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Indian Research Output on Scientometric Literature as Indexed in *Scopus*: a Scientometric Exploration

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Abstract

In recent decay, the scientometric study is one of the major research areas in scholarly communication. Researchers have conducted their research in the scientometric field from different core subject areas. Using bibliographic records on a scientometric field from the SCOPUS database, this paper tries to give a complete view of the evaluation of Indian research in the domain of scientometric. From 2010-2019 researchers have published 41462 publications out of the 334 number publications belongs to the scientometric domain of Indian research. Researchers have critically analyzed the collected data on various aspects like year-wise publication, author collaboration, authorship pattern, degree of collaboration, collaborative coefficient (CC), leading authors, productive journal, state-wise production in India, and mostly used keyword. The finding of the study disclosed that the maximum number of articles (97) published in the year 2019 with 222 citations. In the year 2015 got the highest number of citations (355) from only 31 publications. The highest number of articles are two-authored (140) followed by three-authored (89) and single-authored (54) respectively, and the average number of authors per article is 2.13. In respect of state-wise production, New Delhi has stood the first position with 191 publications. The word "scientometric" is the most used keyword and the top productive journal is Library Philosophy and Practice (114).

Keywords: Scientometric, Scopus, Bibliometric, Citation, Collaboration co-efficient (CC), Degree of collaboration, VOS Viewer

Introduction

'Scientometric' its sound is nothing but its claws are very sharp. In the early 20th century many metrics emerged like Informetric, Bibliometric, Librametric, Technometrics, Webometric, Altmetric, and also Scientometric. This is a sub-field of bibliometric study. In the age of information overload and information pollution, thousands of information is available but which are more relevant, most sophisticated, more genuine, most useful is very tough and time-consuming work for a student as well as teachers. Scientometric is doing this work by measuring and analyzing their impact factor, citation, policy till now. Bibliometric and Scientometric both are overlapping concepts, according to Lancaster (Lancaster 1991) "Bibliometric deals with any published or semi-published literature for quantitative analysis of their production, distribution and use", on the other hand, "Scientometric applied only with the field of science and Technology for a qualitative and quantitative study.

Scopus is a repudiated database in the world. It contains billions of journals, articles, e-books, conference processing, etc. in different subject disciplines. In the last 10 years (2010-19) Scopus digest 41462 documents and there 334 documents are on scientometric. But how many authors write relevant research work, what is author productivity, how much important for further research as well as how it serves society that measurement is necessary.

Statement of the Problem

Scientometric study and analysis are shading like a canopy. In the last 2 decades, billions of authors published their research work on scientometric where most of the publications are incoherent. So on the behalf of the present situation, a scientometric analysis is required on scientometric literature on the Scopus database during the last decade.

Related Literature

Recently scientometric research is increasing rapidly. Researchers have carried out scientometric research in different subject fields to show the evaluation and effectiveness of research trends in their subject areas.

(Mooghali et al. 2012) analyzed bibliographic records on scientometric literature from 1980 to 2009 from Social Science citation (SSCI), Science Citation Index and Arts & Humanities Citation Index. They found that 183 articles were published out of 691 during this period in the domain of scientometrics.

(Mondal and Raychoudhury 2019) made a study to outline the contribution of Indian authors in the domain of scientometric during 1990 to 2017. Researchers found that 208 numbers of articles were published in that period including 29 international collaborations. The average number of authors per paper was 2.27 and the highest number of articles is two-authored.

(Choudhary and Choudhary 2019) carried out a scientometric study of research publications published by Netaji Subhas Institute of technology during 1996-2015, which was indexed in SCOPUS database.

(Biradar and Tadasad 2016) analyzed authorship patterns and collaborative research study in the domain of Economics. They explored different types of collaborations and explained measures of collaborations.

(Garg and Kumari 2019) made a study on bibliometric analysis of 809 Ph.D. theses published by the Department of Chemistry, Aligarh Muslim University (AMU) during 1935-2014. They concluded that during 1980 to 1984 the highest number of theses was submitted. Several 187 theses were submitted by woman scholars out of a total of 809 theses. The highest numbers of these were submitted by female scholars in the last five-year block of 2005-2009 and 2010-2014.

(Bansal and Bansal 2021) examined global research productivity on electronic resources during 1999-2018 from SCOPUS database. They found the largest number of publications came from the USA followed by UK, Australia, Malaysia, Canada, India, and Brazil.

(Sab, Parashappa, and Biradar 2020) analyzed 633 Indian research publications on marketing research during 1990-2018 from Web of Science. The findings of the study revealed that the overall contribution of Indian research on marketing was 11.56 percentages during 2003-2012, which was increased from 10.43 percentages during 2003-2007 to 12.18 percentages during 2008-2012.

