

Global trends of VOSviewer research, emphasizing Environment and Energy areas: A bibliometric analysis during 2000-2020

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Abstract

Although the bibliometric method has been widely used in a large number of sciences, no bibliometric study has been presented on the VOSviewer application as the most prominent software in this area. This study aimed to achieve a bibliometric analysis of research using VOSviewer, emphasizing “environment” and “energy” areas. Various features, including language, chronological trends, source types, subject categories, countries, source titles, affiliations, authors, and author keywords were systematically investigated. The countries’ cooperation, authors’ collaborations based on citations, the author keywords’ occurrences were constructed, visualized, and assessed through the VOSviewer. The study indicated that the number of VOSviewer-related publications has grown significantly. More than 97% of the total publication were journal articles and conference papers, while all publications in the mentioned fields have been in the form of articles. China was the leading country in publications, followed by Spain, Brazil, Italy, and the UK. As well, the USA and Spain had a large number of cooperation with other countries. Li, J., and Li, H. from China were the most cited authors. “Energy”, and “Environmental Science” were widely used areas in the most productive journals, as “Sustainability” published the most VOSviewer articles, followed by “International Journal of Environmental Research And Public Health” and “Journal of Cleaner Production”. Among the author keywords, “sustainability”, “sustainable development”, and “circular economy” could be recognized. Based on database comparison, the number of publications using the “Web of Science” database is higher than “Scopus”. However, the increase of articles published in the “Scopus” database is more.

Keywords: VOSviewer, Bibliometric, Scopus, Environment, Energy

Introduction

Collecting related data, studying and evaluating it from various aspects is the most known method in reviewing the literature (Asgharizadeh et al. 2019). Bibliometric analysis was introduced in 1969 by Alan Pritchard for the first time. Nowadays, it has been commonly presented to analyze the literature of different areas (Otte and Rousseau 2002; Wu et al. 2015; Qi et al. 2019).

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Bibliometric has become a valuable tool for identifying research trends and classifying issues based on publications history in various literature specifications (Ye et al. 2014; Sabour et al. 2021b). This valuable method is used to expose global trends in specific research fields (Sabour et al. 2021a). The required bibliometric data could be extracted from different databases, such as Google Scholar, Research Gate, Web of Science (WoS), and Scopus (Zhao et al. 2019). Scopus has been used in this study, considering its comprehensive statistical supplies and wide application in academic research (Gao et al. 2016; Effendi et al. 2021). Only in 2020, 1551 publications contained the word “bibliometric” in their titles recorded in Scopus. This number has reached 2051 in 2021 (which was not yet completed) (Scopus 2021).

Most bibliometric studies were performed in medicine, social sciences, computer sciences, business, engineering, and environmental sciences. Furthermore, most of the journals in which bibliometric research has been published have been in the fields of environmental science, energy, and social sciences. Among these, could be mentioned to “Scientometrics”, “Sustainability”, “Journal of Cleaner Production”, and “International Journal of Environmental Research And Public Health” (Scopus 2021).

Also, to present an appropriate visualization outcome and succinct explanation of extracted bibliometric data, social network analysis (SNA) maps could be used (Zhuang et al. 2013). The structure and the graphical presentation of these maps are the two most prominent features of bibliometric mapping, while the structure of bibliometric maps is more significant than graphical presentation (van Eck and Waltman 2010).

VOSviewer is one of the software developed by Van Eck and Waltman of Leiden University in the Netherlands (Meng et al. 2020). This software displays bibliometric maps with proper structure and high graphics (Velmurugan and Ramasamy 2021). Also, it can display maps with a large number of items data, while most computer programs used for bibliometric mapping do not have this feature (van Eck and Waltman 2010). The program is accessible to bibliometric researchers freely (www.vosviewer.com). It could be employed to display a map in various forms, such as network, overlay, and density visualization based on the connection of the publications components, chronological of the published researches, and intensity and number of the components, respectively. Besides, the structure of the maps could be consistent with co-authorships of authors or countries, co-occurrences of keywords (all, author and index keywords), citation, bibliographic coupling, and co-citation (Eck and Waltman 2014).

