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Entrepreneurship Through Open Data: An Opportunity for Sustainable Development

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Abstract: Entrepreneurship and open data are key elements in the sustainable development field, improving economic, social, and environmental dimensions. However, entrepreneurship and open data are barely studied together in the literature from a theoretical perspective. Therefore, this study identifies the main themes in the previous studies and proposes a conceptual model for analyzing entrepreneurship through open data. For this purpose, a descriptive analysis and a co-word analysis were performed. Results show that the subject is multidisciplinary, and the main theme of study is how different agents reuse information released by public administrations to generate new entrepreneurial initiatives, especially novel business models associated with new mobile applications. Open data sources, innovation, and business models are studied as critical factors for analyzing entrepreneurship through open data. Likewise, a conceptual model is presented and emerging themes for future research are proposed. Among them, the importance of encouraging collaboration between different agents in the open data ecosystem for service development and improvement is emphasized. Our study identifies an emerging theme that is still in an early phase: The study of sustainable entrepreneurship through open data as a value creation initiative to address global sustainable development.

Keywords: open data; entrepreneurship; sustainable development; co-word analysis; conceptual model; reuse information

1. Introduction

We live in a digital era to which governments, citizens, and companies are adapting at different speeds. Digital technologies foresee a new era in entrepreneurship, one in which the traditional ways and forms of pursuing entrepreneurial opportunities are increasingly questioned and refashioned [1]. In this scenario, entrepreneurial processes and outcomes have been transformed by new digital technologies [1], that have great impact on how new business ventures are created and developed [2]. In this sense, Elia et al. [2] (p. 1) state that "the arising technology paradigm is leveraging the potential of collaboration and collective intelligence to design and launch more robust and sustainable entrepreneurial initiatives". Digital context is also the arena in which open data are developing.

The economic, political, and social importance of open data has increased exponentially in recent years. The European Data Portal [3] defines open data as: "Data that anyone can access, use, and share. Governments, businesses and individuals can use open data to bring about social, economic, and environmental benefits". Zuiderwijk et al. [4] explain that open government ecosystems can help the decision-making and planning process. Open data ecosystems could be analyzed as business ecosystems, that is "an economic community supported by a foundation of interacting organizations and individuals—the organisms of the business world" [5] (p. 9). In addition, open data ecosystems

involve public and private organizations and can be analyzed as a kind of information and innovation ecosystems. Moreover, they are a type of digital ecosystem [4].

In this sense, open data have an impact on economic performance, innovation, and entrepreneurship [6]. Open data policies provide the setting for citizen entrepreneurs to discover new opportunities [1]. Open data can promote sustainable development as a tool that allows the connection and involvement of different society stakeholders [7,8]. For example, through open innovation processes such as the co-creation of products and services [9–12]. In this sense, the use of open data allows for the creation of new digital services, particularly applications [13,14]. Therefore, open data serve as a viable base from which entrepreneurs may generate new business models. Wallace and Castro [15] reinforce this idea, showing that the potential annual contribution of open data to the global economy is 900 billion US Dollars.

Moreover, entrepreneurial ecosystems have been defined as "dynamic institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures" [16] (p. 479). According to Shane and Venkataraman [17] (p. 219), "entrepreneurship is a process that involves the discovery, evaluation, and exploitation of opportunities to introduce new products, services, processes, ways of organizing, or markets". Entrepreneurship actively contributes to economic sustainability [18–20]. Hall et al. [21] (p. 439) state that "entrepreneurship has been recognized as a major conduit for sustainable products and processes, and new ventures are being held up as a panacea for many social and environmental concerns". It has a social and economic impact on job creation, economic production, and gross domestic product, constituting an important driver for economic growth in high-income countries [22]. This impact is evident in countries where start-ups are one of the engines of the economy, such as in the United States, where they account for 70% of gross job creation [23]. Thus, the relationship between open data and entrepreneurship allows for the generation of new digital services by reusing open data, thereby creating new business models [6,24–27].

Some authors have considered the integration of entrepreneurial ecosystem with the digital ecosystem developing a digital entrepreneurial ecosystem framework [28]. In this sense, open data ecosystem can be considered as a type of digital ecosystem [4]. As ecosystems, entrepreneurship and open data need to combine components from different domains to be a functioning whole [4]. However, the study of entrepreneurship through open data is an emerging and unexplored field of research. To explore the field, we searched for it in literature reviews (Table 1). We found literature reviews of open data, and open data for open innovation. In addition, there are several literature reviews of entrepreneurship and types of entrepreneurship such as educational, social, international, female, digital, and sustainable entrepreneurship. However, we found no literature review of entrepreneurship through open data.

Table 1. Literature reviews relating to open data and entrepreneurship.

Topics		Authors (Year)
Open data	General	Corrales-Garay, Ortiz-de-Urbina-Criado and Mora-Valentín, 2019 [29]; Herala, Vanhala, Porras and Kärri, 2016 [30]; Hossain, Dwivedi and Rana, 2016 [31]; Zhang, Hua and Yuan, 2018 [32]
	Open data and open innovation	Corrales-Garay, Mora-Valentín and Ortiz-de-Urbina-Criado, 2019 [33]; Corrales-Garay, Ortiz-de-Urbina-Criado and Mora-Valentín, 2020 [34]
Entrepreneurship	General	Busenitz, Plummer, Klotz, Shahzad and Rhoads, 2014 [35]; Busenitz, West III, Shepherd, Nelson, Chandler and Zacharakis, 2003 [36]; Chen, 2015 [37]; Claire, Lefebvre and Ronteau, 2020 [38]; Ferreira, Fernandes and Kraus, 2019 [39]; Kraus, Breier and Dasí-Rodríguez, 2020 [40]; Landström, Harirchi and Åström, 2012 [41]; Low and Macmillan, 1988 [42]; Ramírez, Sánchez-Cañizares and Fuentes-García, 2019 [43]; Shwetzer, Maritz and Nguyen, 2019 [44]

