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Productivity Trends and Pattern of Scientific Collaboration of Bibliometric Research: An Exploratory Analysis

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Abstract

Bibliometrics is an emerging thrust area of research and has become a standard tool of science policy and research management in the last decades and attracted much attention because of the substantial expansion of literature. This study aims to systematically review the worldwide productivity trends, the pattern of scientific collaboration, and research outputs of Bibliometrics research from Web of Science (WoS) web database, Science Citation Index Expanded (SCI-E). A bibliographic database of scientific papers published by authors affiliated worldwide, and containing the keywords “Bibliometric(s)” or “Scientometric(s)” or “Informetric(s)” or “Altmetric(s)” was built. A corpus of 9,630 publications was obtained and analyzed using the Histcite, VosViewer, and Biblioshiny software to highlight the evolution of the research domain. Publication rates from 2006 to 2020, organization of the research, type of documents, language-wise distribution, publication and citations trend by year, most productive countries, organizations, and authors, preferred types of sources of researchers, citations, and use of influential research; top-ranked papers, most frequently used author keywords; co-occurrence network in Bibliometrics research, Trend Topics and Topic Dendrogram, Conceptual Structure Map of each word in Bibliometrics literature, Collaboration Network (Author, Institutions and Country) were considered and quantitatively analyzed. This study contributes to the Bibliometrics research field in several ways. First, it provides the latest research status for researchers who are interested in the field through literature analysis. Second, it helps scholars become more aware of the research subfields

through trend topic identification. Third, it provides insights to researchers engaging in the field and motivates attention to the relevant research.

Keywords: Bibliometrics, Scientometrics, Informetrics, Citation Analysis, Trend Analysis, Research Productivity

Introduction

Bibliometrics is an emerging thrust area of research from different branches of human knowledge. Bibliometrics has become a standard tool of science policy and research management in the last decades. All significant compilations of science indicators heavily rely on publication and citation statistics and other, more sophisticated Bibliometrics techniques. Bibliometrics is a quantitative evaluation of publication patterns of all macro and micro communication along with their authorship by mathematical and statistical calculation (Roy & Basak, 2013). The term Bibliometrics was coined in 1969 by Alan Pritchard who defined it as, "the application of mathematics and statistical methods to books and other media of communication" (Pritchard, 1969). Earlier to this, the term was recognized as 'statistical bibliography'. Bibliometrics has been an established area of information research that studies bibliographic attributes of publications especially scientific research. One important aspect of increasing interest in Bibliometrics is to evaluate research performance and research trends of individuals and institutions (Panda, Maharana, & Chhatar, 2013).

Bibliometrics, scientometrics, and informetrics (also called the three metrics) are three related terms in metrology. These terms are used to describe similar and overlapping methodologies; however, their well-documented historical origins differ, and they are not necessarily synonymous. (William W. Hood, 2001) However, the terms differ in their discipline attribute; specifically, Bibliometrics belongs to library and document science, Scientometrics belongs to the science of science, and Informetrics belongs to information science. the three metrics belong to different superordinate disciplines; however, they have the same research objects, indicators, and methods. Some believed that the three metrics present a crossing and partial overlapping relationship, but others argued that the three metrics exhibit an inclusive relationship; for example, Informetrics has many meanings and includes Bibliometrics and Scientometrics (Siluo & Qingli, 2017).

Scientometrics was first defined by Nalimov as developing "the quantitative methods of the research on the development of science as an informational process". It can be considered as the study of the quantitative aspects of science and technology seen as a process of communication. Some of the main themes include ways of measuring research quality and impact, understanding the processes of citations, mapping scientific fields, and the use of indicators in research policy and management. Scientometrics focuses on communication in the sciences, the social sciences, and the humanities among several related fields (Mingers & Leydesdorff, 2015).

The most recent metric term, 'Informetrics', comes from the German term 'informetrie' and was first proposed in 1979 by Nacke to cover that part of information science dealing with the measurement of information phenomena and the application of mathematical methods to the discipline's problems, to Bibliometrics and parts of information retrieval theory, and perhaps more widely (William W. Hood, 2001). Informetrics is the quantitative study of

information production, storage, retrieval, dissemination, and utilization. Informetric research investigates the existence of empirical regularities in these activities and attempts to develop mathematical models, and ultimately theories, to better understand information processes (Wolfram, 2000).

Literature Review

(Pattanaik, 2020) the study analyzed that the research profile of Library and Information Science (LIS) Ph.D. of India, and assess the research contribution made by them with the help of bibliometric parameters. It evaluates the research both qualitative and quantitatively that includes identifying research productivity, research trend, publication patterns, discover the key sources of publication, and visualize the research network of Indian researchers in the LIS subject. (Garg & Tripathi, 2018) examines the contents of the published articles in terms of various disciplines or sub-disciplines and the bibliometric aspects discussed in these articles. The analysis of 902 papers published by Indian scholars during 1995-2014 indicates that the main focus of bibliometrics/scientometrics is on the assessment of science and technology in India in different sub-disciplines including contributions by Indian states and other individual countries followed by the bibliometric analysis of individual journals. Papers dealing with bibliometric laws received a low priority as compared to other subdisciplines of bibliometrics/scientometrics. (Martín-Martín, Orduna-Malea, & López-Cózar, 2018)The new web-based academic communication platforms do not only enable researchers to better advertise their academic outputs, making them more visible than ever before, but they also provide a wide supply of metrics to help authors better understand the impact their work is making. This study has three objectives: a) to analyze the uptake of some of the most popular platforms (Google Scholar Citations, ResearcherID, ResearchGate, Mendeley, and Twitter) by a specific scientific community (bibliometrics, scientometrics, informetrics, webometrics, and altmetrics); b) to compare the metrics available from each platform, and c) to determine the meaning of all these new metrics. The results suggest that Google Scholar Citations is the source that provides more comprehensive citation-related data, whereas Twitter stands out in connectivity-related metrics. (Tandale, 2017) examines that bibliometrics study on improving scientific documentation, information & communication activities by quantitative analysis of library collections & services. Bibliometrics is recognized as a method to analyze & quantify the bibliographic data & offers a powerful set of methods. This is important to measures for studying the structure & process of scholarly communication. This study aimed to identify the importance, applications, & limitations of bibliometrics technique (Hasan & Singh, 2015) study investigate the growing trend of "Library and Information and Science" (LIS) literature based on the output of research publications indexed in the Science Citation Index, Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI) during the period from 1975 to 2012. An overall total of 311,886 records was retrieved on LIS including all forms of literature. the study by way of analyzing some of the features of publications of the study period; Year-wise distribution of publications on LIS, Form-wise distribution, Language-wise distribution, Annual output of publications, Geographical distribution, Subject dispersion, Institutional Distribution, Sources preferred for publishing, Indian contribution to LIS, etc (Patra, Bhattacharya, & Verma, 2006) study analyzed that growth pattern, core journals and authors' distribution in the field of bibliometrics using data from *Library And Information Science Abstracts (LISA)*. The growth of literature does not show any definite pattern. Bradford's law of scattering is used to identify core journals and determines '*Scientometrics*' as the core journals in this field. Lotka's law was used to identify authors' productivity patterns. It is observed that authors' distributions do not follow original Lotka's law. The study also identified the 12 most productive authors with more than 20

publications in this field. (William W. Hood, 2001) examines that the terms bibliometrics, scientometrics, and informetrics refer to component fields related to the study of the dynamics of disciplines as reflected in the production of their literature. The origins and historical survey of the development of each of these terms are presented. Profiles of the usage of each of these terms over time are presented, using an appropriate subject category of databases on the DIALOG information service. The overall literature of these fields is determined and the growth and stabilization of both the dissertation and non-dissertation literature are shown. A listing of the top journals in the three fields is given, as well as a list of the major reviews and bibliographies that have been published over the years.

Objectives

The main objective of this study is to analyze the global research performance in the field of Bibliometrics as reflected in the publication and citation output during 2006-2020. In particular, the study focuses on the following aspects:

1. To identify the document type and language-wise distribution.
2. To study the year-wise growth of publications and citations.
3. To identify the most productive countries, organizations, and authors.
4. To identify the preferred journals of researchers in Bibliometrics.
5. To identify the highly influential research papers concerning citation and average citation per year on Bibliometrics
6. To explore the most frequently used author keywords and co-occurrence of author keywords network in Bibliometrics.
7. To explore the most frequently used all keywords in Bibliometrics.
8. To explore the Trends Topics and Topic Dendrogram in Bibliometrics.
9. To explore the Conceptual Structure Map in Bibliometrics.
10. To find out the Collaboration Network (Author, Institutions, and Country) of Bibliometrics Researchers.

Materials and Methods

This paper is based on the Web of Science (WoS) web database, Science Citation Index Expanded (SCI-E). A search has been carried out in the WoS database to get the overall results of the bibliometric publications. The query of searching is TS= “Bibliometric(s)” OR “Scientometric(s)” OR “Informetric(s)” OR “Altmetric(s)” dated 28.03.2021. For the study, we have refined the search.

