimensions, and main areas related to this concept are the most valuable and stimulate its implementation, the purpose of this article is to identify these factors and define their interrelationships and correlations. Therefore, the purpose of this article is to try to identify the basic set of S.C. factors that allow obtaining a complete picture of the S.C. concept and thus supporting entities in its implementation.

This article presents a bibliometric analysis aimed at obtaining as much information as possible about S.C. Moreover, the results of the bibliometric analysis made possible to conduct another analysis to examine the co-occurrences of keywords, determining the factors, key dimensions, and main areas. As a result, it became possible to develop a classification scheme for the keywords used in scientific publications in S.C., the aim of which is to classify and systematize the currently conducted research and create a set containing the most frequently used keywords. This set can be treated as a starting point for creating a coherent set of knowledge in S.C., or the possibility of conceptualization and systematization to identify the key factors of S.C. or other perspectives for the development of this concept. The nature of the research carried out results from the concept of knowledge organization (KO), a field of research, teaching, and practice, which is mainly related to library science and computer science [11]. KO concerns the description, representation, archiving, and organization of documents, and the presentation of documents, entities, and concepts both by people and by computer programs [12]. Thus, bibliometric, citation, and keyword co-occurrence analysis are the subject of KO tasks, in this case consisting in research of the subject concept of S.C.

The conducted research will enable the development of a comprehensive set of S.C. factors, which will allow capturing the individual features of entities implementing the idea of S.C. It will facilitate further research in this area, thus constituting an element supporting both, the future work of researchers and entities striving to further improve the activities carried out in the area of S.C.

Analysis of the coexistence of keywords and the determination of their mutual influence and relationship can be a valuable tool in the implementation of future research, focusing, for example, on the development of S.C. models or frameworks applicable by various entities implementing S.C. Moreover, the conducted analysis will help determine which factors have the most significant impact on the success of S.C. by individual entities (cities in this case).

The conducted analysis of the available literature in S.C. indicated that there are many keywords relating to this concept, covering the main concepts and describing trends or relationships. Therefore, the conducted research is aimed at introducing the topic of S.C. not only by identifying the most influential keywords and relationships but also by providing a comprehensive picture of the following:

- The current stage of research and scientific considerations of the S.C. idea;
- The state and level of research on this concept.

The knowledge obtained in this way will enable researchers and entities to obtain a clear and comprehensive description of the available literature and identify keywords constituting a set of factors determining the implementation of this concept.

Research questions:

1. What is the most significant influence characterizing keywords from the area of S.C., and what are the relationships between them?
2. Which areas of S.C.'s scope are the most relevant now?
3. What are the correlations, properties, and connection patterns among the keywords identified in the cluster analysis?

The presented paper is organized as follows: Section 2—literature review; Section 3—the purpose of the bibliometric analysis; Section 4—citations analysis; Section 5—keyword occurrence analysis – visualization Maps; Section 6—the research results interpretation; Section 7—conclusions.

2. Literature Review

According to the smart city idea, a city is a sustainable center, a place where the quality of life is constantly improving, the natural environment is in an increasingly better condition, and the economic prospects are becoming stronger [13]. The goal of a smart city is to make life in the city better, easier, and more environmentally friendly [14]. A distinguishing feature of such a city is the level of intelligence, understood as a set of various improvements positively influencing the functioning of urban infrastructure, city resources, and public services [8,15–20]. It is visible that the idea of a smart city has a strong relation with the concept of sustainable development, which is based on three main pillars—social, ecological, and economical. The social pillar of sustainable development in the smart city idea takes the form of improving the quality of life of the city's inhabitants, the ecological pillar takes the form of improving the condition of the natural environment, and the economical pillar takes the form of improving economic prospects. On the other hand, the idea of a smart city is probably an extension of sustainable development. Additionally, in the smart city idea, essential roles are played by ICT and the Internet. Both, ICT and the Internet can be perceived as a "core" of the smart city concept—as without them, S.C's further development would not be possible. ICT and the Internet contribute to solving or alleviating many urban problems by improving the efficiency of services or, in some cases, by changing urban regulations [15]. They enable the connection of individual systems and stimulate the development of innovations, influencing the implementation of urban policy objectives in the following areas [14]:

- Smart economy, meaning a highly efficient and technologically advanced economy, focused on developing new products and services, developing new business models, and striving to establish local and global relations with the simultaneous exchange of goods, services, and knowledge.
- Smart mobility in the form of integrated transport and logistics systems, powered by clean energy.
- Smart environment, meaning the sustainable use of natural resources by the city, striving to increase the use of renewable energy sources. A smart environment also means controlling power and water networks, street lighting, and other public services to optimize the environmental and financial costs of their operation. It also includes ongoing control and monitoring of the level of pollution or thermo-modernization of buildings in order to reduce their energy consumption.
- Smart people or social capital, which is created in an environment characterized by diversity, a high level of tolerance, creativity, and commitment.
- Smart living, which means a safe and healthy life in the city, offering a broad and diverse housing and cultural situation, and ensuring universal access to ICT infrastructure, which in turn enables the creation of one's lifestyle, behavior, and consumption.
- Smart governance consisting of managing the city in which the participation of city residents in the strategic decision-making process, transparency of operations, and a high level of quality and availability of public services play an essential role [21]. Moreover, intelligent smart governance enables better organization and integrates the above-mentioned remaining elements [22–24].

As the idea of a smart city is a relatively new concept, and due to the fact that it covers a vast spectrum of elements, there is not one binding definition of this concept [25]. However, there are many proposals in the literature that, for better or worse, reflect the idea of this concept. Only the British Department for Business Innovation and Skills has attempted to standardize the terminology related to the smart city concept. According to this organization, there is one standardized definition: S.C. is a term that refers to the

effective integration of material, digital, and human resources in building an environment that provides a sustainable, developmental, and prosperous future for its inhabitants [26].

One of the reasons for the lack of a universal definition is that the idea of a smart city is set in two different contexts. The first relates to the so-called hard components, in the form of a smart building, energy networks, rational use of natural resources, water, and sewage management, waste management, mobility, and logistics. The second context refers to the so-called soft components, taking into account education, culture, and social participation. At the same time, while for hard components, the use of the most modern ICT solutions is crucial, in the case of the latter, the use of ICT solutions is not a priority [27]. The lack of a single, generally applicable definition is also caused by the fact that various types of institutions and rankings, in their assessments of the smart city idea, place their accents differently in the methodologies used. One of the most popular definitions of a smart city is the one proposed by C. Manville et al. It says that the smart city is a city where public issues are solved with the use of information and communication technologies (ICT), with the involvement of various types of stakeholders operating in partnership with city authorities [23], which largely determine the success of projects and applications in a smart city [28]. It is the inhabitants of the city who constitute the focal point with which solutions for a smart city are designed, bringing them specific benefits in everyday life [29]. Therefore, strategies involving many stakeholders, including end-users, that cooperate to co-create mutual and expected benefits are increasingly used [30,31]. This type of co-creation democratizes the development of new solutions for smart cities. The end-users are involved from the very beginning, from identifying the problem, the problem itself, to the launch of the developed solution. According to A. Glasmeier and S. Christopherson [32], a smart city has two fundamental attributes: the use of technologies that facilitate the coordination of dispersed urban subsystems, and the use of gained experience enabling the creation of a new, better reality. According to N. Komninos [33], a smart city is a territory with high learning and innovation capacity, creativity, research and development institutions, higher education, digital infrastructure, communication technologies, and a high level of management efficiency. G.C. Lazaroiu and M. Roscia [34] indicated that in order to define a city as intelligent, optimization of available and new resources and possible investments is required. Additionally, they emphasized that the achievement of the goals mentioned above is determined by the use of advanced ICT technologies, especially in critical areas such as energy, technical infrastructure, public safety, waste management, and transport [34,35]. In turn, I. Azkuna, in his definition, emphasized the technological aspect of the smart city idea: a smart city uses information and communication technologies in order to increase the interactivity and efficiency of urban infrastructure and its components, as well as raising the awareness of residents [36].

It is also worth mentioning the definitions of a smart city formulated by global IT companies dealing, among others, with creating, producing, and disseminating various ICT technology tools. Thus, for example, Hitachi defines a smart city as an environmentally conscious city that uses IT (information technology) to utilize energy and other resources [37] efficiently. In IBM's opinion, a smart city is a city that uses new technologies to transform its core systems to optimize the use of limited resources [38]. The smart city proposed by IBM sees the city as a unit divided into three pillars: people, infrastructure, and activities. Based on this, three services have been identified: human, infrastructure, and city planning and management [39]. According to CISCO, a smart city uses digital technology to connect, protect, and enhance the lives of citizens. IoT sensors, video cameras, social media, and other inputs act as a nervous system, providing the city operator and citizens with constant feedback to make informed decisions [40].

Moreover, Samsung's smart city idea includes buildings that use sensors to save energy. To reduce congestion, Samsung is moving to commercialize a connected car system that uses 5G communications [41]. There are also differences in the definition of the smart city idea concerning territorial areas. These differences, however, do not concern the issue of the impact of sustainable development on the idea of S.C. and the role played by ICT

and the Internet. Meanwhile, the EU, in its strategic documents, references the smart city idea as emphasizing clean energy, savings in its consumption, and reducing CO_2 emissions to the atmosphere [42]. In the USA, smart cities are characterized by human and social capital. They have both, traditional and modern communication infrastructure. Their development is consistent with the theory of sustainable development. At the same time, the participatory system of the government ensures a better quality of life [43–45]. In Australia, on the other hand, the idea of a smart city focuses on the creative industries and digital media [46]. Current EU programs promote the idea of a smart city as an open, user-oriented innovation environment [47]. The city should be an open innovation platform where citizens or communities engage and empower each other, thus increasing their life opportunities. Striving to increase the quality of life and a high level of innovation is impossible without using the assumptions of the concept of sustainable development and tools in the form of ICT and the Internet in the idea of S.C.

