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STRUCTURE AND GROWTH OF SCIENTOMETRIC RESEARCH: A SCIENTOMETRIC STUDY OF SCIENTOMETRIC JOURNAL

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Abstract: The quantitative and qualitative analysis of publications in Scientometrics journal during the period 2012-2021, lies as the prime purpose for the present study. The study is descriptive in nature. The data were retrieved from the Web of Science database for the period 2012-2021. The study has used various performance analysis and science mapping techniques to conduct this scientometric analysis. The study has also used the bibliometrix R-Package to conduct the visualisation analysis. The study found that the article is the main type of research publication and the multi authorship is prominent. The Relative Growth Ratio indicates constantly decreasing trends during the studied period which supports the constantly increasing trends of doubling time. The study established a negative correlation between the authorship and the number of publications. The thematic evaluation of the study indicates the thrust and declining areas of research in Scientometrics journals. The study has been designed to summarise the quantitative and qualitative growth of scientometric literature in Scientometrics journal. The present study may act as a tool for Scientometrics research community to identify the major thrust areas in Scientometrics research.

Keywords: Scientometrics, bibliometrix, biblioshiny, Thematic analysis, authorship pattern, Keyword analysis

1.0 Introduction

Scientometrics is a peer-review journal of international repute published under the Springer Nature. Springer Nature is touted as one of the best publishers in the world which supports research organisations, and academic institutions through its quality content and services. Since the inception of the journal Scientometrics has been publishing 14 volumes of special issues dealing with the Scientometrics research in different parts of the globe. The research scopes of the Scientometrics journal may fall into 4 interdisciplinary areas in science and technology research such as indicators used, information systems used, interaction and lastly socio organisational structures. The interdisciplinary approach of this journal helps librarians, Scientificresearch organisations and laboratories with its valuable assistance through its various types of publications such as journal articles, short communication, preliminary report, and review report. The journal also feeds its users by giving updated information on advancements in Scientometrics and allied literature. This journal is abstracted and indexed by more than 30 major international databases which indicate its importance. This journal 2 types of publishing models traditional publishing model and the open-access model. The author has the right to choose the model of publication after the acceptance of the article. Though the traditional mode of publication doesnot involves any charges but it is not freely available to readers thus readers or institutions with subscription fees can read the published. Contrary to the open-access model of publishing the author has to contribute the Article Processing Charge (APC) so that anybody can read the article. The open-access publications are available under the CC-BY licence which is considered the best standard for open access publications.

2.0 Review of Literature

The literature search reveals that a range of bibliometrics and Scientometrics literature is available and all such literature is based on different facets of the bibliometrics and Scientometrics domain. Some kinds of literature are tried to find out the research productivity at the institutional level, some are tried to find out the productivity at a specific subject domain or some are tried to find out the productivity at the individual level i.e. at the author level and journal level, some kinds of literature are dedicated to developing the methodological considerations in bibliometrics and Scientometrics.

Some studies were carried out to find out the productivity of some specific journals. In this regard the study of (Kumar et al., 2019)[2]tried to find out the quantitative and qualitative growth journal of promotion management (JPM), for which the authors retrieved the data from SCOPUS for the period 1992 to 2019. The USA was the major contributor to the JPM journal. The study also reveals the major themes included in the JPM through the Bibliographic coupling, the major themes were sales promotion, summer scepticism, online marketing, celebrity endorsement, and Social media. The study of (Bharvi et al., 2003)[3]based on scientometric analysis of the international journal of Scientometrics. The study undertook the first 50 volumes of the journal from 1978-to 2001. The study found a total of 1317 publications during the period, out of which maximum papers were single authored papers followed by 2 authors and multi author publications. The study found a declining contribution of the USA during the period while an incremental trend was noticed for Japan, India, Netherland and France. The study also found the scientometric assessment was the most emphasized theme of scientometric studies during this time. Similarly the study conducted by (Mondal, 2020)[4]emphasised to measure the research productivity of Indian scientists in the top 5 journals of the American Physical Society (APS) from 2004 to 2018. The author found that India got 11th rank in the list. The study found that 50.98% of total publications were with international collaboration, and the Physical Review D was the most preferred journal for Indian scientists. The study found high energy physics was the focus area for Indian scientists.