Numerous studies have been published on the bibliometric analysis, employing VOSviewer. However, no bibliometric analysis has been done on the VOSviewer itself in these few years. In this study, the bibliometric analysis of VOSviewer using in the publication is investigated by all three types of visualization and based on chronological data, authors country, institution, author, and keywords. In addition, the focus of this article has been on using this software in the field of “environment” and “energy”.

All parts of the study were carried out at K.N. Toosi University of Technology in March 2021.

Material and Methods

Data collection

The collected dataset for this study was extracted from Scopus. Scopus as a valid source is the largest abstract and citation database of literature with more than 23500 peer-reviewed journals (Borthakur and Govind 2018; Sharma and Kaur 2020; Fakher et al. 2021)

Considering that the first study in this area was published in 2012, the investigations were carried out on publications that contained “VOSviewer” in the title, abstract, and keywords. Language, source type, subject area, document type, affiliation, author, journal, country,

institution, and keywords were considered from 2012–2020. More than 92% (867) of the publications were in English, followed by 3.2% (30) Chinese and 2.3% (22) Spanish. However, the concentration of the study has been on “environment” and “energy” areas. Of these, 94.7% (142) were in English, 3.3% (5) in Chinese, and 2% (3) in Spanish. All types of documents such as journal articles, conference papers, book series, and books were considered in the research.

Scopus data could be exported in different formats, such as research information systems (RIS), comma-separated values (CSV), and text (Sabour et al. 2020). In this study, the CSV format was used to evaluate data on various classifications analytically.

Social network analysis (SNA)

The VOSviewer 1.6.6 was used in the research to generate the bibliometric maps of collaborations between countries, authors, and analysis of the authors' keywords. “Network visualization” and “density visualization” maps were illustrated in SNA to discover the relationship among different nodes in the networks.

The nodes exhibited in network visualization indicated the countries and the author's name (Wang et al. 2016). The size of the nodes determined the amount of the activity of that country or author. Each link was a relation between two countries or authors, while the thickness determined the level of cooperation between those in the maps. Based on the number of collaborations, a number of countries/authors formed a cluster together displayed in a different color. Also, the concentrated nodes displayed in density visualization showed the author keywords' occurrences in these seven years (Van Eck and Waltman 2019).

Impact factor (IF), H-index, subject area, country, and publisher of each journal were assessed from Scopus and SCImago Journal Rank (SJR) (SCImago Journal Rank 2021; Scopus 2021). Besides, the affiliation of the publications was determined by the countries of its authors. As a result, if the authors of an article are from different countries, that article belongs to all the nationalities of its authors (Mostafa Hatami et al. 2021).

Results and discussion

Chronological trends, Source Types and Databases

The annual number of related publications in two categories and the number of each citation are presented in Figure 1. These two categories are “all VOSviewer publications” and “VOSviewer publications in the field of environment and energy”, which are briefly shown as “ENVI+ENER” in this article henceforth. The first studies using VOSviewer were published in 2012. The VOSviewer studies increased gradually from 3 in 2000 to 494 in 2020, with remarkable growth. The largest percentage of the whole publications is dedicated to journal articles and conference papers, respectively. The total number of publications (938) included 87.6% journal articles (821), 10.1% conference papers (95), 2.0% book series (19) and 0.3% books (3). ENVI+ENER publications contain 90% journal articles (135) and 10% conference papers (15) with a growing annual citation. The annual number of citations increases gradually, presenting a noteworthy consideration to the VOSviewer discussion.

As shown in Figure 2, the number of articles published during 2013 and 2020 in the Scopus and Web of Science databases is comparable (3 articles published in 2012 did not refer to either database). Although the number of the articles referring to the “Web of Science” is higher, the growth of articles published in the “Scopus” database is significant; so that surpassed the “Web of Science” in 2020.