Furthermore, practical cooperation between network stakeholders (residents and municipalities) often facilitates information technology usage [48]. In the definitions mentioned above, it can be noted that one part of the smart city literature emphasizes the need for planning and control on a city-wide scale and the central function of ICT as the urban digital nervous system, causing smart cities to be perceived as sophisticated systems that "sense and act" [49,50]. These systems produce vast amounts of information and are integrated with many processes, systems, organizations, and value chains to optimize the operation and inform the authorities of initial problems [51]. Thus, ICT contributes significantly to solving emerging life problems in cities. However, considering that ICT cannot transform a city into a smart city itself, other research focused on the role of human capital in improving living conditions in a city. Social capital's initiatives therefore include human capital investments aimed at fostering a city's capacity for learning and innovation [52]. It contributes to supporting and motivating the local population in education and improving its own life. This social capital is responsible for attracting and stopping talented and well-educated people, and for investing in innovative enterprises or investors and entrepreneurs with financial and human capital to establish new enterprises [22,53–57].

However, it is erroneous to identify the smart city concept only with modern technology usage [55] because the smart city models developed thus far include many areas in which a city should prosper to be specified as smart. Smart city models presented in the literature include many areas for which multiple elements are constructed, allowing one to carry out analyses under the smart city concept. In recent years, smart cities are perceived as ecosystems defining communities of interacting organisms and their environment. They are described as a network characterized by a large complexity determined by the interdependencies of available resources [58]. In this approach, smart cities constitute intelligent digital ecosystems installed in an urban space [17,22,59–63], wherein the ecosystems, as with all other systems, consist of elements which constitute many models of the smart city idea. However, because in the literature many S.C. models have already been described, only some of them were quickly presented. P. Lee, W. Hunter, and N. Chung [64] in their model grouped factors defining a smart city into two groups—hard domain, and soft domain. The hard domain is completed with subdomains in the form of resources, energy, environment, mobility, building, and healthcare [65]. The soft domain includes subdomains in the form of entertainment, education, culture, public administration, public safety, and economy [66]. All these subdomains have been grouped into services, infrastructure, and land area. Liu, Wei, and Rodriguez [67], in turn, developed the smart city value chain (SCVC) model, in which individual links are responsible for smart inbound logistics, smart operations, smart outbound logistics, smart marketing, and smart services and cover areas such as smart government, smart infrastructure, smart procurement, and smart technology. The goal of all these intelligent elements is to improve human living value. Lombardi et al. [68] developed the ANP model to assess the relationship between smart city development and the triple helix model. The triple helix model emerged as a reference framework for the analysis of knowledge-based innovation systems and links the

multiple and interrelationships between the three leading agencies in knowledge creation and capitalization: university, industry, and government [69]. The purpose of the ANP model is to use it to study the relationship between smart city components, actors, and visions, or strategies which smart cities are utilizing [69]. In turn, Batty et al. [70] developed the Future ICT model, emphasizing the need for modeling in the area of mobility and transport behavior, urban land use transport, urban market transaction, and urban supply chains. In order to carry out the modeling process, it is necessary to have an integrated city database as well as data from sensors and social media networks. An important role is also played by city authorities striving to transform a city into a smart city, and the involvement of all stakeholders in the decision-making processes. Calvillo, Sánchez-Miralles, and Villar [71] proposed the general energy system design model, whose input elements are: parameters and resource availability, system costs, geolocation characteristics, energy prices, regulatory constraints, and energy demand. On the other hand, the expected effects of its implementation included installed capacity, operation schedule or total production, total system costs, environmental benefits, and economic feasibility analysis. L. Anthopoulos, in his model, distinguished five levels: natural environment (landscape, rivers, lakes, sea, forests), hard infrastructure not based on ICT (buildings, roads, bridges, energy-water-waste utilities-based), hard infrastructure based on ICT (datacenters, supercomputers and servers, networks, ICT), services (smart energy, smart transportation, smart healthcare, safety and emergency, education and tourism, waste management, smart buildings, e-government, and e-business), and soft infrastructure (applications, databases, software, and data) [72]. The model proposed by Naphade et al. [73] includes areas such as government services, public safety, transportation, education, energy and water, other core ICT systems, and healthcare. Bakıcı et al. [74] focused on four groups of crucial conditions: on the resources and the needs of investing in a smart city: size and demographic density, economic development, technology development, and environmentally friendly policies. From the point of view of R. Giffinger et al. [20], the smart city concept focuses on improving urban life in six dimensions: people, government, economics, mobility, environment, and life. In contrast, Angelidou [75], in his approach to the smart city concept, used a civil engineering and urban architecture lens, which enabled him to classify smart cities as new vs. existing cities, and corresponding smart city projects as "soft" vs. "hard" implementations [75]. Lee et al. proposed the following in their model [20]:

- Urban openness defined as systems' degree of openness, which enables user-driven innovation in existing and new services;
- Service innovation, understood as the development of innovative services through exploration of a variety of service areas as well as the exploitation of higher interoperability;
- Partnerships formation, which is the determination of types of partnerships formed to promote smart city development. Examination of funding types, whether top-down from government or bottom-up led by the private sector;
- Urban proactiveness, defined as the extent to which smart city services are moving toward sustainable energy use as well as IT-enabled services, through sensors, internet connectivity, or intelligent controls;
- Smart city infrastructure integration—ICT infrastructure for supporting smart city initiatives and creating higher network effects with multiple complementary devices;
- Smart city governance, which is an effective institutional governance structure, impacts sources and uses of resources through dedicated organization support. Innovative institutional approach or governance model to bring together multiple stakeholders to drive growth and foster smart services usage.

L. Anthopoulos, M. Janssen, and V. Weerakkody [76], based on their research, distinguished eight areas under which the smart city models currently operate: architecture, governance, planning and management, facilities, data and knowledge, services, people, and environment. As part of these areas, there are approximately one hundred elements that, according to the authors, make up a smart city. In the smart city rankings, the city's

assessment for SMART is carried out concerning the following areas: health and safety, mobility, activities, opportunities, governance, human capital, social cohesion, economy, governance, the environment, mobility and transportation, urban planning, international projection, and technology [77]. Of course, the above-presented smart model constitutes a short edition of scientific publications that pursue this issue. Their approximation was to show a high degree of complexity of the smart city idea.

3. The Purpose of Bibliometric Analysis

Bibliometric analysis is very often used to study trends and scientific research in many scientific disciplines. In order to meet the adopted goals, bibliometric analysis was carried out based on data obtained from the Scopus database (until February 2021). This database indexes the most significant number of journals from other databases [78]. Bibliometric analysis is a quantitative–qualitative research method used in the analysis of sets of bi-graphical descriptions of documents.

According to A. Prichard, bibliometry is a set of research techniques used to analyze publications [79]. There is evaluative bibliometrics related to the evaluation of research centers or researchers, which is based mainly on article citation indexes [80–82], and descriptive bibliometry, which is used to analyze trends in scientific research, and for the identification of relevant researchers or research centers [81]. A descriptive approach will be applied to the planned analyses. Bibliometric techniques offer convenient analysis methods due to the reference to codified knowledge, the use of measurable data, and the availability of data [83].

According to P. Nowak [84], bibliometric studies are used to describe and explain phenomena occurring in science thanks to the analysis of the information stream they produce, the definition of research effectiveness indicators, and the evaluation of researchers and research units. The specific character of bibliometric techniques is the source of their numerous methodological advantages, as the conducted analyses have the following characteristics [85]:

- Quantitative—objectified, difficult to manipulate, precise, and consistent;
- Normalizable—allow comparing research areas or centers with different productivity;
- Direct—easy to interpret;
- Based on publications and citations—that is, measurable research results and not hard-to-verify expert opinions on achievements;
- Characterized by a short time interval—between the moment of conducting the analyses and obtaining their results;
- Scalable—they allow for the analysis of both small and vast datasets;
- Enable analyses to be conducted by people who are not involved—in most cases, the analyses may be carried out by analysts who do not conduct their scientific research in the analyzed area and therefore do not represent the interests of any of the assessed entities;
- Non-invasive—they do not require collecting data through questionnaires or interviews; they can be carried out repeatedly based on available databases.

Bibliometric analysis allows presenting the scientific position of a given author and considering that the number of citations of their articles is a measure of recognition and validity of their scientific work. Moreover, sometimes, many citations of a scientific publication may turn out to be an indicator of innovation (a new idea, method, discovery) [86]. On the other hand, a group of articles often cited in a specific scientific specialty is treated by some researchers as a specific carrier of its paradigm [87]. Quoting T. Kuhn [88]: "changes in the citation of specialist literature in publications can be considered as a possible symptom of scientific revolutions"; therefore, it can be concluded that bibliometric analysis is a valuable research method that allows an in-depth study of a specific phenomenon, in this case, the smart city idea. The use of bibliometric analysis in this article will enable the collection and presentation of information on:

- Subjects of scientific activity in the area of S.C.;

- Assessing the importance of individual achievements and the position of researchers, institutions, regions, and countries;
- Defining the directions and potential for further development of the S.C. idea;
- Gathering and sharing knowledge on trends in the field of research on S.C., which may serve as inspiration for further research.

The purpose of the bibliometric analysis was to identify the basic set of bibliometric performance indicators and examine the co-occurrence of keywords concerning the smart city concept. As a result, it will assess the set of possible keyword sets for existing similarities, application areas, the most significant impact, and the occurring relationships. The analysis made it possible to identify the process of evolution of the publication on the smart city concept in the adopted time interval and guided the capacity and directions of future research on the smart city concept.

The conducted bibliometric analysis took into account the following:

- Number of documents published in the years 2005–2020;
- The types of documents published in the years 2005–2020;
- The list of the most productive sources, in the form of journals and conference proceedings (minimum 10 documents for the adopted period);
- The types of sources;
- The list of the most productive authors (five or more documents for the adopted period);
- The list of the most often affiliated institutions (20 or more documents for the adopted period);
- The list of the most productive countries (50 or more documents for the adopted period);
- The most often mentioned keywords in analyzed documents (50 or more documents in the adopted period);
- The list of the most often used keywords in analyzed documents.

