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# Mapping of Authorship Pattern and Collaborative Research on Fossil Fuels Publications indexed in A & HCI and SCI-Expanded

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## Abstract

This study has made an attempt to identify the authors' research performance in terms of publication output and their citations to know about the authorship pattern and analysis, author productivity, author relationship and collaborative research on fossil fuel scientific publications which are indexed in A & HCI and SCI- Expanded during 1989-2016. The necessary data was extracted and the total number of scholarly articles was 943, h-index was 73 and average citations per item was 28.63, the total sum of times cited was 26,997, citing articles was 21,694, without self-citations was 21,324 scores. This paper discusses the authorship pattern; most productive authors; collaborative authors using Degree of Collaboration (DC); highly cited authors at global as well as local level; the Average Authors Per Paper (AAPP); the Average Productivity Per Author (APPA) and different types of scholarly publications on fossil fuels published by the Indian authors during the study period.

**Keywords:** Authorship pattern, Scientometrics, Bibliometrics, Fossil fuels, Web of Science, Degree of Collaboration (DC); Scholarly communication.

## Introduction

According to COBUILD Advanced English Dictionary, "fossil fuel is fuel such as coal or oil that is formed from the decayed remains of plants or animals" whereas Collins English Dictionary says that "any naturally occurring carbon or hydrocarbon fuel, such as coal, petroleum, peat, and natural gas, formed by the decomposition of prehistoric organisms". Further, fuels such as gas, coal, and oil, that were formed underground from plant and animal remain millions of years ago (Cambridge Advanced Learner's Dictionary & Thesaurus). Fossil fuels formed from the fossilized remains of the dead plant which was first introduced by Georgius Agricola in 1556 and later by Mikhail Lomonosov in the 18th century (Novaczek, 2000). Fossil fuels come under non-renewable energy resources that are getting depleted rapidly with time. Energy is the indispensable source for the essential activities in various fields like medicine, agriculture, construction, trade and commerce, transportation, industry etc. on the whole, energy gives the way for the development of a nation.

Scientometrics is one of the measuring techniques in the field of Library and Information Science in order to identify the research growth of scholarly publications such as journal articles,

reviews, conference proceedings, notes, letters etc. further, this method is used to measure the authors' research performance and institutions and countries growth too. According to Dictionary of Bibliometrics, Scientometrics applies "the bibliometric techniques to science and examines the development of the sciences". Van Raan (1997) says that "scientometric research is devoted to quantitative studies of science and technology. It aims at the advancement of knowledge and the development of science and technology; it is also in relation to the social and political question". According to Tague-Sutcliffe (1992), Scientometrics is "the study of the quantitative aspects of science as a discipline or economic activity. It is part of the sociology of science and has application to science policy-making. It involves quantitative studies of scientific activities, including, among others, publications, and so overlaps bibliometrics to some extent".

## **Literature Review**

Review of related literature is a part and parcel of any discipline to identify the previous scientists' works in terms of research design, research pattern and research analysis. For the present study, few recent studies have been taken into account, which is apt for it. Narzary and Murugan (2017) measured the authorship and collaborative research in ETRI Journal using scientometric indicators with 939 research papers. The study showed that a good number of publications were found in 2013 and the multi-authored publications were predominant. Murugan and Balasubramani (2012) analyzed the scientometric mapping on Remote Sensing literature at the global level during 1975-2010. The findings showed that out of 59 countries, only top fifteen were selected for research and found that USA was ranked first with (39.8%) publications, followed by UK (10.8%) and India got a third rank (7.8%). A total of 3735 authors published papers and out of it, single author publications were only 17% of the total articles. Two authors (18.94%), 21.04% were from three authors etc, and this study revealed that joint authors contributed more, compared to single authors.

Hydar Ali and Adithya Kumari (2016) examined the authorship patterns in Biodiversity Literature during 1989-2016 with 154654 research articles. The results showed the authorship trend, where solo authored articles declined and collaborative contributions expressed an increased trend and the collaborative index value of 4.50, indicate the popularity in terms of shared research pattern than the single research in biodiversity publications. Kollé (2016) tried to focus the authorship pattern and publication growth in the Indian Journal of Traditional Knowledge using bibliometric techniques to measure the research output during 2007-2015. A total number of 990 research publications were found including four types of manuscripts such as articles, review, editorial material, corrections, and biographical item. The results revealed that the major proportion of research papers were published by joint authors (30.91%) and only a small number of papers (9.80%) were from a single author and noted collaborative research is evident in the journal during the study period. Velmurugan (2018) carried out a study in Nephrology literature produced by Indian Scientists during 2011-2016. It was found that the USA got ranked first and the degree of collaboration was evaluated and the average degree of collaboration was 0.86. The growth rate of multi-authored contributions was more compared to single-authored papers. Singh (2017) examined the authorship and collaboration pattern in Biotechnology with special reference to IBSA countries during 2007-2016. A total of 24,888 research publications were retrieved from Scopus database. For analysis, scientometric indicators such as Collaboration Coefficient, Authorship pattern, and Activity Index were used to measure

the appropriate record count. As a result, multi-authored papers were predominant than solo authorship.