Table 1. *Cont.*

Topics	Authors (Year)
Educational entrepreneurship	Aparicio, Iturralde and Maseda, 2019 [45]; Barnard, Pittz and Vanevenhoven, 2019 [46]; Blenker, Elmholdt, Frederiksen, Korsgaard and Wagner, 2014 [47]; Da Silva, Costa and De Barros, 2015 [48]; Fellnhofer, 2019 [49]; Longva and Foss, 2018 [50]; Pittaway and Cope, 2007 [51]; Roslan, Hamid, Ijab, Norman, Yusop, Ghani, 2018 [52]; Sirelkhatim and Gangi, 2015 [53]; Skute, 2019 [54]; Wu and Wu, 2017 [55]
Social entrepreneurship	Bansal, Garg and Sharma, 2019 [56]; Dionisio, 2019 [57]; Ferreira, Fernandes, Peres-Ortiz and Alves, 2017 [58]; Lehner and Kansikas, 2013 [59]; Macke, Sarate, Domeneghini and Silva, 2018 [60]; Rey-Martí, Ribeiro-Soriano and Palacios-Marqués, 2016 [61]; Roslan, Hamid, Ijab, Norman, Yusop and Ghani, 2018 [52]
Entrepreneurship by geographical area	Bagheri and Akbari, 2019 [62]; Bagheri, Akbari, Zolfaghari and Razi, 2018 [63]; Berbegal-Mirabent, Alegre and Ribeiro-Soriano, 2018 [64]; He, Lu and Qian, 2019 [65]; Lopez and Alvarez, 2018 [66]; Su, Zhai and Landström (2015) [67]; Wu and Wu, 2017 [55]
International entrepreneurship	Baier-Fuentes, Merigó, Amorós and Gaviria-Marín, 2019 [68]; Ferreira, Fernandes and Ratten, 2017 [69]; Perényi and Losoncz, 2018 [70]
Female entrepreneurship	Ferreira, Fernandes, Peris-Ortiz and Ratten, 2017 [71]; Foss, Henry, Ahl and Mikalsen, 2019 [72]; Santos, Marques and Ferreira, 2018 [73]
Digital entrepreneurship	Anim-Yeboah, Boateng, Awuni Kolog, Owusu and Bedi, 2020 [74]; Antonizzi and Smuts, 2020 [75]; Satalkina and Steiner, 2020 [76]; Secundo, Rippa and Cerchione, 2020 [77]; Zaheer, Breyer and Dumay, 2019 [78]
Sustainable entrepreneurship	Fellnhofer, Kraus and Bouncken, 2014 [79]; Johnson and Schaltegger, 2016 [80]; Konys, 2019 [81]; Levinsohn, 2013 [82]; Muñoz and Cohen, 2018 [83]; Terán-Yépez, Marín Carrillo, Casado-Belmonte and Capobianco-Uriarte, 2020 [84]; Sarango-Lalangui, Santos and Hormiga, 2018 [85]; Thananusak, 2019 [86]; Villar and Miralles, 2019 [87]; Weng and Du, 2013 [88]

As the relationship between entrepreneurship and open data has not yet been thoroughly investigated, this work focuses on research into entrepreneurship that makes use of open data. Open data are sources of information for the creation of new businesses, mainly through entrepreneurship and innovation [89], which generates new products and services [6,90]. As a subject that can be depth studied in the literature, it would be interesting to propose models that help to analyze and develop open data entrepreneurship.

Therefore, this study presents a framework for analyzing entrepreneurship through open data. First, to identify the main themes in the previous studies, we review the joint literature on entrepreneurship and open data. Second, considering the results obtained, we propose a conceptual model for analyzing entrepreneurship through open data. For this purpose, the following research questions were posed: (1) What are the main knowledge areas related to entrepreneurship and open data? (2) what are the main themes of study on entrepreneurship through open data? and (3) what factors are critical for analyzing entrepreneurship through open data?

The first question is answered by the descriptive analyses of journals, conferences, and authors. The second is answered by performing a co-word analysis. Co-word analysis can uncover the main concepts explored by a field and the interactions between different fields of scientific research [91]. Based on these results, the third question is answered by identifying the main factors of entrepreneurship through open data and a conceptual model to guide research is proposed. Finally, emerging themes for future research are analyzed.

After answering these research questions, we will be better able to (a) know the main themes analyzed in the literature and their relationships (conceptual structure); (b) propose a conceptual framework for analyzing entrepreneurship through open data; and (c) orient new research about

entrepreneurship through open data. Moreover, we identify an interesting future research line: The study of sustainable entrepreneurship through open data as a value creation initiative to address global sustainable development.

2. Methodology

A literature search was carried out using Web of Science (WoS) and Scopus databases, since they are the most relevant academic databases. They include a significant number of indexed journals [92]. The employed search protocols are shown in Table 2.

Table 2. Search protocols used in the literature search.

	WoS	Scopus
Search date (for entrepreneurship)	20 April 2019	20 April 2019
Years	Until 2018 (inclusive)	Until 2018 (inclusive)
Indexes	All except chemistry databases	-
Search	By "Topic"	"Article title, Abstract, Keywords"
Search Terms	("open data" or open-data) AND ("entrepreneur*" or "incubat*" or "new firm*" or "new venture*" or "start up*" or "new-firm*" or "new-venture*" or "start-up*")	("open data" or open-data) AND ("entrepreneur*" or "incubat*" or "new firm*" or "new venture*" or "start up*" or "new-firm*" or "new-venture*" or "start-up*")
Number of Documents	39	66
Filtering Process	Eliminated: 1 editorial, 1 conference paper (later published in a journal), and 6 documents that did not address this topic	Eliminated: 5 conference reviews and 1 business article (the authors were not identified), 1 note, 1 conference paper (later published in a journal), and 7 documents that did not address this topic
Total Number of Documents in Each Database	31	51
Total Number of Documents From Both Databases (for Entrepreneurship)	61 (after removing duplicates from both databases)	

The bibliometric SciMAT software [93] was used for a co-word analysis and to identify the main topics related to this research area. Co-word analysis identifies relationships between ideas using models of co-occurrence of term pairs from a set of documents. Therefore, the relationships between the topics represented by the terms can be established [94]. Word filtering was carried out using the following criteria:

- Initial number of keywords: 445.
- Synonymous terms (e.g., "e-government" and "electronic government" were grouped as one keyword).
- Terms that appear in their singular and plural forms (e.g., "hackathon," "hackathons") were grouped as the singular form.
- Derived terms (e.g., "entrepreneurs" and "entrepreneurship") were grouped together.
- Total number of keywords after filtering: 403.

Next, co-occurrence matrix and equivalence index calculations were carried out [95]. With these indices in mind, a simple centers algorithm [91] was used to create subgroups of terms with strong relationships, allowing identification of topics relevant to this line of research. Thematic networks with

a maximum network size of 12 and a minimum size of 3 were then created. Callon et al. [95] proposed classifying each thematic network into one of the following groups: Well-developed and isolated themes; emerging or disappearing themes; basic and cross-sectional themes; and central themes, based on their measures of centrality and density for creating a strategic diagram.

3. Results

The number of documents combining entrepreneurship and open data published annually is shown in Figure 1. The first two documents were published in 2011; since 2013, the number of publications has increased. Furthermore, 62.3% of the documents were published in the last three years under analysis, with 13 in each of the last two years.

