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SUSTAINABLE ENTREPRENEURSHIP: AN APPROACH FROM BIBLIOMETRIC ANALYSIS

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Abstract. Researchs on issues of Sustainable Entrepreneurship are gaining traction in recent years, with this trend being aligned to the achievement of sustainable development goals set by the UN in 2030. The purpose of this paper is to carry out a bibliometric analysis on research on the subject of sustainable entrepreneurship. The information gathered is extracted from the main collection of the Web of Science (WoS) database since 1999 up to December 2019. Nvivo and VOSviwer software are used to perform initial analysis and citation analysis, co-citations, bibliographic coupling, co-authoring, among others. This study presents advances associated with the main authors, journals and countries, the general and annual citation structure and the development of this field. The results show that the publication trend increases from 2015 onwards, however 2018 and 2019 have seen the greatest production of articles. In relation to the most influential countries, the Netherlands, the United States, Germany, England and Spain are the most representative. It was also found that the most influential journals are the Journal of Cleaner Production and Sustainability. The main contribution is to show the evolution of this topic, so that researchers can use it in their theoretical frameworks and research.

Keywords: bibliometric analysis, sustainable entrepreneurship, sustainable start-up, sustainable innovation, co-citation, bibliographic coupling.

JEL Classification: M00, M13, L26.

Introduction

Literature research on sustainable entrepreneurship has had different approaches (Fichter & Tiemann, 2020; Halberstadt et al., 2019; Terán-Yépez et al., 2020). It has focused on issues related to environment or ecology (Boons & Lüdeke-Freund, 2013; Dean & McMullen, 2007), leading to the use of terms such as eco-entrepreneurship (Rodgers, 2010), understood as entrepreneurs who have an environmental perspective (Schaltegger, 2014, p. 47), that is,

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a green perspective (Demirel et al., 2019; Gast et al., 2017). It has also been related to social areas, known as social entrepreneurship (Betáková et al., 2020; Schaltegger & Wagner, 2011), among other it is defined as an individual with innovative solutions to respond to society's problems (Neck et al., 2009). Research has also been related to sustainable development and the triple botton line (Terán-Yépez et al., 2020).

Schaltegger and Wagner state that sustainable entrepreneurship "is in essence the realization of sustainability innovations aimed at the mass market and providing benefit to the larger part of society" (Schaltegger & Wagner, 2011, p. 225). The above definition leads us to address the term "sustainable innovations". According to Boons there is no single definition for sustainable innovation, while it is also associated with the term eco-innovation, Boons suggests sustainable innovation as "Innovation that improves the performance of sustainability" (Boons & Lüdeke-Freund, 2013, p. 2), taking into account ecological, economic and social issues. However, Varadarajan mentions that there are three types of sustainable innovations; one associated with the decrease in the use of resources; another related to the innovation of elimination of the use of resources and, finally; the innovation of replacement of the use of resources (Varadarajan, 2017, p. 8). Another definition is "the integration of conservation and development to ensure that modifications to the planet do indeed secure the survival and well-being of all people" (Albort-Morant et al., 2017, p. 2).

Another vision of sustainable entrepreneurship is that "is focused on the preservation of nature, life support, and community in the pursuit of perceived opportunities to bring into existence future products, processes, and services for gain, where gain is broadly construed to include economic and non-economic gains to individuals, the economy, and society" (Muñoz & Cohen, 2018, p. 304). In the same way, Cohen and Winn (Cohen & Winn, 2007) define it as the review of how opportunities to create goods and services are discovered and with what economic, psychological, social and environmental consequences. In this same sense, Belz and Binder (Belz & Binder, 2017, p. 2) believe that sustainable entrepreneurship is to recognise, develop and take advantage of opportunities by individuals to create future goods and services with social, economic and ecological benefits. Likewise, the main idea of sustainable entrepreneurship is that the activities carried out by entrepreneurs must not undermine the ecological and social environments in which they operate (Muñoz & Cohen, 2018). Thus, sustainable entrepreneurship begins with the identification of ecological or social problems, and then identifies possible solutions through innovation (Eller et al., 2020). Similarly, sustainability start-ups differ from conventional start-up companies in their pronounced value-based approach and intention to initiate social and environmental change in society (Bocken, 2015, p. 3).

The purpose of this research is to present a bibliometric analysis of the sustainable entrepreneurship, in order to have an approach to this topic and identify the main authors, countries and journals that investigate this topic. Similarly, by means of maps, visualize elements such as co-citation, bibliographic coupling and co-authoring. Likewise, the presentation of the citation structure by years, which allows us to understand the historical evolution of both the number of publications and citations.

This document is organised as follows. Section 1 reviews the bibliometric methods used herein. Section 2 presents the results including the citation structures of the most representa-

tive publications, authors, institutions and countries for the topic of sustainable entrepreneurship. Also includes a graphic analysis of the bibliographic data using the VOSviewer software. Finally, the main discussions and conclusions.

1. Bibliometric method

In order to carry out the bibliometric analysis, the main collection of the Web of Science (WoS) database was consulted and the following search equation was used: *Topic*: ("sustainable entrepreneurship") or Topic: ("sustainability entrepreneurship") *or Topic*: ("sustainable venturing") *or Topic:* ("sustainable start-up") *or Topic*: ("sustainable innovation") *or Topic*: ("sustainab* entrepreneur*"). The search was refined excluding 2020 and only Article or Review document types were taken into account. The time frame was from 1968 to 2019 . The indices used were: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC. In this sense, by refining the search with the above equation, 761 documents were found, of which 710 are Articles and 51 are Reviews. A bibliometric analysis is done based on these articles.

Broadus' research presents different definitions of the term bibliometric, a definition presented by the author is that of Porter who suggests that "bibliometrics is a set of methods used to study or measure texts and information of all forms of written communication, their authors and publication patterns" (Broadus, 1987, p. 374). In this sense, the bibliometric analysis allows quantitative analysis of the academic literature (Cancino et al., 2017; Merigó & Yang, 2017; Pineda Ospina, 2015). The most representative publications, citations, authors, countries and journals are analysed, which allows us to get an idea of a certain field of research (Merigó et al., 2015).