The analysis carried out was based on the Scopus database that made it possible to obtain documents, the congregation of the necessary data, and bibliometric technology usage. Not only the total number of published documents was examined. At the same time, in order to determine their quality, the height of the Hirsch index and citations ratio were assessed. This enabled the development a road map associated with scientific activities carried out in the smart city field. In our case, the Scopus database inquiry adopted the "Smart City" character (Title-ABS-Key) or "Smart Cities" as phrases found in the title of publications, keywords, and summaries. The reason for choosing these two concepts is that they are treated as synonyms. Therefore, omitting "Smart Cities" may have resulted in not taking into account a large number of publications in the conducted analysis, thus reducing the credibility of the obtained results. The result of the first search was 27,949 documents. In the next step, the period of publication of documents was selected by adopting the years 2000–2020, reducing the number of documents to 26,863. The choice of the period 2000–2020 was dictated by the fact that by 2000, only eight publications were indexed in Scopus. In turn, 2020 is the last full year. After narrowing the search results for Business, Management, and Accounting, this result was decreased to 1431 documents. The narrowing of the results was dictated by the willingness to present S.C. conceptual dimensions and areas from the business, management, and accounting points of view. In the next step, a choice was made for the type of publication—articles, conference papers, books, book chapters, and reviews were selected, which, in effect, adopted the figure of 1378 documents. Documents in the forms of conference reviews, editorials, short surveys, notes, and errata were omitted in this search because these have the lowest number of publications and do not make a scientific contribution to the S.C. area. The last choice was the language of the publication— English was selected due to the fact that this is the most popular language—thus returning 1354 documents (Figure 1).
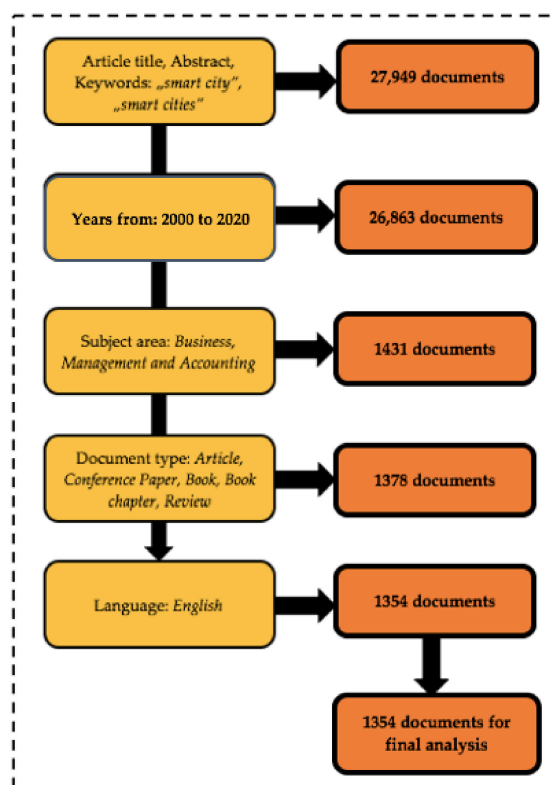
**Figure 1.** The document selection process scheme.

The final set of documents included 1354 scientific publications, which were subjected to subsequent stages of bibliometric analysis to create a visualization map. This collection was then exported to an Excel spreadsheet, which allowed viewing the results according to the author's name (or authors' names), year of publication, DOI number, link, type of publication, type of access, or keywords.

As Figure 2 below presents, the most significant increase in the number of published documents has been recorded since 2017. Until 2011, no more than ten documents in the smart city area were published annually. However, since 2012, a noticeable increase in the number of published documents is visible. The significant dynamics of the increase in the number of publications from the smart city area, since 2017, indicates that this topic has enormously gained popularity in recent years.
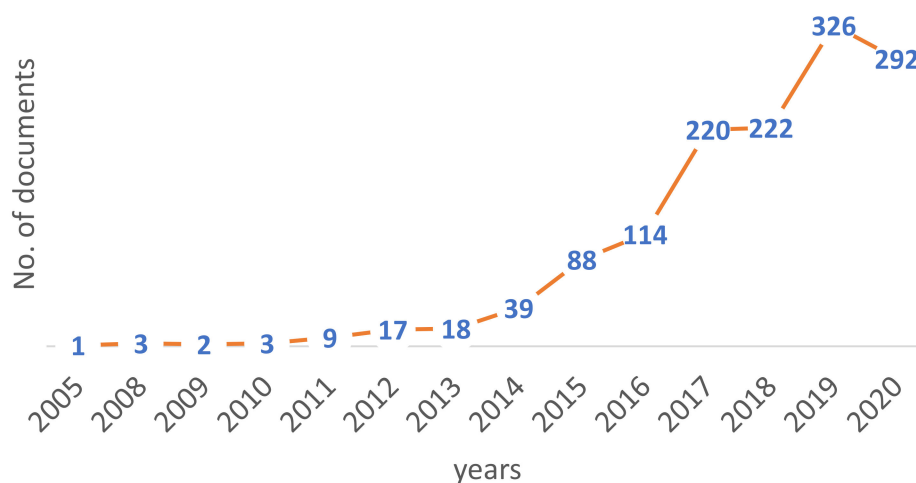
**Figure 2.** Number of documents published in the years 2005–2020.

Therefore, it can be assumed that this year was not only a breakthrough for the development of this research area. Moreover, it indicates that at the moment, the smart city concept is located in the center of the scientific world center, constituting a wide range of scientific explorations in this area (Figure 3).
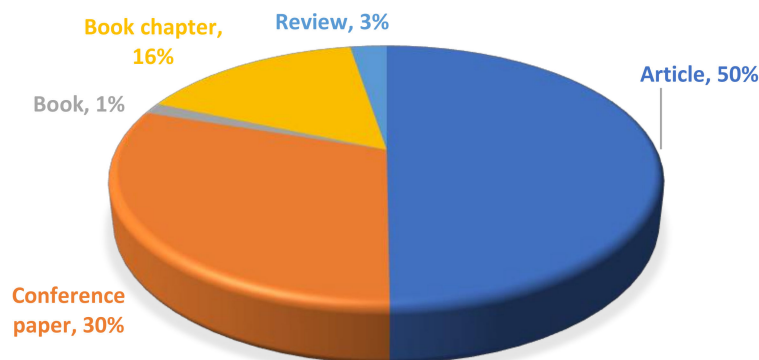
Figure 3. The types of documents published in the years 2005–2020.

Half of these documents were publications classified as articles (675), second place included conference papers (410), and third place included book chapters (215). The least occurring types of publication were reviews (35) and books (19).

Identification of sources publishing research from the smart city area includes journals and conference proceedings. Due to the high number of sources in which the documents on the smart city concept were found, only the first ten of them were taken into account (Figure 4).
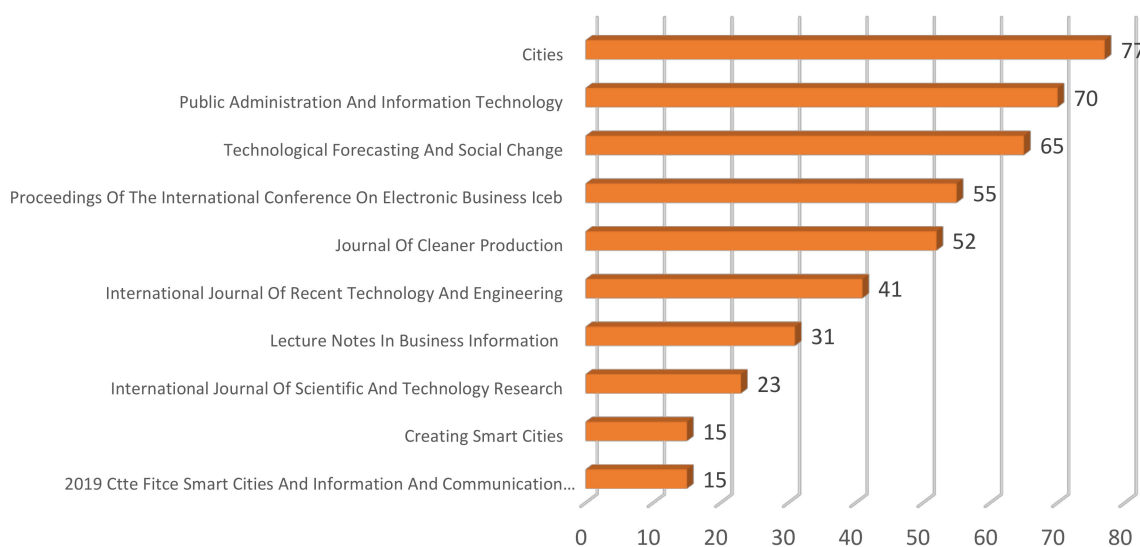
Figure 4. The list of the most productive sources (minimum 10 documents for the adopted period).

The highest score was reached by cities (17%), followed by public administration and information technology (16%), and technologically forecasting and social change (15%). In the following places, there are sources: proceedings of the International Conference on Electronic Business ICEB, *Journal of Cleaner Production*, *International Journal of Recent Technology and Engineering*, *Lecture Notes in Business Information*, *International Journal of Scientific and Technology Research*, 2019 CTTE Fitch Smart Cities and Information and Communication Technology CTTE Fitce 2019, and *Creating Smart Cities*, in which the number of published articles in 2005–2020 did not exceed 60 per year.

In regard to the source type (Figure 5), the most significant number of articles was published in journals (708) and conference proceedings (403). In the following places, there were books (124) and books series (115). On the other hand, the rarest source type were trade journals (8).

Figure 5. The types of sources.