DOCUMENT TYPE (Article OR Editorial Material OR Proceeding Paper OR Review OR Book Review OR Book Chapter OR Letter OR Review OR Early Access OR Meeting Abstract OR Correction) AND [excluding] DOCUMENT TYPES: (Data Paper OR Retracted Publication). Timespan: 2006-2020. Indexes: SCI-EXPANDED, SSCI, A&HCI. REFINED BY WEB OF SCIENCE. A total of 9630 documents were retrieved, 7061 Article, Review

1617, Editorial Material 239, Article; Proceeding Paper 180, Meeting Abstract 152, Letter 144, Article; Early Access 116, Review; Early Access 64, Correction 27, Review; Book Chapter 12, Book Review 10 and Article; Book Chapter 5. This study used the data published in the WoS database to analyze the scientific publication time, document type, author's productivity, source country/region, research organization, research direction, publication, h-index value, g-index, and total citation frequency, citation link citation impact and to export the results for charting and analysis. The Biblioshiny, Histcite, and VOSviewer software were used to draw the national cohesive network density knowledge map of the research literature on Bibliometrics, the research organization coauthored knowledge map, the published citation knowledge map, the author's co-cited knowledge map, and the keyword coexisting knowledge structural map to perform Bibliometrics analysis and interpretation for building data matrixes of study.

Result and Discussion

Based on the results of the collection of articles on the theme of Bibliometrics research from 2006 to 2020, there are 9630 documents published by 2704 sources (journals, books, etc.), written by 21089 authors, affiliated with 6427 institutions and 130 countries. These documents received 150101 total citations. An overview of the research in the Bibliometrics field was presented with the information related to the type of documents, language-wise distribution, publication and citations trend by year, most productive countries, organizations, and authors, preferred types of sources of researchers, citations, and use of influential research; top-ranked papers, most frequently used author keywords; co-occurrence network in Bibliometrics research, Trend Topics and Topic Dendrogram, Conceptual Structure Map of each word in Bibliometrics literature, Collaboration Network (Author, Institutions and Country) based on collected data.

Distribution of publication by Documents type

Figure 1 shows the type of documents published under the Bibliometrics research area. It can be noted that out of 9630 research output, a total of 7061 of the publication published in the form of the Article followed by Review 1617, Editorial Material 239, Article; Proceeding Paper 180, Meeting Abstract 152, Letter 144, Article; Early Access 116, Review; Early Access 64, Correction 27, Review; Book Chapter 12, Book Review 10 and Article; Book Chapter 5. It is observed that researchers prefer journals to publish and communicate their research out in the form of articles.

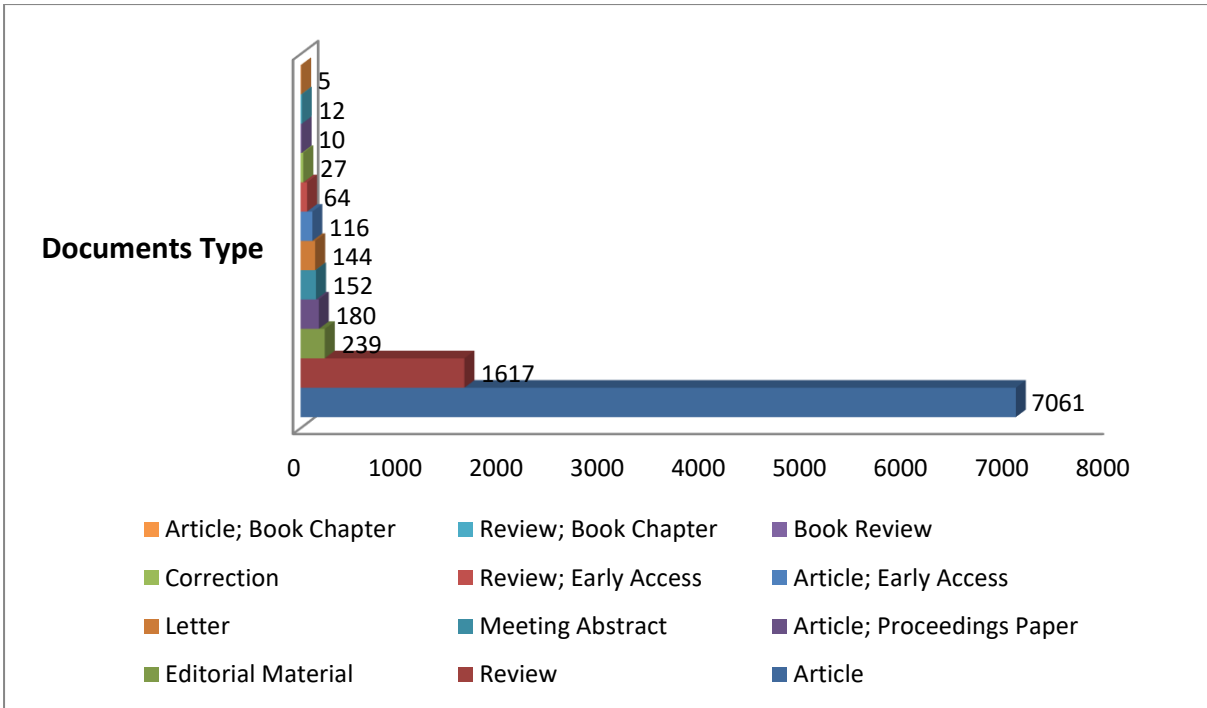


Figure 1: Type of documents

Distribution of publication by language

Figure 2 shows the Language-wise distribution of publications on Bibliometrics research. It is found that the maximum of the research publications is written in the English language (8982) followed by Spanish (388), Portuguese (132), German language (57), French (23). The remaining publications are published in other types of language such as Russian, Turkish, Czech, Hungarian, Italian, Lithuanian, Croatian, Dutch, Japanese, Polish, Slovene, Arabic, Chinese and Serbian.

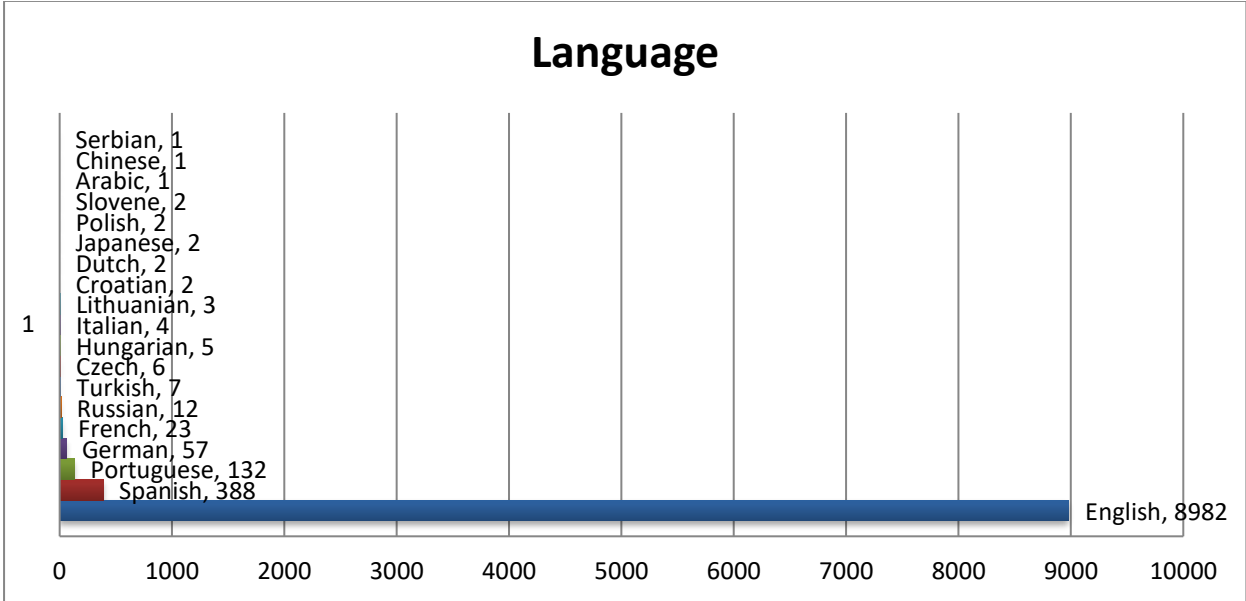


Figure 2: Language wise distribution

Year-Wise Research Growth Trend

Figure 3 shows the year-wise frequency of publications and citations published from 2006 to 2020. It shows that 2006 was the starting year for research publication on Bibliometrics. The trend shows that publication and citation have not gradually increased. The total number of publications are gradually increased in Bibliometrics research but the number of citations was decreased. The trend shows that the 2009-2014 were average citation in that period and 2015 marvelous as in that year's highest number of citation were produced. After that 2016-2020 citations were gradually decreased.