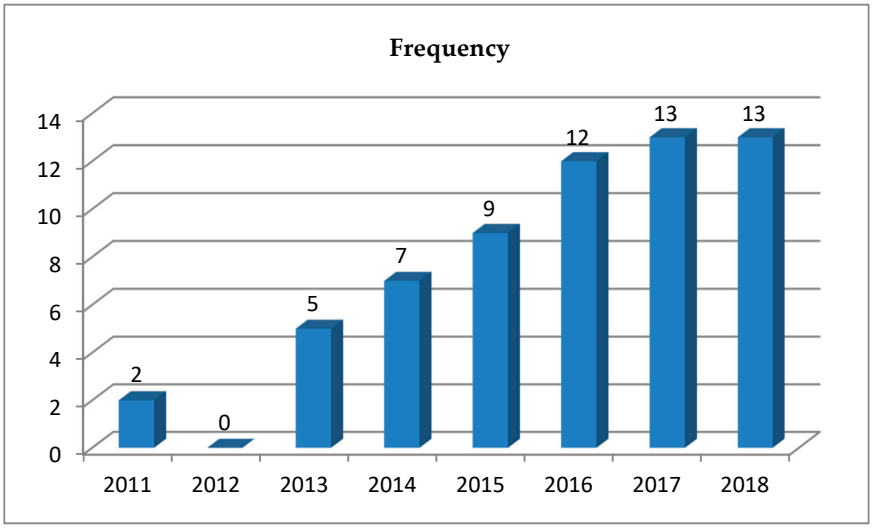

Figure 1. Number of documents per year.

To answer the first research question, an analysis of knowledge areas by document and author is presented.

3.1. Knowledge Areas by Document

Documents by type (article or conference paper) have been categorized by Journal Citation Report (JCR) and Scimago Journal and Country Rank (SJR) subject areas are shown in Tables A1–A3 (Appendix A). Most of the studies are related to the knowledge areas of Information Technology, Computer Sciences, and similar areas. For instance, several categories were identified in the subject area of Computer Science, among which Computer Science Applications and Information Systems stand out. Other areas include Computer Science (miscellaneous), Computer Networks and Communications, Software, Computational Theory and Mathematics, Computer Graphics and Computer-Aided Design, Hardware and Architecture, Human-Computer Interaction, and Computer Vision and Pattern Recognition. Within the Engineering knowledge area, the most relevant categories are Engineering (miscellaneous) and Control and System Engineering.

In contrast, Public Administration is highly relevant in the Social Sciences subject area, with Library and Information Sciences being the most notable category. The knowledge area Business Administration is also relevant and is primarily identified in the subject area of Business, Management, and Accounting; there are multiple associated categories, including Business, Management and Accounting (miscellaneous), Business and International Management, Management Information Systems, and Management of Technology and Innovation.

Other knowledge areas also appear, such as Medicine, which is linked to the categories of Health Care Sciences and Services and Medical Informatics. Likewise, Agriculture is found within the

Agricultural and Biological Sciences subject area, associated with the Agronomy and Crop Science and Animal Science and Zoology categories.

3.2. Knowledge Areas by Author

The seven authors with the highest number of publications are listed in Table 3 by affiliation and knowledge area. Lindman, from the University of Gothenburg, Sweden, has three documents and specializes in the knowledge areas of Information Technology, Information Systems, and Business Administration. His studies focus on the creation of new businesses using data from an open data ecosystem [24–26].

Table 3. Top authors (by affiliation and knowledge area).

Author	Affiliation	Knowledge Area	Documents
Lindman, J.	University of Gothenburg, Gothenburg, Sweden	Information Technology/Information Systems/Business Administration	3
Kitsios, F.	University of Macedonia Thessaloniki, Greece	Strategic Management/Information Systems/Innovation Management	2
Kamariotou, M.	University of Macedonia Thessaloniki, Greece	Strategic Management/Information Systems/Innovation Management	2
Chatfield, A.T.	University of Wollongong, Wollongong, New South Wales, Australia	Information Technology/Public Administration/e-Government/e-Governance	2
Reddick, C.G.	The University of Texas at San Antonio, San Antonio, Texas, United States	Information Technology/Public Administration/e-Government/e-Governance	2
Kinnari, T.	Aalto University School of Business, Helsinki, Finland	Information Systems/Business Administration	2
Rossi, M.	Aalto University School of Business, Helsinki, Finland	Information Systems/Business Administration	2

The main knowledge areas of the authors were also analyzed based on the JCR and SJR subject areas and categories. Several topics were studied within the knowledge areas of Information Technology, Computer Science and its derivatives, and Engineering. The influence of public open data or open government data is primarily analyzed with respect to the generation of new services and products through open innovation processes [96–98]. In addition, improvements in the usability of public open data have been analyzed with respect to the generation of new businesses through the open linked data format [99]. Some studies have also assessed the development of platforms that connect multiple agents, facilitating access to information and services, which favors innovation and entrepreneurship [100,101].

The effect of open data on the generation of new services and products is the primary subject of study in the knowledge areas of Public Administration and Business Administration. In the area of Public Administration, previous studies have primarily evaluated the role of open data portals as a support for reusing data [102,103] and the importance of the quality of open data with respect to its effective use [104]. In the knowledge area of Business Administration, attention was focused on the impact of open data on the creation of new businesses [24,105,106].

Finally, the creation of specific applications that use open data was investigated in the knowledge areas of Medicine and Agriculture. The development of mobile health applications based on open government data was studied specifically in the area of medicine [107]. Likewise, the development of Big Data applications was investigated in the knowledge area of Agriculture [108].

3.3. Main Topics of Study. Co-Word Analysis

To answer the second research question, the bibliometric technique of co-word analysis was used to identify different themes/topics and networks in the literature relating to open data and entrepreneurship. Science mapping uses co-occurrences among keywords to obtain thematic clusters [91].

Based on the strategic diagrams presented (Figure 2), "Public Sector" is the central theme. That is, it is characterized by a high degree of internal development and by strong ties with other concepts within a given field of research. The well-developed and isolated theme is "Public Sector Information". It has a high degree of internal development but is of marginal importance to the scientific area. Finally, "Open Data" is the basic and cross-sectional theme. It shows strong ties with other issues and is very relevant to the area of knowledge considered. No emerging or disappearing themes are identified in the co-word analysis.