Some topical research publications have been covered under this study for review. In this connection the study of (Malik et al., 2019)[5]tried to examine the Crowdsourcing publications during 2008 to 2017. The study found the maximum publications were in form of research articles, all the publications were in the English language. The study noticed that the USA, China and UK contributed 80% of total publications during the studied period. The study found that PLOS One was the most favoured journal in terms of publications and citations till 2016. The study of (Francis & Das, 2019)[6]was to evaluate the research productivity of water-related technology research from 2006-to 2017 by taking the data from the SCOPUS and Scimajo data base. The study analysed the Scimago data and found that the USA topped the list with 333 h-index score and India took 6th position with 125 h-index score in thenumber publications list. It was found that the Environmental Monitoring and Assessment, was the most preferred journal for publication, in which India contributed the maximum documents. The study found that the maximum of India's contribution was from Bhabha Atomic Research Centre followed by IIT Kharagpur. The study of (Pandey et al., 2021)[7]based on Scientometrics analysis to evaluate the Artificial intelligence research in India during the period 2009-2018, for which SCOPUS data base was accessed. The study found that the highest number of publications was during 2016 followed by 2017. The year 2009 contributed the lowest number of publications. The study used the doubling time to measure the growth rate of publications and found that doubling time was a constantly increasing trend during the studied period. Conference proceedings were the major document type for research communication followed by journal articles. The study found the University Grants Commission was the major research funder for maximum research projects in the area of Artificial intelligence.

3.0 Objectives of The Study

The present study has been conducted to archive the below-mentioned objectives:

1. To find the authorship pattern and to get the correlation between the authorship and publications
2. To get an overview of types of publication.
3. To know the Doubling time and Relative Growth Rate of publications
4. To find the Collaborative Index, Degree of Collaboration and Collaborative coefficient.
5. To get a Thematic overview of research publications in Scientometrics Journal

4.0 Methodology

The present study uses a Web of Science (WoS) database to retrieve the required data for the study. The Publication Title field in the WoS database has been selected and the "Scientometrics" has been written as the publication title to get the required data. The search result was again modified by using the filter option in WoS.

The Publication Year filter has been selected and the range has been given as 2012 to 2021. The results have been exported in plain text format for further analysis. The retrieved data have been processed through bibliometrix software for bibliometric analysis.

The exported data were in plain text format. The data were then imported to Biblioshiny by selecting the Import Data option on Biblioshiny. The Bibliophily app facilitates the download of the processed data in various formats. The data was then exported in excel format from the Bibliophily for further analysis in Excel.

4.1 Authorship Pattern : It was observed that some papers were single-authored papers and some papers were multi authored papers. The number of papers has been divided into 5 categories according to the number of author's contributions as 1 authored paper, 2 authored papers, 3 authored papers and more than or equal to 5 authored papers. The data in Table Irepresents the yearwise contribution of singleauthored, and multiauthored papers and their respective citations from 2012-to 2021. The citations for each category have been calculated along with their average citations per publication (ACPP). The ACPP has been calculated by dividing the total number of citations received by each category by the number of publications in that category during certain studied period.

