

A STUDY OF RESEARCH PUBLICATIONS OF RAJA RAMANNA CENTRE FOR ADVANCED TECHNOLOGY FROM 1987 TO 2020

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Publication patterns and trends of Raja Ramanna Centre for Advanced Technology (RRCAT) affiliation papers has been studied. The publication data was downloaded from two main sources, Web of Science (WoS) 'Science Citation Index - Expanded (SCI-E)' and 'Scopus'. In the database, appropriate search functions and keywords were applied to retrieve all relevant records; and data was analyzed using MS-Excel worksheet. The results of analyzed parameters showed that RRCAT research publications have steadily increased over the period. Publication growth trend per year as per Scopus was 8.52 and SCI-E was 6.70. The average increase during 1987-2020 in Scopus was 18.99 publications per year and 18.83 per year in SCI-E. The average number of Citation Per Paper (CPP) found in Scopus and SCI-E are 18.39 and 16.77 respectively. The largest number of papers 'document type' category was journal articles. The papers were scattered in 628 different publications as per Scopus and as per SCI-E, it was scattered in 447 journals. The Bradford's law of scattering formula was applied to find zone-wise number of journals. It was found that in zone-1 as per Scopus just 2.23% journals/publications have published 1/3 of total papers and as per SCI-E just 3.13% journals have published 1/3 of total papers. Most preferred journals of RRCAT researchers were also identified. Authorship patterns show that 95.97% of papers were collaborative work. All papers' title word analysis shows that the term 'laser' and 'optical' are used repeatedly in many papers' title. Though, the number of records in both databases varied, the study found a significant correlation in the results and only a marginal difference in some parameters. The study purpose of preparing a comprehensive list of RRCAT author's publications was also accomplished.

Keywords: Bibliometric analysis, Publication pattern and trend, Authorship pattern, Keyword analysis, RRCAT

INTRODUCTION

Raja Ramanna Centre for Advanced Technology, formerly Centre for Advanced Technology is a premier research and development unit of Department of Atomic Energy, Government of India. The scientific activities of the centre started in the year 1986; and the centre was renamed on December 17, 2005. The center is mainly engaged in R & D activities in the areas of laser, accelerator, and its related fields. The indigenously designed, developed, and commissioned two synchrotron radiation sources, Indus-1 and Indus-2 are national facilities serving the research communities round the clock (Gupta, 2013). R & D in the field of lasers is another major activity of centre and over the period it developed many laser systems and transferred technologies to industries.

Research works are communicated mainly to primary publications, such as journals, conference proceedings, scientific and technical reports, etc. Journals also known as serials or periodicals are one of the predominantly used channels by the researchers to disseminate research findings. The journals also play an important role among the scholarly communities for sharing their results, report experimental procedures, seek information, and building knowledge repository. Journals are mainly published by organizations such as societies, universities, research and development institutions, and commercial publishers. Journals usually cover multidisciplinary or specialized articles depending on the scope and aim of the concerned publication. Around 33100 active peer-reviewed English language journals and 9400 non-English language journals were published in Science, Technology, and Medicine (STM) areas worldwide. Every year they publish

around three million articles. The annual estimated growth rate of the number of STM articles was 3% (Johnson et al., 2018). The bibliographic details of published journal articles are indexed in abstracting and citation databases. The databases serve as a gateway to find published papers for scholarly communities. Users search for desired articles in these databases depending on the availability of access at the institution. The WoS SCI-E and Scopus are two leading commercial databases that offer online access to publications and citation records in various STM disciplines. Each database maintains its own standard of indexing policies, the number of documents in each database varies according to publications it covers. Apart from commercial databases, the number of free databases such as Google Scholar, PubMed, SAO/NASA Astrophysics Data System, Crossref, Microsoft Academic, etc. are also available to search publication and citation data. However, every database comes with its features and limitations from coverage to search and retrieval. Also, several research studies opined that no database comprehensively covers and indexes published literature.