There are several indicators to measure the academic production of authors, the most popular include the total number of papers published and total number of papers published in a given period of time. There are also indicators to measure the impact of publications, including the total number of citations, the average citations per paper and the impact of the journals where the papers are published, which should be taken into account in the bibliometric analysis (Alonso et al., 2009).

However, Hirsh in 2005 designed an indicator called index h, which takes into account the quantity and impact of the researcher's publications (Alonso et al., 2009). This revolves around the idea that "a scientist has index h if h of his or her Np papers have at least h citations each and the other (Np-h) papers have ≤h citations each" (Hirsch, 2005, p. 16569). That is, if the index h of an author is X, thus that X of his or her publications have been cited more than X times.

The main analyses include, among other: bibliographic coupling, co-citation, co-occurrence of key words. Next, each one is detailed (Boyack & Klavans, 2010; Merigó et al., 2018; Zupic & Čater, 2015): Bibliographic Coupling (Figure 2): When two papers have a common reference, that is, if paper A is cited in papers B and C, it means that they are coupled bibliographically speaking. The greater the number of common references, the greater the intensity of the relationship (Kessler, 1963), see Figure 1. Co-citation: When two papers are cited in a single paper it means that they are co-cited, in other words, when papers A and C are cited in

paper B, this indicator allows the degree of relationship of the papers according to the citing authors, that is, that the more citations the two papers have in the same paper, the greater their relationship (Small, 1973), see Figure 2. Co-authorship: It refers to documents that have more than one author, which allows to identify scientific collaboration (Merigó et al., 2018). Co-occurrence of keywords: It identify keywords more frequently and those that appear more frequently in the same documents (Merigó et al., 2018).

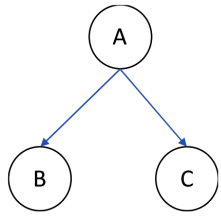

Figure 1. Example of bibliographic coupling example (Kessler, 1963)

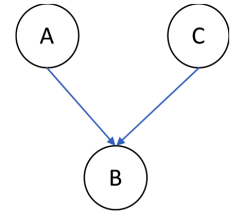

Figure 2. Example of co-citation (Small, 1973)

Finally, it is worth noting that the research that uses bibliometric analysis has focused on performing them when a journal is celebrating its anniversary (Biemans et al., 2007; Cancino et al., 2017; Merigó et al., 2018). They have also been performed focusing on a topic (Cancino et al., 2018; Fahimnia et al., 2015; Liao et al., 2018; Merigó et al., 2015; Merigó & Yang, 2017; Zupic & Čater, 2015) and in other cases they have focused on the publications of a country or region (Bonilla et al., 2015; Glänzel et al., 1999), among others.

2. Results

Since 2015, the amount of documents that have been published around the research topic of "Sustainable Entrepreneurship" has been increasing in a very representative way, having an upswing since 2011 as shown in the Figure 3. By the way (Wagner et al., 2019) mentions that as of 2009 is this increase. This originates since different disciplines have increased their interest to research the subject (Muñoz & Cohen, 2018), together with the fact that the concept of sustainability is increasingly significant. In this sense, 78.6% of the documents published correspond to the time frame from 2015 to 2019. Figure 3 displays the evolution over time of the publications per year. It is worth noting that only papers and reviews are taken into account in the bibliometric analysis presented. In total, 93.3% correspond to papers and 6.7% to reviews.

To identify the main terms that were found in the systematic information search, the NVIVO (QSR International, 2020) software was used (version 12), the author, year, title, and summary were chosen as key data. Out of the 761 papers, the title and the summary were taken and the frequency of words analysis was carried out, which consists of identifying the most frequently used words, followed by a word cloud chart, which allows to identify the most frequently used words by the size of the text, the larger the text the greater the frequency. The main words are sustainable, innovation, environmental, business, entrepreneurship, among others, see Figure 4.

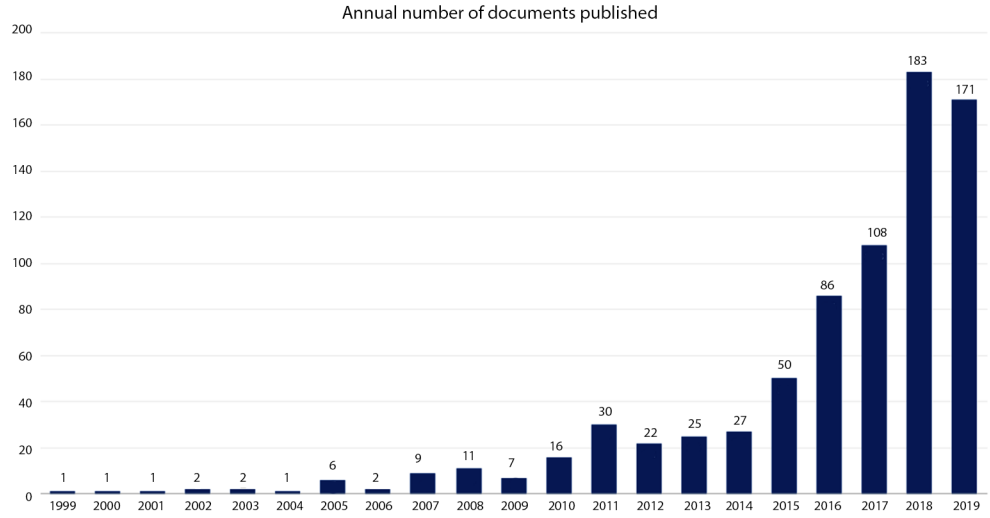

Figure 3. Annual Number of Documents published in research on Sustainable Entrepreneurship

Regarding the terms of sustainability, entrepreneurship and innovation, the NVIVO Software was used to track the use of these throughout the years, using the abstract of the 761 papers as data. The following table shows the historical development of these three terms. It is found that there is a greater use of these terms in research since 2010. However, it is found that there is an increase in the use of terms in 2010 compared to previous years. It is also clear that the use of the term of sustainability is growing very programmatically, especially in the last four years. Figure 5 displays the increase in the use of words.