Table I (Year-wise distribution of Authorship & Publication)

Year	1 Author			2Authors			3 Authors			4 Authors			>=5 Authors		
	NP	NC	ACPP	NP	NC	ACPP	NP	NC	ACPP	NP	NC	ACPP	NP	NC	ACPP
2012	71	2055	28.94	84	1896	22.57	55	1508	27.42	30	765	25.50	27	623	23.07
2013	60	1283	21.38	77	1673	21.73	64	1559	24.36	32	772	24.13	29	807	27.83
2014	69	1099	15.93	93	2047	22.01	107	2643	24.70	45	1152	25.60	48	1115	23.23
2015	65	1237	19.03	109	2096	19.23	87	1819	20.91	58	1351	23.29	47	815	17.34
2016	58	869	14.98	107	3199	29.90	114	2015	17.68	54	896	16.59	45	807	17.93
2017	66	835	12.65	121	2406	19.88	109	1547	14.19	45	627	13.93	55	789	14.35
2018	79	808	10.23	124	1330	10.73	95	1326	13.96	53	621	11.72	46	573	12.46
2019	59	583	9.88	79	693	8.77	84	642	7.64	39	258	6.62	46	428	9.30
2020	83	333	4.01	121	705	5.83	99	449	4.54	76	362	4.76	64	368	5.75
2021	82	103	1.26	109	184	1.69	120	202	1.68	68	176	2.59	67	151	2.25
TOTAL	692	9205	13.30	1024	16229	15.85	934	13710	14.68	500	6980	13.96	474	6476	13.66

Table I shows the total number of publications with their corresponding citations and ACPP. The value of ACPP was highest for 2 authored papers i.e. 15.85, followed by 3 authored publications i.e. 14.68. A maximum number of single-authored papers and 4 authored papers were published during 2020 but single-authored papers received maximum citations in 2012 whereas 4 authored papers received maximum citations in 2015. Similarly, the highest number of 2 authored papers were published in 2018 but the citations received by 2 authored papers were highest during the year 2016. A maximum number of 3 authored and more than or equal to 5 authored papers were published during 2021 but citations received by 3 authored papers and more than or equal to 5 authored papers were highest during 2014.

Correlation analysis: The present study tried to find out the Correlation between authors' collaboration with the number of publications. For this purpose, this study tabulated the total number of publications data for each category of collaborated authors. This study has considered all those papers which have up to 12 co-authors. Thus, this study has mentioned the number of publications under each category of authorship in an excel sheet. Then this study has used Karl Pearson's product-moment method to find out the correlation between the number of publications with collaboration.

$\frac{n\Sigma xy-\Sigma x\Sigma y}{\sqrt{n\Sigma y^2-(\Sigma y)^2}\sqrt{n\Sigma x^2-(\Sigma x)^2}}$……..Equation 1

In this present study x,y and n indicate the number of authors, number of papers and number of observations respectively.

Table II (Corelation analysis)

No. of Authors (x)	No. of Papers (y)	xy	y^2	x^2
1	692	692	478864	1
2	1024	2048	1048576	4
3	934	2802	872356	9
4	500	2000	250000	16
5	264	1320	69696	25
6	121	726	14641	36
7	45	315	2025	49
8	18	144	324	64
9	17	153	289	81
10	4	40	16	100
11	1	11	1	121
12	2	24	4	144
∑x=78	∑y=3622	∑xy=10275	$\sum y^2$=2736792	$\sum x^2$=650

By applying the values of x, y and n in Equation 1 the collaborative coefficient became -0.866 which indicates a strong negative correlation between the number of authors and the number of publications. The strong negative correlation indicates a declining trend in the number of publications when the number of authors increased for each publication.

5.0Types of Publications

The Scientometrics journal published a range of publications. The different types of publications have been represented in Figure 1 of the study.