### **Scope and objectives of the study**

The main purpose of this study is to observe the current research trends in the field of fossil fuels which were contributed by the Indian authors. The study undertaken is limited to 25 years from 1991-2016 and as far as the paper is concerned, there is no such a study, which has been carried out for this particular analysis so far. Further, the other objectives are to:

- Analyze the year wise contributions and to examine the different kinds of documents on fossil fuels in India;
- Know about the authorship pattern and to identify the top ten productive authors;
- Evaluate the collaborative authors on fossil fuels using the Degree of Collaboration (DC);
- Find out the top 10 highly cited prolific authors at global as well as local level and
- Identify the Average Authors Per Paper (AAPP) and to know about the Average Productivity Per Author (APPA) on fossil fuels.

### **Methodology**

The data was collected from Web of Science database using the term “Fossil fuel” and refined by Country “India” for the period from January 1989 to December 2016 indexed in SCI-Expanded, A & HCI. But, we retrieved the data only for the year 1991 and 1993 to 2016 and we could not collect any data for the years 1989 and 1992, as there is no available data for these particular years and therefore, we collected a total of 943 research articles for the analysis, except those years. A total number of seven types of bibliographic documents such as articles, reviews, an article in proceedings papers, editorial materials, letters, an article in the retracted publication, and notes were identified. The hiscite bibliographic software is used and the data was transferred to an Excel spreadsheet for further statistical analysis. Moreover, to evaluate the data, simple percentage and other scientometric indicators such as Degree of Collaboration (DC), the Average Authors Per Paper (AAPP); the Average Productivity Per Author (APPA) and software such as HistCite to retrieve the data and VOS viewer for mapping the literature output and trend lines techniques such as linear growth model and exponential growth models were also applied to data analysis in terms of authorship pattern, number of authors, place of authors, number of publications, year wise contribution, types of contributions, and many more features during the period of study.

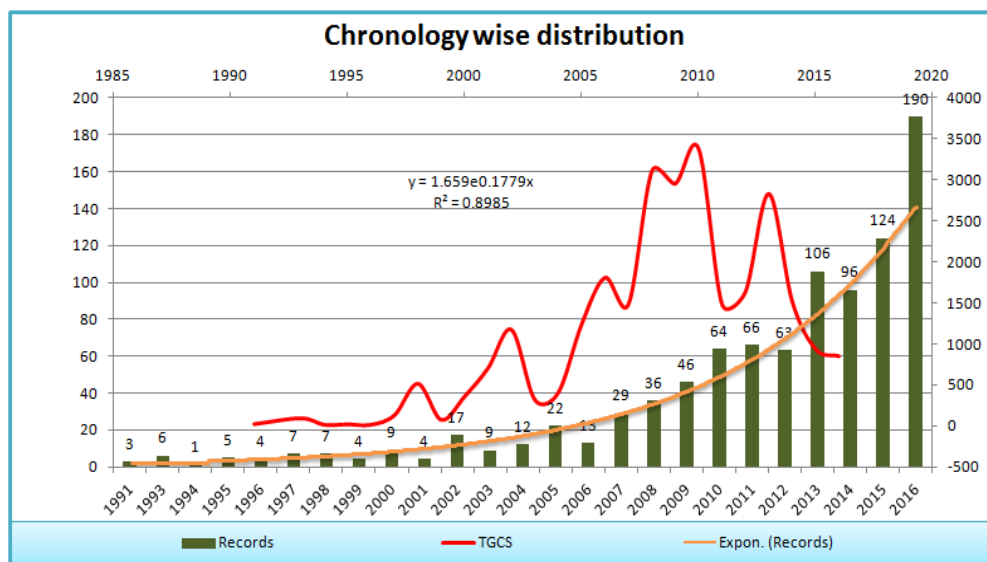
## Results and Discussion

Based on the data of fossil fuel literature in India retrieved from the Web of Science (WoS), a total of 943 scholarly papers along with 759 local citations and 26997 global citations were found during the period of 25 years from 1989 to 2016.