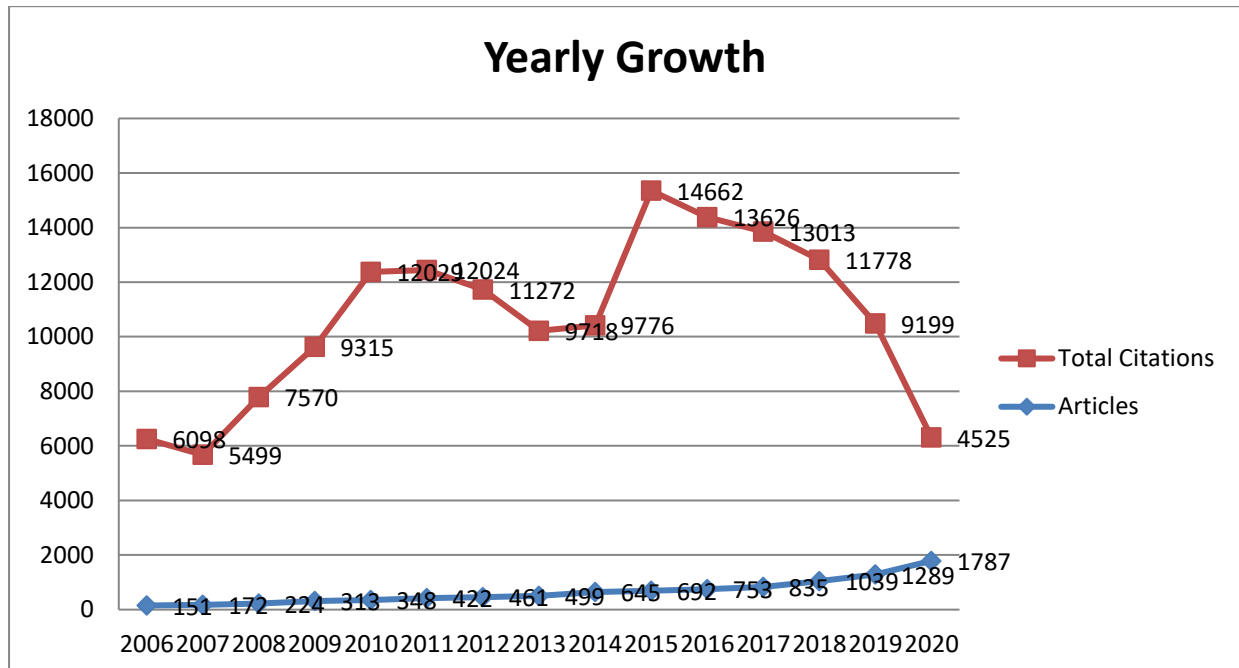


Figure 3: Publication and citations trend

Country/Regional distribution

The top twenty (20) highly publishing countries on Bibliometrics literature were as presented in Table 1. The result shows that China is at a top of the list with 1773 publications, 22035 citations, 12.43 citation impact and it received the highest 17126 total link strength. The USA on 2nd rank with 1600 publications, 34637 citations, 21.65 citation impact and it received 13802 total link strength, in case the total number of citation USA getting the highest position. After this, Spain occupied the third position, with 1259 publications, 18309 citations, 14.54 citation impact and it received 11452 total link strength. Denmark and Chile are at the bottom of the list, with 127 and 154 publications, respectively. It shows that the country Netherlands has received the highest citation impact (47.02).

Table 1: Top Twenty Influential Countries on Bibliometrics

Country	Documents	Citations	Citation Impact	Total Strength	Link
China	1773	22035	12.43	17126	
USA	1600	34637	21.65	13802	
Spain	1259	18309	14.54	11452	

England	702	16471	23.46	7966
Germany	629	9627	15.31	5353
Brazil	567	5382	9.49	2443
Italy	529	9077	17.16	4930
Australia	462	8838	19.13	6003
Canada	425	7976	18.77	4113
Netherlands	369	17351	47.02	7679
Taiwan	341	7477	21.93	5539
India	309	3300	10.68	2924
France	300	4224	14.08	2482
Turkey	204	2331	11.43	1664
Belgium	195	4784	24.53	2174
Portugal	184	2807	15.26	2003
Sweden	167	3643	21.81	1635
Switzerland	159	4179	26.28	1910
Chile	154	2830	18.38	4405
Denmark	127	3129	24.64	1475

Organization Distribution

The top twenty (20) organizations producing research publications on Bibliometrics are given in Table 2. It shows that the University of Granada (Spain) is on the top of the list with 209 publications, 5156 citations, 24.67 citation impact, and total link strength of 4822. University of Valencia (Spain) on 2nd rank with 155 publications, 1781 citations, 11.49 citation impact, and total link strength 2423. Leiden University (Netherlands) on 3rd rank with 154 publications, 9629 citations, 62.53 citation impact, and total link strength 5903, however it received the highest citations, citation impact, and total link strength of the list. Hungarian Academy of Sciences and Huazhong University of Science and Technology are at the bottom of the list, with 59 and 61 publications, respectively.

Table 2: Top Twenty Highly Productive Organizations

Organization	Documents	Citations	Citation Impact	Total Link Strength
University of Granada	209	5156	24.67	4822
University of Valencia	155	1781	11.49	2423
Leiden University	154	9629	62.53	5903
Asia University	142	3807	26.81	4520
Chinese Academy of Sciences	139	1989	14.31	2791
Peking University	106	3007	28.37	3851
Katholieke University Leuven	103	2511	24.38	1527
Spanish National Research Council	99	1920	19.39	1509
Polytechnic University of Valencia	92	1378	14.98	1779

Wuhan University	92	1572	17.09	1758
University of Almeria	88	1197	13.60	1349
Georgia Institute of Technology	77	2272	29.51	1533
An-Najah National University	72	1291	17.93	1661
Indiana University	71	3569	50.27	1320
Sichuan University	71	1049	14.77	2067
University of Sao Paulo	70	926	13.23	369
Tor Vergata University of Rome	69	2037	29.52	1182
University Chile	68	2244	33.00	4213
Huazhong University of Science and Technology	61	567	9.30	814
Hungarian Academy of Sciences	59	1677	28.42	923

Most Prolific Authors

Table 3 highlights the top twenty (20) most prolific authors on Bibliometrics presented with their total publications, total citations, Citation Impact, G Index, H Index, and Publication year start. The results show that majority of the authors starting their publication year between 2007 to 2014. The list of most prolific authors shows that Ho Y.S. is the most productive author with 142 publications, 4214 citations, 19.68 citation impact, 39 H Index, 61 G Index. The author Bornmann L. listed 2nd rank with 90 publications, 3301 citations, 36.68 citation impact, 27 H Index, 56 G Index. Followed by Groneberg D.A. with 68 publications, 678 citations, 9.97 citation impact, 15 H Index, 20 G Index. Li J. on the bottom of the list with 34 publications, 317 citations, 9.62 citation impact, 10 H Index, 17 G Index. It's also observed that the author Waltman L. has the highest citation impact (160.43) among the listed authors.

Table 3: Top Twenty Most Prolific Authors

Author	Total Publication	Total Citation	Citation Impact	H Index	G Index	Publication Year Start
Ho Y.S.	142	4214	29.68	39	61	2007
Bornmann L.	90	3301	36.68	27	56	2007
Groneberg D.A.	68	678	9.97	15	20	2009
Sweileh W.M.	59	1130	19.15	21	28	2014
Merigo J.M.	58	2210	38.10	24	46	2015
Glanzel W.	57	1539	27.00	25	38	2006
Abramo G.	56	1896	33.86	25	42	2007
D'angelo C.A.	55	1839	33.44	25	41	2007
Alexandre-Benavent R.	54	557	10.31	13	20	2006
Zyoud S.H.	53	1173	22.13	21	30	2014
Al-Jabi S.W.	43	863	20.07	20	26	2014

Zhang Y.	42	462	11.00	12	20	2013
Herrera-Viedma E.	38	2581	67.92	20	38	2009
Van Eck N.J.	38	5535	145.66	28	38	2007
Leydesdorff L.	37	1478	39.95	21	37	2009
Waltman L.	37	5936	160.43	30	37	2007
Gonzalez-Alcaide G.	36	445	12.36	12	19	2007
Cobo M.J.	35	1694	48.40	16	35	2009
Klingelhofer D.	35	262	7.71	11	14	2013
Li J.	34	327	9.62	10	17	2010

Publication Distribution

The journal's impact in respect of the number of publications, citations, H Index, G Index, and starting publication year are highlighted in Table 4. It shows that the Journal "Scientometrics" is a highly influential journal producing a maximum of 1334 publications, 29021 citations, 73 H Index and 119 G Index. "Journal of Informetrics" is on 2nd rank with 266 publications, 8593 citations, 48 H Index, and 82 G Index, followed by "Sustainability" with 249 publications, 1623 citations, 31 H Index and 45 G Index. The "Renewable & Sustainable Energy Reviews" is at bottom of the list and has produced 36 publications, 1765 citations, 26 H Index, and 36 G Index.