Collecting and indexing bibliographical details of institution publications which produce a huge number of papers is an enormous task for the library and information centre. The comprehensive records collected show various bibliometric indicators of the institution. It also helps to understand the literature pattern and trends of the institution over the time. This study attempted to identify bibliometric indicators of RRCAT publications during 1987 to 2020.

LITERATURE REVIEW

Bibliometric and quantitative studies conducted in the past, based on the institution's research publications are reviewed. In an earlier study author quantitatively reported RRCAT research publications based on WoS data from 1995 to 2004; and found that the average growth rate during the period was 3.93% per year and 90.9% as multi-authored papers (Rajendiran, 2006). Research publications of five IIT (Indian Institute of Technology) retrieved from Scopus between 2006 and 2017 were analyzed using various bibliometric indicators and the results are discussed in the paper (Pradhan & Sahu, 2018). A scientometric study conducted with 14410 publications of All India Institute of Medical Sciences, New Delhi, felt that 20 years bibliometric study using PubMed and MedInd databases was more appropriate for better results (Nishavathi, E., & Jeyshankar, 2018). The publications study of Maharshi Dayanand University, Rohtak during 2000-2013 using Scopus database explored productive journals, prolific authors, subject-wise distribution of papers, etc (Sivach, & Kumar, 2015). A bibliometric study analyzes 801 research publications of Al-Jouf University, Dubai-based Scopus database and found year-wise publications, national and international collaboration, etc (Ahmed, & Al-Reyae, 2019). Another scientometric analysis found that journal articles as the most preferred publications; and gender-wise distribution of papers, authorship pattern, and other parameters were also discussed (Sudhier, & Priyalakshmi, 2013).

Some research papers that compare publications data as per WoS, Scopus, and other database together were also reviewed. A paper compared

252 subject categories citations count from Google Scholar (GS), WoS, and Scopus. The study reports that GS covers 95% of WoS and 92% Scopus citations. It also found that 48% to 65% GS citations are from non-journal sources (Martín-Martín et al., 2018). Review articles 'document type' verified in Scopus, WoS, PubMed, and publisher websites found that PubMed database has labeled more accurately than others databases and pointed both WoS and Scopus inaccurately mislabelled review papers as articles (Yeung, 2019). A comparative analysis done for journal coverage in Scopus and WoS with Ulrich's periodical database concluded that both databases are biased on coverage of English-language literature (Mongeon, & Paul-Hus, 2016). The differences in funding information data as per WoS, PubMed, Scopus studied and found that WoS has more records with funding information than others databases (Kokol, & Vošner, 2018)¹². Another study compares the strength and weaknesses of Scopus, WoS, GS, and PubMed; and viewed that in biomedical electronic research filed to search bibliographic records the PubMed database as an optimal tool (Falagas et al., 2008)

OBJECTIVES

The objectives of the study are to find the followings quantitatively in each database:

- a). Year-wise Number of publication and citation
- b). Document type-wise distribution of paper
- c). Scattering of papers in different source publication
- d). Preferred journals among the authors
- e). Analysis of words used to form the title of publication, and
- f). Authorship pattern

METHODS AND LIMITATIONS

As the database SCI-E and Scopus index bibliographical records with their benchmark policies, the total number of records retrieved from each database varied. However, a study has pointed-out number of inaccuracies in both Scopus and WoS(van Eck& Waltman, 2019).