As in journals, the number of authors publishing research on the smart city concept is very high (over 150). Therefore, a limit of five or more published documents from the smart city area was adopted. The most productive authors of smart city research are R. P. Dameri (10%), L. G. Anthopoulos (9%), and M. P. Rodríguez Bolívar (9%). In the following places, A. Ferraris (8%) and G. Graham (7%) were found (Figure 6).
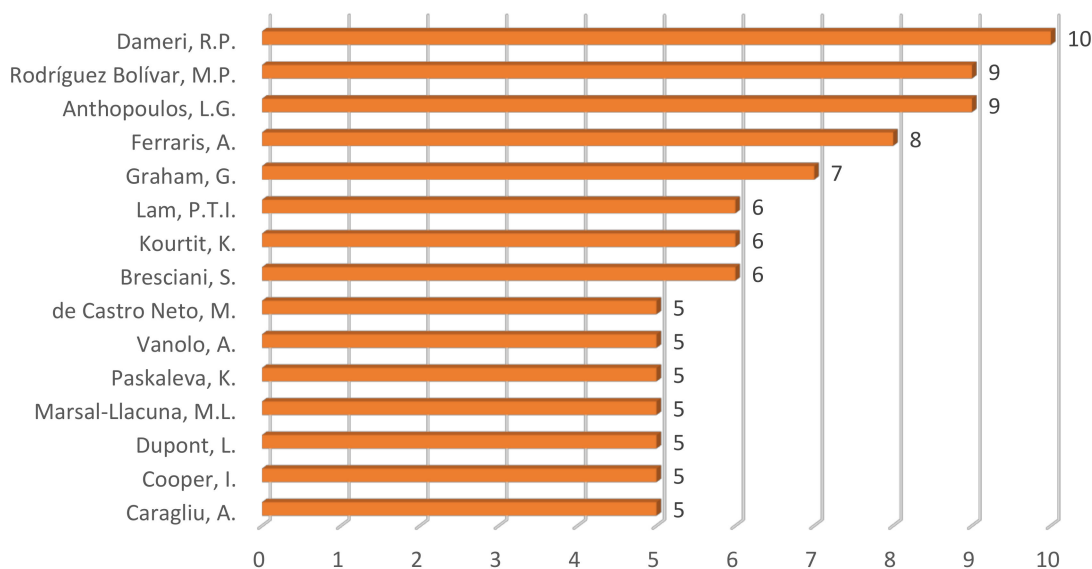
Figure 6. The list of the most productive authors (5 or more documents for the adopted period).

In regard to the documents in terms of affiliation, the leading institution is Politecnico di Milano (13%), followed by Università degli Studi di Torino (10%) and National Chengchi University (9%). Due to a large number of affiliated institutions, only those affiliated with 20 or more documents were selected for the analysis. This resulted in limiting the number to the 13 leading institutions (more than 150 in total) presented in Figure 7.
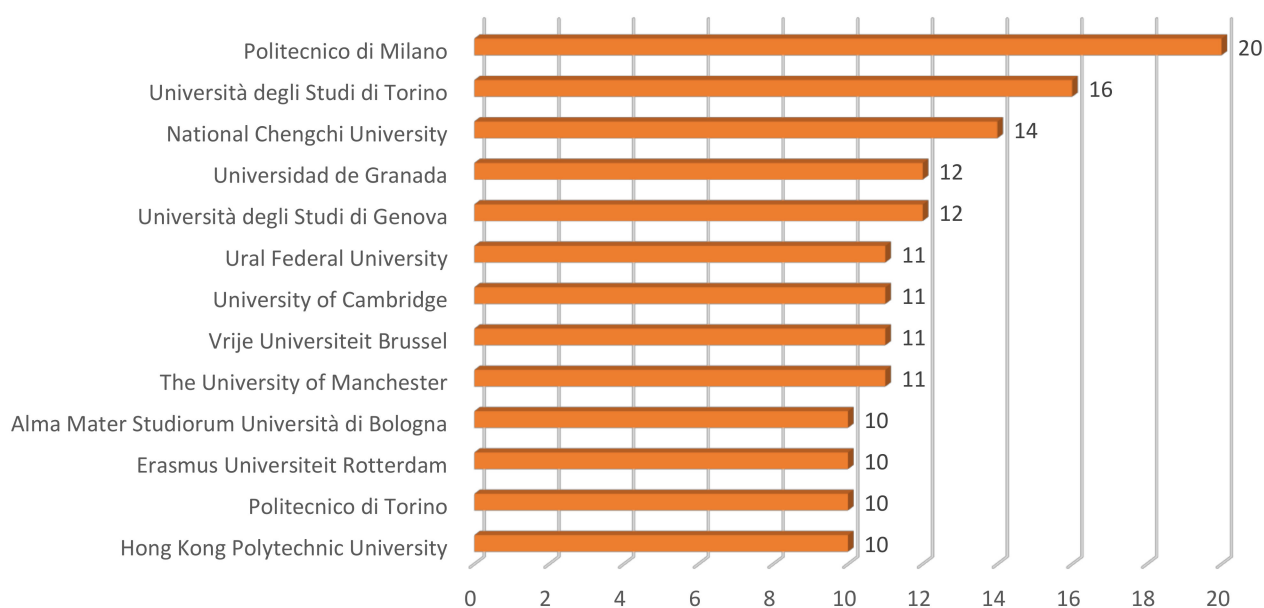
Figure 7. The list of the most often affiliated institutions (20 or more documents for the adopted period).

This study also included an analysis of the results for each country in terms of the number of documents published. As in previous cases, due to the extensive dispersion of the published documents (almost 100 countries), these countries were selected for analysis. The number of published documents amounted to 50 or more in the tested period (Figure 8).
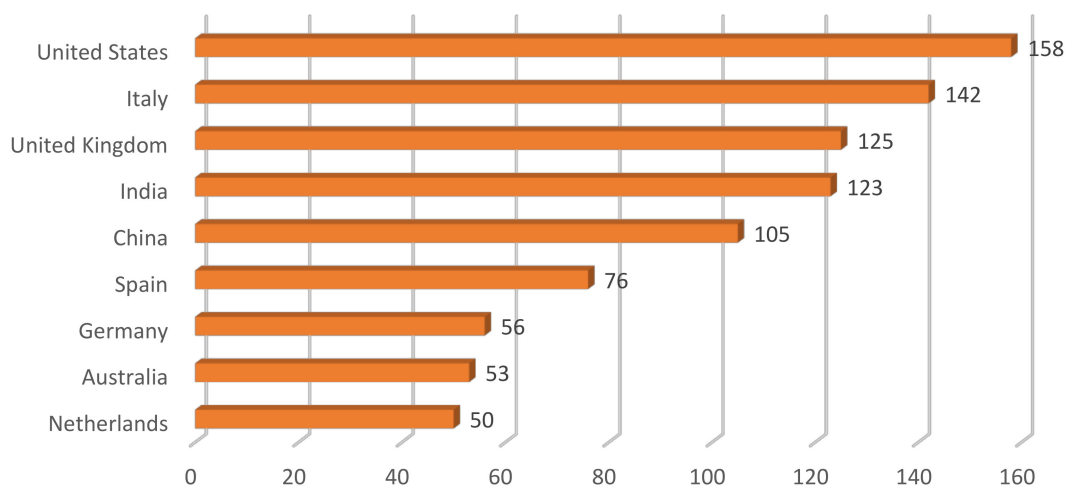
Figure 8. The list of the most productive countries (50 or more documents for the adopted period).

In first place, there is the United States (18%), followed by Italy in second (16%), and two countries—the United Kingdom and India—in third (14%). There were countries such as China, Spain, Germany, Australia, and the Netherlands in the following places.

4. Citations Analysis

Relationships between the scientific literature are determined by mutually cited documents. In general, when preparing an article or book, it is required to refer to other publications related to the same research area. A complete research paper consists of two parts: the body part and references. Citation analysis uses a variety of means including mathematical, statistical, comparative, inductive, abstract, generalizing, and logical methods [89].

Citing the scientific literature reflects the interconnection of science and technology, and the interconnection of disciplines from the perspective of the literature used. Many studies have shown that citing scientific works influences the development of relationships both between researchers and individual scientific disciplines. This makes science move in time and space, and a complete network system is created from small fragments of a specific research topic related to the discipline. In this article, the citation analysis was carried out taking into account the following criteria: articles, authors, subject and topic, year of publication, and journal name.

Regarding the articles (Table 1), the most cited article is one by Neirotti P., De Marco A., Cagliano A. C., Mangano G., and Scorrano F., from 2014, published in the *Cities* journal, with 976 citations.

Table 1. Articles with the highest number of citations.

Article Title	Authors	Journal	Publication Year	No. of Citations
Current trends in smart city initiatives: Some stylised facts	Neirotti P., De Marco A., Cagliano A. C., Mangano G., Scorrano F.	*Cities*	2014	976
The role of big data in smart city	Hashem I. A. T., Chang V., Anuar N. B., Adewole K., Yaqoob I., Gani A., Ahmed E., Chiroma H.	*International Journal of Information Management*	2016	445
Modelling the smart city performance	Lombardi P., Giordano S., Farouh H., Yousef W.	*Innovation: The European Journal of Social Science Research*	2012	395
What are the differences between sustainable and smart cities?	Ahvenniemi H., Huovila A., Pinto-Seppa I., Airaksinen M.	*Cities*	2017	373
Smart city policies: A spatial approach	Angelidou M.	*Cities*	2014	364
Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco	Lee J. H., Hancock M. G., Hu M.-C.	*Technological Forecasting and Social Change*	2014	362
Sustainable-smart-resilient-low carbon-eco-knowledge cities; Making sense of a multitude of concepts promoting sustainable urbanization	De Jong M., Joss S., Schraven D., Zhan C., Weijnen M.	*Journal of Cleaner Production*	2015	357
Smart cities: A conjuncture of four forces	Angelidou M.	*Cities*	2015	306
An integrated service-device-technology roadmap for smart city development	Lee J. H., Phaal R., Lee S.-H.	*Technological Forecasting and Social Change*	2013	230
Blockchain-based sharing services: What blockchain technology can contribute to smart cities	Sun J., Yan J., Zhang K. Z. K.	*Financial Innovation*	2016	207
How to strategize smart cities: Revealing the SMART model	Ben Letaifa S.	*Journal of Business Research*	2015	199
Lessons in urban monitoring taken from sustainable and livable cities to better address the Smart Cities initiative	Marsal-Llacuna M.-L., Colomer-Llinas J., Melendez-Frigola J.	*Technological Forecasting and Social Change*	2015	183
Smart tourism destinations: ecosystems for tourism destination competitiveness	Boes K., Buhalis D., Inversini A.	*International Journal of Tourism Cities*	2016	164
How do we understand smart cities? An evolutionary perspective	Kummitha R. K. R., Crutzen N.	*Cities*	2017	163

In second place was an article by Hashem et al., namely, "The role of big data in smart city", published in the *International Journal of Information Management* in 2016, which was cited 445 times. Additionally, in third place, with 395 citations, is the article by Lombardi et al., called "Modeling the smart city performance", published in 2012 in the journal *Innovation: The European Journal of Social Science Research*.