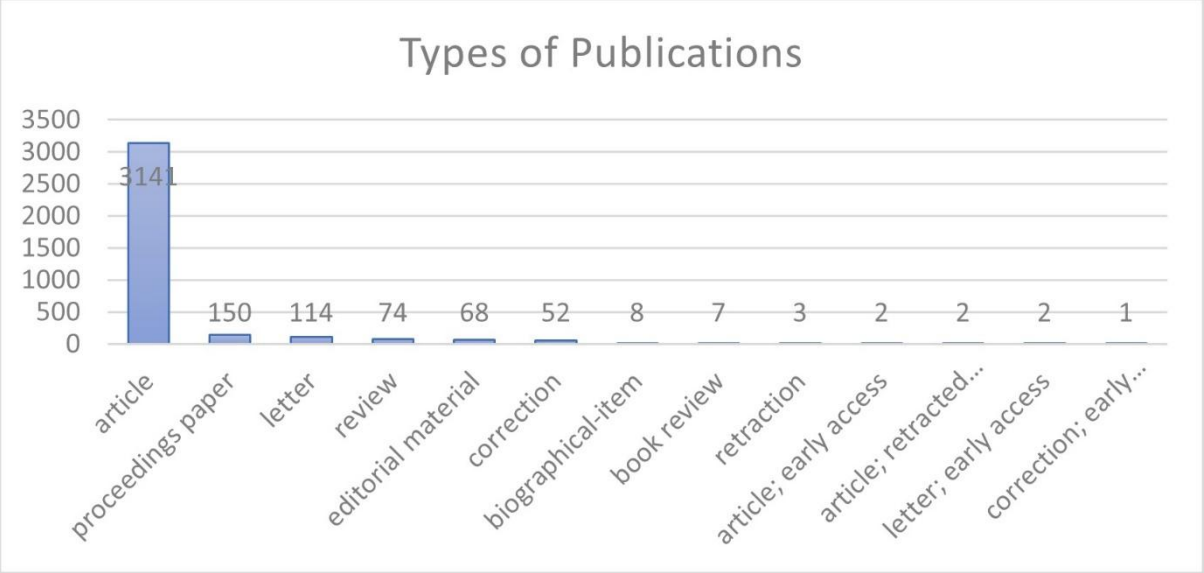


Figure 1 (Types of Publications)

It can be noticed from Figure 1 that maximum publications are in form of articles followed by proceedings papers, letters, reviews and so on. Thus, the present study includes a maximum of 3141 articles followed by 150 proceedings papers, 114 letters and so on. Correction; early access, letter; early access, article; retracted are contributed minimum number of publications in the Scientometrics journal.

6.0 Relative Growth Rate(RGR) and Doubling Time(DT)

The present study uses Relative Growth Rate and Doubling Time as a measure to find out the growth of publications during the period. An excel sheet has been prepared by taking the number of publications in each year of study then the mathematical formula, as given in equation-1,has been used to find out the RGR has been given below (Mahapatra,1985)[11].