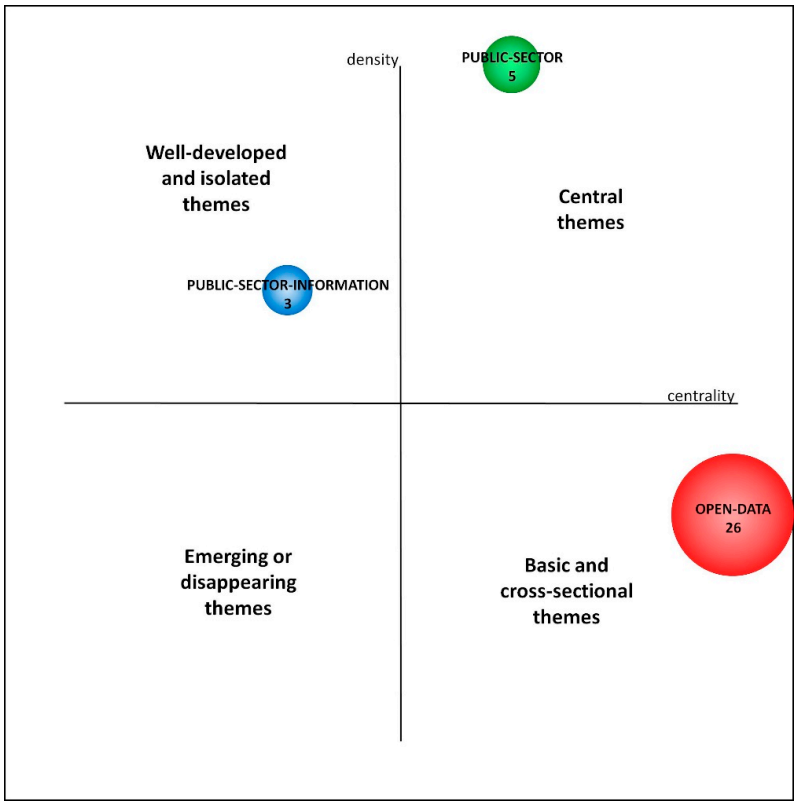

Figure 2. Strategic diagram based on the number of documents relating to entrepreneurship and open data.

In addition, for each theme, a subnetwork (Figures 3 and 4) is presented. Each subnetwork contains keywords that are related and form a topic. We have tagged each subnetwork with its most significant keyword.

-"Open data": This basic and cross-sectional theme has the highest number of documents (26) and the highest h-index (7).

The analysis of the subnetwork of the term demonstrates the relationships between the different terms and the main term (Figure 3). The most important source of "Open Data" is "Government" because public administrations are providers of open data, specifically "Open Government Data", which are published in an open and machine readable format ("Government Data Processing") so as to be available for "Re-Use" [109]. In a few cases, the "Re-Use" of these data occurs within an "Open Innovation" process that involves multiple agents [27,98,110].

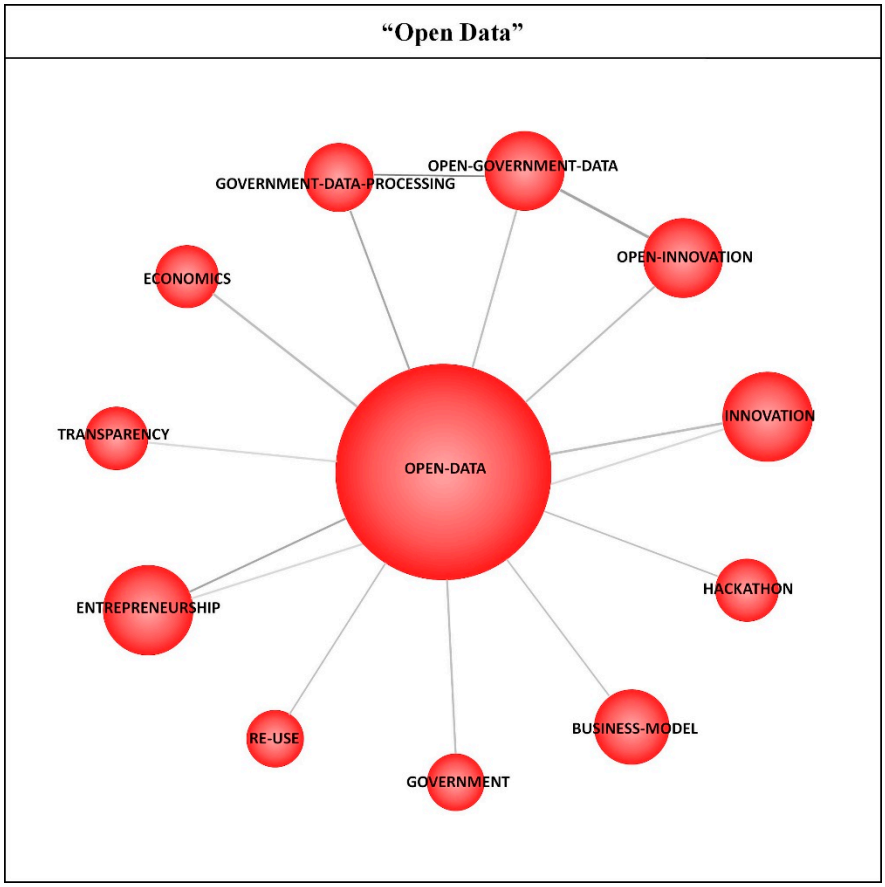

Figure 3. Thematic subnetwork for "Open Data".

Therefore, the "Open Data" ecosystem favors "Entrepreneurship" and "Innovation," and new "Business Models" are created by improving or creating novel services or products based on "Open Data" [6], such as new applications. Some of these actions are promoted through collaborative meetings, such as "Hackathons" [111]. These actions generate value, lending "Open Data" a positive "Economic" impact [109,112,113] and contributing to the "Transparency" of the public administrations that release them [113,114].

-"Public Sector": This central theme provided five documents and an h-index of 2. The term refers to different institutions, administrations, and organizations that form the public sector.

The analysis of the term subnetwork (Figure 4) showed a significant relationship between the terms "Societies and Institutions" and "Knowledge Management", demonstrating that high-quality public services can be generated, and access of entrepreneurs and citizens to data can be improved [114]. There was also a relationship between the terms "Open Government" and "e-Government." The latter is part of the concept of openness shown by the "Open Government" in electronically giving citizen access to information and services provided by the government and other public administrations ("Public Sector") [114,115].

Finally, there was a relationship between "Artificial Intelligence" and the main term, indicating the introduction of "Artificial Intelligence" technologies to create a platform that uses open data to assist public administrations, citizens, private entrepreneurs, and experts in multiple fields of study; this improves decision-making with respect to the valuation and adaptive reuse of cultural heritage ("Public Sector") [100].