The next table presents a comparison of two statements: authors with the largest number of publications and authors with the greatest number of citations (Table 2).

Table 2. Authors with the highest number of citations.

By No. of Articles			By No. of Citations		
Author Name	**No. of Articles**	**No. of Citations**	**Author Name**	**No. of Articles**	**No. of Citations**
Dameri, R. P.	10	241	De Marco A.,	2	991
Anthopoulos, L. G.	9	320	Neirotti P.,	1	976
Rodríguez Bolívar, M. P.	9	90	Cagliano A. C.,	1	976
Ferraris, A.	8	508	Mangano G.,	1	976
Graham, G.	7	299	Scorrano F.	1	976
Bresciani, S.	6	467	Chang V.	5	534
Kourtit, K.	6	218	Hashem I. A. T,	2	449
Lam, P. T. I.	6	49I	Anuar N. B.,	1	445
Caragliu, A.	5	143	Adewole K.,	1	445
Cooper, I.	5	42	Yaqoob I.,	1	445
Dupont, L.	5	44	Gani A.,	1	445
Marsal-Llacuna, M. L.	5	298	Ahmed E.,	1	445
Paskaleva, K.	5	42	Chiroma H.	1	445
Vanolo, A.	5	196	Lombardi P.,	3	414
de Castro Neto, M.	5	8	Giordano S.,	1	395
			Farouh H.,	1	395
			Yousef W.	1	395

The list on the right includes the two most cited articles in the field of S.C., and the authors are co-authors of these publications. As the results show, the number of publications does not translate into the number of citations because despite the fact that Dameria R.P. wrote 10 articles, which are almost four times less cited than A. De Marco, De Marco, who is the author of only two scientific publications, has a total number of citations of almost 1000. However, these publications are characterized by a very high number of citations, which means that they make a significant contribution to the research area of S.C.

In the next part, the year in which publications in the field of S.C. were most often cited was checked (Table 3).

The list on the right shows that the most frequently cited scientific articles were published in 2018, despite the fact that this year is not characterized by the highest number of publications. The highest number of published scientific articles is in 2019, but in terms of the number of citations, it is in fourth place. Therefore, this confirms the previously formulated conclusion that the number of publications does not translate into the number of citations.

Table 3. Articles with the highest number of citations by the year of publication.

By the Year of Publication			By the No. of Citations		
The Year of Publication	No. of Publications	No. of Citations	The Year of Publication	No. of Publications	No. of Citations
2005	1	9	2018	222	2859
2008	3	18	2016	114	2545
2009	2	1	2017	220	2525
2010	3	21	2019	326	2483
2011	9	103	2014	39	2271
2012	17	1086	2015	88	2251
2013	18	365	2012	17	1086
2014	39	2271	2020	292	963
2015	88	2251	2013	18	365
2016	114	2545	2011	9	103
2017	220	2525	2010	3	21
2018	222	2859	2008	3	18
2019	326	2483	2005	1	9
2020	292	963	2009	2	1

The last stage of the citation analysis was to check the number of citations in terms of journals (Table 4).

Table 4. Journals with the highest number of citations.

By the No. of Publications			By the No. of Citations		
Journal Title	No. of Publications	No. of Citations	Journal Title	No. of Publications	No. of Citations
Cities	77	4606	*Cities*	77	4606
Public Administration and Information Technology	70	425	*Technological Forecasting and Social Change*	65	2489
Technological Forecasting and Social Change	65	2489	*Journal of Cleaner Production*	52	1543
Proceedings of the International Conference on Electronic Business Iceb	55	653	*Proceedings of The International Conference on Electronic Business Iceb*	55	653
Journal of Cleaner Production	52	1543	*Public Administration and Information Technology*	70	425
International Journal of Recent Technology and Engineering	41	30	*Lecture Notes in Business Information*	31	235
Lecture Notes in Business Information	31	235	*International Journal of Recent Technology and Engineering*	41	30
International Journal of Scientific and Technology Research	23	14	*Creating Smart Cities*	15	26
2019 Ctte Fitce Smart Cities and Information and Communication Technology Ctte Fitce 2019	15	8	*International Journal of Scientific and Technology Research*	23	14
Creating Smart Cities	15	26	*2019 Ctte Fitce Smart Cities and Information and Communication Technology Ctte Fitce 2019*	15	8

As it can be seen from the presented table, the *Cities* journal is not only the place where the most articles from the S.C. area are published but it also publishes articles with the highest citations. In total, this journal published 77 articles on SS, with a citation

count of 4606, meaning that, on average, one article was cited almost 60 times. In second place, in terms of the number of citations, was the periodical *Technological Forecasting and Social Change* journal, whose articles were cited almost 2500 times, with a total number of 65 articles, which means that, on average, one article was cited over 38 times.

The citation analysis indicated that the two most cited publications are the following scientific articles: (1) Current trends in smart city initiatives: Some stylised facts, by Neirotti P., De Marco A., Cagliano A. C., Mangano G., and Scorrano F.; and (2) The role of big data in smart city, by Hashem I. A. T., Chang V., Anuar N. B., Adewole K., Yaqoob I., Gani A., Ahmed E., and Chiroma H. Thus, it is worth presenting both of these publications.

The purpose of the first article was to provide a comprehensive understanding of the concept of S.C. by developing a taxonomy of relevant fields of application, which include: natural resources and energy, transport and mobility, buildings, living, government and economy, and people. A total of 24 subdomains were assigned to each of the areas mentioned above, along with a description of specific actions that should be taken for a city to develop according to the idea of S.C.

The second most cited article focused on the description of existing communication technologies and applications based on intelligent technologies used in the context of S.C. Additionally, the authors of the article presented their own concept of a model that enables the management of large amounts of data and information for smart cities. This model also identifies business and technological challenges. Thus, it can serve as a reference point for researchers and the business environment who will further develop the S.C. concept, which they perceive in the context of big data [90].

5. Keyword Occurrence Analysis—Visualization Maps

Each of the documents subjected to the bibliometric analysis contained keywords selected by the author(s) of the given publication. These words correspond to the smart city area. Therefore, the next step was to analyze the co-occurrence of keywords in published documents. For this purpose, VOSVIEWER software 1.6.16 (CWTS, Leiden, Holland) [91] enabled the development of visualization maps based on the network data and the use of "visualization of similarities" and clustering techniques. VOSVIEWER offers a wide range of possibilities to carry out a reliable bibliometric analysis, enabling a complete study of a bibliometric map [92,93].

As a result, this will enable the indication of leading keywords in the smart city area. The purpose of this analysis was to isolate the key dimensions of the smart city concept. The classification conducted was based on a pre-conducted bibliometric analysis. In addition, the analysis of keywords from the smart city area will contribute to increasing the understanding of challenges placed by the smart city idea, which constitute a multifaceted perspective of continuous development of this concept. In addition, the analysis carried out will also enable the systematization of various terms and determine the links between them.

This analysis will enable the creation of a complete set of factors specifying the smart city idea. Acquired data from the Scopus database based on which bibliometric analysis was carried out were then processed in VOSVIEWER. Due to the research questions set out in this article, special attention was devoted to the phrasing of keywords. Thus, a search was carried out by defining the following "Smart City" inquiry—which was then searched in the articles' titles, abstracts, and keywords. As in bibliometric analysis, search results containing the interval 2000–2020 were taken into account.

The obtained search results were then imported into a CSV file and opened in VOSVIEWER. Based on the separation of a separate file, a file containing 1840 keywords was created, along with the linked links assigned to them (total link strength). Table 5 contains a list of keywords characterized by the highest number of occurrences and the highest link force.

Table 5. The most popular keywords with the highest level of occurrence and total link strength.

Keyword	Occurrences	Total Link Strength
smart city	272	272.00
smart cities	182	182.00
Internet of Things	37	37.00
big data	32	32.00
iot	29	29.00
sustainability	25	25.00
innovation	24	24.00
technology	22	22.00
governance	15	15.00
blockchain	13	13.00
entrepreneurship	13	13.00
open data	12	12.00
Internet of Things (iot)	11	11.00
urban development	11	11.00
urban planning	11	11.00
sustainable development	10	10.00