Search in SCI-E was done on 1st June 2021 to collect all RRCAT authored records. According to the Web of Science SCI-E Master Journal List, the database covers 9258 journal citation details currently. The database 'Advanced Search' option selected and the search terms submitted to retrieve the records were, (((OO=CTR ADV TECHNOL AND (AD=INDORE OR AD=452013 OR AD=RRCAT)) OR (OO=RRCAT AND AD=INDORE) OR (OO=RAJA RAMANNA CTR ADV TECHNOL)) OR (OG= RAJA RAMANNA CTR ADV TECHNOL) OR (OG=RRCAT) OR (OG= RAJA RAMANNA CTR ADV TECHNOL) OR (AD=RAJA RAMANNA CTR ADV TECHNOL) OR (AD=RRCAT) OR (AD= RAJA RAMANNA CTR ADV TECHNOL)) Indexes=SCI-EXPANDED Timespan=1987-2020. The search retrieved 3400 records and all records were downloaded in tab-delimited(Win) file format.

As per the Scopus 'April 2019 Source list', the database indexes bibliographical records of 39111 source publications. Out of 39111 sources, 24520 were active and 14591 were inactive sources. It also covers bibliographical records of 29682 post-1995 conference proceedings and 5991 pre-1995 conference proceedings. In the Scopus database, the 'Affiliation search' option chosen and the search term submitted was (AF-ID ("Raja Ramanna Centre for Advanced Technology"

60008263)). The search was conducted on 23rd May 2021 and 4156 records were retrieved and downloaded in a CSV(comma-separated values) file format.

The download records were carefully imported into MS-Excel worksheet before analysis. Different excel functions were applied to measure various study parameters and results were obtained.

ANALYSIS AND RESULTS

5.1 Year-wise Number of Publications and Citations in Scopus and SCI-E

From time to time the top management seeks publication and citation data for review and decision-making process. Being provider of bibliometric and citation data to the top management, the library and information centre collects bibliographical data from available sources and carries out analysis. Year-wise publication data is one such key bibliometric parameter through which an organization research and development progress is measured. To find out year-wise publication and citation trends of RRCAT research publications this parameter is studied. **Table 1**, summarises the year-wise number of publications and citations. The CPP (Citations Per Publication) was also calculated for each year. CPP calculated here was an average number of citation including all self-citations per publication. The publication trend is also visualized in **Figure 1**.

The total number of RRCAT publications from 1987 to 2020 found in the Scopus database was 4156 and 3400 in the SCI-E database. The starting year of publication in both databases was 1987. Overall, the study found that publication

from RRCAT steadily increased every year in both databases, except for some years. The average increase trend per year found was 8.52 publications as per Scopus and 6.7 publications as per SCI-E. The average increase per year during the study period was 18.99 in Scopus and 18.83 in SCI-E respectively. However, the reason for the total number of publications in the Scopus database being marginally higher is due to its wider coverage of publications, including book chapter, individual conferences paper, and coverage of open access journals, etc. The SCI-E

purely covers journals paper alone and conference papers were part of journal issues. The total number of citations received for all publications till the time of data download was 76437 in Scopus and 67121 in SCI-E. Average citations during 1987-2020 were 18.39 in Scopus and 16.17 in SCI-E including the year 2019 and 2020 for which the citation window period is short. The study found some degree of correlation in publication growth trend both in Scopus and SCI-E database, though the coverage of each database was marginally different.

Table 12: Year-wise distribution of RRCAT papers in Scopus and SCI-E during 1987-2020