Figure 4. Word cloud source: own development using NVIVO

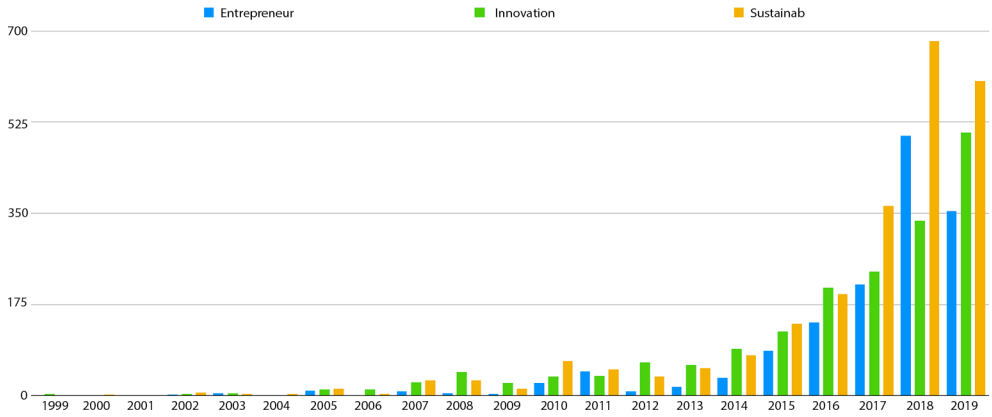

Figure 5. Development of the terms entrepreneur, innovation and sustainable

The general citation structure allows analysing the amount of documents in relation to a citation threshold (Cancino et al., 2017), in this sense, 28.52% of the documents have received at least 10 citations and 15.37% have received at least 20 citations. Only nine documents have received at least 300 citations and five documents have received at least 400 citations, see Table 1. Regarding index h, it stands at 50 for this group of documents, which means that 50 documents have received at least 50 citations.

In regards to the annual citation structure of the published documents, it is found that 74% have received at least one citation in documents indexed in the WoS database. 28.5% have received at least 10 citations, 3.2% at least 100 and 1.2% at least 300 citations, see Table 2. The year with the most citations is 2010 with a total of 1,798, with the main authors being (Bos-Brouwers, 2010; Hockerts & Wüstenhagen, 2010; Short et al., 2010; Smith et al., 2010), followed by the year 2007 with 1,469, the main authors being (Cohen & Winn, 2007; Dean & McMullen, 2007; Hellström, 2007; Stirling, 2007).

Table 1. General citation structure (source: own elaboration based on WoS)

Number of citations	TP	%
≥400 citation	5	0.66%
≥300 citation	9	1.18%
≥200 citation	12	1.58%
≥100 citation	24	3.15%
≥50 citation	53	6.96%
≥20 citation	117	15.37%
≥10 citation	217	28.52%
Total Papers	761	

Note: TP – Total Papers.

Table 2. Annual citation structure on Sustainable Entrepreneurship research (source: own elaboration)

Year	TP	TC	≥1	≥10	≥50	≥100	≥200	≥300
1999	1	5	1	0	0	0	0	0
2000	1	1	1	0	0	0	0	0
2001	1	0	0	0	0	0	0	0
2002	2	133	2	2	2	0	0	0
2003	2	141	2	2	2	0	0	0
2004	1	10	1	1	0	0	0	0
2005	6	210	6	4	2	0	0	0
2006	2	17	2	0	0	0	0	0
2007	9	1469	9	9	5	4	3	3
2008	11	968	10	7	4	2	1	1
2009	7	243	7	3	1	1	0	0
2010	16	1798	15	12	7	6	3	2
2011	30	1085	18	12	6	3	2	1
2012	22	659	19	10	4	2	0	0
2013	25	1271	23	14	4	2	2	2
2014	27	983	20	15	5	3	1	0
2015	50	749	45	23	4	0	0	0
2016	86	974	79	31	2	1	0	0
2017	108	1182	92	39	5	0	0	0
2018	183	851	139	28	0	0	0	0
2019	171	222	72	5	0	0	0	0
Total	761	12 971	563	217	53	24	12	9
%	100%		74.0%	28.5%	7.0%	3.2%	1.6%	1.2%

Note: TP and TC – Total Papers and citations; ≥300, ≥250, ≥200, ≥150, ≥100, ≥50, ≥10, ≥5, ≥1 – Number of Papers with equal or more than 300, 250, 200, 100, 50, 10, 5 and 1 citation.

As mentioned above, the research published in the WoS database related to Sustainable Entrepreneurship is increasing. In the search carried out, it was found that the first paper (taking into account the search equation mentioned in section 1) is from 1999; Table 3 displays the 20 most cited papers. Authors such as Schot, J; Geels, FW; Smith, A; Voss, JP; Grin, J; Boons, F; Ludeke-Freund, F; Dean, TJ; McMullen, JS; Cohen, B; Winn, MI; Schaltegger, S; Wagner, M. Similarly, 2010 is stands out with six papers in the top 20, for its part 2007 have four papers, the years 2011 and 2014, have three papers each in the top 20. It was also found that the paper with the most citations per year is that of Boons and Ludeke-Freund.

In relation to the authors, Table 4 contains the 15 authors with their respective institutions and country, who publish the most on Sustainable Entrepreneurship matters. Authors such as Bossink, Blok and Horisch stand out with 13, 10 and 7 publications respectively. Of the 20 authors that publish the most, there are ten that have more than 100 citations, and two of whom have more than 500 citations. In relation to the index h, one author have an index of six, eight authors have an index of four, six authors have an index of three and four authors have an index of two.