### Chronology wise distribution

It is inferred from the figure 1, the chronology-wise distribution of fossil fuels publications produced by Indian authors from 1991 to 2016. The publications range was from 1 in 1994 to 190 in 2016. It is shown from the table 1 that the major proportion of 21.1% of research articles was published in the year 2016 and followed by 31.1% of articles were in 2015. The counted citations based on the data and the range was from 6 to 3385 and the huge number of global citations was 3385 in the year 2010. We employed trend line techniques i.e. exponential growth model and found  $y$  value is  $1.659e^{0.1779x}$  and  $R^2$  value is 0.8985 and it shows the level of growth rate has gradually increased during the study period.

Figure 1: Chronology wise distribution



### The ranking order of Authors and their h-index on fossil fuel research

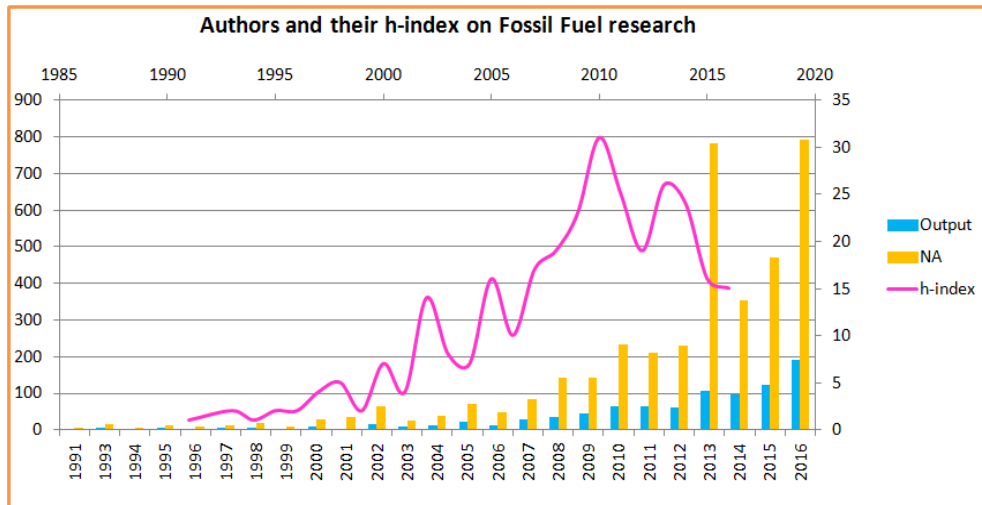
Table 1 and figure 2 shows the ranking of authors on fossil fuel literature output published by Indian authors, a total number of authors and their mean value and also their h-index were computed. In this context, it is analyzed and noted that the range of a number of authors was from 5 to 792 during 1991-2016. The maximum number of authors was found in the year 2016 and the least number of authors was found in 1991 as well as 1994 respectively. It is identified that there was no progressive trend in terms of publications from the year 1991 to 2007 and the growth level has been increased from the year 2008 onwards during the study period.

Further, we have analyzed the ranking of authors and their h-index and the range was from 1 to 31 and the majority of h-index (31) in terms of authors as well as research output was in the year 2010 and the small amount of h-index (1) was in the year 1991.

Table 1: Authors and their h-index on Fossil Fuel research

Year	Total Output	Total no of authors	Mean no of authors	h-index	Rank
1991	3	5	1.67	1	17
1993	6	17	2.83	2	16
1994	1	5	5.00	1	17
1995	5	12	2.40	2	16
1996	4	11	2.75	2	16
1997	7	12	1.71	4	15
1998	7	20	2.86	5	14
1999	4	9	2.25	2	16
2000	9	30	3.33	7	13
2001	4	36	9.00	4	15
2002	17	64	3.76	14	10
2003	9	27	3.00	8	12
2004	12	40	3.33	7	13
2005	22	70	3.18	16	8
2006	13	48	3.69	10	11
2007	29	85	2.93	17	7
2008	36	141	3.92	19	6
2009	46	143	3.11	23	5
2010	64	232	3.63	31	1
2011	66	210	3.18	25	3
2012	63	229	3.63	19	6
2013	106	782	7.38	26	2
2014	96	354	3.69	24	4
2015	124	470	3.79	16	8
2016	190	792	4.17	15	9
Total	943	3844			

Figure 2: Authors and their h-index on fossil fuel research



### The ranking order of authors and their citations (top 25)

Prolific authors and eminent scholars and researchers are a very essential source of information in any field of knowledge. It is important to identify the productive authors and their related works which are vital for any research. In this regard, the purpose of the table is to locate some (top 25) most productive authors in the field of fossil fuel literature. A rank list is prepared based on the frequency of scientific publications and citations used.