Year	Scopus	SCI-E	PIPYs	PIPYSCI-E	CiS	CiSCI	CPP Scopus	CPP SCI-E
1987	2	2	0.00	0.00	3	2	1.50	1.00
1988	4	3	100.00	50.00	20	19	5.00	6.33
1989	6	6	50.00	100.00	59	56	9.83	9.33
1990	8	7	33.33	16.67	49	49	6.13	7.00
1991	15	14	87.50	100.00	252	223	16.80	15.93
1992	21	24	40.00	71.43	277	278	13.19	11.58
1993	27	23	28.57	-4.17	425	360	15.74	15.65
1994	50	51	85.19	121.74	615	604	12.30	11.84
1995	45	45	-10.00	-11.76	508	531	11.29	11.80
1996	52	44	15.56	-2.22	462	449	8.88	10.20
1997	50	50	-3.85	13.64	756	706	15.12	14.12
1998	87	72	74.00	44.00	1048	758	12.05	10.53
1999	70	72	-19.54	0.00	1001	944	14.30	13.11
2000	71	62	1.43	-13.89	1076	949	15.15	15.31
2001	74	62	4.23	0.00	1092	1031	14.76	16.63
2002	104	89	40.54	43.55	1293	1202	12.43	13.51
2003	106	79	1.92	-11.24	1717	1284	16.20	16.25
2004	98	78	-7.55	-1.27	1710	1498	17.45	19.21
2005	139	110	41.84	41.03	2278	2239	16.39	20.35
2006	158	122	13.67	10.91	2921	2550	18.49	20.90
2007	179	142	13.29	16.39	3096	2754	17.30	19.39
2008	168	144	-6.15	1.41	2652	2612	15.79	18.14
2009	129	117	-23.21	-18.75	2441	2143	18.92	18.32
2010	190	167	47.29	42.74	2275	2041	11.97	12.22
2011	197	133	3.68	-20.36	2351	2109	11.93	15.86
2012	226	148	14.72	11.28	2031	1864	8.99	12.59

2013	220	170	-2.65	14.86	2999	2544	13.63	14.96
2014	259	213	17.73	25.29	2956	2614	11.41	12.27
2015	206	163	-20.46	-23.47	3785	3529	18.37	21.65
2016	237	203	15.05	24.54	14356	12692	60.57	62.52
2017	247	209	4.22	2.96	11669	10265	47.24	49.11
2018	201	171	-18.62	-18.18	4014	2320	19.97	13.57
2019	266	218	32.34	27.49	3094	2804	11.63	12.86
2020	244	187	-8.27	-14.22	1156	1098	4.74	5.87
34 Years	4156	3400	18.99	18.83	76437	67121	18.39	16.17

Legend: **DiSco**- Number of documents in Scopus; **DiSCI**- Number of documents in SCI-E; **CiSco**- Number of citations in Scopus; **CiSCI**- Number

of citations in SCI-E; **PIPYs** - % of increase from the previous year in Scopus; **PIPYSCI-E** - % of increase from the previous year in SCI-E.