Table 3. The 20 most cited documents between 1999 and 2019 (source: own elaboration)

No.	TC	Title	Author/s	Year	TC/Y
1	617	Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy	Schot & Geels	2008	56.1
2	577	Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges	Smith et al.	2010	64.1
3	550	Business models for sustainable innovation: state-of-the-art and steps towards a research agenda	Boons & Lüdeke-Freundthe Boons & Lüdeke-Freund	2013	91.7
4	420	Sustainable Entrepreneurship and Sustainability Innovation: Categories and Interactions	Schaltegger & Wagner	2011	52.5
5	406	Toward a theory of sustainable entrepreneurship: Reducing environmental degradation through entrepreneurial action	Dean & McMullen	2007	33.8
6	386	Market imperfections, opportunity and sustainable entrepreneurship	Cohen & Winn	2007	32.2
7	359	A general framework for analysing diversity in science, technology and society	Stirling	2007	29.9
8	314	Greening Goliaths versus emerging Davids – Theorizing about the role of incumbents and new entrants in sustainable entrepreneurship	Hockerts & Wüstenhagen	2010	34.9
9	300	Sustainable innovation, business models and economic performance: an overview	Frank Boons, Carlos Montalvo, Jaco Quist, & Marcus Wagner	2013	50.0
10	286	Sustainability-oriented innovation of SMEs: a systematic review	Klewitz & Hansen	2014	57.2
11	224	Corporate Sustainability and Innovation in SMEs: Evidence of Themes and Activities in Practice	Bos-Brouwers, HEJ	2010	24.9
12	207	The New Field of Sustainable Entrepreneurship: Studying Entrepreneurial Action Linking "What Is to Be Sustained" with "What Is to Be Developed"	Shepherd & Patzelt	2011	25.9
13	183	Green innovation in technology and innovation management – an exploratory literature review	Schiederig, Tietze, & Herstatt	2012	26.1
14	180	The influence of sustainability orientation on entrepreneurial intentions – Investigating the role of business experience	Kuckertz & Wagner	2010	20.0
15	179	The entrepreneur-environment nexus: Uncertainty, innovation, and allocation	York & Venkataraman	2010	19.9
16	173	Evolutionary approaches for sustainable innovation policies: From niche to paradigm?	Nill & Kemp	2009	17.3
17	163	Transforming Innovation for Sustainability	Leach et al.	2012	23.3
18	162	Overcoming barriers to innovation and diffusion of cleaner technologies: some features of a sustainable innovation policy regime	Foxon & Pearson	2008	14.7

End of Table 3

No.	TC	Title	Author/s	Year	TC/Y
19	141	Escaping the green prison: Entrepreneurship and the creation of opportunities for sustainable development	Pacheco, Dean, & Payne	2010	15.7
20	140	Adopting Sustainable Innovation: What Makes Consumers Sign up to Green Electricity?	Ozaki	2011	17.5

Note: TC – Total number of citations. TC/Y – It is the total of citations on the number of years that the document has been published.

On the other hand, regarding the documents most cited in the research on Sustainable Entrepreneurship, we find that the most representative authors are: Dean Tj, Schaltegger S, Cohen B, Hockerts K, and Hall Jk., the main journals are also identified, namely: Journal of Business Venturing, Journal of Cleaner Production, Academic of Management Review and Entrepreneurship Theory and Practice, see Table 5.

Table 4. The 15 authors that publish the most on the topic of Sustainable Entrepreneurship (source: own elaboration)

No.	Author	TP	University	Country	TC	H	TC/TP	≥100	≥50	≥10	≥1
1	Bossink Bart	13	Vrije Univ Amsterdam Univ Twente	Netherlands	8	2	0.62	0	0	0	4
2	Blok Vicent	10	Wageningen University & Research	Netherlands	235	6	23.50	0	2	4	10
3	Horisch Jacob	7	Alanus Univ	Germany	109	4	15.57	0	0	4	7
4	Tsai Snag-Bing	6	Dalian Univ Technol Univ Elect Sci & Technol	China	36	2	6.00	0	0	1	5
5	Quist Jaco	5	Delft Univ Technol	Netherlands	382	4	76.4	1	1	4	5
6	Ratten Vanessa	5	La Trobe Univ	Australia	0	0	0	0	0	0	0
7	Schalte-gger Stefan	5	Leuphana Univ Lueneburg	Germany	522	4	104.4	1	2	2	4
8	Tvarona-viciene Manuela	5	Vilnius Gediminas Tech Univ	Lithuania	53	4	10.6	0	0	4	5
9	Wagner Marcus	5	Univ Wurzburg	Germany	900	3	180	3	3	3	3
10	York Jeffrey G	5	Univ Virginia	USA	274	3	54.8	1	1	3	4

End of Table 4

No.	Author	TP	University	Country	TC	H	TC/TP	≥100	≥50	≥10	≥1
11	Chare-onpanich Metta	4	Kasetsart Univ	Thailand	36	3	9	0	0	2	4
12	Cohen Boyd	4	Univ Victoria EADA Business Univ Vic Univ Desarrollo	Canada Spain Australia Chile	412	4	103	1	1	2	4
13	Dickel Petra	4	Univ Kiel	Germany	14	2	3.5	0	0	1	3
14	Donphai Walee-porn	4	Kasetsart Univ	Thailand	36	3	9	0	0	2	4
15	Fichter Klaus	4	Carl von Ossietzky Univ Oldenburg Borderstep Inst Innovat & Sustainabil	Germany	29	3	7.25	0	0	2	3

Note: Abbreviations are shown in Table 2.