In order to receive appropriate and comprehensive information, the keywords which were not connected (a total of 42 keywords) were excluded from the analysis. Thus, a set consisting of 3603 keywords was received. The collection obtained consisted of 101 clusters. The largest of them contains 104 elements, the second collection consists of 98 elements, the third consists of 97 elements, the fourth consists of 94 elements, and the fifth consists of 93 elements (Figure 9).
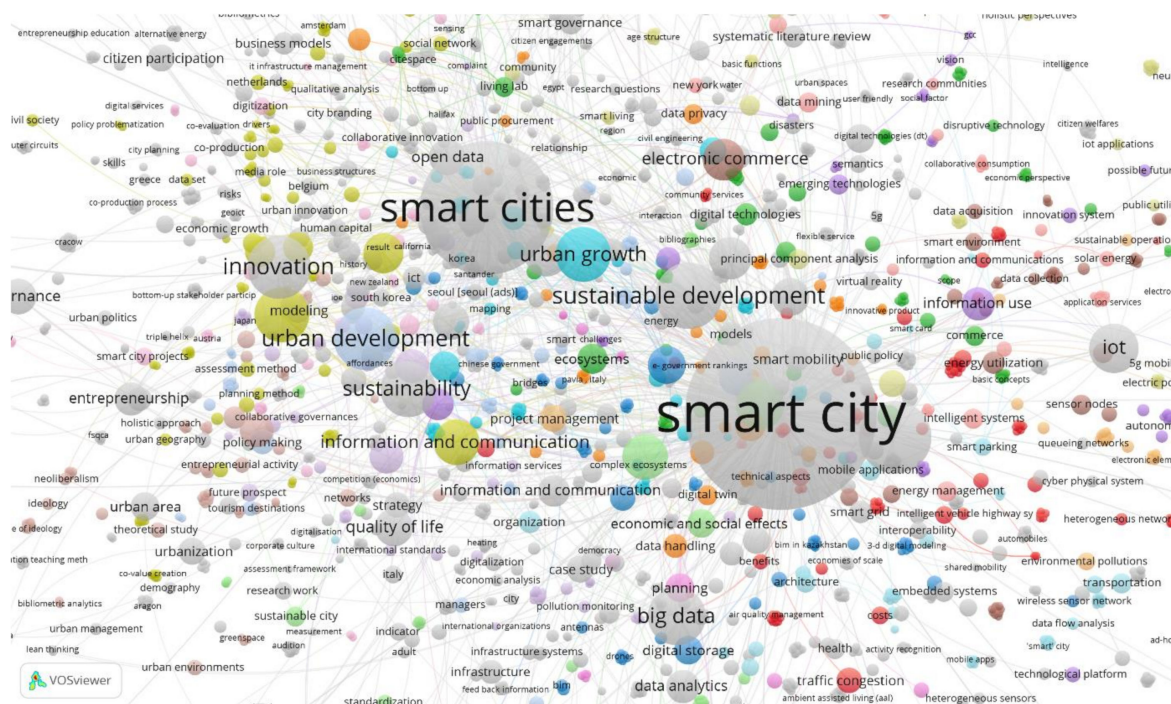

Figure 9. Visualization of a collection consisting of keywords.

As it is indicated by the above figure, the size of the wheel refers to the level of validity of a given keyword, while the colors indicate a cluster to which the word data belong. Clusters located close to each other in the figure indicate closely related keywords. As the drawing above presents, the most visible keywords are "Smart City" and "Smart Cities". Additionally, the following words are used often: "Urban Growth", "Sustainable Development", "Innovation", "Urban Development", "Sustainability", "IOT", or "Big Data". However, the figure presented above is characterized by two features. First of all, many keywords are displayed, which may disrupt the perception and understanding of relationships between individual keywords. Secondly, some keywords such as "Smart City" and "Smart Cities" can be treated as synonyms, even though, in the drawing, they form separate clusters, which can even make it difficult to understand the occurring relationship. The situation in the case of "Sustainable Development" and "Sustainability" looks similar, which indicates that a data cleaning process should be carried out to obtain more transparent and legible results.

In the first step of the data cleaning process, the number of keywords was limited by assuming that the minimum number of keywords occurring must be at least 2 to 2. As a result, a set of 695 elements grouped in 21 clusters was obtained, which means 2908 elements were excluded (Figure 10).
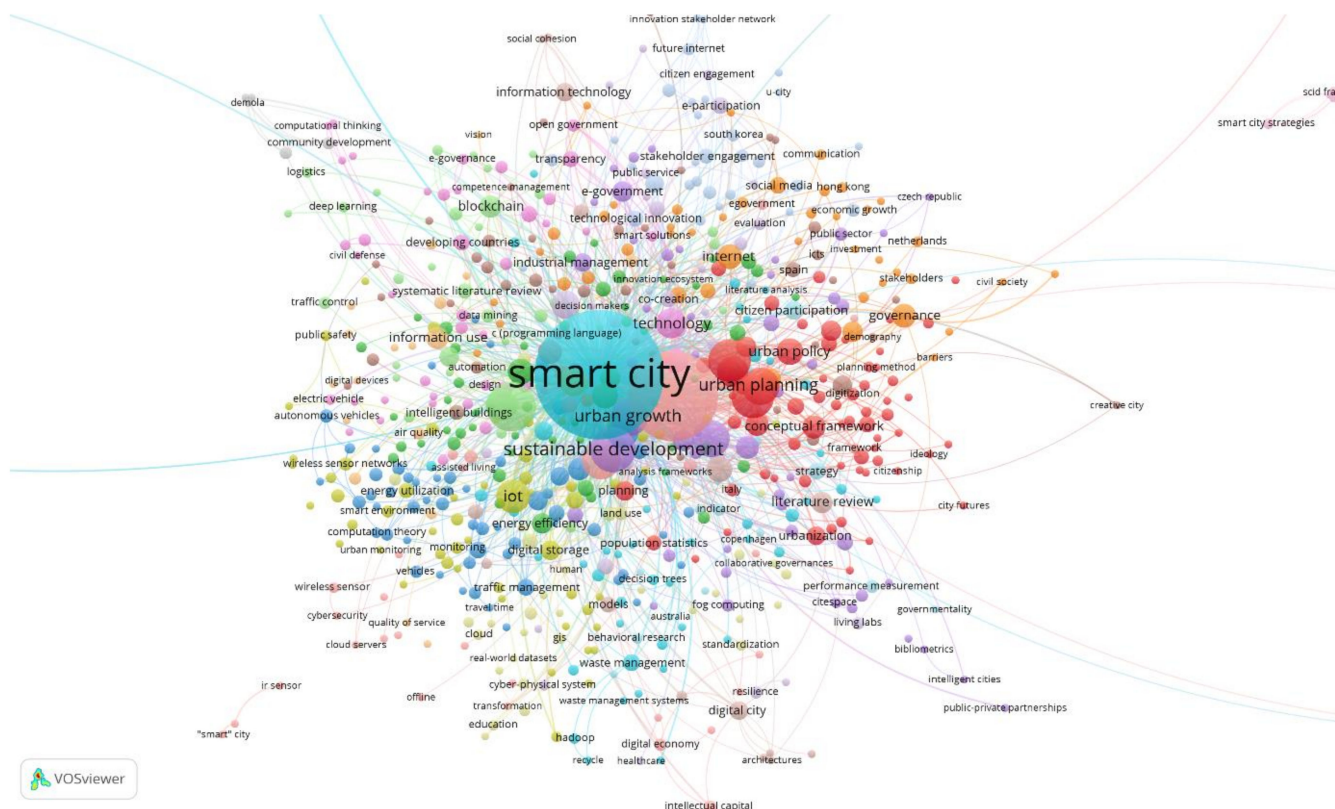
Figure 10. Visualization of a set grouped into clusters.

The first set consists of 65 elements, the second consists of 59 elements, the third consists of 58 elements, the fourth consists of 56, and the fifth consists of 51 elements.

The next stage of the data cleaning process was to remove synonyms, increasing the transparency and readability of the results obtained. For this purpose, a thesaurus file was created, which enabled the combination of various variants of spelling specific keywords, e.g., "Smart Cities" was replaced with the phrase "Smart City", specific synonyms, e.g., "Bibliometrics", were replaced by "Bibliometrics Analysis", or we removed specific keywords not related to the "Smart City" concept, e.g., "Co-Citations Analysis".

The created thesaurus file was then imported into the VOSVIEWER program, and the keyword coexistence analysis was again carried out. The table below presents the results for the first ten most occurring keywords (Table 6).

Table 6. The list of the first ten most occurring keywords.

	Keyword	Occurrences	Total Link Strength
1.	smart city	568	568
2.	urbanization	149	149
3.	sustainable development	100	100
4.	City	96	96
5.	Technology	92	92
6.	Internet of Things	92	92
7.	smart system	75	75
8.	ICT	72	72
9.	data	72	72
10.	innovation	70	70

The data cleaning process's final effect is a more detailed visualization map consisting of 458 elements grouped in 16 clusters. The cluster consists of keywords characterized by the most significant number of links and words with the most co-occurrence relationships in a given cluster. The first set contains 58 elements, the second contains 54 elements, the third contains 43 elements, the fourth contains 36 elements, and the fifth contains 35 elements (Figure 11).
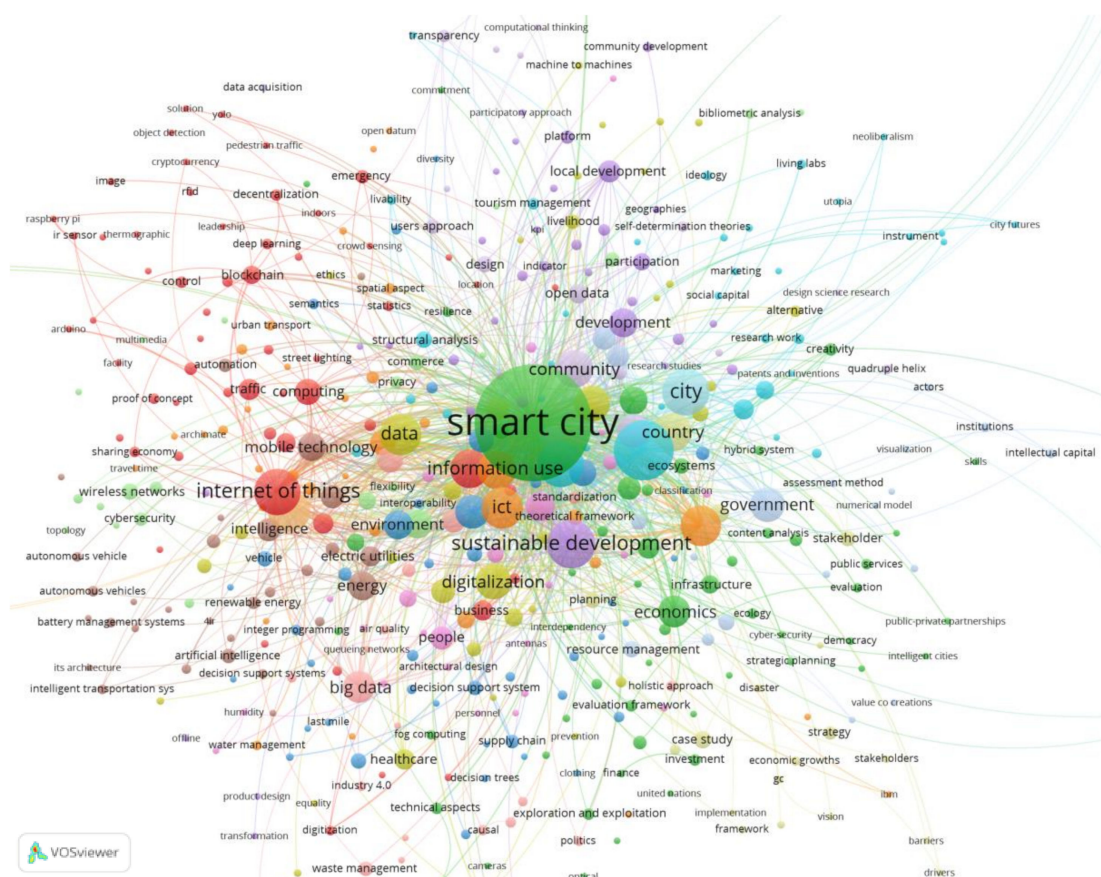

Figure 11. The visualization effect of data cleaning process.