Table 2 shows the pattern of authors and their records, percentage, local citation score, and global citation score and cited references and ranking of the publications according to their research performance. It is very clear that Kumar A is the most prolific author with 17 research publications. Kumar S and Tiwari S have ranked second with 14 papers each and followed by Sharma MP and Srivastava AK who got the third place with 13 scholarly articles each. According to the frequency of citations, Venkataraman C was ranked first among the top 25 authors and it is found that the local citations score was 80 and global citation score was 1825.

Table 2: Ranking of Authors (top 25)

Rank	Author	Total Records	Total Percent	Total Local Citations	Total Global Citations
1	Kumar A	17	1.8	9	270
2	Kumar S	14	1.5	5	260
2	Tiwari S	14	1.5	21	149
3	Sharma MP	13	1.4	38	881
3	Srivastava AK	13	1.4	28	315
4	Sarin MM	12	1.3	30	318
4	Venkataraman C	12	1.3	80	1825
5	Jain S	11	1.2	12	351
6	Babu SS	10	1.1	25	190

6	Banerjee R	10	1.1	0	70
6	Singh S	10	1.1	14	123
7	Bisht DS	9	1.0	20	118
7	Sharma D	9	1.0	1	99
8	Agarwal AK	8	0.8	16	311
8	Das D	8	0.8	10	435
8	Ghosh S	8	0.8	5	66
8	Kumar R	8	0.8	17	155
8	Lal S	8	0.8	28	543
8	Mandal TK	8	0.8	12	105
8	Moorthy KK	8	0.8	24	182
8	Nagarajan G	8	0.8	7	153
8	Rao PSP	8	0.8	31	355
8	Singh D	8	0.8	18	602
8	Tripathi SN	8	0.8	7	350
9	Abbasi SA	7	0.7	16	354

### Top 10 Highly Cited Authors (Global Level)

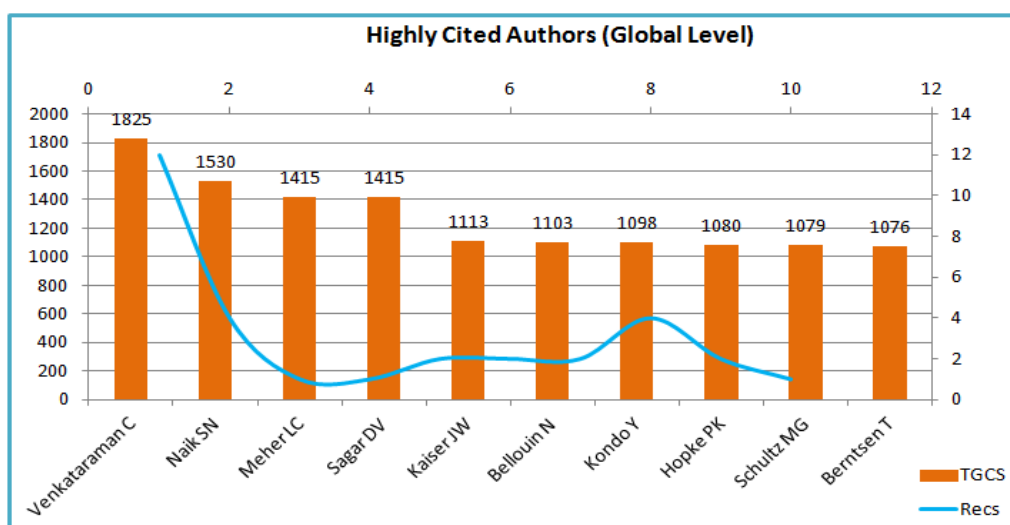
Table 3 and figure 3 shows the highly cited authors in global level fossil fuel research and the data for the analysis made only for the top 10 productive authors. The total records, percentage, citations, cited references etc were counted. Among the top 10 authors, the maximum number of 1825 global citations with 12 research papers was for ‘Venkataraman C’ from the department of Centre for Environmental Science & Engineering, Indian Institute of Technology, Mumbai, India and followed by ‘Naik SN’ with 1530 citations got for 4 research articles from the Department of Centre Rural Development & Technology, Indian Institute of Technology Delhi, India and the least number of 1076 global citations received by ‘Berntsen T’ and the 1076 global citations was for only one paper from the Department of Geoscience, University of Oslo, Norway.