Table 5. Most cited papers in research on sustainable entrepreneurship (source: own elaboration)

No.	Reference (first author only)	TC	TLS
1	Dean Tj, 2007, J Business Venturing, V22, P50	152	1757
2	Schaltegger S, 2011, Bus Strateg Environ, V20, P222	143	1622
3	Cohen B, 2007, J Business Venturing, V22, P29	131	1534
4	Hockerts K, 2010, J Business Venturing, V25, P481	99	1357
5	Hall Jk, 2010, J Business Venturing, V25, P439	104	1285
6	Shepherd Da, 2011, Entrep Theory Pract, V35, P137	100	1103
7	Pacheco Df, 2010, J Business Venturing, V25, P464	67	973
8	Kuckertz A, 2010, J Business Venturing, v25, p524	65	906
9	York Jg, 2010, J Business Venturing, V25, P449	64	906
10	Parrish Bd, 2010, J Business Venturing, V25, P510	62	828

Note: TC – Total Citations. TLS – Total Link Strength.

However, analysing the countries with the most publications, it has been found that the Netherlands is the country with the most papers published on the topic of Sustainable Entrepreneurship, followed by the USA, Germany and England. These countries reached at least 300 citations in one or more papers, as did Canada, Denmark and Switzerland, see Table 6. During the first ten years (1999 to 2008) the USA published more papers than Netherlands, followed by England. In the eleven years that followed (2009 to 2019), the Netherlands leads

the field in terms of publications. Likewise, the USA stands out for having more publications in the 2008, 2009 and 2012, while the Netherlands stood out from 2013 to 2015 and Germany in 2017 and in 2018, see Table 7.

Table 6. The 11 Countries that publish the most on the topic of Sustainable Entrepreneurship (source: own elaboration)

No.	Country	TP	TC	H	TC / TP	%/ 761	≥300	≥200	≥100	≥50	≥10	≥1
1	Netherlands	102	3789	25	37.15	13%	4	5	6	14	46	80
2	USA	97	2366	24	24.39	13%	1	2	5	13	42	74
3	Germany	84	3462	18	41.21	11%	4	6	8	12	29	67
4	England	80	2676	24	33.45	11%	2	2	5	12	39	72
5	Spain	58	624	12	10.76	8%	0	0	1	2	16	45
6	Italy	55	361	11	6.56	7%	0	0	0	0	14	42
7	Peoples R China	49	313	9	6.39	6%	0	0	1	1	9	27
8	Brazil	42	367	8	8.74	6%	0	0	1	3	8	23
9	Denmark	34	666	11	19.59	4%	1	1	1	3	11	30
10	Canada	31	640	10	20.65	4%	1	1	1	2	10	29
11	Sweden	31	446	10	14.39	4%	0	0	1	2	11	24

Note: Abbreviations are shown in Table 2.

Table 7. Evolution over time of publications by country (source: own elaboration)

Country	99	00	01	02	03	04	05	06	07	08	09	10	11	12	1	14	15	16	17	18	19
Netherlands	0	0	0	1	0	0	1	1	1	3	1	6	11	3	9	7	9	10	9	17	13
USA	0	1	0	0	2	1	0	0	1	4	3	4	10	4	6	4	7	9	9	13	19
Germany	1	0	0	0	0	0	2	0	1	0	0	2	3	2	3	3	5	7	16	24	15
England	0	0	0	0	0	0	0	1	4	1	1	2	4	3	2	5	7	11	6	12	8
Spain	0	0	0	0	0	0	0	0	2	0	1	1	2	1	0	0	2	5	9	20	15
Italy	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	7	10	16	19
Peoples R China	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	2	2	5	14	23
Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	12	13	9
Denmark	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1	5	4	9	9	3
Canada	0	0	0	0	0	0	0	0	0	1	1	1	1	2	0	1	1	4	6	5	8
Sweden	0	0	0	0	0	0	1	0	0	1	0	1	0	2	0	0	0	5	3	10	8

Note: TP – Total Papers; 99, 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12, 1, 14, 15, 16, 17, 18, 19 – year of publication.

On the other hand, the leading journals to publish papers related to the topic of sustainable entrepreneurship according to the search carried out in WoS are the following: Journal of Cleaner Production and Sustainability, the first has an impact factor of 6.395 as of 2018 and the second of 2.592, see Table 8. In relation to the citation structure, only three journals have had at least 300 citations or more in a document, the citation structure is found in Table 8. When analysing the evolution over time of journal publications, it is clear, as mentioned before, that as of 2015 there is a representative growth in publications on the subject of sustainable entrepreneurship. However, there is a significant amount of publications in 2011, see Table 9.

Table 8. Citation structure of the journals that publish the most (source: Own elaboration)

Journal	TP	TC	H	TC / TP	IF 2018	IF 5 years	%	≥300	≥200	≥100	≥50	≥10	≥1
Journal of Cleaner Production	101	3028	25	29,98	6.395	7.051	13%	2	3	5	12	58	94
Sustainability	99	431	11	4.35	2.592	2.801	13%	0	0	0	0	15	67
Entrepreneurship and Sustainability Issues	18	115	7	6.39	NA	NA	2%	0	0	0	0	5	17
Business Strategy and the Environment	16	1069	12	66.81	6.381	7.557	2%	1	2	3	5	12	14
Corporate Social Responsibility and Environmental Management	14	87	3	6.21	5.513	7.131	2%	0	0	0	1	1	8
International Journal of Entrepreneurial Venturing	11	46	4	4.18	NA	NA	1%	0	0	0	0	1	10
CSR Sustainability Ethics and Governance	10	6	1	0.60	NA	NA	1%	0	0	0	0	0	3
Managing Environmentally Sustainable Innovation Insights from the Construction Industry	10	1	1	0.10	NA	NA	1%	0	0	0	0	0	1

End of Table 8

Journal	TP	TC	H	TC / TP	IF 2018	IF 5 years	%	≥300	≥200	≥100	≥50	≥10	≥1
Routledge Studies in Innovation Organization and Technology	10	1	1	0.10	NA	NA	1%	0	0	0	0	0	1
Small Business Economics	10	103	6	10.30	3.56	4.45	1%	0	0	0	0	4	6

Note: Abbreviations are shown in Table 2. NA: Not Available.