Table 4: Top Twenty Highly Influential Research Journals

Source	Total Publication	Total Citation	H_Index	G_Index	Publication Year Start
Scientometrics	1334	29021	73	119	2006
Journal of Informetrics	266	8593	48	82	2007
Sustainability	249	1623	31	45	2016
Plos One	146	2945	31	45	2008
Journal of the American Society for Information Science and Technology	125	7274	44	83	2006
Journal of Cleaner Production	113	3823	30	59	2014
Research Evaluation	95	1385	23	32	2006
Current Science	87	414	10	16	2006
Revista Espanola De Documentacion Cientifica	86	474	13	16	2008
International Journal of Environmental Research and Public Health	85	512	13	16	2009
Journal of the Association for Information Science and Technology	75	1731	20	40	2014
Environmental Science and Pollution Research	72	436	11	17	2015
Profesional De La Informacion	58	496	13	19	2006
Technological Forecasting and Social Change	58	1262	20	33	2006
Medicine	53	273	9	13	2015

Malaysian Journal of Library & Information Science	51	302	9	15	2007
World Neurosurgery	51	386	12	16	2014
Investigacion Bibliotecologica	44	85	4	6	2007
Research Policy	40	1689	21	40	2006
Renewable & Sustainable Energy Reviews	36	1765	26	36	2011

Top Twenty Highly Cited Articles

The bibliographic information of the top twenty (20) most cited articles is indicated in Table 5. The article entitled "Software survey: VOSviewer, a computer program for bibliometric mapping" by Van Eck N. J. published in 2010 in " Scientometrics " is on the top of the list with 1946 citations and 162.16 total citations per year. The article entitled "What do citation counts measure? A review of studies on citing behavior" by Bornmann L. published in 2008 in "Journal of Documentation" is on 2nd rank with 628 citations and 44.85 total citations per year. The article entitled "Impact of data sources on citation counts and rankings of LIS faculty: Web of Science versus Scopus and Google Scholar" by Meho L.I. published in 2007 in "Journal of the American Society for Information Science and Technology" is on 3rd rank with 615 citations and 41 total citations per year. It is noted that "A review of the literature on citation impact indicators" is the bottom of this list, written by Waltman L. published in 2016 in "Journal of Informetrics" with 334 citations and 55.66 total citations per year. It's observed that the Maximum number of highly cited articles published from "Scientometrics" that is the highest number of the article published from one journal.

Table 5: Top Twenty Highly Cited Articles

Paper	Author	Source Title	Total Citations	Total Citations per Year
Software Survey: Vosviewer, a Computer Program for Bibliometric Mapping,2010	Van Eck N. J.	Scientometrics	1946	162.16
What do citation counts measure? a review of studies on citing behavior, 2008	Bornmann L.	Journal of Documentation	628	44.85
Impact of data sources on citation counts and rankings of LIS faculty: Web of Science versus Scopus and Google Scholar, 2007	Meho L.I.	Journal of the American Society for Information Science and Technology	615	41
The journal coverage of Web of Science and Scopus: a comparative analysis, 2016	Mongeon P.	Scientometrics	562	93.66
PERSPECTIVE—absorbing the	Volberda	Organization	556	46.33

concept of absorptive capacity: how to realize its potential in the organization field, 2010	H.W.	Science		
Science mapping software tools: review, analysis, and cooperative study among tools, 2011	Cobo M.J.	Journal of the American Society for Information Science and Technology	526	47.81
Does the H index have predictive power? 2007	Hirsch J.E.	Proceedings of the National Academy of Sciences of the USA	520	34.66
Misconduct accounts for the majority of retracted scientific publications, 2012	Fang F.C.	Proceedings of the National Academy of Sciences of the USA	468	46.8
Bibliometric methods in management and organization, 2015	Zupic I.	Organizational Research Method	455	65
A unified approach to mapping and clustering of bibliometric networks, 2010	Waltman L.	Journal of Informetrics	443	36.91
Bibliometric monitoring of research performance in the social sciences and the humanities: a review, 2006	Nederhof A.J.	Scientometrics	433	27.06
H-index: a review focused on its variants, computation, and standardization for different scientific fields, 2009	Alonso S.	Journal of Informetrics	428	32.92
Green supply chain management: a review and bibliometric analysis, 2015	Fahimnia B.	International Journal of Production Economics	420	60
<i>Bibliometrix</i> : an r-tool for comprehensive science mapping analysis, 2017	Aria M.	Journal of Informetrics	397	79.4
Comparison of the Hirsch-index with standard bibliometric indicators and with peer judgment	Van Raan A.F.J.	Scientometrics	386	24.12

for 147 chemistry research groups,2013				
Is science becoming more interdisciplinary? Measuring and mapping six research fields over time,2009	Porter A.L.	Scientometrics	373	28.69
Google Scholar, Scopus and the Web of Science: a longitudinal and cross-disciplinary comparison, 2015	Harzing A.W.	Scientometrics	358	59.66
Growth rates of modern science: a bibliometric analysis based on the number of publications and cited references,2015	Bornman L.	Journal of the Association for Information Science and Technology	355	50.71
Citation advantage of open access articles,2006	Eysenbach, G.	PLOS Biology	344	21.50
A review of the literature on citation impact indicators, 2016	Waltman L.	Journal of Informetrics	334	55.66

Co-Occurrence Network of Author Keywords

Frequently used authors' keywords in Bibliometrics research are highlighted in Figure 4. The keywords analysis has been performed in VOSviewer software. The minimum number of 5 keywords occurrence is selected and hence only 1042 keywords meet the threshold out of a total of 15965 keywords. The distance and size of the bubble indicate the number of keyword occurrences and associational links. 'Bibliometrics' is the most frequently and representative keyword as it appears 1782 times and 4140 total link strength, followed by 'Bibliometric Analysis' that appear 1502 times and 1914 total link strength, followed by 'Bibliometric' that appear 522 times and 1215 total link strength, followed by 'Citation Analysis' that appear 497 times and 1269 total link strength.

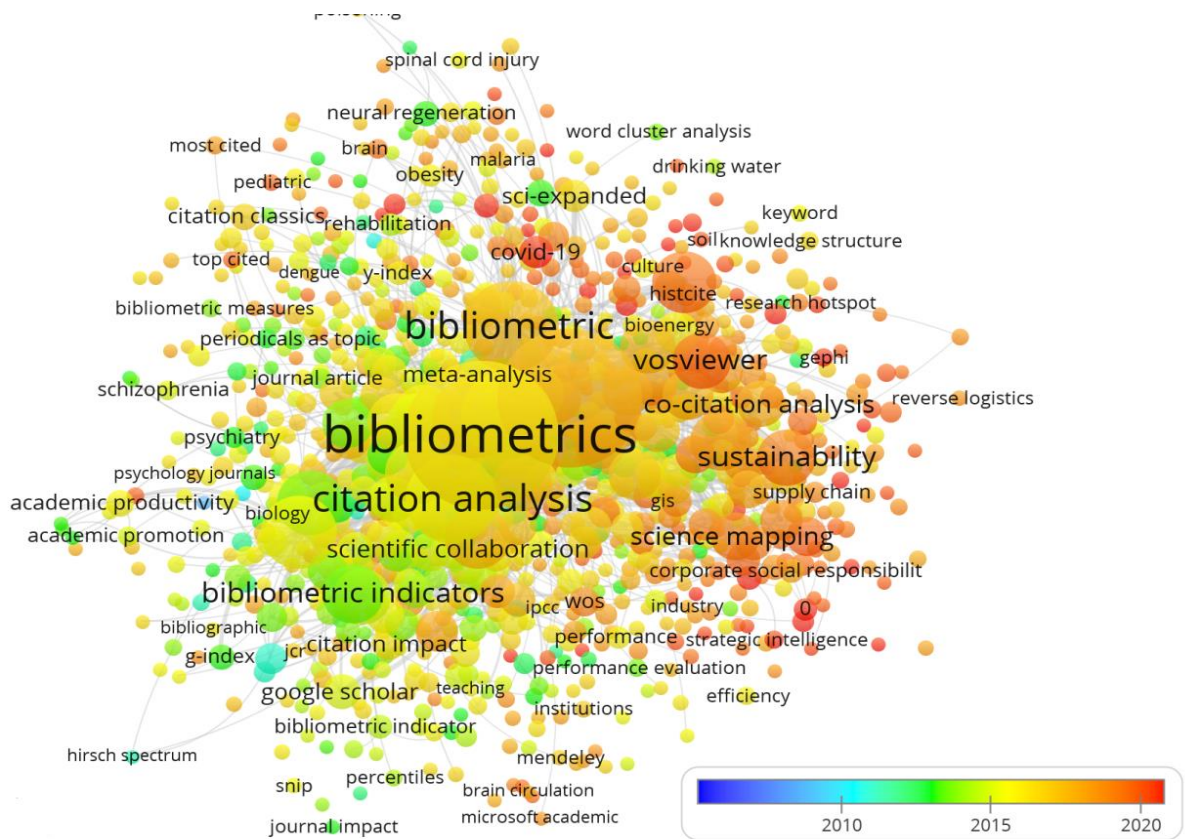


Figure 4: Co-Occurrence Network of Author Keywords

Term Analysis (All Keywords)