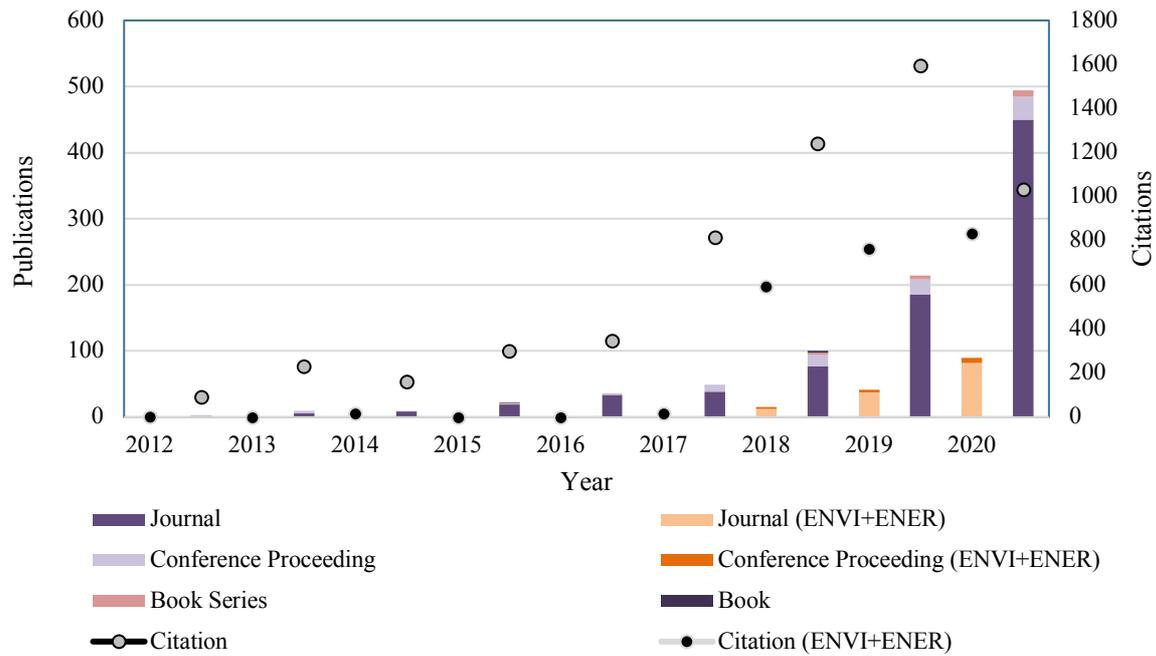


Figure 1. A cumulative number of publications by year.

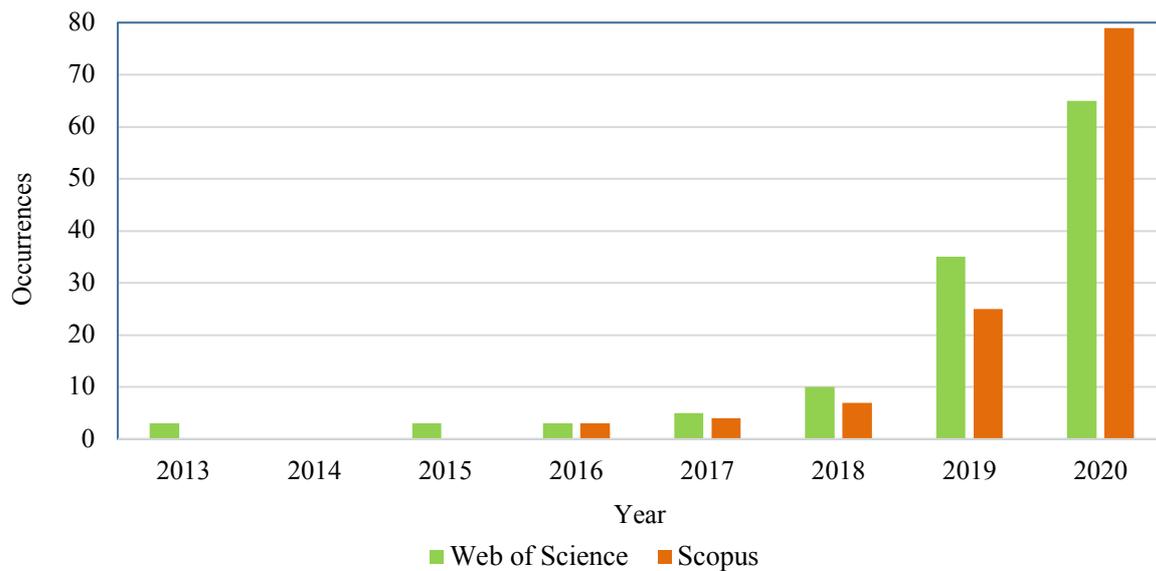


Figure 2. The number of VOSviewer publications related to databases.