(Okhovati et al. 2015) represented the trends on global assisted reproductive technologies (ARTs) research from the MEDLINE database during 1998-2014. The study focused on global research on ARTs (Assisted Reproductive Technologies), which were geographically distributed and highly concentrated among the World's richest countries. IVF and cryopreservation were the most productive research fields among ARTs.

(Djalalinia et al. 2017) carried out a scientometric study on health researches during 2000-2014 in the National Knowledge Production of Iran. This paper analyzed that 237056 scientific papers have been published in Iran between 2000-2014 time period and 81867 (34.53 percentages) publications came from health science. Tehran University of Medical Science was contributed 21.87 percentage knowledge

production followed by Azad University (11.15 percentages) and Sahid Beheshti University of Medical Science (7.28 percentages).

(Najari and Yousefvand 2013) represented growth of scientific production of Iran in the domain of medical science during 2000-2011 from SCOPUS database. They have shown that Iran contributed 32.77 percentages of the Middle East and considered for 1.57 percentages of the World's scientific production. In respect of the number of articles and citation count, Iran stood the position of 17th and 23rd respectively among 226 countries.

(Keshava et al. 2021) analyzed 646 records of Tumkur University. Data retrieved from SCOPUS database for a period of 15 years (2005 to 2019). Findings of the study published that in the year 2015, the maximum number of publications (116) was produced. Former Vice-Chancellor, Prof. S. C. Sharma has the highest citations. The highest occurrence keyword was photoluminescence.

(Neelamma and Gavisiddappa 2018) highlighted research collaboration and authorship patterns in the field of Crystallography during 1989-2013. This study illustrated 45320 scholarly communications contributed to the crystallography domain.

(Karpagam 2014) carried out scientometric research on nanobiotechnology from a different perspective for the period of 2003-2012 from SCOPUS database. The study found that a total number of 114684 publications were produced during this period and received a total number of 2503795 citations with an average of 21.83 citations per paper. The USA stood in the first positions by several publications (34736), h-index (349), g-index (541), hg-index (434.52), and p-index (326.47). Massachusetts Institute of Technology (MIT), USA has received the highest h-index (120) among the top 10 institutions. 'Biomaterials' (1631) was the top productive journal in this study.

(Nath and Jana 2020) examined 8917 research papers contributed by 32071 authors worldwide during 2009 to 2018. They concluded that the USA was the highest productive country with 21.51 percentages world publication share and 11.42 percentages international collaborations. Chinese Academy of Science was the top productive institution, they published 311 numbers of articles and P. Pradhan was the top-ranked author in respect of the number of publications (70).

Objectives

The main objectives of this study are mentioned below:

- To enumerate growth of literature on scientometric in Scopus database in India during 2010-2019.
- To study authors and co-authorship pattern, degree of collaboration and Collaboration coefficient index of authors and publications.
- To determine relevancy and quality of publications on scientometric on Scopus database behalf of India.
- To observe the fitness of author productivity with Lotka's Law.
- Identify the most productive and contributing states in India.
- Explore the most active and favorite journal where authors published mostly.

Research methodology

This research paper is adequate to study and analyze the research output on scientometric literature during the period 2010-2019 in Scopus database. All taken data are from secondary data sources (<https://www.scopus.com/>). The search (Data retrieved on 23rd April 2021) has occurred with the keyword "scientometric" from Title-Abstract-Keyword (TITLE-ABS-KEY) field and limitation with affiliation country India from 2010 to 2019. After downloading data in excel format, tabulation has been completed

as per objectives. To calculate annual growth rate, author productivity, degree of collaboration some statistical methods have been adequate. For data analysis and representation different tools and software are used namely, Bibexcel for statistical analysis, MS-Excel for data presentation and tabulation, VOS Viewer, Gramener, QGIS software for visualization and other software was applied for keyword mapping, co-authorship mapping. Creating a search query is not a simple task, in this query some strings have used as follows:

TITLE-ABS-KEY (scientometric) OR TITLE-ABS-KEY (scientometry) OR TITLE-ABS-KEY (productivity analysis) AND (LIMIT TO (AFFILCOUNTRY , "India")) AND (LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010)).

Results and Discussions

This research work has been divided into two categories (1) descriptive analysis of research output (2) Graphical presentation of research results.