Frequently used all keywords in Bibliometrics research are highlighted in Figure 5. The minimum number of 5 keywords occurrence is selected and hence only 2412 keywords meet the threshold out of a total of 27212 keywords. The term ‘Bibliometric Analysis’ is the most frequently and representative keyword as it appears 2074 times and 10548 total link strength, followed by ‘Bibliometrics’ that appear 1829 times and 9358 total link strength; ‘Science’ that appear 1511 times and 9391 total link strength; ‘Impact’ that appear 1176 times and 7252 total link strength; ‘Citation Analysis’ that appear 712 times and 4219 total link strength;

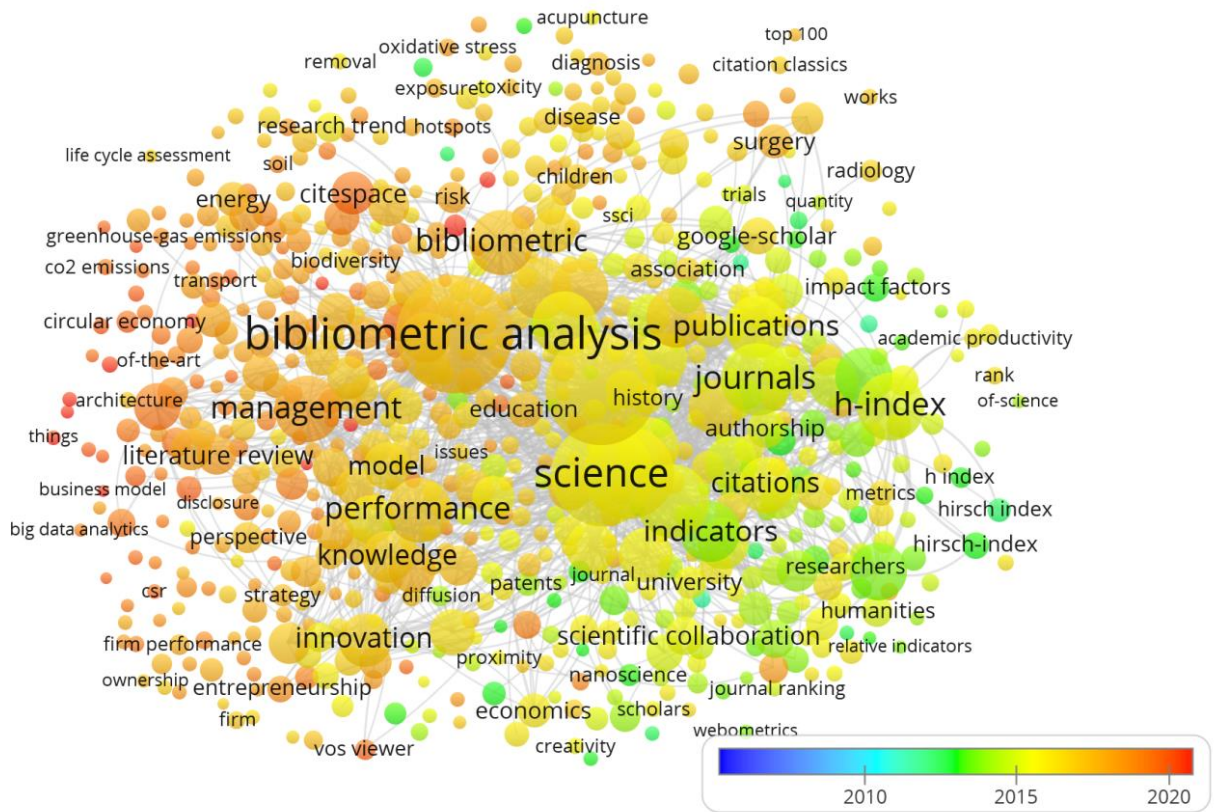


Figure 5: Term Analysis

Trend Topics

Trend topic of author keywords in Bibliometrics research is highlighted in Figure 6. The most frequent keywords in the last 15 years to observe the latest trends in Bibliometrics research. Topic trends are also part of this research, where the picture above shows an overview of the development of the topic from time to time with the division per year. It is known what topics have been used for a long time and what topics have been used recently. The emergence of topics is also adjusted to the frequency of the number of words appearing in research on Bibliometrics. The figure shows that 'Bibliometrics' 1743 frequency is the most trending word in the year 2017, 'Bibliometrics Analysis' 1330 frequency(2018), 'Bibliometric' 666 frequency(2018), 'Scientometrics' 481 frequency(2016), 'Citation Analysis' 449 frequency(2016)) are the top three keywords that are repeated most frequently in Bibliometrics literature from 2006 to 2020. 'Citespace', 'Analysis', 'Sustainability', 'Literature Review' are the most trending keyword in the year 2019 and 'Machine Learning', 'Systematic Literature Review', 'Covid-19', 'Coronavirus', 'Scimat' are the most trending keyword in the year 2020.