Table 3: Top 10 Highly Cited Authors (Global Level)

#	Author	Recs	Percent	TLCS	TLCS/t	TGCS	TGCS/t	TLCR
1	Venkataraman C	12	1.3	80	8.49	1825	325.69	22
2	Naik SN	4	0.4	28	2.75	1530	145.35	0
3	Meher LC	1	0.1	25	2.27	1415	128.64	0
4	Sagar DV	1	0.1	25	2.27	1415	128.64	0
5	Kaiser JW	2	0.2	16	4.00	1113	278.25	6
6	Bellouin N	2	0.2	16	4.00	1103	271.08	6
7	Kondo Y	2	0.2	16	4.00	1098	273.40	5
8	Hopke PK	4	0.4	18	5.00	1080	272.00	24
9	Schultz MG	2	0.2	17	4.50	1079	270.50	6
10	Berntsen T	1	0.1	16	4.00	1076	269.00	5



Figure 3: Top 10 Highly Cited Authors (Global Level)



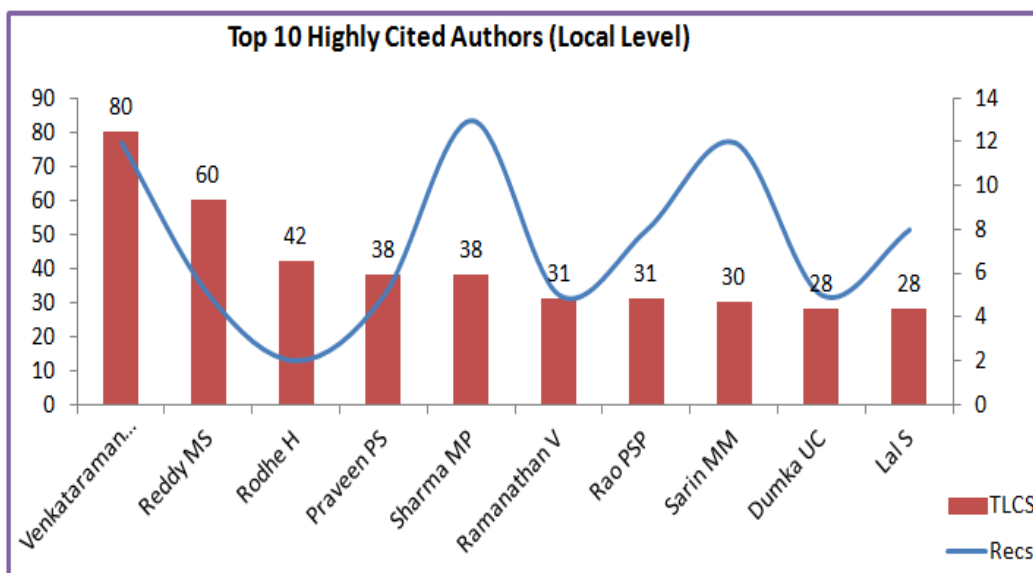
### Top 10 Highly Cited Authors (Local Level)

It is understood from the data of table 4 and figure 4 the highly cited authors at local level in fossil fuel publications and found as expected the most productive local citations was 80 with 12 records occupied by 'Venkataraman C' from the department of Centre for Environmental Science & Engineering, Indian Institute of Technology, Mumbai, India. The second productive local citations 60 with 5 research articles received by 'Reddy, MS' from the Department of University Science & Technology Lille, Opt Atmosphere Lab, University of Paris, France. The third productive local citations score 42 with only 2 papers was got by 'Rodhe H' from the Department of Meteorology, Stockholm University in Sweden. The small amount of local citations 28 with 8 records was by 'Lal S' from Physics Research Laboratory in Ahmedabad, Gujarat, India.

Table 4: Top 10 Highly Cited Authors (Local Level)