Growth of scientometric research output

During the study time, (2010-19) total of 334 publications was undertaken from Scopus database. The annual growth rate has measured the exponential growth of publications on scientometric study in India. Table 1 shows that 97 publications in 2019, 59 documents in 2018 have been published but the number of citations is not good enough. Comparatively, in 2015 only 31 papers were published but most of them were relevant and of good quality. It carried maximum citations (335) with 11.45 per document. The annual growth rate was also very high in 2013 (133.33) and 2019 (118.52) but in 2015 the growth rate was -2.86. That means exponential growth carried quantitative growth, not qualitative. It could see that the trend of output is impressive but the quality was fluctuating during 2010-19.

Table 1: Trend of Research output during 2010-19

Year	No. of Total Publication (TP)	No. of Total Citation (TC)	Citation per paper(CPP)	Percentage of Publication (%)	AGR Percentage
2010	9	86	9.55	2.70	
2011	10	146	14.6	2.99	11.11
2012	12	62	5.16	3.59	20.00
2013	28	181	6.46	8.38	133.33
2014	35	220	6.28	10.48	25.00
2015	31	355	11.45	9.28	-2.86
2016	26	119	4.57	7.80	-16.13
2017	27	194	7.18	8.08	3.85
2018	59	188	3.18	17.66	118.52
2019	97	222	2.28	29.04	64.41
Total	334	1773	--	100.00	--

AGR=Annual Growth Rate

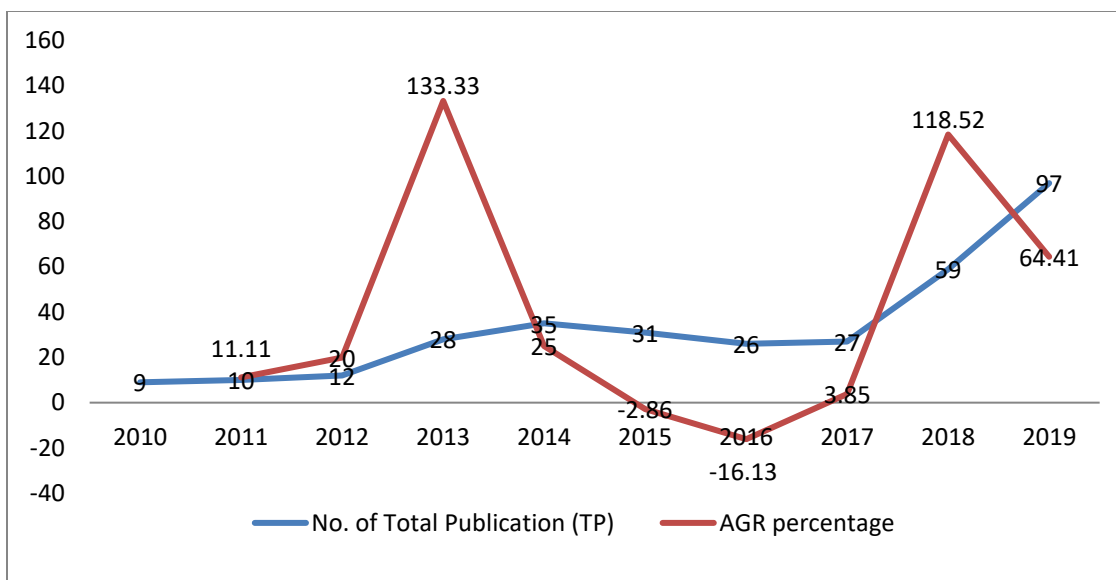


Figure 1: Year wise research trends with an annual growth percentage

This diagram shows the Annual Growth Rate (AGR) of scientometric literature from 2010 to 2019. During the last 10 years, Indian authors have contributed so many research publications in different formats, article is the most productive publication format among them. In the year 2013, Indian researchers have contributed 28 publications and the annual growth rate percentage of 2013 to 2019 is 133.33. During 2014 to 2015 and 2015 to 2016 AGR percentage are showing -2.86 and -16.13 respectively.

Measures Authorship pattern and Degree of collaboration

Authorship study is a vital and necessary aspect for information communication (Cronin, Shaw, and Barre 2003). Nowadays every subject discipline is merging with other subjects especially in science and technology that is why many authors and a variety of authors are collaborating. According to Table 2, in 334 articles 54 authors followed single authorship, 140 authors two authors pattern, 89 authors three authorship and others authors collaborated with more than four authors. In a new trend, scientists are also collaborating with researchers at the national and international levels. But how much collaboration is effective and from which year this trend came out that is showing in this Table 2.

A total number of multiple authors against a total number of multiple and single authors in a specific year brings the result, where 0.97 collaboration was in 2015 and between 0.90-0.95 collaboration happened in 2010-13, 2016, 2019. But in 2018 it was true that the total numbers of authors are 14 but most of them preferred single authorship patterns rather than collaboration patterns (0.35). So the conclusive result is that the average publication per author in 2018 is far better (4.21) than any other year.