RGR = $\frac{W2-W1}{T2-T1}$……. Equation-2

Where W1= Natural logarithm of the initial number of contributions

W2= Natural logarithm of the final number of contributions

T1= The unit of initial time

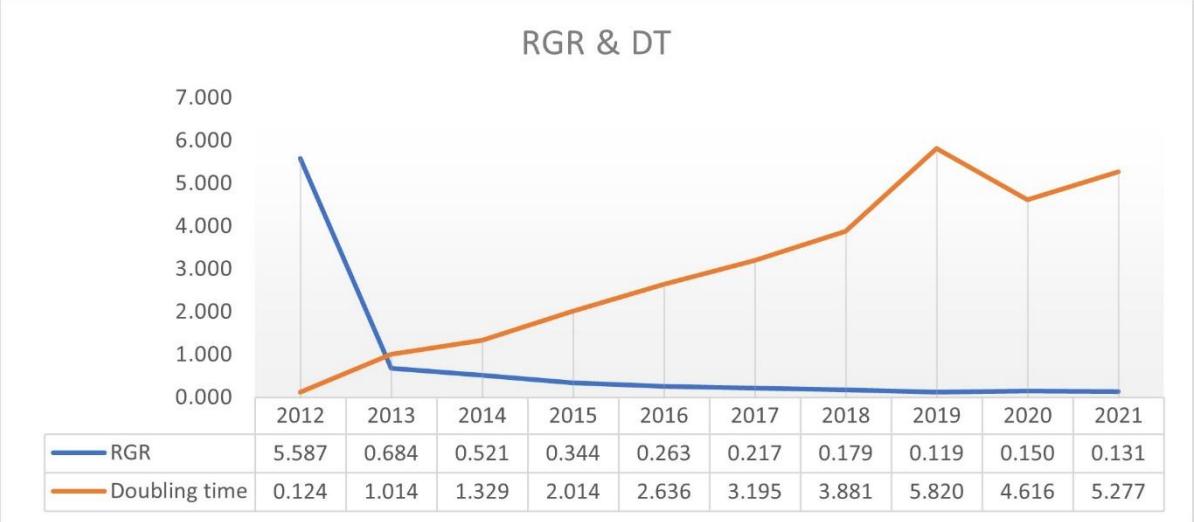
T2= The unit of the final time

Doubling time is the time required for publications to become double the initial number of publications. Doubling time is directly related to the RGR. In this connection (Librarian &Kannappanavar, 2020)[12]explained that if the number of publications became double in a given time then the difference in the logarithm of the initial and final number of publications must be a logarithm value of 2. Thus, the following formula can be applied to evaluate the doubling time.

Doubling Time (DT) = $\frac{0.693}{RGR}$……Equation-3

The present study uses the formula mentioned in equation-2 to find out the doubling time for each year of publications.

The RGR and the Doubling Time for each studied period have been represented in Figure 2.



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
RGR	5.587	0.684	0.521	0.344	0.263	0.217	0.179	0.119	0.150	0.131
Doubling time	0.124	1.014	1.329	2.014	2.636	3.195	3.881	5.820	4.616	5.277

Figure 2 (RGR & DT)

Figure 2 reveals a sharp decline in RGR during the studied period. The RGR value increased slightly during 2020 but the RGR value again declined during 2021. The Doubling time also increased sharply in the studied period but a slight variation can be noticed during 2020. The DT value decreased during 2020 and 2019 again the DT value increased in 2021.

7.0 Collaborative Index (CI), Collaborative coefficient (CC) and Degree of collaboration (DC)

The present study has used Lawin's formula to get the collaborative Index (Lawani, 1986)[13]. The Collaborative index is defined as the number of authors in each jointly authored publication. Lawin gave the formula as follows:

CI=$\frac{\sum_{j=1}^{k} if\, j}{N}$……. Equation-4

In Equation-4 fj indicates the number of j authored papers.

N indicates the total number of papers

K indicates the maximum number of authors per paper.

The value of CI always remains between 0 and 1. If the CI value is 0 then it indicates single-authored papers or no collaboration and if the value is nearer to 1 then it indicates strong collaboration(Barik & Jena, 2021)[14].

Column 6 of Table III indicates the CI of publications during the period.

7.1 Collaborative Coefficient (CC): The present study has used the formula used by (Ajiferuke, 1985)[15] to evaluate the CC for the publications. The formula is given by

$CC=1-\frac{\sum_{j-1}^{k}(\frac{1}{j})fj}{N}$……..Equation-5

The idea behind the CC is to distribute the credit among the various authorship. As a result, a single-authored paper receives 1 credit, a two authored paper receives ½ credit each, a three authored paper receive 1/3 credit and similarly, an "n" authored paper receives 1/n credit(Price&Beaver, 1966)[16].
Equation-5 j indicates the number of authors
Fj indicates the number of j authored publications.
N indicates the total number of publications.
The lower value of CC indicates less collaboration and the higher value of CC indicates a higher chance of collaborative papers. Column 7 in Table III indicates the CC of publications across the concerned period of study.

7.2 Degree of Collaboration (DC): The present study has used Subramanyam's (Subramanyam, 1983)[17] formula to find the degree of collaboration. The formula is given below as Equation-6.