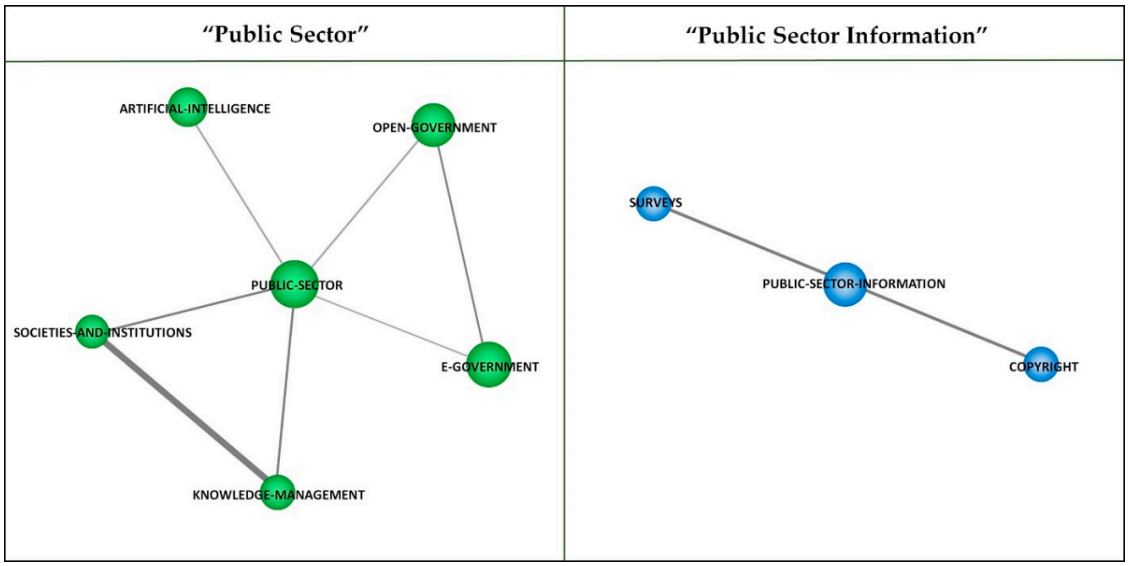

Figure 4. Thematic subnetworks for "Public Sector" and "Public Sector Information".

-"Public Sector Information": This theme is well-developed and isolated, with three documents and an h-index of 2. The term refers to the information provided by different institutions, administrations, and organizations that constitute the public sector.

The study of the term subnetwork (Figure 4) demonstrates a strong relationship between the main term and both "Copyright" and "Surveys" because of the execution of "Surveys" of various public institutions to improve open government initiatives and present open government data in an open licensing format; this takes into consideration the fact that the data released by the public sector ("Public Sector Information") and governments are sometimes under "Copyright" and, therefore, must be released under certain licenses that allow their reuse [116].

4. Discussion

To answer the third research question we have identified the key elements for engaging in entrepreneurship using open data. The elements were identified using the results obtained from the subnetwork of the basic and cross-sectional theme, "Open Data" (Figure 3). This is the most relevant theme to the area of knowledge considered.

We have identified three key elements in the study of entrepreneurship through open data: (1) Open data sources, (2) innovation, and (3) business models. We have developed a discussion of each element, and we have proposed a conceptual model for analyzing entrepreneurship through open data.

-Open data sources: The literature focuses on the study of open data released by public administrations, which is the main source of open data for generating new businesses and services [97,98]. These data are usually published in open data portals, facilitating their reuse in generating new services, such as applications [102,117]. Nonetheless, few studies have evaluated the development of entrepreneurial initiatives based on open data from companies, except for some that analyzed open data released by entrepreneurs and their effect on the open data ecosystem [25]. Sadiq and Indulska [104] have shown that there is no consensus on what open data quality means.

Therefore, additional studies are necessary in order to analyze the effective use of open data for creating new businesses. In addition, it is generally necessary to develop studies that thoroughly identify and classify types of open data and applications developed by entrepreneurs. In contrast, several studies have used open data from crowdfunding platforms to elucidate this phenomenon and entrepreneurial initiatives, consolidating these topics as a new area of study [118,119].

-Innovation: The main topic of study in the literature is the reuse of open data and its impact on the generation of new entrepreneurial initiatives, with a focus on new businesses based on services and applications in different fields. These studies evaluated hackathons and the innovation they generate, favoring contacts between entrepreneurs and companies and encouraging the generation of applications based on open data, thereby creating start-ups based on these applications [110,111]. Kitsios and Kamariotou [105] reported that, generally speaking, more research and development of guidelines were required for hackathon organizers to efficiently meet the needs of participants. In turn, Kitsios and Kamariotou [111] stressed the need to develop a public catalog consisting of the most demanded open data.

Similarly, Kitsios and Kamariotou [105] have shown that hackathons are only the first phase of application development, and that knowledge about their collaborative development should be expanded. In this respect, research has also focused on the collaborative ecosystem that generates open innovation, in which public entities encourage entrepreneurs and citizens to collaborate with each other to develop specific services and applications [11]. In this context, users of services are the main players involved in providing high-quality services. Authors like Smith and Sandberg [97] highlight the need to focus on the innovation ecosystem for open government data users, which favors entrepreneurial initiatives.

-Business models: The literature has primarily focused on the relationships and collaboration between the different agents of the open data ecosystem and the development of entrepreneurial initiatives. In this respect, the elements necessary to build an open data business model through the Canvas model have been analyzed [6,27]. Some studies have used different classifications of open data business models [27].

Among those authors who study open data and business models, Marijn Janssen from the Delf University of Technology in the Netherlands has authored the highest number of documents (5). Janssen's publications have analyzed the efficient use of open data that yields benefits to public and private entities, thereby generating value through innovation and allowing the development of new business models [120–124]. While these publications primarily investigate the generation of value through innovation using open data released by public entities, one of them proposes a decision support framework for opening data by private entities in order to generate an open data ecosystem that would improve transparency, innovation, and the generation of new business models; this in turn would benefit various actors, including the private and public sectors and academia [121]. This research stresses that, because of uncertainty, open data business models need to be constantly reviewed and remade to adapt to changes in the environment [123].

The absence of emerging themes in the strategic diagram is notable (Figure 2). Thus, it is interesting to propose some emerging themes. To do that, we have conducted a qualitative analysis of the previous literature considering our co-word analysis. Based on these analyses, we have identified several factors that affect entrepreneurship through open data and proposed a conceptual model for analyzing entrepreneurship through open data (Table 4).

Table 4. A conceptual model for analyzing entrepreneurship through open data.

Context	Inputs	Process	Outputs	Impact
-Open government -e-Government -Open data principles -Business ecosystem -Open data ecosystem -Smart-city -Sustainable development	-Open government data -Linked data -Big data	-Re-use -Information management -Innovation; open innovation -Hackathons	-Products/services Apps -Business models	-Social -Economical -Environmental -Political

Our starting point is that "entrepreneurship research has ignored the role that digital technologies play in entrepreneurship and the role that users and agents play in digital entrepreneurship" [28]

(p. 56). In this sense, the concept of digital entrepreneurship ecosystem is mostly new [2]. Otherwise, open data ecosystem is considered as a business and digital ecosystem. Then, a new proposal for understanding the entrepreneurship through open data as ecosystem can be developed: "open data entrepreneurship ecosystem".

The model proposed in Table 4 shows the different aspects to be considered to understand entrepreneurship through open data, grouped by key elements. The first element, context, is determined by the theories and principles (open government and e-government) that govern the open data world and by the combination of the business and open data ecosystems. There are two specific applications. One that shows significant study is the smart city. The other is sustainable development, which is an emerging theme.