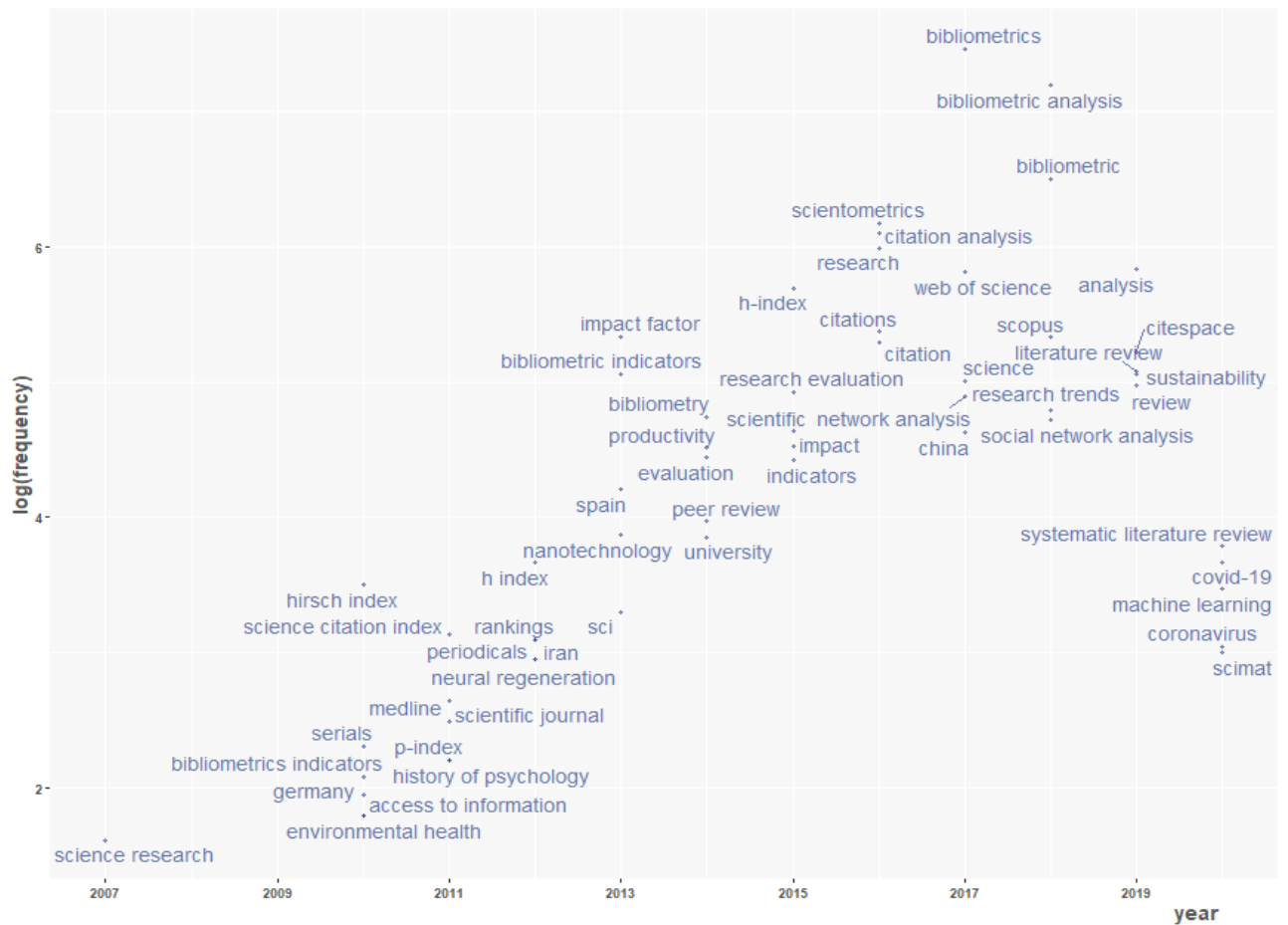


Figure 6: Trend topics on Bibliometrics in 2006-2020

Topic Dendrogram

The topic dendrogram tree diagram showing the most widely used topics and their relation to other topics and classification of these topics depicted in different colors and the relationship between the keywords generated by hierarchical clustering. Figure 7 is showing a Topic Dendrogram of the top 50 author keywords of Bibliometrics literature. The result shows that there are two major topic clusters. Cluster 1 consists of five (5) sub-clusters and one single keyword 'Scientific Production', where each sub-cluster consists of sub-clusters. Sub-cluster 1.1 consists of certain topics on 'H-Index' and 'Research Evaluation'. Sub-cluster 1.2 consists of certain topics on 'Bibliometric Indicators', 'Publications', 'Publication', 'Research Productivity', 'Research Performance', 'Impact Factor', 'Altmetrics'. Sub-cluster 1.3 consists of certain topics on 'Co authorship', 'Indicators', 'Bibliometrics', 'Citations', 'Citation Analysis', 'Scientometrics'. Sub-cluster 1.4 consists of certain topics on 'Research', 'Journals', 'Bibliometry', 'Collaboration', 'Spain'. Sub-cluster 1.5 consists of certain topics on 'Scientific', 'Productivity', 'Evaluation' 'Impact'. Cluster 2 also consists of five (5) sub-clusters and one single keyword 'Scientific Production', where each sub-cluster consists of sub-clusters. Sub-cluster 2.1 consists of certain topics on 'China', 'Scientometric Analysis', 'Science', 'Network Analysis', 'Bibliometric Analysis', 'Innovation'. Sub-cluster 2.2 consists of certain topics on 'Sustainable Development', 'Literature Review', 'Sustainability', 'Systematic Review', 'Research Trends'. Co-citation2.3 consists of certain topics on Co word Analysis', 'Science Mapping', 'Analysis'. Sub-cluster 2.4 consists of certain topics on 'Review', 'Research Trends', 'Co citation Analysis', 'Vosviewer', 'Scientometric', 'Citespace', 'Visualization'. Sub-cluster

2.5 consists of certain topics on ‘Bibliometric Study’, ‘Web of Science’, ‘Scopus’, ‘Citation’, ‘Bibliometric’ and ‘Social Network Analysis’.

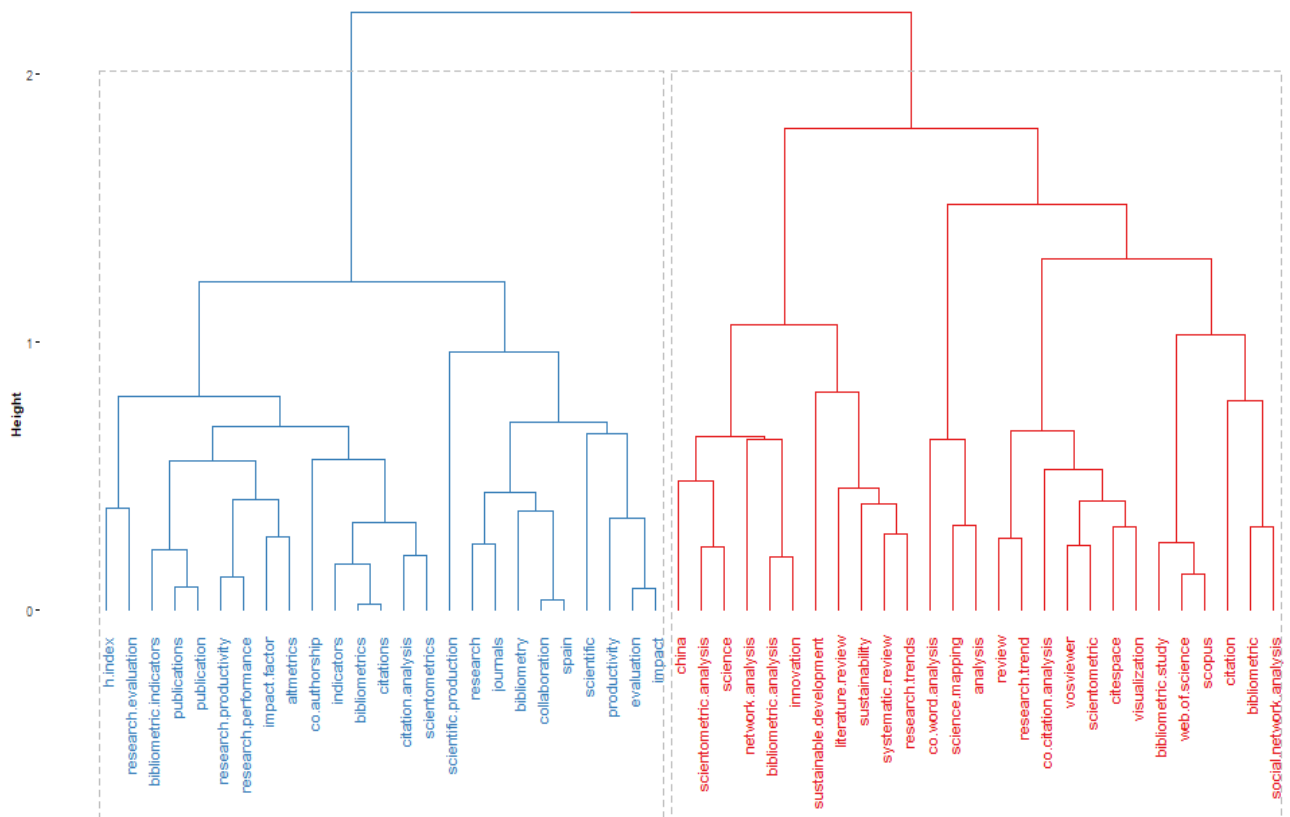


Figure 7: Topic Dendrogram on Bibliometrics

Conceptual Structure Map

This study also describes the Conceptual Structure Map or Contextual Structure Map of each word that often appears in research papers on Bibliometrics by dividing them based on mapping the relationship between one word and another through area mapping. Each word is placed according to the values of Dim 1 and Dim 2 to produce a mapping between words whose values do not differ much. (Srisusilawati, Rusydiana, Sanrego, & Tubastuvi, 2021) In this data, there are 2 parts of the area divided, namely the red and blue areas. Each area contains words that are related to one another. Based on the picture above, the red area shows more and various words related to each other. Included in it, this shows that many research papers link between the words listed in this area.