Table 2: Distribution of Authorship pattern and Degree of collaboration

Author Productivity	Average pub. per author	0.42	0.34	0.48	0.40	0.40	0.37	0.31	0.41	4.21	0.40	--
	No. of Publication	9	10	12	28	35	31	26	27	59	97	334
Degree of Collaboration	Degree of collaboration	0.90	0.96	0.88	0.95	0.93	0.97	0.95	0.89	0.35	0.92	--

Year	Distribution by Authorship Pattern										Number of Articles	(%)	Single author (N1)	Multiple author (N2)	(N1+N2)	
	1	2	3	4	5	6	7	8	9	10						10>
2010	2	3	3	1	0	0	0	0	0	0	0	9	2.70	2	19	21
2011	1	4	3	1	0	1	0	0	0	0	0	10	2.99	1	27	28
2012	3	5	4	0	0	0	0	0	0	0	0	12	3.59	3	22	25
2013	3	11	11	3	0	0	0	0	0	0	0	28	8.38	3	67	70
2014	6	16	5	7	1	0	0	0	0	0	0	35	10.48	6	80	86
2015	2	14	9	5	1	0	0	0	0	0	0	31	9.28	2	80	82
2016	4	4	9	7	0	0	1	0	0	1	0	26	7.80	4	79	83
2017	7	6	10	4	0	0	0	0	0	0	0	27	8.08	7	58	65
2018	9	28	15	6	0	1	0	0	0	0	0	59	17.66	9	5	14
2019	17	49	20	5	2	0	0	2	1	1	0	97	29.04	17	221	238
Total	54	140	89	39	4	2	1	2	1	2	0	334	100	54	658	712

Author's Collaborative index measurement: Collaborative coefficient (CC) (Singh 2017) shows the average number of authors per paper or proportion of multiple authors' publications. How much collaboration is relevant or necessary and how the degree of collaboration effective can be measured by CC index (Ajiferuke, Burell, and Tague 1988).

$$\begin{aligned}
& [\{ (f_1)1 + (f_2)2 + (f_3)3 + (f_4)4 + \dots + (f_k)k \} / N] \\
& = [\{ (2) + (3)2 + (3)3 + (1)4 \} / 9] \\
& = [\{ 2 + 6 + 9 + 4 \} / 9] \\
& = [21 / 9] \\
& = 2.33 \text{ (in 2010, as such others are calculated)}
\end{aligned}$$

Table 3: Collaborative co-efficient index measurement

Year of Publication	No. of Publication	No. of Authors	Number of Authors						CC
			One	Two	Three	Four	Five	Six or above	
2010	9	21	2	3	3	1	0	0	2.33
2011	10	28	1	4	3	1	0	1	2.60
2012	12	25	3	5	4	0	0	0	2.08
2013	28	70	3	11	11	3	0	0	2.50
2014	35	86	6	16	5	7	1	0	2.45
2015	31	82	2	14	9	5	1	0	2.64
2016	26	83	4	4	9	7	0	2	3.23
2017	27	65	7	6	10	4	0	0	2.40
2018	59	14	9	28	15	6	0	1	2.37
2019	97	238	17	49	20	5	2	4	2.56
Total	334	712	54	140	89	39	4	8	--

According to Table 3, CC value was maximum in 2016 (3.24) and the minimum was in 2012 (2.08). The average collaboration was 2.65. During 2010-19 the CC value was not static, overall CC is 0.82 (82%) which means the degree of collaboration is positive.

Most productive authors

Table 4: Top 10 productive authors

Sl.No.	Name of Authors	Number of publications
1	B. M. Gupta	46
2	R. Gupta	24
3	S. M. Dhawan	17
4	V. K. Singh	17
5	A. Uddin	12
6	A. Bala	9
7	S. Kumar	9
8	K. C. Garg	8
9	B. S. Kademani	8
10	K. Bhanumurthy	7

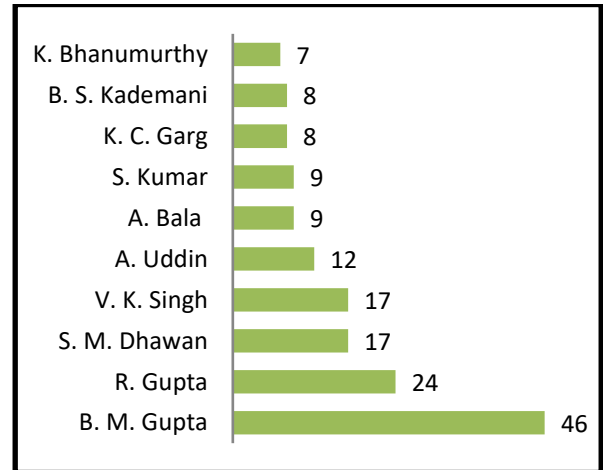


Figure 2: Author wise publications distribution

From this table and diagram scholars have interpreted that B. M. Gupta is the highest productive Indian author in this domain, he has produced 46 publications during 2010 to 2019. We have found 712 numbers of authors during this period. R. Gupta has got the 2nd position with 24 publications. S. M. Dhawan and V. K. Singh both are ranked jointly 3rd with 17 publications.