Second, we have to consider the necessary inputs for the entrepreneurial process, which in this case are data: Open government data, linked data, and big data. Various processes are then applied to these data to carry out entrepreneurial actions. Entities must manage the information, apply reuse actions, and consider innovation processes, especially open innovation and its possible development through tools such as hackathons. All this gives rise to outputs, that is, products/services, and apps that allow entities to define and delimit the business model. Finally, the phenomenon of entrepreneurship through open data by combining different areas and applications has an impact in the social, economic, environmental, and political spheres.

Third, taking into account the absence of emerging themes about these topics in the strategic diagram, some emerging themes for future studies have been identified. We comment on these emerging themes below.

More studies on the relationship between entrepreneurship and the concepts of open government and e-government are necessary. Smith and Sandberg [97] have analyzed the effect of barriers to innovation on the use of open government data by various agents, including entrepreneurs. However, future studies will have to determine the types of open government data released by public administrations and classify the data used in open data portals by entrepreneurs, correlating them with the type of products, services, applications, or business models developed. This information is key for decision making and the development of new entrepreneurial activities. In addition, few studies have specifically assessed the importance of open data for the smart city ecosystem with regards to generating entrepreneurial initiatives.

There are studies, including that of Rojas et al. [106], which have jointly assessed open data and big data and have established certain connections with the development of new businesses. In this respect, released open data are not always in a structured format that favors their reuse. Gandomi and Haider [125] have shown that 95% of big data has an unstructured format.

Although studies have analyzed the type of machine-readable data format of open data released by public administrations in open data portals [102], further studies should work to resolve the problem of open data released in an unstructured format.

Furthermore, although previous studies have shown that big data create new opportunities for entrepreneurship [126], the use of big data technologies should be further investigated to standardize data format and allow their effective reuse. This approach could enhance entrepreneurship and the generation of new business models based on the development of digital services, such as applications.

Therefore, open data should be in a structured format appropriate for reuse, as is the case of linked data [117,127–129], thereby allowing their effective reuse by application developers. In this respect, the lack of consensus on the quality of open data should be addressed, as highlighted by Sadiq and Indulska [104]. In this sense, it is necessary that more studies analyze the datasets used by entrepreneurs in open format, assessing the degree of compliance with fundamental principles of open government data [130] as the first step in determining the quality of released open data. In this respect, entrepreneurs can use open data sources that allow a more effective reuse of data to create new products or services, such as applications.

It should be emphasized that while there is research like that of Kitsios et al. [6], which evaluates the open data ecosystem from a business perspective, more studies are needed that elucidate the concept of the so-called business ecosystem within the open data ecosystem. While most open data come from public administrations, some open data is released by the private sector as well. The literature should further investigate the use of open data coming from companies as a factor that promotes entrepreneurship, adding to the existing research on the equivalent role that open government data plays [25]. Questions like the following need to be addressed to encourage entrepreneurship from this perspective: (1) What kinds of products, services, applications, or business models can be developed through the innovative reuse or management of open data coming from the private sector? (2) How, and through what guidelines, can companies be incentivized to release their data in an open format? (3) How can the primary barriers to the release of data by companies, in an open format, be overcome?

New studies on entrepreneurship and the generation of new open data business models via the collaborative development of specific applications and services in open innovation processes are necessary. Lindman [24] has considered the business perspective stressing that additional studies focusing on the commercial impact of open data are necessary, especially considering differing legislation in different countries. In addition, more research is needed regarding the type of data most commonly used by developers of applications, which is particularly important for organizers of events, like hackathons, and what type of open data services capture user attention most effectively. These are fundamental in generating new entrepreneurial initiatives that are supported by new business models. This study also compared open data business models with open source models using information collected by entrepreneurs, given the need for more studies that focus jointly on the development of data and on the development of applications through said data [24].

Although some authors, such as Ramos [113], have tried to address questions like "how successful are government actions in supporting economic development through open data?" generally, few studies have quantitatively measured the potential social, economic, environmental, and political impact of open data on the development of entrepreneurial activities.

Finally, there is a lack of articles focused on the influence of entrepreneurial initiatives through open data on the different dimensions that make up the sustainability concept. The context of sustainable development for entrepreneurship through open data is an interesting emerging theme that remains in an early research phase. Sustainable development is a topic that has been increasingly researched and applied by academics and practitioners in recent decades [131]. Sustainable development has a two-part application in our model. On the one hand, it offers a new context for the study of entrepreneurship through open data. On the other hand, it affects the impact of this phenomenon, especially in the environmental, social, and economic spheres. Some authors have shown an interest in studying the emerging field of sustainable entrepreneurship [79–88]. Entrepreneurs are increasingly aware of sustainability, introducing new sustainable services and products to provide social and environmental value [132,133]. According to Muñoz and Cohen [83] (p. 300), "The recognition of entrepreneurship as a solution to, rather than a cause of, environmental degradation and social inequality moved the field to identify a new type of entrepreneurial activity, namely sustainable entrepreneurship". Sustainable entrepreneurship applies the entrepreneurial approach to achieve societal and environmental goals [81]. Therefore, sustainable entrepreneurship can be defined as "the examination of how opportunities to bring into existence 'future' goods and services are discovered, created, and exploited, by whom, and with what economic, psychological, social, and environmental consequences" [134] (p. 35).

According to Hall et al. [21] sustainable development implies that renewable resources should be used wherever possible and it seeks to place social, environmental, and economic objectives (triple bottom line). In this context, open data are free and accessible and can be reused [6], allowing a sustainable development of new business. Lindman et al. [25] highlight the importance of open data entrepreneurship in order to create new services and sustainable value networks based in open data released by governments. The release of open data by public administrations such as governments promotes more transparent and accountable institutions, with this being important

for social development and sustainable development [135]. However, we have observed a lack of works that study the generation of entrepreneurial initiatives through open data from a sustainable development perspective. Thus, sustainable entrepreneurship through open data constitutes a new phenomenon to be studied.

We have seen that open data can foster sustainable development as an instrument that allows the connection and involvement of society stakeholders [7,8] via co-creative open innovation processes [9–12]. In addition, sustainability is a concept that presents three main dimensions: Environmental, social, and economic [136]. Sustainable development initiatives improve these three dimensions, fostering innovation and collaboration between stakeholders of the socio-economic system in order to achieve their main objectives [136–139]. In addition, we have adapted the Elia et al. [140] framework to define responses to sustainable development challenges; then, five dimensions can be analyzed: (1) What (participating sides, actors, and groups), (2) who (actions, flows, and coordination mechanisms; (3) how (actions); (4) why (value drivers, benefits, and externalities); and (5) governance (rules regulating the affiliation and interaction processes). Therefore, studies that analyze the impact of sustainable entrepreneurship through open data can be an interesting new field of research.