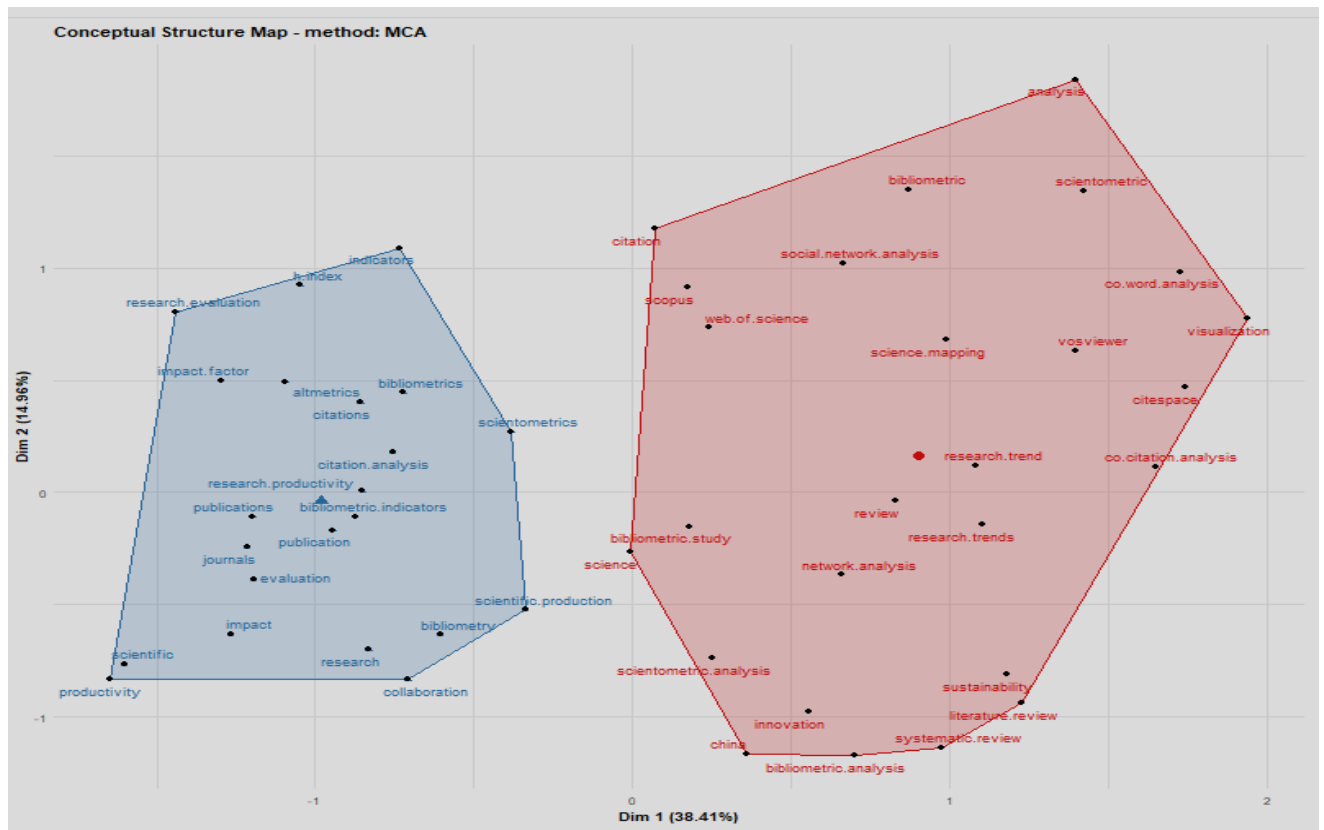


Figure 8: Conceptual Structure Map

Collaboration Network (Author, Institutions, and Country) of Bibliometrics Research

Author Collaboration Network of Bibliometrics Research

The Collaboration Network or Collaboration between authors on Bibliometrics research is presented in Figure 9. In this figure total of 50, author names are displayed, and some have a connection, and some are not. The authors' relationship is shown by clusters of color equations and lines between one name and another. The size of each square also indicates the number of papers published in this area. The figure shows the collaboration between the seventeen (17) clusters of authors, but there are the four (4) largest clusters in this study. The first cluster shows the collaboration between Yang Y, Atanasov AG, Yeung AWK, Liu Y, Zengin G, Mozos I, and Tzvetkov NT. The second cluster shows the collaboration between Tran BX, Latkin KA, Ho CSH, Ho RCM, and Vu GT. The third cluster shows the collaboration between Zhang Y, Zhang L, Wang L, Bornmann L, Glanzel W, and Ho YS. The fourth cluster shows the collaboration between Klingelhofer D, Bruggmann D, Groneberg DA, Quarcoo D, and Scutaru C. The authors who are not related and indexed in the data above show no collaboration between the author and other authors in making papers related to the area of Bibliometrics literature.

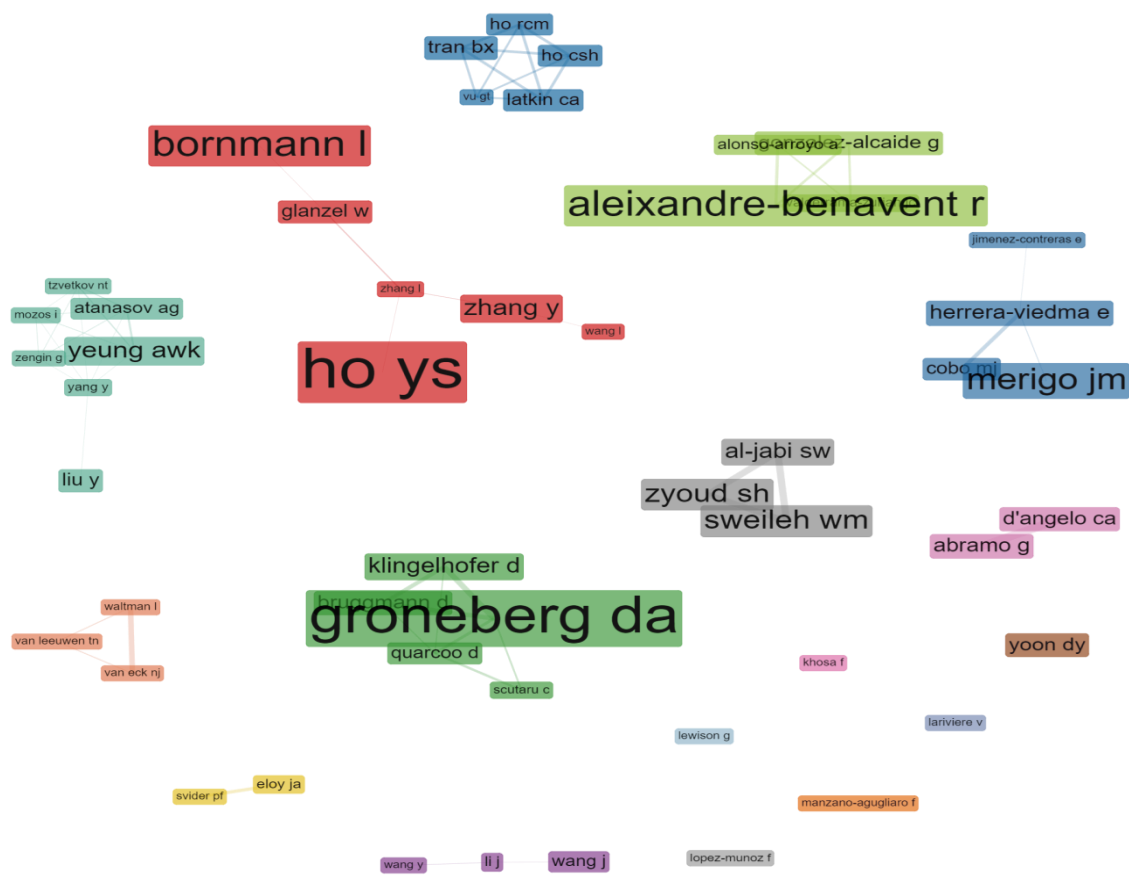


Figure 9: Authors Collaboration Network

Institution Collaboration Network on Bibliometrics Research

The Collaboration Network or Collaboration between Institutions on Bibliometrics research is presented in Figure 10. In this figure total of 50 Institutions' names are displayed and some have a connection, and some are not. The figure shows the collaboration between the eleven (11) clusters of institutions, but there are the three (3) largest clusters in this study. The first cluster shows the collaboration between Univ Manchester, Sch Management and Econ, Indiana Univ, Univ Technol Sydney, Univ Cadiz, Sichuan Univ, Univ Barcelona, Univ Almeria, Univ Granada, Univ Valencia, Univ Complutense Madrid, Univ Chile, Univ Sydney, Univ Politecn Valencia, Leiden Univ, Leiden Univ, Sch Publ Policy and Univ Montreal. The second cluster shows the collaboration between Univ Ottawa, Duy Tan Univ, Natl Univ Singapore, Univ Alberta, Univ Toronto, Harvard Univ, Johns Hopkins Univ, Hanoi Med Univ, and Natl Univ Singapore Hosp. The third cluster shows the collaboration between Hong Kong Polytech Univ, Shanghai Jiao Tong Univ, Univ Pavia, Univ Vigo, Inst Genet, and Anim Breeding, Univ Vienna, Univ Hong Kong, and Univ Porto.