Most cited paper

Now a day scientometric is a burning topic all over the world. Thousands of research output have come out. But according to India during 2010-19 only 334 research works have been published. The most cited paper titled “Mapping the intellectual structure of scientometrics: A co-word analysis of the journal scientometrics (2005–2010)” was published in “Scientometric” journal. The paper titled “Analytical

mapping of opinion mining and sentiment analysis research during 2000–2015" has been cited 86 times which is published by the "Information Processing and Management" journal.

Table 5: Journal wise most cited paper

Title	Source Journal	No of Citation
Mapping the intellectual structure of scientometrics: A co-word analysis of the journal scientometrics (2005–2010)	Scientometrics	89
Analytical mapping of opinion mining and sentiment analysis research during 2000–2015	Information Processing and Management	86
Biodiesel production from Calophyllum inophyllum oil a potential non-edible feedstock: An overview	Renewable Energy	44
Mapping of nanoscience and nanotechnology research in India: A scientometric analysis, 1990-2009	Scientometrics	36
A scientometric analysis of mobile technology publications	Scientometrics	34
A scientometric analysis of Indian research output in medicine during 1999-2008	Journal of Natural Science, Biology and Medicine	30
Mapping of Indian neuroscience research: A scientometric analysis of research output during 1999-2008	Neurology India	30
Applied soft computing: A bibliometric analysis of the publications and citations during (2004–2016)	Applied Soft Computing Journal	28
Computer science research: the top 100 institutions in India and the world	Scientometrics	24
Scientometric mapping of research on ‘Big Data’	Scientometrics	23
Advances in Thermochemical Conversion of Biomass- Introduction	Recent Advances in Thermochemical Conversion of Biomass	23
Publication productivity of University of Kerala: A scientometric view	DESIDOC Journal of Library and Information Technology	23

Most favored journal

This table has been prepared with the top 12 journals where authors communicated mostly. The scientometric study is now a mash-up with library science and many other subjects. So, Table 6 is showing that medical, Library science, Engineering, etc. subject related journals are gathering together. And my most preferred journal is "Library Philosophy and Practice" where 114 research works published with 34.13 percentages of the total publication. "DESIDOC Journal of Library and Information Technology" has contained 33 works, Current science and scientometrics digested every 23 works. Out of 334 publications, 248 came from the top 12 listed journals, which is 74.25 percentages of the total contribution.

Table 6: Top twelve productive journal

Journal Name	No. of Publication	Percentage (%)
Library Philosophy and Practice	114	34.13
DESIDOC Journal of Library and Information Technology	33	9.88
Current Science	23	6.90
Scientometrics	23	6.90

Annals of Library and Information Studies	22	6.58
Malaysian Journal of Library and Information Science	8	2.39
Journal of Scientometric Research	5	1.50
Journal of Young Pharmacists	5	1.50
Innovations in Measuring and Evaluating Scientific Information	4	1.19
International Journal of Information Science and Management	4	1.19
Pharmacognosy Journal	4	1.19
Library Hi Tech News	3	0.90
Total	248	74.25

Fitness of author productivity with Lotka's Law

Lotka's inverse square law is used to verify author productivity frequency (Nicholls 1989). In this study productivity of scientometric in India has been tested through Lotka's law. Chi-Square hypothesis test has adequate for data set where

(5degree of freedom for tabulation value of χ^2 at level 5% was 60.203 and 1% was 69.312.)

Degree of Freedom = (row total-1) x (column total-1)
=45

Fe = (row total x column total) / total frequency
=1.59 (for 2010, similarly others are calculated)

Chi-Square = $\sum(\text{fo}-\text{fe})^2 / \text{fe}$ (where fe \approx Expected frequency, fo \approx Observe frequency)
=167.744

Through this calculation, the Chi-Square value comes out 167.744 which is greater than 5% and also 1% of tabulation value. So, it is highly significant and greater than the expected value. Now we can conclude that Lotka's law does not follow the author's productivity distribution in this study.

Distribution of Research output among states of India

In this study among 712 authors, 170 were from foreign countries. As the study is based on the Indian perspective, only Indian authors have mapped in this Table 7.