In the figure presented above, each circle represents an individual keyword. At the same time, its size indicates the number of occurrences of this word in the article and its abstract and keywords. The closer two clusters are to each other, the more substantial the conformity between keywords. The largest cluster is green and consists of terms related to "Smart City". There are community, social systems, technology, information use, public, and performance in the immediate vicinity. These keywords represent key dimensions inextricably link to the S.C. idea. Community represents a society that is the primary recipient of solutions offered by S.C., and social systems are created by individual groups of societies. Technology and information use refer to the technological dimension of S.C., while public emphasizes the nature of S.C. as a concept oriented to the public; performance emphasizes that this is a concept characterized by a sizeable practical dimension. There are words such as data, networking, environment, management, ICT, sustainable development, knowledge, urbanization, e-services, country, and collaboration in the near distance. In turn, in the distance, there are two large clusters: Internet of Things, and smart system, innovation, government, and city.

In the above figure, the compounds resulting from the distance between individual clusters can be also observed. Lines between clusters also represent the strongest links. In connection with the above, based on the illustration, a close relationship between smart city and Internet of Things, ICT and Internet of Things, smart city and environment, smart city and economics, smart city and blockchain, smart city and entrepreneurship, sustainable development and environment, sustainable development and economy, and sustainable development and entrepreneurship can be observed. This again shows the relationship between S.C., sustainable development, and ICT.

We developed another figure which presents an overlay visualization, indicating a given keyword in a specific time interval, in 2015–2020 (Figure 12). The keyword color was determined based on the keyword result from the lowest result (blue) to the highest (yellow color).
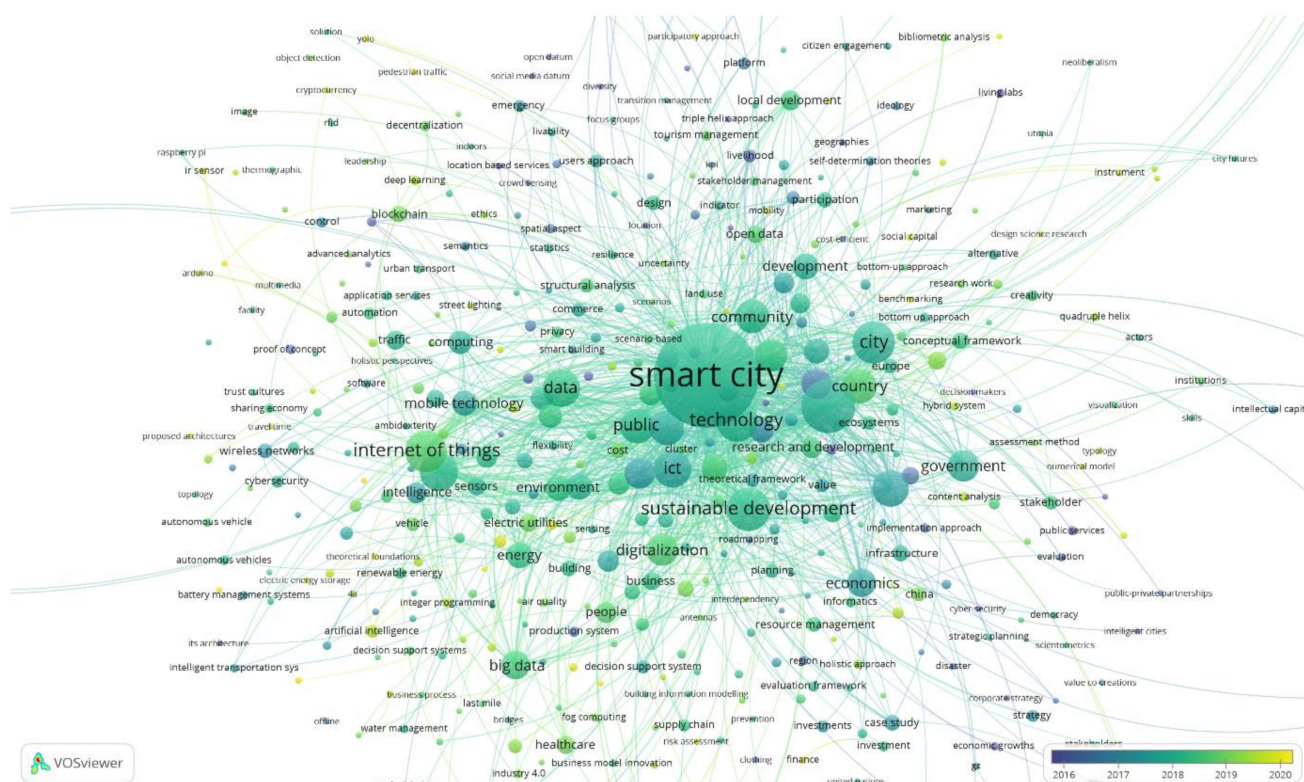
Figure 12. Density visualization.

This overlay visualization presents the average annual number of publications in the adopted period. As it is described in the above figure, the most significant number of publications containing the examined keywords was published in 2017–2018.

The following figure presents a density map in which every keyword has a color that indicates the density of keywords at this point (item density). By default, colors range from blue through green to yellow. The larger the number of keywords in the vicinity of the point, and the greater the weight of neighboring keywords, the closer the point's color to yellow. On the other hand, the smaller the number of keywords in the vicinity of the point, and the smaller the weight of neighboring keywords, the closer the point is to blue (Figure 13).
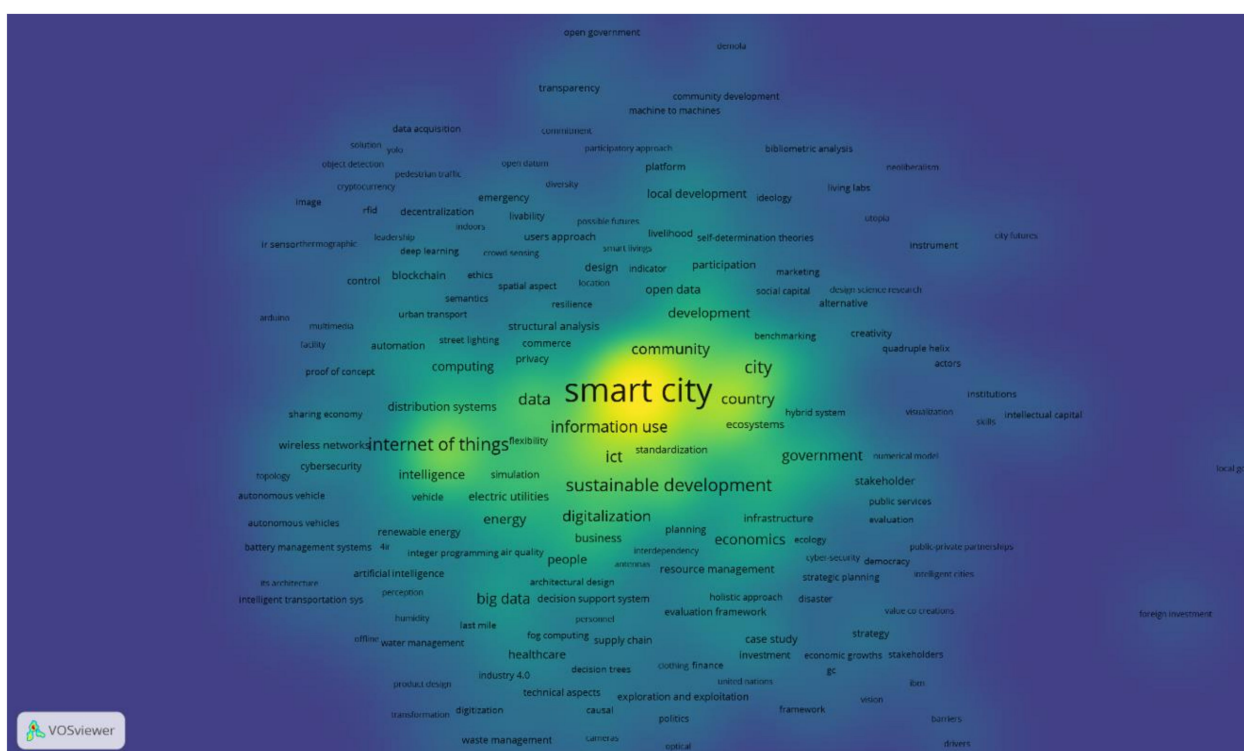
Figure 13. Item density visualization.

From the presented figure, important keywords include smart city, urbanization, technology, ICT, Internet of Things, community, city, sustainable development, and smart system. On the other hand, the density of these areas indicates that keywords in these areas are characterized by a large number of occurrences and total links. On the other hand, there is a clear division between the areas used—sustainable development, Internet of Things, and smart city.