Publication distribution by Subject categories

VOSviewer has been widely used in 27 disciplines. Among them, according to Figure 3, the distinction of social science (16%), computer science (12%), and medicine (12%) are significant. 11% (7%+4%) of publications are related to environmental science & energy. It is principally because of the growth of public knowledge about the quality of the environment (Usmani et al. 2021).

The following categories are Business, Management and Accounting (9%), Engineering (7%), Decision Sciences (4%), Biochemistry, Genetics and Molecular Biology (4%), Agricultural and Biological Sciences (3%), Mathematics (3%), and Arts and Humanities (3%), while the rest (Economics, Econometrics and Finance; Pharmacology, Toxicology and

Pharmaceutics; Earth and Planetary Sciences; Chemical Engineering; Psychology; Immunology and Microbiology; Physics and Astronomy; Materials Science; Nursing; Multidisciplinary; Chemistry; Health Professions; Neuroscience; Dentistry; and Veterinary) contributes to the remaining 16%.

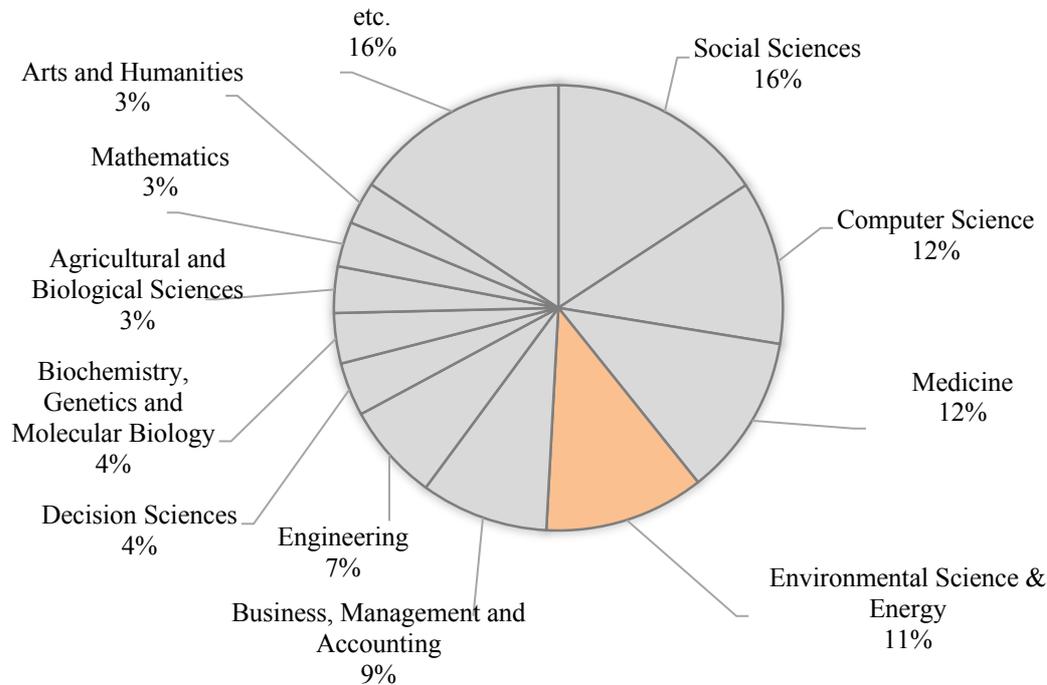


Figure 3. The most major disciplines

Publication distribution by countries

The total number of VOSviewer related publications for distribution analysis of 82 countries was 938. The top six most productive countries were China (237), the USA (96), India (93), Spain (81), Iran (57), and the UK (57).