$DC=\frac{Nm}{Nm+Ns}$……. Equation-6

The degree of collaboration is a measure of the rate of multiauthored publications.
In Equation-6 Nm indicates the number of multiauthored publications
Ns indicates the number of single-authored publications
The higher value of DC indicates the greater number of multi-authored papers in a given collection and the lower value of DC indicates the less collaboration among authors in a given collection. The DC value is given in Column 8 of Table III.

Table III (CI, CC, DC)

Year	Total Publications	Multi authored publications	Total Single authored Publications	Rateof Single Authorship	CI	CC	DC
2012	267	196	71	0.266	3.485	0.462	0.734
2013	262	202	60	0.229	3.475	0.492	0.771
2014	362	293	69	0.191	3.509	0.527	0.809
2015	366	301	65	0.178	3.485	0.532	0.822
2016	378	320	58	0.153	3.403	0.547	0.847
2017	396	330	66	0.167	3.436	0.536	0.833
2018	397	318	79	0.199	3.418	0.511	0.801
2019	307	248	59	0.192	3.593	0.530	0.808
2020	443	360	83	0.187	3.597	0.533	0.813
2021	446	364	82	0.184	3.725	0.541	0.816

The analysis of Table III shows that the value of CI was lowest during 2016 and highest in 2021 followed by 2020. Which Indicates maximum collaboration was done during 2021 and minimum during 2016. Table III shows that the value of CC was highest during 2016 followed by 2021 and lowest during 2012. This indicates during 2016 each author got maximum credit than other years and in 2012, each author got the lowest credit than other years. It can be observed from Table 2 that the DC value was highest during 2016 followed by 2017. This indicates maximum collaborative papers during these years and the lowest value of DC was during 2012 which indicates less number of collaborative papers.

8.0 Thematic Map

Thematic Map of bibliometrix presents the status of a topic in a given field. It integrates and differentiates various topics and visualises different types of themes(Zhang & Wang, 2022)[18]. Each theme has a separate connotation with different notions. These 4 different themes have been deduced by the intersection of 2 axes, viz. Centrality and Density. The upper right quadrant is called Motor Theme, which has a higher value of centrality and density. The motor theme represents the most matured topics with relevant content in the given literature. The upper left corner is called Niche Theme, which is low on centrality and high on density thus this theme represents already developed areas in literature but marginalised areas in that literature. The lower-left corner represents the Peripheral theme which is low on the centrality and density thus the topics in this area are either emerging topics or less researched topics or marginalised topics in literature. The lower right corner is called a basic theme, it is high on centrality and low on density, thus it represents fundamental topics in given literature(Aria&Cuccurullo, 2017)[19].

The present study uses the Author keyword as the input data for the thematic map. The bibliometrix tool analyses the author keyword and represents it in a thematic map as shown in figure 3.

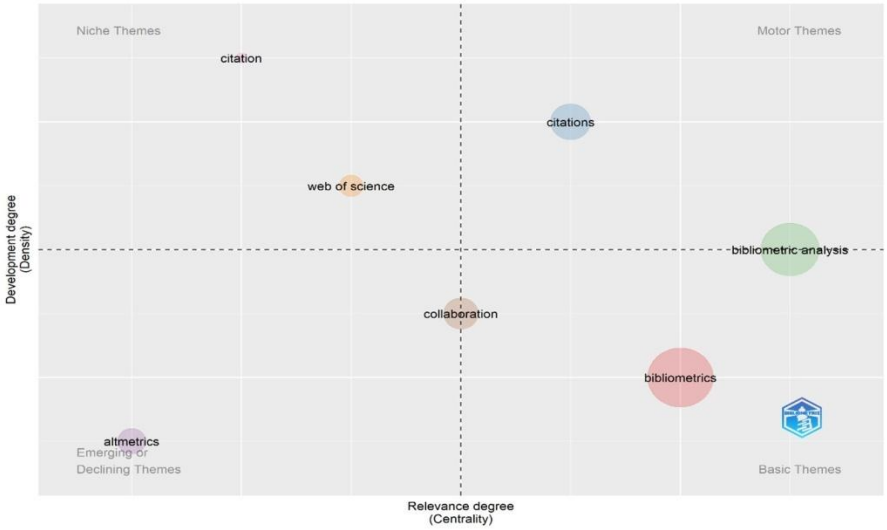


Figure 3 (Thematic Map)