Table 9. Evolution over time of publications by journal (source: Own elaboration)

Journal	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
Journal of Cleaner Production	0	0	1	0	0	0	2	0	2	1	0	2	0	0	6	4	6	14	19	28	16
Sustainability	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	9	11	30	46
Entrepreneurship and Sustainability Issues	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	4	2	4	2
Business Strategy and the Environment	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	1	2	1	3	2	3
Corporate Social Responsibility and Environmental Management	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	12
International Journal of Entrepreneurial Venturing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	7	1

End of Table 9

Journal	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
CSR Sustainability Ethics and Governance	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	7	1
Managing Environmentally Sustainable Innovation Insights from the Construction Industry	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
Routledge Studies in Innovation Organization and Technology	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
Small Business Economics	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	6

Note: Abbreviations are shown in Table 7.

The subject of sustainable entrepreneurship is addressed, according to the categories defined by the WoS database, from the standpoint of the Green Sustainable Science Technology, environmental sciences, management, business, and environmental studies, among others, see Table 10. Management and business are the main categories that have had at least 300 citations or more in a document. Similarly, in relation to the research areas, it has been found that this is the case for business economics, environmental and ecological sciences, technology sciences and engineering, among others, see Table 11.

Table 10. Main categories in WoS and citation structure (source: own elaboration)

WoS Categories	TP	%	TC	H	C/P	≥300	≥250	≥200	≥100	≥10	≥1
Green Sustainable Science Technology	245	32%	3912	28	16	2	3	6	15	84	190

End of Table 10

WoS Categories	TP	%	TC	H	C/P	≥300	≥250	≥200	≥100	≥10	≥1
Environmental Sciences	236	31%	3917	28	17	2	3	6	14	86	186
Management	218	29%	4332	26	20	3	4	7	18	60	159
Business	214	28%	4823	30	23	4	6	11	24	64	159
Environmental Studies	175	23%	2467	22	14	1	1	5	11	44	125

Note: Abbreviations are shown in Table 2.

Table 11. Main research and citation structure areas (source: own elaboration)

Research areas	TP	%	TC	H	TC/ TP	≥300	≥200	≥100	≥50	≥10	≥1
Business Economics	353	46%	7128	36	20.19	6	8	14	30	94	257
Environmental Sciences Ecology	298	39%	5658	33	18.99	3	5	10	24	109	232
Science Technology Other Topics	257	34%	5007	29	19.48	4	5	8	17	91	201
Engineering	147	19%	3700	28	25.17	2	3	5	16	76	129
Social Sciences Other Topics	37	5%	327	9	8.84	0	0	0	3	8	26

Note: Abbreviations are shown in Table 2.

3. Graphic Analysis with VOSviewer

This section aims to present a more detailed analysis to the citation structure. The software used for this analysis was VOSviewer, (van Eck & Waltman, 2020) (version 1.6.14), this software allows to create and visualise, taking into account the map co-citation of author or journal (Liao et al., 2018; van Eck & Waltman, 2010), bibliometric networks based on citation, co-citation, co-authorship, bibliographic coupling, among others (Merigó et al., 2018). With regard to the co-citation of journals, between 1999 and 2019, it is found that the most representative journals are: Journal of Cleaner Production, Journal of Business Venturing, Entrepreneurship Theory and Practice, Academy of Management Review, Research Policy and Strategic Management Journal. The more papers published the larger the size of the node, in the same way the distance between two nodes means that the frequency of citations between these, the greater the distance, the lower the frequency of citations and vice versa (Liao et al., 2018). Figure 6 shows that the Journal of Cleaner Production is the most cited and has the broadest network just like the Journal of Business Venturing. It is worth noting that the colours of Figure 6 represent the group to which each journal belongs. The threshold used was 20 documents and the 100 most representative connections. In this figure, six clusters are identified, the red and green clusters are the ones that have the most connections with the greatest number of co-citations.

The bibliographic coupling shows the papers that refer to the same set of cited papers (Boyack & Klavans, 2010). Figure 7 shows how the authors are bibliographically coupled. The

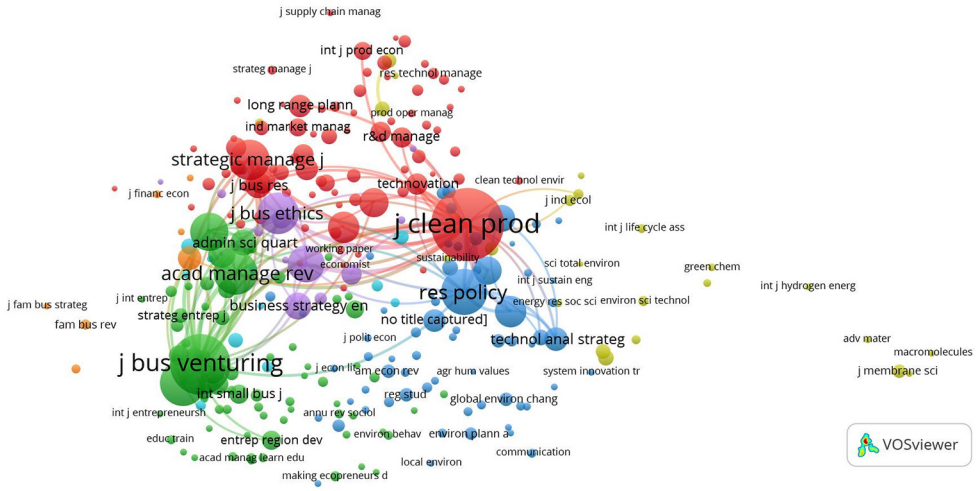

Figure 6. Co-citation of journals

minimum threshold of 4 documents was used and the 100 most representative connections. Figure 7 is consistent with the results shown in Table 5, with Bossink, Blok, York, Cohen, Muñoz and Tsai being the most representative. This figure also shows the networks that are created between the authors, five clusters are identified, the main one is the red one, which contains a higher concentration of connections. In this cluster we find that York, Schaltegger have a stronger connection and therefore appear closer, which implies that it is common for researchers to quote these two authors in the same document.