5. Conclusions

This study identifies the main knowledge areas in which research into entrepreneurship through open data has been carried out (first research question). The JCR and SJR subject areas and categories were used as a basis, with most relating to the Information Technology and Computer Sciences knowledge areas. However, the subject is multidisciplinary, and other knowledge areas are present as well, including Public Administration, Engineering, Business Administration, Medicine, and Agriculture.

In addition, a co-word analysis was performed to identify relevant themes/topics and the relationships between them, as well as the key elements to engage in entrepreneurship through open data (second research question). The main subject under study is how entrepreneurial initiatives can be generated using information openly published by public administrations and reused by other agents, wherein these initiatives are primarily new business models based on new mobile applications. Three elements are critical for entrepreneurship through open data: Open data sources, innovation, and business models. Finally, a conceptual model for analyzing entrepreneurship based on open data is developed (third research question). This model allows us to propose emerging themes for future research lines.

Two academic contributions are derived from this paper. First, we have proposed a conceptual model focused on entrepreneurship through open data that presents a new combination of ecosystems in a digital context: "open data entrepreneurship ecosystem". This model constitutes a guide for researchers interested in both lines of research. Second, and due to the absence of emerging themes about these subjects, new emerging research topics are proposed. Future research should consider our proposals. For example, sustainable entrepreneurship through open data can be a value creation initiative to address global sustainable development. The main objective of sustainable development is "the long-term stability of economic systems, through the integration of environmental and social concerns throughout the policy and decision-making process" [140] (p. 1). A growing number of organizations operate in an environmentally and socially responsible manner, with stakeholders expecting this attitude from them [141]. Thus, sustainability is an important aspect in current business operations, with entrepreneurship and innovation appearing as key elements in the sustainable development field [131]. In this sense, sustainable development could be considered as an arena for innovation and an entrepreneurship field [140].

Further, the study of sustainable entrepreneurship based on open data is an interesting new research line with some future research questions such as (1) What are new approaches to sustainable development in entrepreneurship based on open data? (2) How can value be created through sustainable entrepreneurship based on open data? (3) How do open innovation processes affect the

development of sustainable entrepreneurship based on open data? Lastly, (4) who are the main agents, and what are the main factors present in sustainable entrepreneurship based on open data?

With respect to the managerial implications for those intending to develop entrepreneurial initiatives with open data, such as new business models based on applications, we emphasize the importance of encouraging collaboration between different agents in the so-called open data ecosystem. This study also stresses the relevance of collaborating with users of digital services for service development and improvement. However, certain questions still need to be more thoroughly addressed, including the following: (1) What are the main sources of open data used in entrepreneurial initiatives? (2) What approaches other than the simple reuse of data are available for entrepreneurship? (3) How do open innovation processes affect the development of open data entrepreneurial initiatives? And, (4) what factors shape entrepreneurship through open data?

This study has implications for public administrations that release open data, as it considers a range of aspects, such as the importance of the format and quality of open data for its effective reuse and the key role of public entities in promoting entrepreneurial initiatives, which must encourage collaboration between citizens/users and entrepreneurs. Governments could use our model of open data for developing sustainable entrepreneurship programs/initiatives through open data. Finally, our study can be a guide for entrepreneurs to develop sustainable initiatives using open data.

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Appendix A

Documents by type (article or conference paper) have been categorized by JCR and SJR subject areas.

Table A1. Articles: journal/ranking and category; JCR [1].

Journal	Ranking and Category JCR 2018	Articles
Information Polity	NA [2]	2
Frontiers in Nutrition	NA [2]	1
IT-Information Technology	NA [2]	1
Education in the Knowledge Society	NA [2]	1
JMIR mHealth and uHealth	Q1 (Health Care Sciences and Services—SCIE) Q1 (Medical Informatics—SCIE)	1
International Journal of Innovation Science	NA [2]	1
Journal of Information Technology in Construction	NA [2]	1
International Journal of Advanced Science and Technology	NA [2]	1
European Research Studies Journal	NA [2]	1
International Journal of Information Management	Q1 (Information Science and Library Science—SSCI)	1

Table A1. *Cont.*

Journal	Ranking and Category JCR 2018	Articles
Agricultural Systems	Q1 (Agriculture, Multidisciplinary—SCIE)	1
Government Information Quarterly	Q1 (Information Science and Library Science—SSCI)	1
Information Technology and People	Q3 (Information Science and Library Science—SSCI)	1
Journal of Official Statistics	Q3 (Statistics and Probability—SCIE) Q4 (Social Sciences, Mathematical Methods—SSCI)	1
Advanced Science Letters	NA [2]	1
IEEE Software	Q1 (Computer Science, Software Engineering—SCIE)	1
Urban Geography	Q1 (Geography—SSCI) Q1 (Urban Studies—SSCI)	1
Informacios Tarsadalom	Q4 (Information Science and Library Science—SSCI)	1
Journal of Theoretical and Applied Electronic Commerce Research	Q4 (BusinessSSCI)	1
IEEE Access	Q1 (Computer Science, Information Systems—SCIE) Q1 (Engineering, Electrical and Electronic—SCIE) Q1 (Telecommunications—SCIE)	1

[1] Note: Information about books ranking and categories JCR is not available. [2] NA: Not available.

Table A2. Articles: journal/ranking, subject area, and category; SJR [1].

Journal	Ranking, Subject Area and Category SJR 2018	Articles
Information Polity	Q3 (Computer Science—Information System) Q3 (Social Sciences—Communication) Q3 (Social Sciences—Geography, Planning and Development) Q3 (Social Sciences—Public Administration) Q3 (Social Sciences—Sociology and Political Science)	2
Frontiers in Nutrition	NA [2]	1
IT-Information Technology	NA [2]	1
Education in the Knowledge Society	NA [2]	1
JMIR mHealth and uHealth	NA [2]	1
International Journal of Innovation Science	Q2 (Engineering—Engineering (miscellaneous)) Q3 (Business, Management and Accounting—Management of Technology and Innovation)	1
Journal of Information Technology in Construction	Q2 (Computer Science—Computer Science Applications) Q2(Engineering—Building and Construction) Q2 (Engineering—Civil and Structural Engineering)	1
International Journal of Advanced Science and Technology	Q4 (Computer Science—Computer Science (miscellaneous)) Q4 (Energy—Energy (miscellaneous)) Q3 (Engineering—Engineering (miscellaneous))	1