Figure 3 represents the "Citations" and other allied topics such as h-index, impact factor, ranking and research fundings in the Motor theme. Thus, it indicates that these are the hot areas of contemporary research in Scientometrics journal. Similarly, the basic themes in figure 1 represent "bibliometrics" with other allied topics such as citation analysis, Scientometrics, research evaluation, higher education, Universities, text mining, bibliographic coupling, and machine learning. Thus the basic theme in the present study represents the fundamental research areas of Scientometrics journal. The cluster "bibliometric analysis" lies symmetrically both in the motor theme quadrant and basic theme quadrant. Thus the allied topics of the cluster such as social network analysis, scientific collaboration, network analysis, co-authorship, research collaboration and interdisciplinarity are the areas where more research is going and some topics are already well-researched background.

The "altmetrics" and the allied topics such as open access, Twitter, webometrics, Covid-19, scholarly communication, social media, content analysis, and research impact are the less researched areas or emerging areas of research in Scientometrics journal. The Cluster "Collaboration" with its allied topics such as innovation, patent, gender, and patent analysis lies symmetrically between the basic theme and the emerging theme. Thus research on such topics is going on which will further contribute to the literature. The Niche theme for the present study represents 2 clusters, the web of science cluster contains the allied topics such as SCOPUS, google scholar, research assessment, and social sciences and the citation cluster contains the allied topics such as impact, journal impact factor, indicators and quality. Thus these areas are already developed areas but these areas are not getting much concentration.

Co-occurrence of Author's keywords

The present study has considered the author's keyword to find the co-occurrence network on the bibliometrix

tool. The network parameters under the Co-occurrence network of the bibliometrix tool facilitates individual to select the required parameters from a range of available network parameters. The studyhas selected the normalisation measure as an association and the clustering algorithm as Louvain, the minimum number of edges as 5 and the number of nodes as 50. Figure 4 shows the Co-occurrence of the author's keyword.

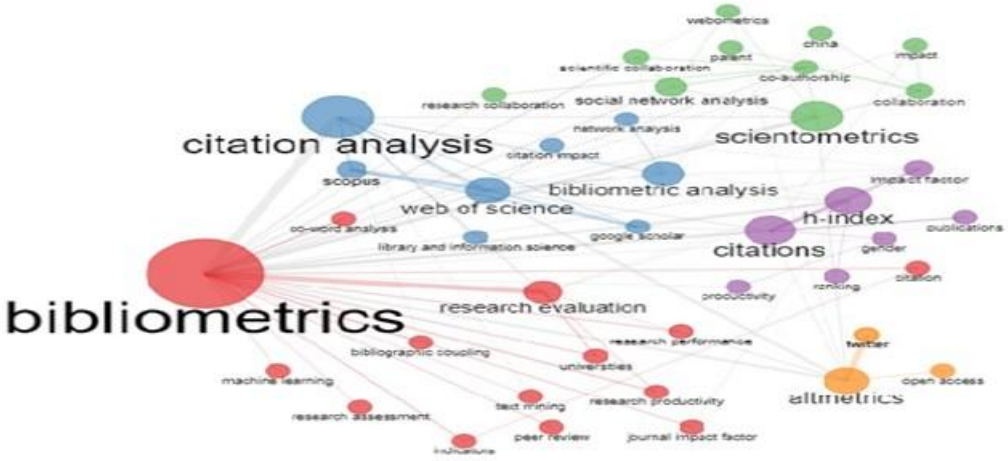


Figure 4 (Co-occurrence of Author's keywords)