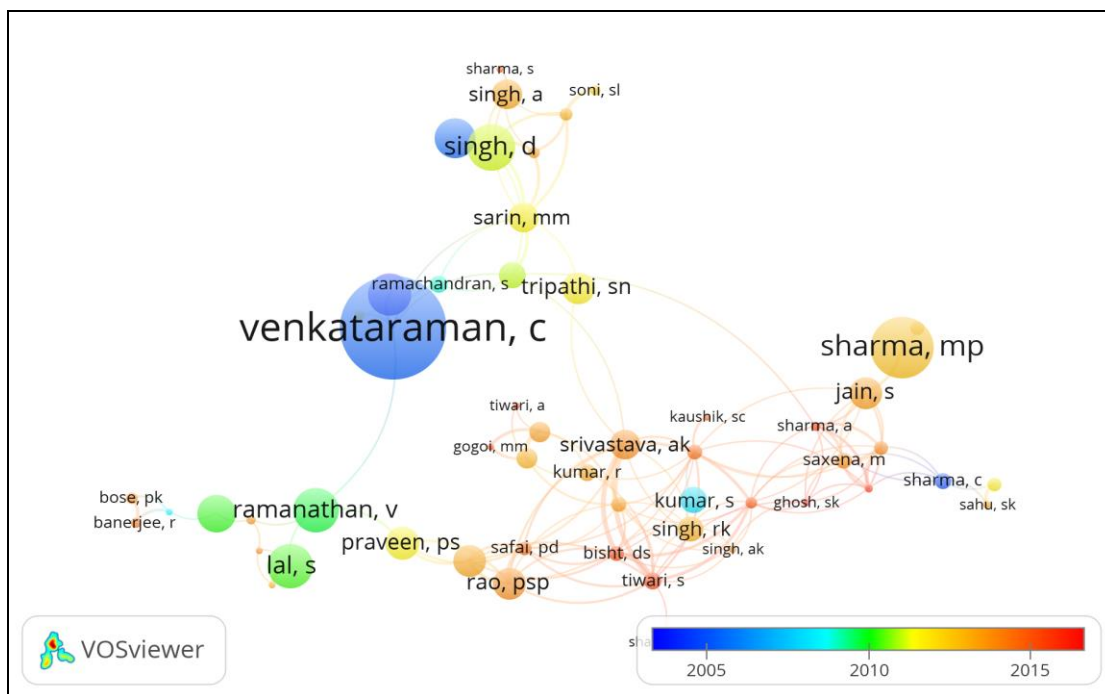
#	Author	Recs	Percent	TLCS	TLCS/t	TGCS	TGCS/t	TLCR
1	Venkataraman C	12	1.3	80	8.49	1825	325.69	22
2	Reddy MS	5	0.5	60	4.03	516	35.99	8
3	Rodhe H	2	0.2	42	4.06	699	59.25	4
4	Praveen PS	5	0.5	38	5.76	359	53.74	14
5	Sharma MP	13	1.4	38	7.86	881	148.98	23
6	Ramanathan V	5	0.5	31	3.32	557	49.86	7
7	Rao PSP	8	0.8	31	4.96	355	62.33	31
8	Sarin MM	12	1.3	30	4.51	318	54.59	25
9	Dumka UC	5	0.5	28	5.49	123	23.10	23
10	Lal S	8	0.8	28	2.61	543	44.98	12

Figure 4: Top 10 Highly Cited Authors (Local Level)

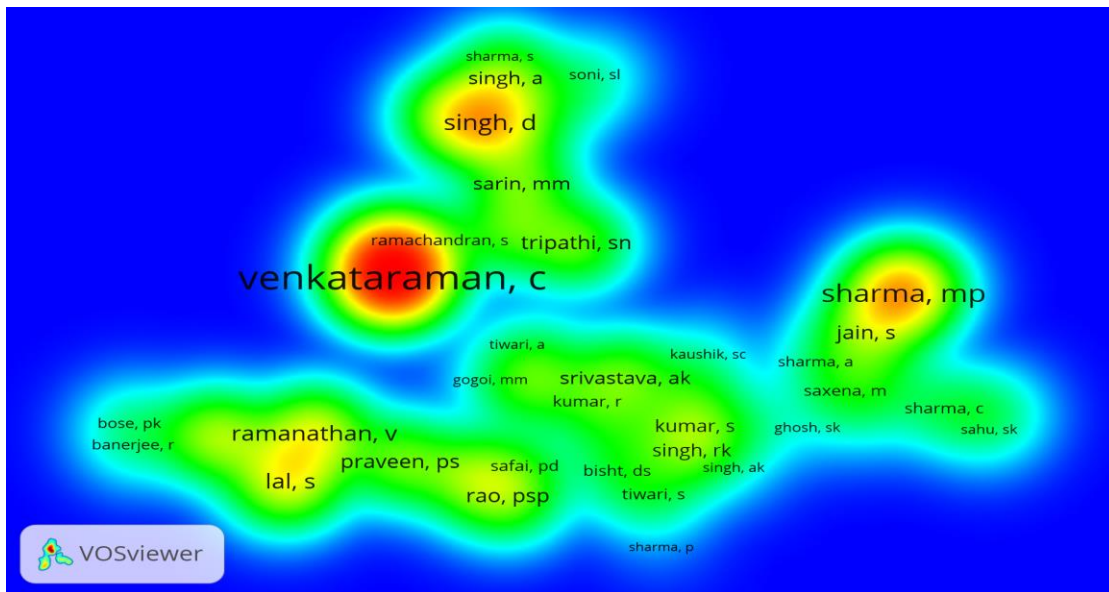


Vos viewer is one of the network-based visual mapping software which is widely used software all over the world for the purpose of projecting the data in the form of mapping. This technique consists of three types such as network visualization, overlay, and density visualization. For this present study, we have taken only two types such as overlay and density visualization mapping for analysis.