Table 7: Distribution of research output among states of India

State	No. of Authors	State	No. of Authors	State	No. of Authors	State	No. of Authors
Andhra Pradesh	12	Haryana	28	Maharashtra	48	Rajasthan	5
Assam	10	Himachal Pradesh	6	Meghalaya	1	Tamil Nadu	169
Bihar	1	Jharkhand	3	Mizoram,	14	Telangana	11
Chandigarh	18	Karnataka	79	New Delhi	191	Uttar Pradesh	46
Chhattisgarh	3	Kashmir	10	Odisha	24	Uttarakhand	6
Goa	2	Kerala	29	Punjab	21	West Bengal	39
Gujarat	7	Madhya Pradesh	6	Pondicherry	6	Foreigner	170

Most of the authors are affiliated with New Delhi (191) and Tamil Nadu (169) but it is true that from every corner of India, authors contributed their research works on scientometric study in Scopus.

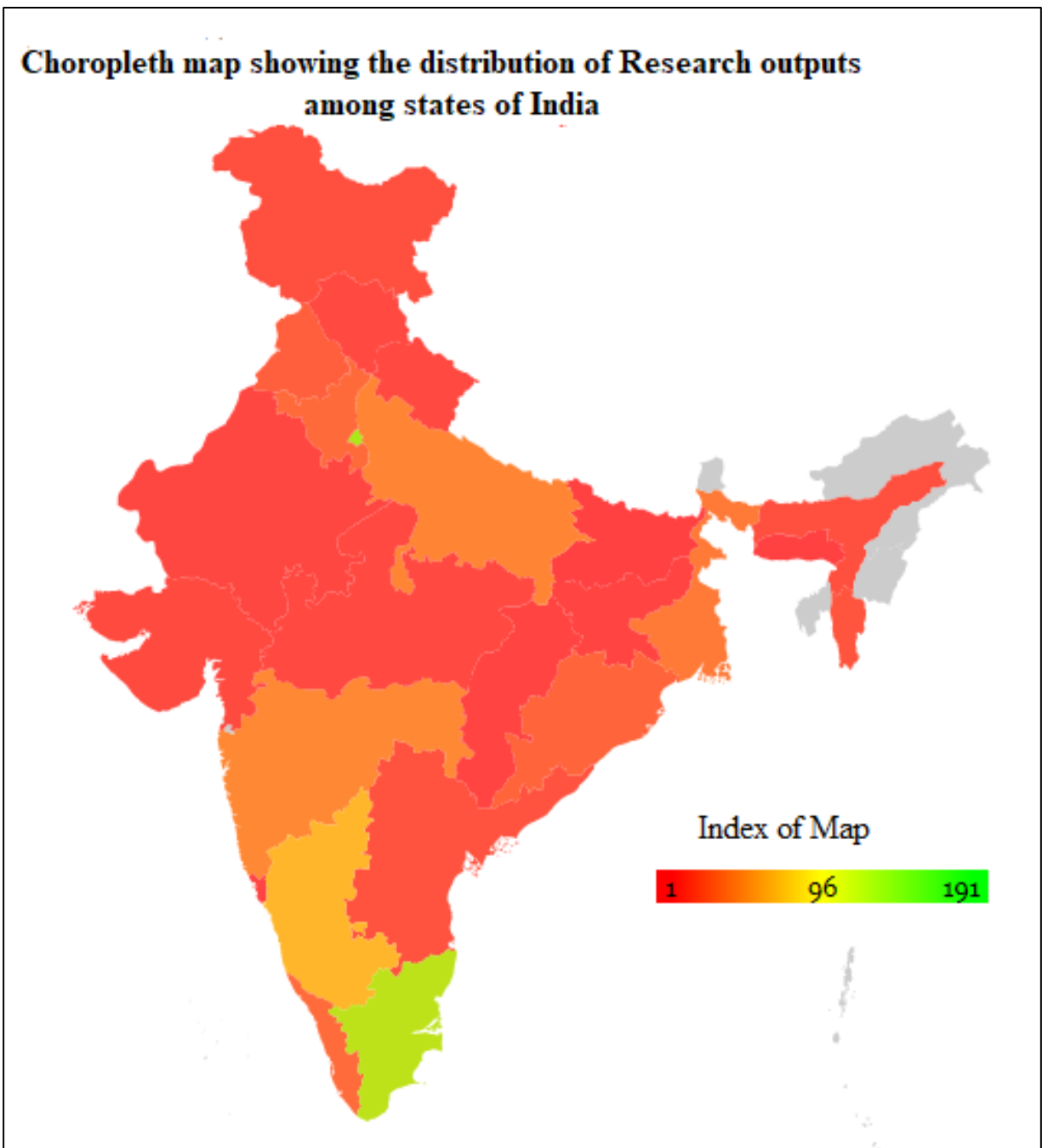


Figure 3: Distribution of Research output among states of India

Author keyword and Index keyword mapping

According to the Scopus database below Figure 4 has been prepared based on authors and index keywords which were used in scientometric study during 2010-19. It shows mostly used keywords are bright and bold and all interconnected terms are connected by a graphical line.