The nodes in Figure 4 represent the author's keyword and the edges show the relationship among the various keywords. The bigger the node size the greater it has been cited. From Figure 3 it is clear that there are a total of 5 clusters with a different number of nodes and each cluster has been represented with various types of colours. The word "bibliometrics" has been represented as the biggest node of the red cluster. The red cluster also represents other words such as research evaluation, bibliographic coupling, machine learning, research assessment, and text mining. Thus, it can be summarised that the bibliometrics research in the Scientometrics journal uses bibliographic coupling, machine learning, and text mining for research evaluation or research performance analysis. The term bibliometrics is also connected with nodes of another cluster such as citation analysis and Scientometrics. The term altmetrics has been represented as the biggest node in the yellow colour cluster. The yellow colour cluster also includes the term open access and Twitter. Thus, yellow colour cluster represents how the altmetrics research has been gaining importance in the bibliometrics and Scientometrics literature. It also indicates that altmetrics research is more prominent on Twitter and open access publications. The blue colour cluster includes the databases such as Goggle Scholar, SCOPUS and Web of Science along with the phrase citation analysis, network analysis and bibliometric analysis and this cluster is well connected with the "bibliometrics" and "Scientometrics" nodes. Thus, blue colour cluster primarily gives the idea of the database used for bibliometric or Scientometrics analysis. The purple colour cluster is associated with the terms citation, h-index, and impact factor. Thus, these are the measures used in the bibliometrics or Scientometrics study. The purple colour cluster represents the measures used in bibliometrics or Scientometrics analysis to perform the performance analysis in these studies.

9.0 Major Findings

The present study is an endeavour to evaluate the research productivity of the Scientometrics journal. The major findings of the present study may be represented as the relationship with the objectives of the study as follows:

1. The study found that the multi authorship was prominent during the studied period though the correlation analysis shows there is a strong negative correlation between the number of authors and the number of publications.
2. The study also found that a journal article is the most preferred way to communicate research publications though other types of document types exist in a very nominal type.
3. The study observed a decreasing value in RGR value and at the same time, the DT value also increased rapidly. This increasing value of doubling time indicates the time required for literature to become double is increased substantially which ultimately indicates the lower growth of the number of publications across the period. The study found that the value of DT was highest during the year 2016

which indicates the highest number of collaborations were made during 2016 than in any other studied year.

4. The CC value was highest for the year 2016, thus it indicates the credit of each of the authors was highest during the year 2016. The value of CI is highest 2021followed by the year 2014. Thus, it indicates highest collaboration in the year 2021 followed by 2016. The lower CI value in 2016 indicates the dominance of single authored papers in 2016.
5. The thematic evaluation indicates that the bibliometrics literature in Scientometrics journal includes bibliographic coupling, machine learning, research assessment, text mining etc. so it may be assumed that these are the prime techniques used for bibliometrics analysis in Scientometrics journal. The emerging or declining area represents the term "altmetrics" with other associated words such as open access, Twitter, webometrics, Covid-19, scholarly communication, social media, content analysis, and research impact. Thus, altmetrics research is gaining importance with Twitter, open access publications and Covid-19 related literature. The co-word analysis by using the Author's keyword represents the Bibliometrics as the largest node, followed by other nodes of different clusters such as Citation analysis, citations and h-index. So these clusters with their associated keyword portray the importance of Bibliometrics and Scientometrics literature with various word associations.

10.0 Conclusion

Scientometrics as an international journal has been gaining popularity among authors to publish their research literature. The present study is an endeavour to evaluate the research publications of the Scientometrics journal for the period 2012-2021. The study has used the performance analysis techniques such as TC, CI, and CC ACPP for quantitative measurement of research publications. The study also used the thematic map and co-word analysis to know the thrust areas of the Scientometrics journal. This study may be helpful for the research community to get an overview of Scientometrics journals.

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