In terms of “ENV+ENER”, 150 publications from 49 countries were studied. Twenty countries had only one, and eighteen countries had only two publications in this field. As shown in Figure 4, China was significantly leading in publications with 42 articles (equal to 28.0% of all articles in this field). It had the uppermost growth rate from 3 articles in 2018 to 27 in 2020. Spain (21) ranked as the second in publication position, followed by Brazil (17), Italy (13), UK (11), and the USA (9). They are countries with a growing investigation using VOSviewer in environment and energy areas.

With 49 and 45 links, the USA and China had the most significant number of cooperations with other countries, based on total VOSviewer related publications. In the fields of environment and energy, China (13), Spain (12), and the UK (11) are the 1st, 2nd, and 3rd in cooperation with other countries, as shown in Figure 5. China is the most productive country regarding the number of citations (582); the next are Spain (415), UK (372), and Brazil (317), with more than 300 citations. Based on “total link strength” analysis (i.e., the total number of publications cooperated with other countries), China (24), UK (16), Spain (15), and Canada (11) are the countries that have issued the most significant number of publications using VOSviewer.

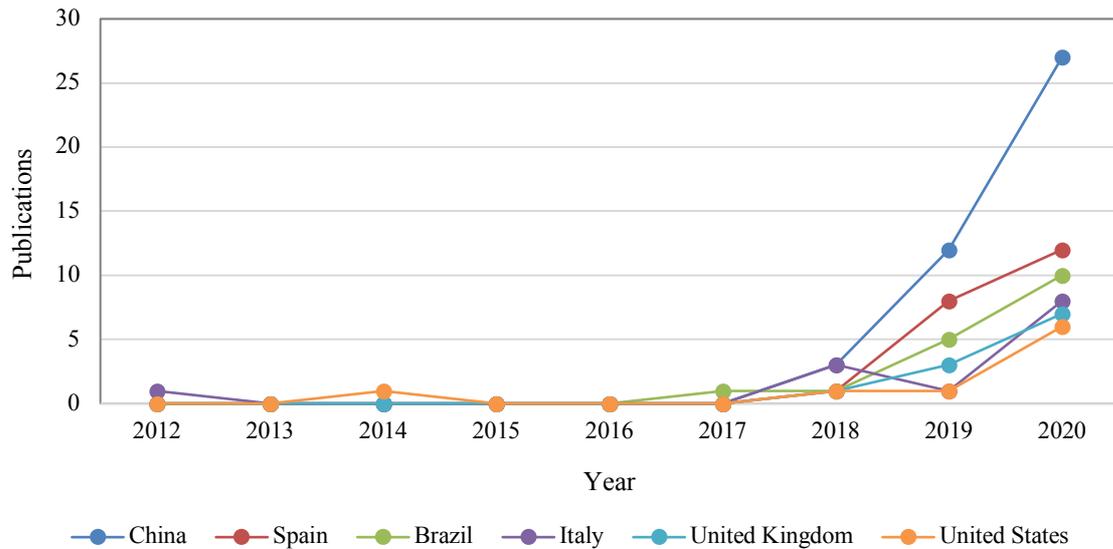


Figure 4. Trends of the Top five most productive countries

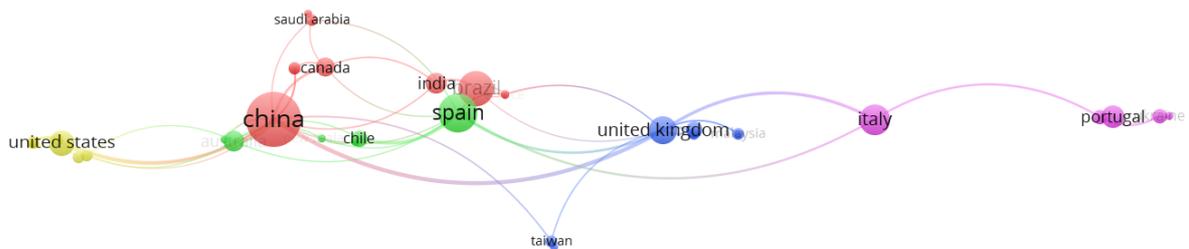


Figure 5. Cooperation of the countries

Publication distribution by Source Title

“Library Philosophy And Practice” published the highest number of articles (36) in VOSviewer research, followed by “Scientometrics” (35), “Sustainability” (33), “International Journal Of Environmental Research And Public Health” (15), and “Journal Of Cleaner Production” (9). As a result, among the top five journals on the use of VOSviewer, ranked 3rd, 4th and 5th are the journals that have published the most VOSviewer related articles in the field of environment and energy.