An additional density map option is to group keywords in clusters (cluster density), in this case, in 16 clusters. Cluster density is only available if the elements have been assigned to clusters. The visualization of the concentration density is similar to the visualization of the keyword density, except that the keyword density is displayed separately for each element's focus. In the visualization of the concentration density, the color in the visualization is obtained by mixing the colors of various clusters. The color of a particular focus determines the number of keywords belonging to this concentration in the vicinity of the point. As in the case of the visualization of the subject density, the subject's weight is taken into account (Figure 14).

Figure 14. Cluster density visualization.

In the default settings, this drawing was generated with a black background. However, to increase its readability, the black background was replaced with white. As it can clearly be seen, the clusters relate to areas such as the Internet of Things, data, ICT, digitalization, sustainable development, economics, innovation, technology, and public.

6. The Research Results Interpretation

The analyses carried out showed that the variety of keywords regarding the smart city idea is wide. The analysis made it possible to identify the process of evolution of the publication on the smart city concept in the adopted time interval and guided the capacity and directions of future research on the smart city concept.

We can assume that, currently, the smart city concept is the subject of many research works and analyses, which results in a growing trend in the number of emerging scientific publications. It is true that in the period, the most publications were found in 2019. However, the decrease in the number of publications in 2020 can be explained by the worldwide COVID-19 pandemic, which could, among others, have affected the slowdown of scientific work in this area. Therefore, it can be assumed that in subsequent years, the trend in the number of publications from the smart city area should be increased because, for the moment, it can be assumed that this topic has not been exhausted and fully described. Currently, the smart city idea is at the center of interest in the scientific world, constituting a wide range of scientific explorations in this area.

In response to research questions, the analysis carried out in the first part of this article indicated the following:

- As we could predict, keywords in the form of "Smart City" and "Smart Cities", treated as synonyms, were the most common words in scientific publications. In second place, however, were keywords in the form of "Internet of Things" (including the phrase "IoT"), "Sustainable Development (including the phrase "Sustainability"), and "Urban Development "(including the phrase "Urban Growth"). These most common

keywords indicate that the smart city idea is inextricably linked to the Internet of Things, sustainable development, and urban development. The keyword "Internet of Things" emphasizes the use of the smart city idea in the most modern ICT solutions, and "Sustainable Development" emphasizes that the idea of smart cities is also based on social and ecological pillars. However, "Urban Development" indicates entities in which the idea of smart cities is implemented. As it was previously mentioned, definitions determining the idea of smart cities can be divided into two groups—those that emphasize the use of ICT solutions, and those that take into account aspects such as people or the environment. At the same time, the second group provides the first extension, as ICT solutions are mentioned in them. On the other hand, the common point of these definitions is that they concern the city as the primary entity of this concept.

- Analysis of crucial words carried out in a further stage indicated that the most common words were characterized by the most significant total link strengths to: smart city, urbanization, sustainable development, city, technology, and Internet of Things. At the same time, it is worth noting that a bibliometric analysis was carried out in the first stage of this study, and the obtained results were based on the so-called raw data. On the other hand, analysis of the co-occurrence of keywords was carried out based on data subjected to a cleaning process under which synonyms were removed. Some words that were more general were changed, or literary errors were liquidated. What, however, was not changed was that the fact that "Smart City" is the most common keyword and characterized by the highest value of the total link strength—568. The word "Urbanization" was replaced by the earlier phrases "Urban Development" and "Urban Growth", wand it was characterized by a more than three times smaller total link strength force. In third place was the phrase "Sustainable Development"— characterized by the value of 100 in its total link strength. Therefore, it can be assumed that the greatest impact is characterized by "Smart City", which can be taken for obviousness. On the other hand, "urbanization" indicates that the smart city idea is focused on one type of entity: cities. Another phrase again emphasizes that the idea of smart cities is largely based on the concept of sustainable development; if, however, S.D., in these assumptions, is a very general concept, its three pillars are underlined in the idea of smart cities. Subsequent words "City" and "Technology" re-emphasize that the smart city idea is implemented concerning cities, and that the latest technologies are used as part of this idea, but not included in the ICT area, and this combination was placed in eighth position. The results of the coexistence analysis indicate that the most critical areas and research trends in the S.C. idea include urbanization, sustainable development, city, technology, and Internet of Things.

- As part of the analysis of the coexistence of keywords, it was also possible to identify compounds that result from a distance between individual clusters (Figure 15). Lines between clusters also represent the strongest links. A very close relation can be observed between S.C. and Internet of Things, blockchain, entrepreneurship, economy, and environment. This can be called a first-degree relation. However, entrepreneurship, economy, and environment can be treated as the pillars that make up the concept of sustainable development: entrepreneurship as a social pillar, economy as an economic pillar, and environment as an ecology pillar. On the other hand, the Internet of Things is inextricably linked with ICT—one of the effects of the continuous development of ICT. Moreover, the blockchain plays a crucial role in the S.C. idea. It enables network participants to exchange information and data, ensuring a high level of transparency and reliability. Additionally, bearing in mind that cities have a lot of stakeholders (inhabitants), the information and data exchange is essential for highly convenient city services. Thus, the blockchain is now treated as an integral part of the idea of S.C.
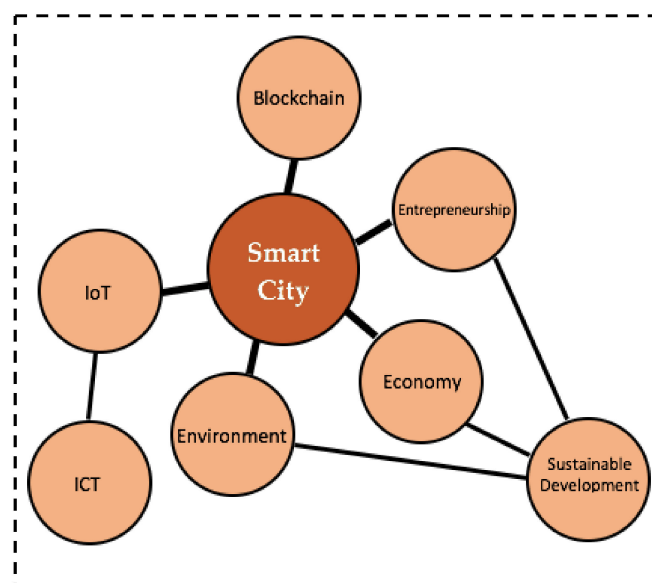
Figure 15. The correlations and their strengths between the keywords.

Therefore, this analysis indicated the occurrence of strong correlations between smart city and IoT, environment, economics, blockchain, and entrepreneurship. IoT is strongly correlated with ICT, environment, and economics, and entrepreneurship with sustainable development. The last stage of this research was to conduct cluster analysis, the results of which indicate that the most significant concentrations were clusters for areas such as Internet of Things, data, ICT, digitalization, sustainable development, economics, innovation, technology, and public.

The following Figure 16 is a comprehensive approach to the S.C. idea, with the strength of the relationships between individual areas.
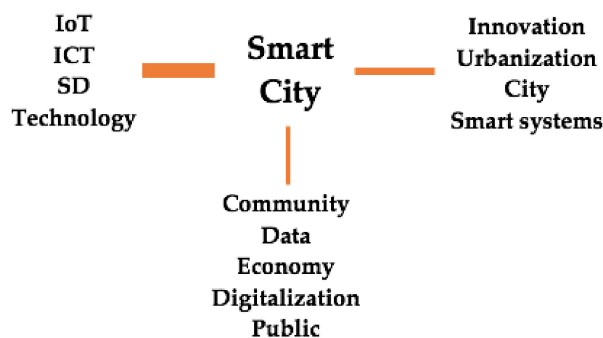
Figure 16. A comprehensive approach to the S.C. idea with the strength of the relationships between main areas.

According to the above figure, research conducted in the smart city area is highly focused on technological aspects, including IoT, ICT, or technology areas. However, the same strength of the relationship also occurs concerning the concept of sustainable development. A slightly weaker relationship can be observed for smart city and innovation, urbanization, city, and smart system, and the weakest relationship can be found in the case of community, data, economy, digitization, and public. This indicates that researchers dealing with the knowledge area that is the idea of smart city mainly concentrated on its technological aspects. In second place, there is the concept of sustainable development, from which the social, ecological, and economic pillars were implemented in the idea of smart cities. The most substantial relationship between S.C. and IoT, ICT, SD, and technology clearly indicates that the idea of S.C. is inextricably linked with the concept of sustainable development and ICT and emphasizes the technical nature of this idea. Without technology, the

S.C. idea would probably not remain the same; thus, technology and the high degree of its development enable the realization of S.C.'s assumptions in practice. Emphasis is placed mainly on the technological aspects of the smart city idea, indicating that even though the technological aspect of the smart city idea has already been thoroughly investigated, we can still identify specific areas of the smart city idea which should be examined, such as community, urbanization, or smart systems. This, in turn, translates into innovation, urbanization, city, and smart systems. Urbanization and city emphasize that the idea of S.C. is used to manage cities and urban areas. Innovation is, on the one hand, the result of using the idea of S.C. On the other hand, S.C. may be the result of striving to implement innovative solutions in cities. Areas such as community, data, economy, digitization, and public are characterized by the weakest relations; this is because they are characterized by the greatest generality, which means that they can be treated as a background for S.C.

7. Conclusions

The study carried out in this article indicates that the smart city idea is not yet a fully exploited area, offering a wide range of future research avenues. The essential contribution is to develop a set of keywords strongly associated with S.C., which, at the same time, determine the key dimensions and main areas of this idea. An additional result of the studies is to specify a different path that scientists can follow, leading their research in this area. The research results can also be helpful for entities who want to implement the smart city idea in cities. On the one hand, guided by the developed set, they have the option of developing a starting point, i.e., outlining the main areas of the idea of S.C., or, in relation to the developed path, checking at what stage there is a city in the implementation of the idea of S.C.

This article constitutes a developing theory regarding the idea of S.C., which is why it is worth bearing in mind that the results obtained do not create one complete strategy. However, they constitute a valuable research contribution in the S.C. area. This contribution, together with the effects of other researchers or the effects of activities carried out by practitioners, will contribute to further developing the theory of the idea of S.C.

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