Map 1: Overlay visual of authors



Map 2: Density visual of authors



### Degree of Collaboration

Table 5 and figure 5 illustrates the degree of collaboration on fossil fuel research in India and it is defined as the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period of time. The formula has been used for the present study and shown below which is suggested by K.Subramanyam.

$$\text{The formula is } C = \frac{Nm}{Nm + Ns}$$

Where,

C – Degree of collaboration;

Nm – the number of multi-authored papers;

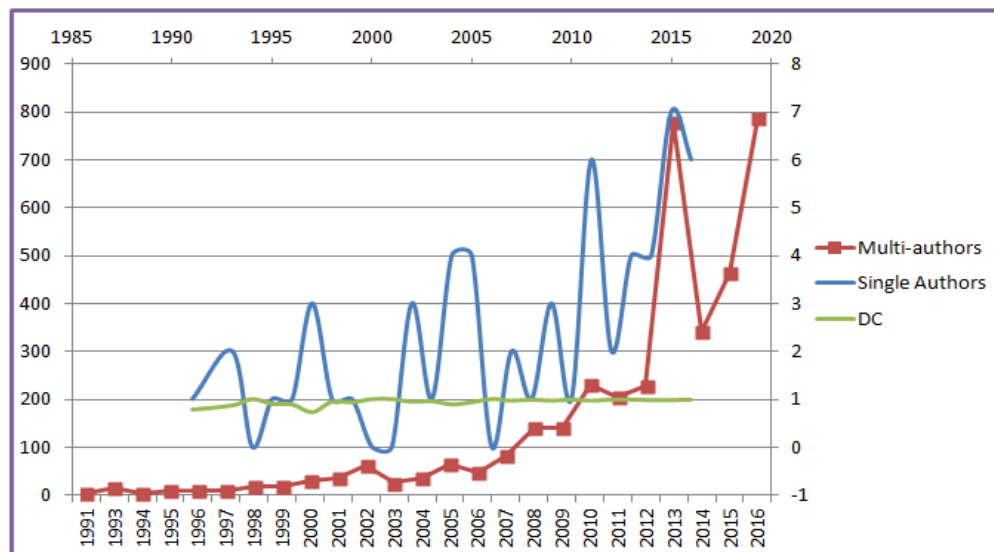
Ns – the number of single-authored papers.

Table 5: Degree of Collaboration on Fossil fuels in India

Year	SAs	MAs	DC
1991	1	4	0.8
1993	2	15	0.88
1994	0	5	1
1995	1	11	0.91
1996	1	10	0.90
1997	3	9	0.75
1998	1	19	0.95
1999	1	18	0.94

2000	0	30	1
2001	0	36	1
2002	3	61	0.95
2003	1	26	0.96
2004	4	36	0.9
2005	4	66	0.94
2006	0	47	1
2007	2	83	0.97
2008	1	140	0.99
2009	3	140	0.97
2010	1	231	0.99
2011	6	204	0.97
2012	2	227	0.99
2013	4	778	0.99
2014	4	341	0.98
2015	7	463	0.98
2016	6	786	0.99
Total	58	3786	0.98

Figure 5: Degree of Collaboration on Fossil fuels



The degree of Collaboration (DC) is a prominent area of research in scientometric studies which indicate trends in single and joint authorship from 1989 to 2016. The degree of collaboration ranges from 0.75 to 1 and the average degree of collaboration was 0.98 which clearly represents that its dominance upon multi-authored contributions. Table 5 shows that the Degree of Collaboration (DC) in authorship on “Fossil fuels literature in India”, and found that the multi-authored papers were more than that of single-authored papers.

## Author productivity and Collaborative index (CI)

The evaluated pattern of the collaborative index (CI) which is also called as average productivity per author (APPA), has been measured with the total number of scholarly publications and a total number of authors in the field of fossil fuel research in India for a period from 1991 to 2016 except 1992. The range of collaborative index is from 0.11 to 0.6. The maximum range of productivity is 0.6 in the year 1991.