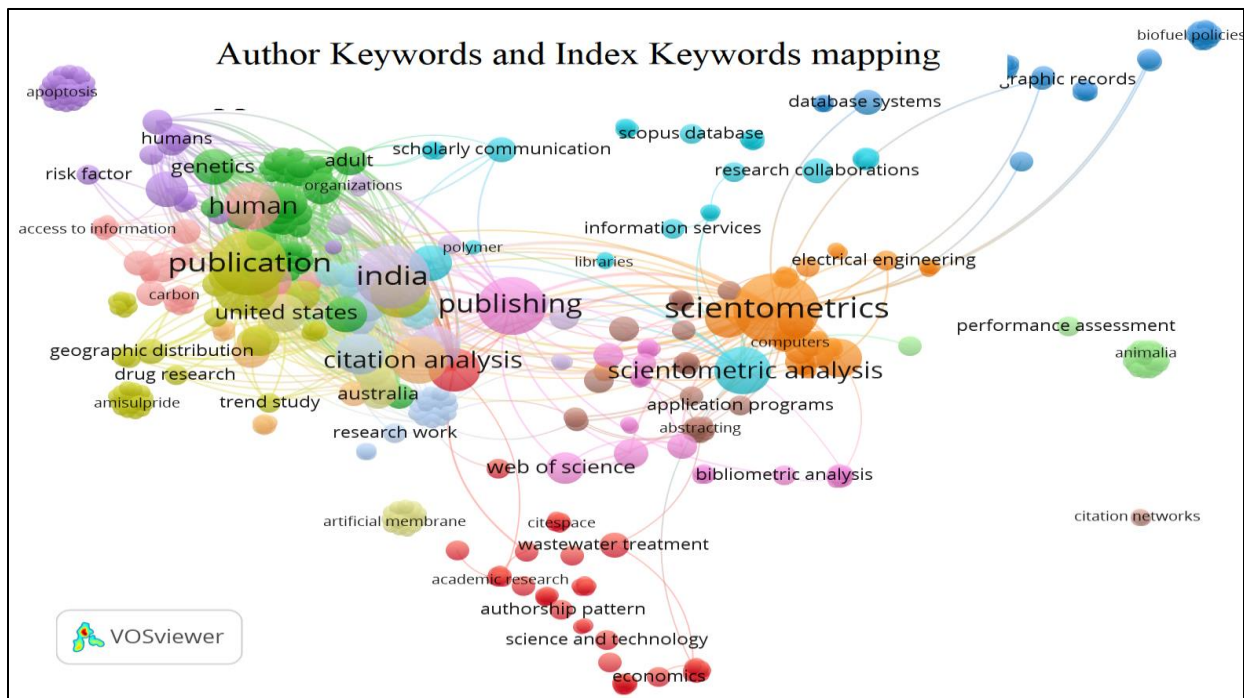


Figure 4: mostly used Author keyword and Index keyword mapping

Types of publication

Table 8: Publication types wise distribution

Document Type	Record Count	Percentage (%)
Article	289	86.52
Conference Paper	18	5.39
Book Chapter	12	3.60
Review	10	3.00
Letter	4	1.19
Note	1	0.30
Total	334	100

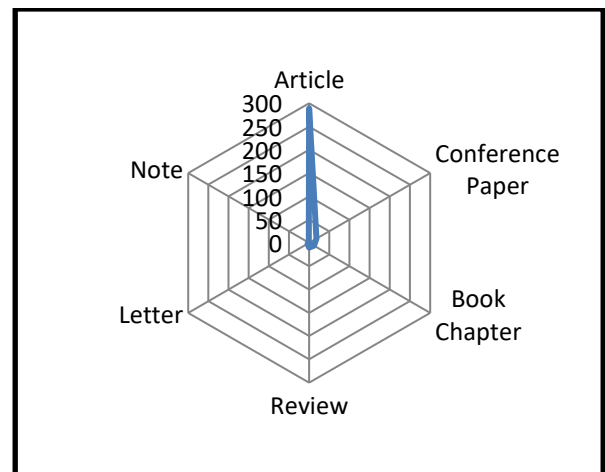


Figure 5: Production distribution with publication format

The above data table and diagram give a complete image of production distribution according to types of publication format. Several 289 publications (86.52 %) came from “Article” among all publications format out of total research output. Rest of total 13.84 percentages research output came from others type publication format namely, Conference Paper (5.39 %), Book Chapter (3.60 %), Review (3.00 %), Letter (1.19 %) and Note (0.30 %).