Table 1 shows the five most productive journals with the highest number of published “ENVI+ENER” articles in VOSviewer research with their respective subject area, country, publisher, impact factor (IF), H-index, and the number of publications. The presented information in Table 1 has been achieved from “Scopus” and “SJR”.

There were 68 articles published in these five journals. All were from Europe, while Switzerland has two leading journals in this field.

The Impact Factor (IF) corresponds to the mediocre number of citations an article issued in the two previous years receives in a specified year (Aleixandre-Tudo et al. 2019). H-index is determined as the h number of articles with at least h number of citations each (Hirsch 2005). “Journal of Cleaner Production” was ranked 1st in IF (9.297), while “Science Of The Total Environment” ranked 1st in H-index (244). Of these five journals, the publisher of “Sustainability” and “International Journal of Environmental Research And Public Health” is

MDPI, and “Journal of Cleaner Production” and “Science Of The Total Environment” published by Elsevier.

Table 1. Top five most productive journals

#	Source	Number of publications	Subject area	Country	Publisher	IF	H-index
1	Sustainability	33	- Energy - Environmental Science - Social Sciences	Switzerland	MDPI AG	2.576	85
2	International Journal of Environmental Research And Public Health	15	- Environmental Science - Medicine	Switzerland	MDPI Multidisciplinary Digital Publishing Institute	3.390	113
3	Journal of Cleaner Production	9	- Business, Management and Accounting - Energy	UK	Elsevier Ltd.	9.297	200
4	Environmental Science And Pollution Research	6	- Environmental Science - Medicine	Germany	Springer Science Business Media	4.223	113
5	Science Of The Total Environment	5	- Environmental Science	Netherlands	Elsevier	7.963	244

Publication distribution by affiliation

“The University of Hong Kong” and “Malaviya National Institute of Technology Jaipur (India)” with 22 articles, are the two institutes that have had the most publications in use of VOSviewer. The first institution to have the most “ENVI+ENER” articles on the use of VOSviewer, is ranked 16th among all institutions. The top four most productive institutes linked with an affiliation for at least one author is shown in Table 2. “Parthenope University of Naples” (Italy), with 9 articles, is ranked first, followed by “Beijing Institute of Technology” (China), “Shanghai Maritime University” (China), and “Universidade Tecnológica Federal do Paraná” (Brazil) with 4 articles. It is worth noting that among the top four countries in this field, “China”, “Brazil”, and “Italy” are present in the list.

Table 2. Top four productive institutes

Rank	Affiliation	Number of publications	Country
1	Parthenope University of Naples	9	Italy
	Beijing Institute of Technology	4	China
2	Shanghai Maritime University	4	China
	Universidade Tecnológica Federal do Paraná	4	Brazil

Publication distribution by Authors

The contributions of 70 authors were exposed based on the number of citations of their publications. According to Figure 6, nodes represent the author, and links indicate the most connections between these authors. The size of the nodes displays the citation weight of the authors. Moreover, the colors of nodes indicate the years of the most citations to the authors.

As shown in Figure 6, Li, J., and Li, H. have made the top nodes due to their highest citations with 75 and 51 citations and 6, and 2 documents, respectively. Guo, J., Guo, X. R., Guo, Y. M., Huang, Z. L., Nkeli, M. J., Chen, J., and Zhang, X. all had 40 citations. Besides, Zhao. Y. had the most collaborations with a total link strength of 20 and 19 links. Song, Y., and Li, J. are ranked 2nd and 3rd, with 17 and 16 total link strengths and 17 and 13 links.