Figure 8 contains the bibliographic coupling between countries, the main countries that create documents related to the topic of sustainable entrepreneurship are the Netherlands, the USA, England and Germany, in accordance with what is presented in Table 6. This map also shows the relationships that exist between countries, with Spain, the USA and the Netherlands close to each other, which means they have greater connections. This figure was made with a threshold of at least five documents and 100 connections.

Figure 9 contains the co-authorship by country, showing the most influential countries and the degree of communication between them. While it is similar to Figure 8 on biblio-

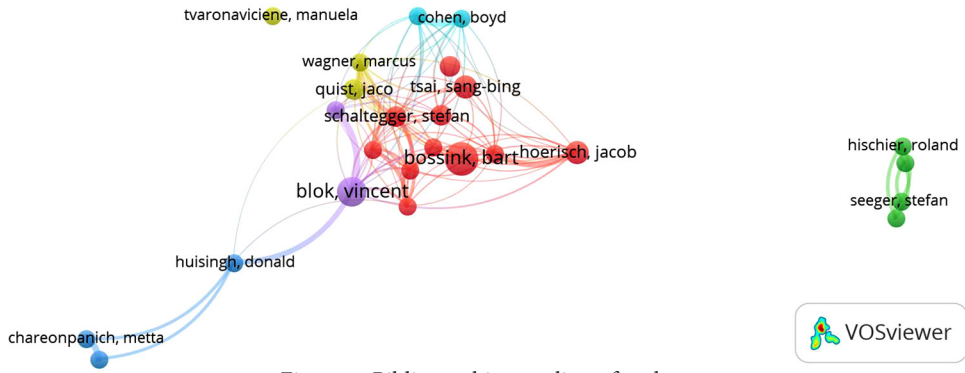

Figure 7. Bibliographic coupling of authors

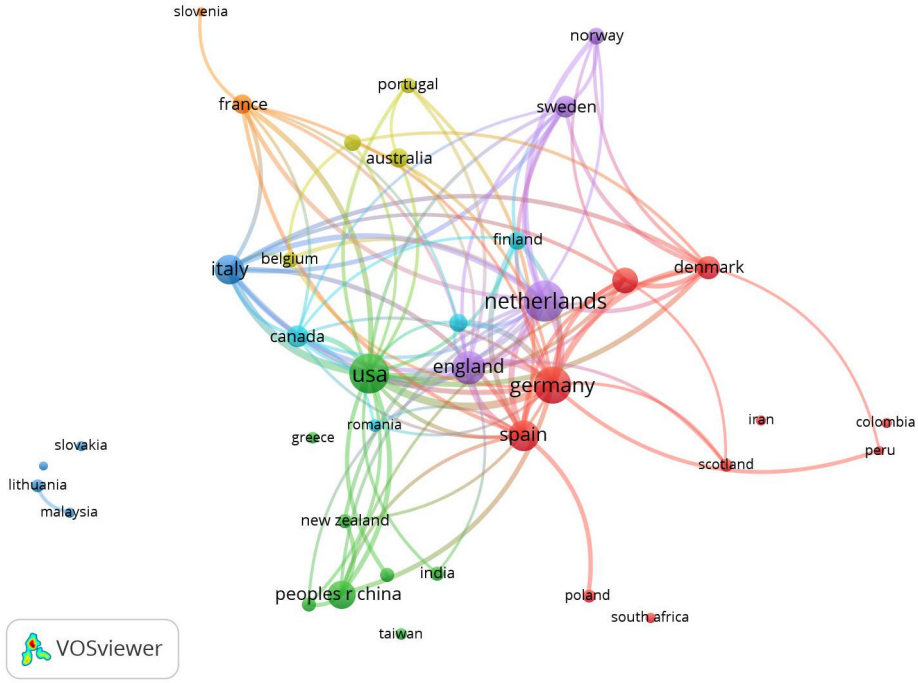

Figure 8. Bibliographic coupling by countries

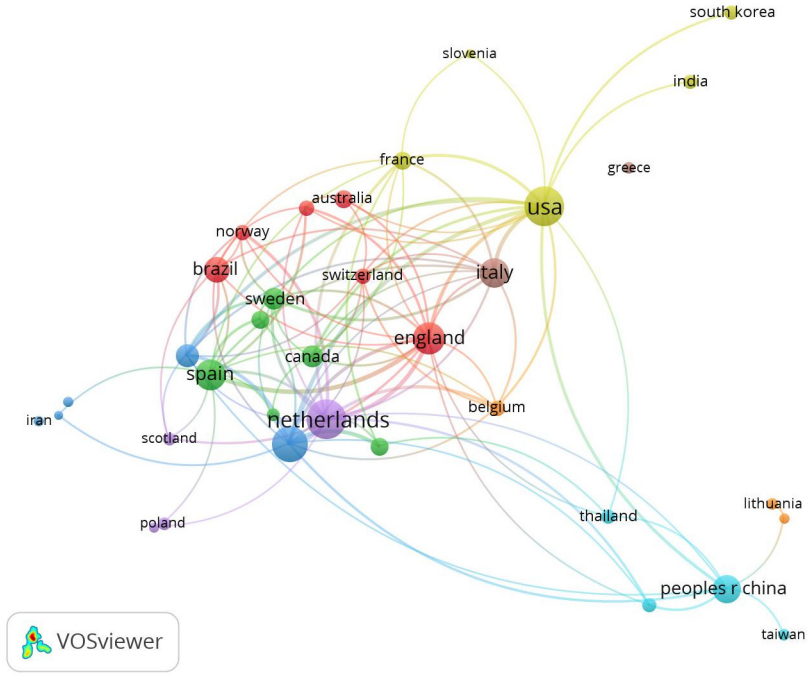

Figure 9. Co-authorship by countries

graphic coupling, the difference can be found in the connections. It is worth noting that the largest nodes mean that they are the most influential countries, in this case the Netherlands, Germany, England, the USA and Spain. The relationship lines represent the cooperation between the countries. This figure was made with a threshold of at least five documents and 100 connections.