Co-author network mapping

This figure is prepared based on Table 2 and Table 3. Most of the productive authors and their collaborative authors (Basu and Kumar 2000) have mapped in this diagram and through different colors, year wise variation is also shown.

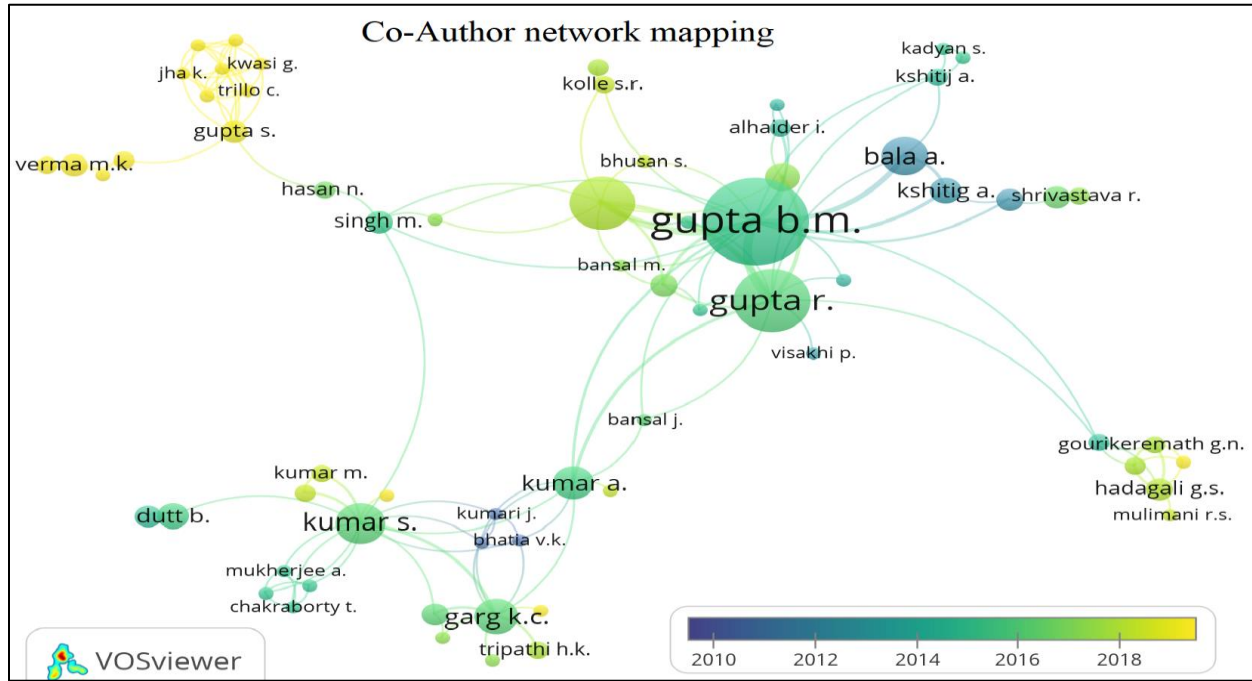


Figure 6: Co-authorship network mapping among most productive authors

Conclusion

Over the last 10 years (2010-2019), Indian authors' contribution on scientometric domain showing that this the most popular focused area in Indian research of Science and Technology domain as well as Library Science and others subject discipline. This paper has represented qualitative as well as quantitative contributions of Indian researchers in the field of scientometric from 2010 to 2019. Indian authors have produced a total of 334 research publications during this period and the majority of publications were published in the year 2019 with 29.04 percentages of total publications followed by in the year 2018 and 2015 with 17.66 and 10.48 percentages respectively. The article titled "*Mapping the intellectual structure of scientometrics: A co-word analysis of the journal scientometrics (2005–2010)*" is the top cited paper of "Scientometric" journal and B. M. Gupta is the highest productive Indian author in this domain. The journal "Library Philosophy and Practice" has produced the highest number of publications (114) or 34.13 percentages of total output. "DESIDOC Journal of Library and Information Technology" has contributed 9.88 percentage of the total with 33 publications. From collaborative coefficient (CC) index measurement (Table No.3) researchers may conclude that the degree of collaboration is positive because of overall CC value is 0.82. In 2016 CC value was a maximum of 3.24 and the average collaboration value is 2.65.

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