Table A2. *Cont.*

Journal	Ranking, Subject Area and Category SJR 2018	Articles
European Research Studies Journal	Q2 (Business, Management and Accounting—Business, Management and Accounting (miscellaneous)) Q2 (Economics, Econometrics and Finance—Economics, Econometrics and Finance (miscellaneous))	1
International Journal of Information Management	Q1 (Computer Science—Computer Networks and Communications) Q1 (Computer Science—Information Systems) Q1 (Social Sciences—Library and Information Sciences)	1
Agricultural Systems	Q1 (Agricultural and Biological Sciences—Agronomy and Crop Science) Q1 (Agricultural and Biological Sciences—Animal Science and Zoology)	1
Government Information Quarterly	Q1 (Social Sciences—E-learning) Q1 (Social Sciences—Law) Q1 (Social Sciences—Library and Information Sciences) Q1 (Social Sciences—Sociology and Political Science)	1
Information Technology and People	Q1 (Computer Science—Computer Science Applications) Q1 (Computer Science—Information Systems) Q1 (Social Sciences—Library and Information Sciences)	1
Journal of Official Statistics	Q2 (Mathematics—Statistics and Probability)	1
Advanced Science Letters	Q4 (Computer Science—Computer Science (miscellaneous)) Q4 (Energy—Energy (miscellaneous)) Q4 (Engineering—Engineering (miscellaneous)) Q4 (Environmental Science—Environmental Science(miscellaneous)) Q4 (Mathematics—Mathematics (miscellaneous)) Q4 (Social Sciences—Education) Q4 (Social Sciences—Health (Social Science))	1
IEEE Software	Q2 (Computer Science—Software)	1
Urban Geography	Q1 (Social Sciences—Geography, Planning and Development) Q1 (Social Sciences—Urban Studies)	1
Informacios Tarsadalom	Q4 (Social Sciences—Communication)	1
Journal of Theoretical and Applied Electronic Commerce Research	Q2 (Business Management and Accounting—Business Management and Accounting (miscellaneous)) Q3 (Computer Science—Computer Science Applications)	1
IEEE Access	Q1 (Computer Science—Computer Science (miscellaneous)) Q1 (Engineering—Engineering (miscellaneous)) Q2 (Materials Science—Materials Science (miscellaneous))	1

[1] Note: Information about books ranking, subject areas and categories SJR is not available. [2] NA: Not available.

Table A3. Conference papers: source/ranking, subject area, and category; SJR [1].

Source	Ranking, Subject Area and Category SJR 2018	Conference Papers
Lecture Notes in Computer Science	Q2 (Computer Science—Computer Science (miscellaneous)) Q3 (Mathematics—Theoretical Computer Science)	2
Proceedings of the International Astronautical Congress, IAC	(Earth and Planetary Sciences—Space and Planetary Science), (Engineering—Aerospace Engineering), (Physics and Astronomy—Astronomy and Astrophysics)	2
Lecture Notes in Business Information Processing	Q3 (Business Management and Accounting—Business and International Management) Q3 (Business Management and Accounting—Management Information Systems) Q3 (Computer Science—Information Systems) Q3 (Decision Sciences—Information Systems and Management) Q3 (Engineering—Control and Systems Engineering) Q4 (Mathematics—Modeling and Simulation)	1
Proceedings of the International Scientific Conference of Business Economics, Management and Marketing, ISCOBEMM 2017	NA [2]	1
SSR International Conference on Social Sciences and Information, SSR-SSI 2015, Pt 1	NA [2]	1
10th International Forum on Knowledge Asset Dynamics: Culture, Innovation and Entrepreneurship: Connecting the Knowledge Dots, IFKAD 2015	NA [2]	1
9th International Forum on Knowledge Asset Dynamics: Knowledge and Management Models for Sustainable Growth, IFKAD 2014	NA [2]	1
Proceedings of the 9th European Conference on Innovation and Entrepreneurship, ECIE 2014	(Engineering—Electrical and Electronic Engineering), (Engineering—Mechanical Engineering)	1
2nd International Conference on Smart Digital Environment, ICSDE 2018	NA [2]	1
19th Annual International Conference on Digital Government Research: Governance in the Data Age, DG.O 2018	NA [2]	1
11th International Conference on Theory and Practice of Electronic Governance, ICEGOV 2018	NA [2]	1
9th ITU Kaleidoscope Academic Conference: Challenges for a Data-Driven Society, ITU K 2017	NA [2]	1
39th International Conference on Information Systems, ICIS 2018	NA [2]	1
10th International Scientific and Professional Conference on Geodesy, Cartography and Geoinformatics, GCG 2017	NA [2]	1
19th IEEE Conference on Business Informatics, CBI 2017	NA [2]	1

Table A3. *Cont.*

Source	Ranking, Subject Area and Category SJR 2018	Conference Papers
18th Annual International Conference on Digital Government Research, DG.O 2017	NA [2]	1
2016 Portland International Conference on Management of Engineering and Technology, PICMET 2016	(Computer Science—Computational Theory and Mathematics), (Computer Science—Computer Networks and Communications), (Computer Science—Computer Science Applications), (Engineering—Control and Systems Engineering)	1
17th European Conference on Digital Government, ECDG 2017	NA [2]	1
1st International Conference on Smart Data and Smart Cities 2016, at 30th Urban Data Management Society Conference, UDMS 2016	NA [2]	1
17th Annual International Conference on Digital Government Research, DG.O 2016	NA [2]	1
3rd International Conference on eDemocracy and eGovernment, ICEDEG 2016	(Computer Science—Hardware and Architecture)	1
19th International Academic Mindtrek Conference, AcademicMindTrek 2015	(Computer Science—Computer Graphics and Computer-Aided Design), (Computer Science—Human-Computer Interaction), (Computer Science—Software)	1
23rd Interdisciplinary Information Management Talks: Information Technology and Society—Interaction and Interdependence, IDIMT 2015	(Engineering—Control and Systems Engineering)	1
47th Hawaii International Conference on System Sciences, HICSS 2014	NA [2]	1
10th International Symposium on Open Collaboration, OpenSym 2014	(Computer Science—Computer Networks and Communications)	1
9th International Symposium on Open Collaboration, WikiSym + OpenSym 2013	(Computer Science—Software)	1
46th Annual Hawaii International Conference on System Sciences, HICSS 2013	NA [2]	1
10th IASTED International Conference on Web-Based Education, WBE 2013	(Computer Science—Computer Networks and Communications), (Social Sciences—Education), (Social Sciences—E-learning)	1
7th International Conference on Theory and Practice of Electronic Governance, ICEGOV 2013	NA [2]	1
1st IEEE Symposium on Large-Scale Data Analysis and Visualization 2011, LDAV 2011	(Computer Science—Computer Science Applications), (Computer Science—Computer Vision and Pattern Recognition)	1
9th International Conference on Mobile Systems, Applications, and Services, MobiSys'11 and Co-located Workshops—5th ACM Workshop on Networked Systems for Developing Regions, NSDR'11	(Computer Science—Computer Networks and Communications), (Computer Science—Computer Science Applications), (Engineering—Media Technology)	1
Proceedings of the 16th European Conference on E-government, ECEG 2016	NA [2]	1

[1] Note: Information about conference papers ranking and categories JCR is not available. [2] NA: Not available.

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