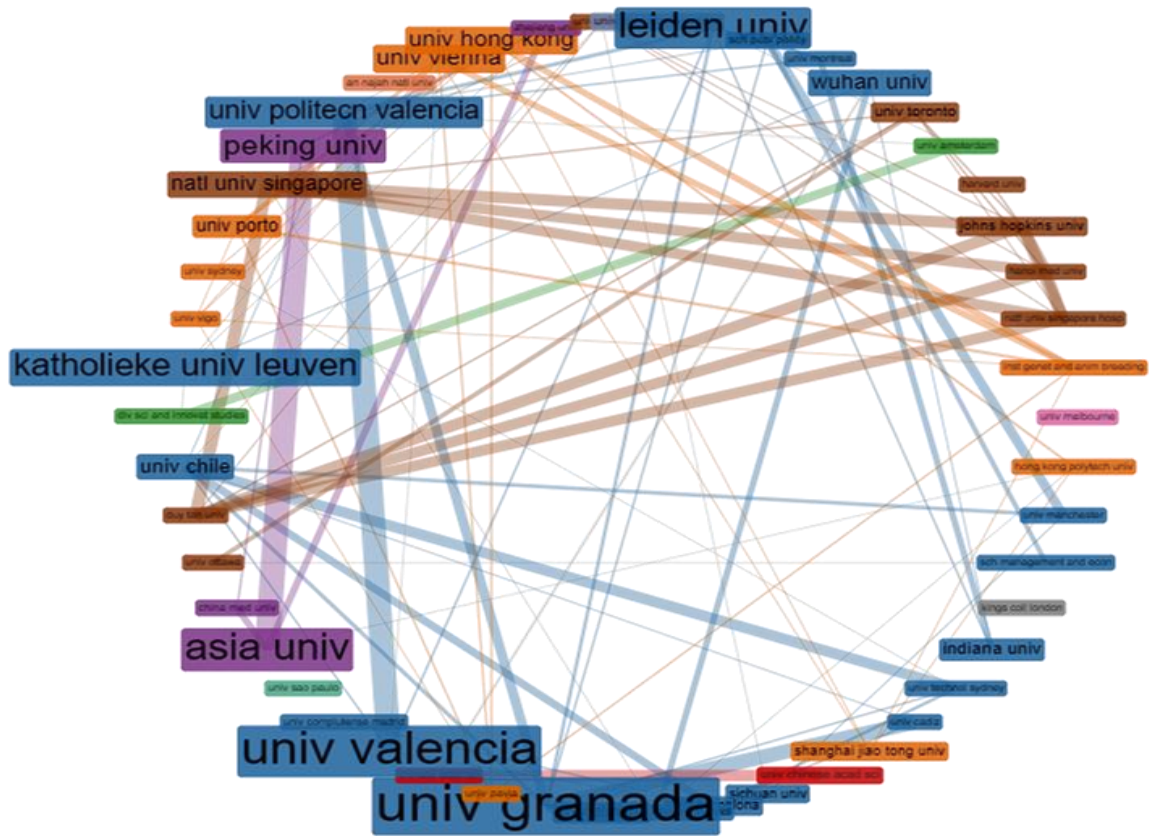


Figure 10: Institutions Collaboration Network

Country Collaboration Network on Bibliometrics Research

The Collaboration Network or Collaboration between Countries on Bibliometrics research is presented in Figure 11. In this figure, we observed that a total of 50 countries' names are displayed and all countries have a connection. It is noted that the collaboration between the four (4) clusters of countries, but there are the three (3) largest clusters in this study. The first cluster shows the collaboration between Germany, Sweden, Czech Republic, Belgium, Norway, Hungary, Denmark, Finland, Greece, Switzerland, Slovenia, Netherlands, Austria, Russia, and New Zealand. The second cluster shows the collaboration between South Africa, Australia, the USA, Thailand, United Kingdom, China, India, Singapore, Canada, Pakistan, Saudi Arabia, Korea, Malaysia, Vietnam, and Israel. The third cluster shows the collaboration between Italy, Turkey, France, Poland, Egypt, Japan, Iran, Romania, Bulgaria, Ireland, Croatia, and Estonia.

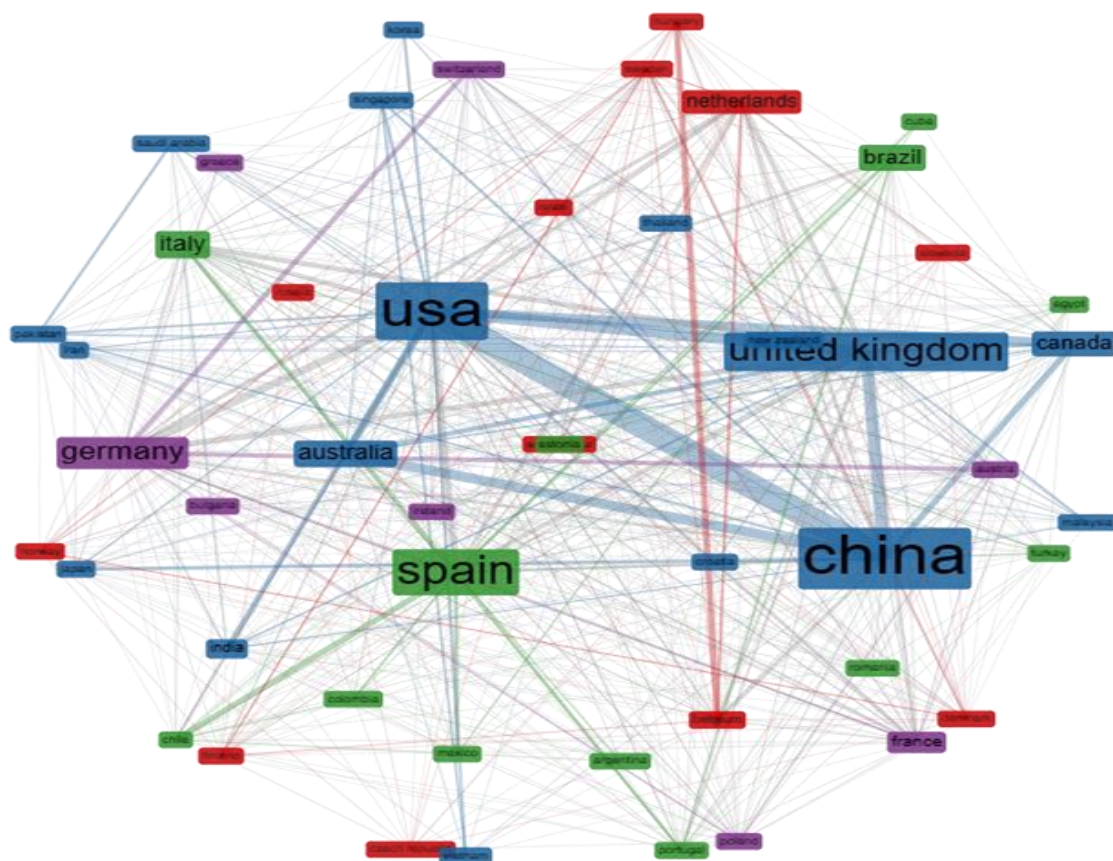


Figure 11: Country Collaboration Network

Conclusions

The current research review used the bibliometrics method and visualization technology to analyze the literature on Bibliometrics research published in the Web of Science during 2006-2020. Bibliometric analysis software packages Biblioshiny, Histcite, and VOS-viewer are used for data processing and extraction of bibliometric indicators. Document types in this field are in the form of articles. There are 9630 documents published by 2704 sources (journals, books, etc.), written by 21089 authors, affiliated with 6427 institutions, 130 countries, and received 150101 total citations. The result shows that China is the most productive country with 1773 publications, 22035 citations, 12.43 citation impact and it received the highest 17126 total link strength. The USA on 2nd rank with 1600 publications, 34637 citations, 21.65 citation impact and it received 13802 total link strength, in case a total number of citation USA getting the highest position. University of Granada (Spain) is the most productive institution with 209 publications, 5156 citations, 24.67 citation impact, and total link strength of 4822. University of Valencia (Spain) on 2nd rank with 155 publications, 1781 citations, 11.49 citation impact, and total link strength 2423. Ho Y.S. is the most productive author with 142 publications, 4214 citations, 19.68 citation impact, 39 H Index, 61 G Index and the author Bornmann L. listed 2nd rank with 90 publications, 3301 citations, 36.68 citation impact, 27 H Index, 56 G Index. The Journal “Scientometrics” is a highly influential journal producing a maximum of 1334 publications, 29021 citations, 73 H Index,

and 119 G Index. "Journal of Informetrics" is on 2nd rank with 266 publications, 8593 citations, 48 H Index, and 82 G Index. The article entitled "Software survey: VOSviewer, a computer program for bibliometric mapping" by Van Eck N. J. published in 2010 in "Scientometrics" is the most productive paper with 1946 citations and 162.16 total citations per year. 'Bibliometrics' is the most frequently and representative authors keyword as it appears 1782 times and 4140 total link strength, followed by 'Bibliometric Analysis' that appears 1502 times and 1914 total link strength, followed by 'Bibliomeric' that appear 522 times and 1215 total link strength. In case of all keywords in Bibliometrics literature the term 'Bibliometric Analysis' is the most frequently and representative keyword as it appears 2074 times and 10548 total link strength, followed by 'Bibliometrics' that appear 1829 times and 9358 total link strength; 'Science' that appear 1511 times and 9391 total link strength. Topic developments indicated by Trend Topic provide an overview of the position of each topic. It is found that there is a development of the words used in various Bibliometrics literature, the emergence of topics is also adjusted to the frequency of the number of words appearing in research on Bibliometrics. The keyword 'Bibliometrics' 1743 frequency is the most trending word in year 2017, 'Bibliometrics Analysis' 1330 frequency(2018), 'Bibliometric' 666 frequency(2018), 'Scientometrics' 481 frequency(2016). Topics dendrogram describe the result in the form of hierarchical grouping. Conceptual Structure Map that divides into two clusters and each area contains words that are related to one another. The collaboration network or collaboration between authors, institutions, and countries on Bibliometrics research, results show some have a connection, and some are not. Several collaboration clusters show that many authors, institutions, and countries are collaborating in Bibliometrics research.

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