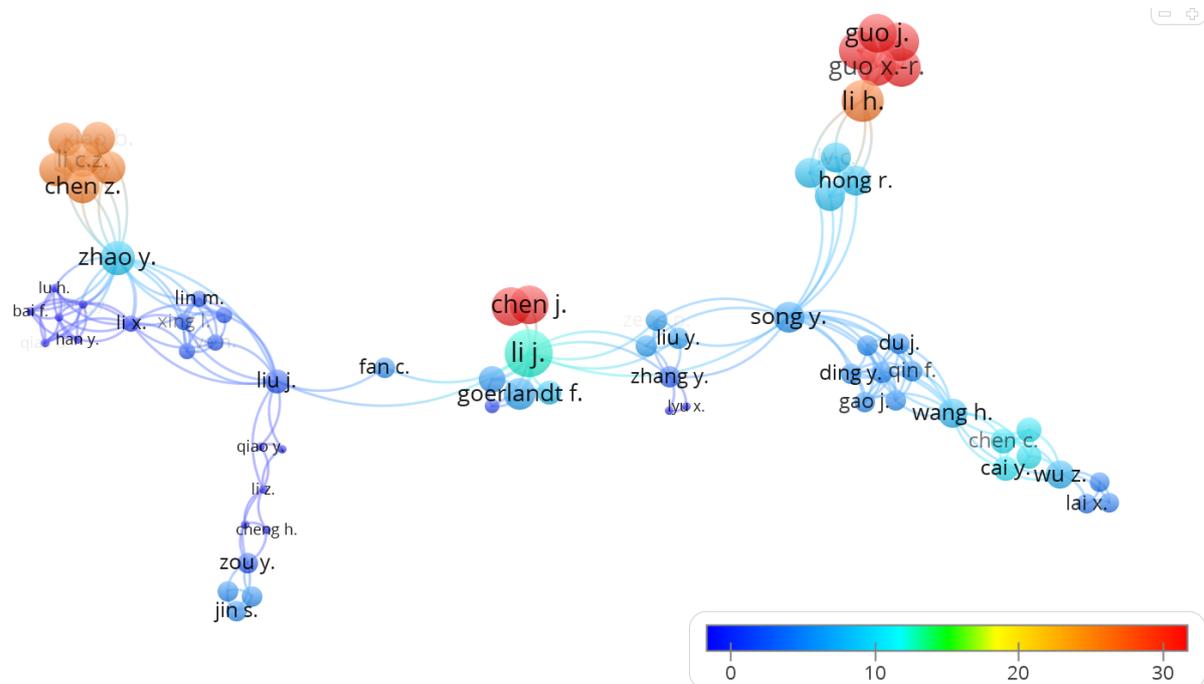


Figure 6. Collaborations of authors based on the citations

Analysis of author keywords

A total of 332 author keywords were examined in this bibliometric study, while 268 (80.7%) keywords appeared only once. After eliminating the top records manually, namely “vosviewer”, “bibliometric analysis”, “bibliometrics”, and “bibliometric”, with 61, 48, 20, and 11 occurrences, respectively, the remaining author keywords were calculated in density visualization map.

The most prominent topic area could be found in Figure 7. The more concentrated the colors, the more researchers used the topic keywords (Eck and Waltman 2014). “Scopus” and “Web of Science” as two widely used databases could be recognized, obviously. In addition to the most commonly used keywords used in the bibliometric study (“visualization”, “citespace”, “research trends”, “scientometrics”, and “literature review”), the emerging keywords “sustainability”, “sustainable development”, “circular economy” and “covid-19” are visible.

Conclusion

Based on research using VOSviewer retrieved from the Scopus database, the systematical analysis has been achieved from 2012 to 2020. The VOSviewer-related publications have increased in the past nine years significantly. A total of 938 publications were published in 27 subject categories, distributed in 9 document data. More than 92% of them were issued in English. The mainstream of publications belonged to journal articles (87.6%, 821) and conference papers (10.1%, 95). Social science (16%), computer science (12%), and medicine (12%) were the most prominent subject areas.

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