Table 6: Author productivity and Collaborative index (CI)

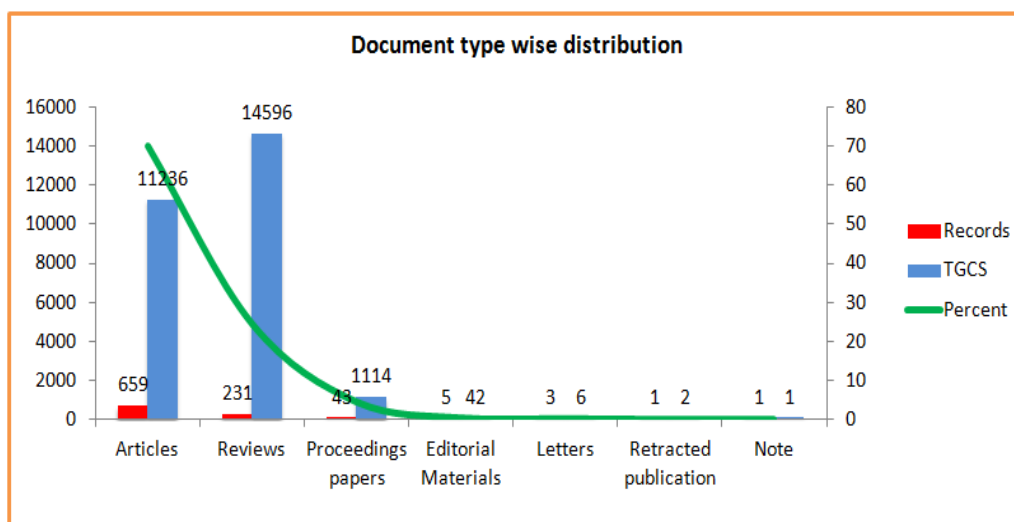
Year	Total number of Papers	Total number of Authors	AAPP*	Productivity per author
1991	3	5	1.67	0.6
1993	6	17	2.83	0.35
1994	1	5	5	0.2
1995	5	12	2.4	0.42
1996	4	11	2.75	0.36
1997	7	12	1.71	0.58
1998	7	20	2.86	0.35
1999	4	9	2.25	0.44
2000	9	30	3.33	0.3
2001	4	36	9	0.11
2002	17	64	3.76	0.266
2003	9	27	3	0.33
2004	12	40	3.33	0.3
2005	22	70	3.18	0.31
2006	13	48	3.69	0.27
2007	29	85	2.91	0.34
2008	36	141	3.92	0.255
2009	46	143	3.11	0.32
2010	64	232	3.63	0.28
2011	66	210	3.18	0.31
2012	63	229	3.63	0.28
2013	106	782	7.37	0.13
2014	96	354	3.69	0.27
2015	124	470	3.79	0.26
2016	190	792	4.17	0.24
Total				

\*Average Authors per Paper (AAPP) = Number of authors/ Number of papers.  
Productivity per author= Number of papers/ Number of authors.

## Types of contributions

Seven different kinds of documents such as articles, reviews, an article in proceedings papers, editorial materials, letters, an article from retracted publication, and notes were identified. Figure 4 shows that among the seven documents, journals articles are the primary source with 659 (69.9%) records and got placed first. The next productive document was review papers (24.5%), and articles in proceeding papers (4.6%) and placed the third rank. Other items such as the editorial materials (0.5%), Letters (0.3%), article from retracted publication and notes were each 0.1%. The citations were also noted based on the output and found that a huge number of citations at the global level were 14596 based on the review papers and the next prolific numbers were 11236 according to articles.

Figure 4: Document type wise distribution



## Findings and Conclusion

- ❖ It is found that the major proportion of 21.1% of research articles was published in the year 2016.
- ❖ It is noted that the maximum number of authors was found in the year 2016 and the least number of authors found in 1991 as well as 1994 respectively.
- ❖ It is identified that 'Kumar A' is the most prolific author with 17 research publications.
- ❖ It is noted that a huge number of 1825 global citations with 12 research papers got by 'Venkataraman C' from the department of Centre for Environmental Science & Engineering, Indian Institute of Technology, Mumbai, India, was among the top 10 authors.
- ❖ It is measured and seen that the majority of h-index in terms of authors, as well as research output, was in the year 2010 and the small amount of h-index was in 1991.

- ❖ According to the frequency of citations, Venkataraman C from the department of Centre for Environmental Science & Engineering, Indian Institute of Technology, Mumbai, India got ranked first among the top 25 authors and it is found that the highest local citations score was 80 and global citation score was 1825.
- ❖ The degree of collaboration ranges from 0.75 to 1 and the average degree of collaboration was 0.98 which clearly represents the dominance of multi-authored contributions.
- ❖ It is inferred from the analysis of the seven documents, that journals articles are the primary source with 659 (69.9%) records and got placed first. The next productive document was review papers with 24.5%.

It is examined and concluded that on the basis of the previous literature studies, it is found that there are no such studies found in the discipline/topic of 'authorship pattern and collaborative research work on fossil fuels in India' during the particular study period. As a result, in future, this present study will surely help to research scholars, eminent scientists, and academicians to evaluate the current trends, development, and impact of fossil fuels research.

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