Finally, by reviewing the main keywords, Figure 10 displays the main keywords, taking into account a threshold of five occurrences and the 100 most representative connections. The words that stand out the most are: sustainability, sustainable innovation, sustainable entrepreneurship, innovation, entrepreneurship, sustainable development, social entrepreneurship, environmental entrepreneurship, eco-innovation and corporate social responsibility. On the other hand, Table 12 shows all the most common author keywords with their respective co-occurrences and the total strength of the connection. It is evident that the main word is Sustainability, Sustainability Innovation and Sustainability Entrepreneurship.

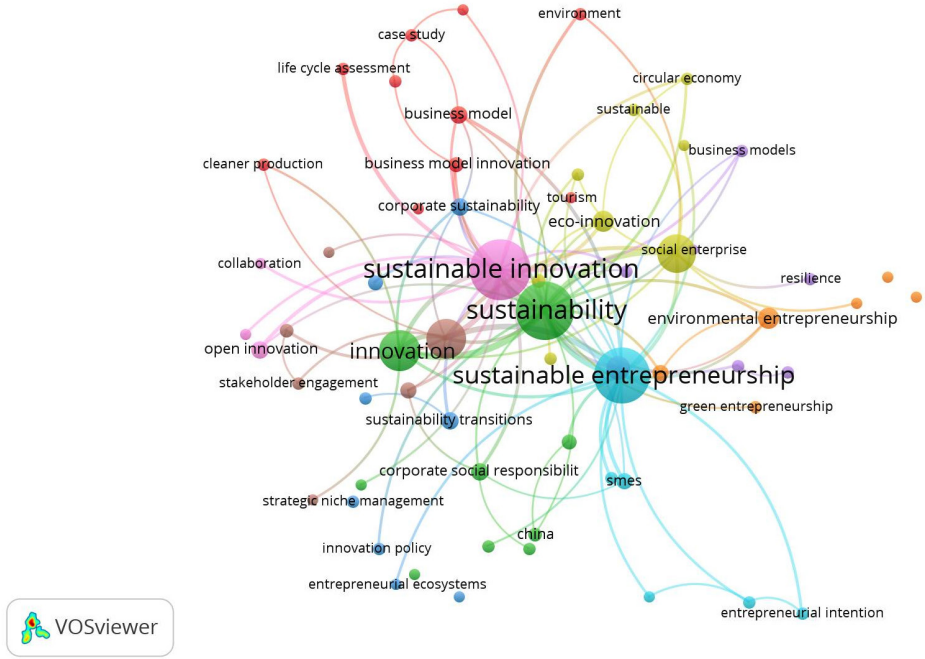

Figure 10. Co-occurrence of author keywords

Table 12. Most common author keywords (source: own elaboration)

No.	Keywords	Occurrences	TLS
1	Sustainable Innovation	138	87.00
2	Sustainability	124	104.00
3	Sustainable Entrepreneurship	113	72.00
4	Innovation	64	49.00
5	Sustainable Development	60	53.00

Note: TLS – Total Link Strength.

4. Discussion

The number of researches related to sustainable entrepreneurship has increased since 2015 on the back, firstly, that the issue of sustainability is flourishing and, secondly, since there is greater access to databases and the internet more publications can be found on the subject. While the increase can be seen in 2015, it is worth noting that, starting in 2010, the terms (with their derivatives) Entrepreneur, Innovation and Sustainability, had a greater growth. This approach indicates that the issue of sustainable entrepreneurship is becoming emerging fields of interest for researchers in different areas of knowledge, entrepreneurs, State and professionals.

Development trends on sustainable entrepreneurship have focused on reviewing how sustainable entrepreneurship relates to sustainable development, in this sense researches have focused on innovation issues, sustainable innovation and sustainable business models, among others. Likewise, there is a tendency to define what sustainable entrepreneurship is, but there is no unification of concepts, researches have been focused towards ecological, environmental and social areas. Nevertheless, there are other definitions of sustainable entrepreneurship. It is important to mention that these trends have solved problems related to environmental and social issues and how sustainable entrepreneurship contributes to the solution of these problems. They have also solved how market imperfections create opportunities for sustainable entrepreneurship.

Conclusions

This research contributes to the field of investigation since it presents the main authors and documents on the subject, as well as the main countries and journals through 2019. In conclusion the most relevant countries in publishing topics on sustainable entrepreneurship are the Netherlands, the USA, Germany, England and Spain. The authors more related to leading journals establish that the Journal of Cleaner Production and Sustainability are the most relevant. The authors with the most publications are York (USA), Blok (Netherlands), Bossink (Netherlands) and Cohen (Canada, Spain, Australia and Chile). However, it is necessary to strengthen the academic production of Latin American countries, since, as shown in Figure 9, academic production and co-authorship are very low. Equally, the documents found in their majority do not have more than 10 citations, this reflects that it is still necessary to disclose more knowledge and generate impact that it serves for future researches.

Among the future lines of research there is the possibility of a comparative sustainable entrepreneurship by countries taking into account that the main publications are in Europe. Another line is to analyze how sustainable entrepreneurship is being approached in Latin American countries and compare the results with other countries, however, this type of analysis could be carried out using other databases such as Scopus or Google Scholar, in order to have more information, because it is evidenced that Latin American countries have very few publications in the WoS on the subject, but this does not mean that they are not writing and publishing. Another line of research is to analyze how the different areas of knowledge are interwoven. In this sense, it would be of great value for researchers to understand what is

being researched and where research is going in each field of knowledge, taking into account that in our analysis we presented areas associated with business/management, environment, engineering, among others. Finally, a research problem was identified that has not been solved and that is that there is no index that measures sustainable entrepreneurship, this could be a very interesting line of research.

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Author contributions

All authors have contributed equally in this work.

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