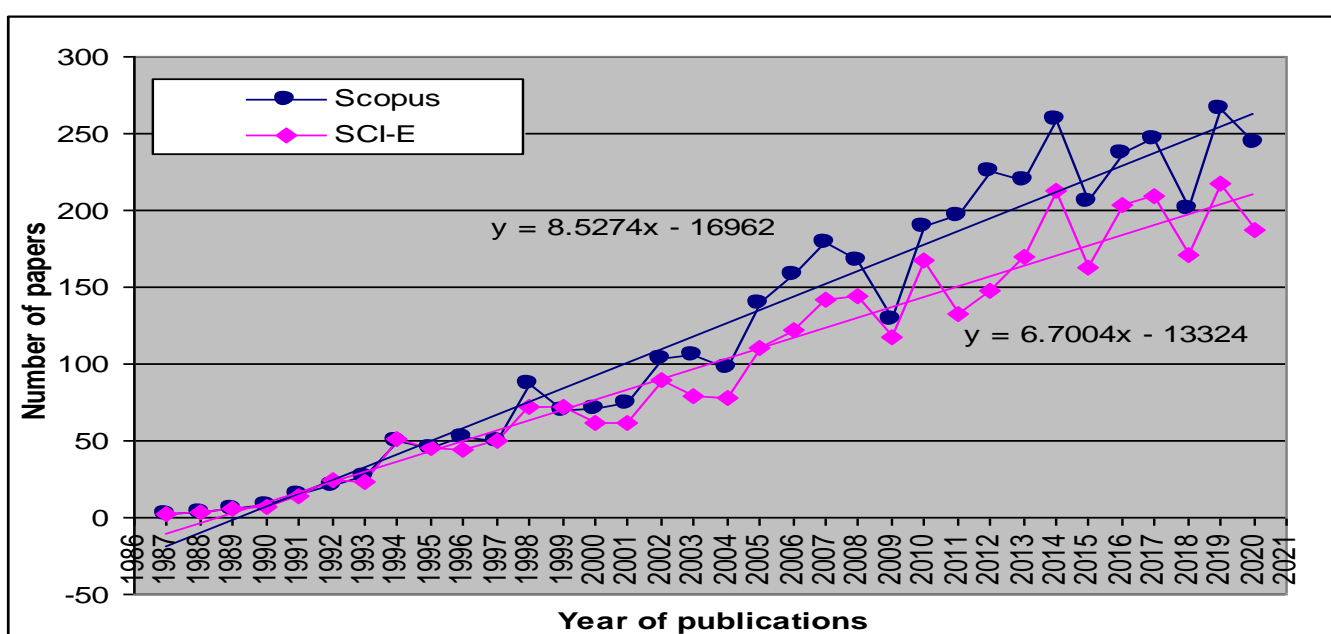


Figure 1: Publication Trend as per Scopus and SCI-E indexing database

It is clear from the **Figure 1** that publication from RRCAT during the study period has steadily increased. Except few years, remaining all years the number of papers was above the trend line. The figure also visualizes that in the year 2019 RRCAT researchers have produced maximum number of papers as per both databases, that is in

Scopus 266 and in SCI-E 218; followed by the year 2014.

5.2 Document Type

Document type (DT) also known as type of paper is a field of biographic record assigned for published paper by the indexing database depending on its appearance in various

publications. It reflects the value of a document or paper, for instance, a journal ‘article’ is more valuable than a ‘conference paper’. It also helps users’ to limit records while search and retrieve in an indexing database. The number of document type categories also varies from database to database and its policy of indexing.

Table 2 shows the distribution of RRCAT papers as per document type in Scopus and SCI-E. Nine distinct DT were found in Scopus and 12 in SCI-E. The number and percentage of journal article DT in Scopus were 3314 (79.74%) and in SCI-E 3090 (90.88%). The second highest document type in Scopus was ‘Conference paper’ and also

in SCI-E. The number of conference papers in Scopus was 739 (17.42%), whereas in SCI-E it was only 195 (6.52%). The SCI-E categorized 202 paper document type as ‘Article’ and ‘Proceedings Paper’. All these papers were part of a journal issue; thereby SCI-E categorized in two DT for these 202 papers. Out of 739 conference papers in Scopus, 485 were found as individual conference proceedings that are not part of a journal issue. It is found that the Scopus database not separated papers that appeared in the individual conference proceeding and that appeared in journal issue separately. From the table, it is clear that RRCAT researcher primarily communicate their findings in a journal.

Table 13: RRCAT Papers Document Type as per Scopus and SCI-E

DT in Scopus	No. of documents	% of total DT	DT in WoS	No. of documents	% of total DT
Article	3314	79.74	Article	3090	90.88
Book Chapter	26	0.63	Article; Proceedings Paper	202	5.94
Conference Paper	739	17.78	Review	27	0.79
Editorial	2	0.05	Letter	18	0.53
Erratum	15	0.36	Editorial Material	17	0.50
Letter	10	0.24	Note	17	0.50
Note	10	0.24	Correction	17	0.50
Review	34	0.82	Meeting Abstract	7	0.21
Short Survey	6	0.14	Book Chapter/Review	2	0.06
			Correction, Addition	1	0.03
			News Item	1	0.03
			Early Access	1	0.03
Total	4156	100		3400	100.00

DISTRIBUTION OF PAPERS IN VARIOUS SOURCES

As per the SCI-E, all 3400 papers were published in 447 different journals. As per Scopus 4156 papers published in different publications were

516 journals, 112 conference series, book, and other materials. The total number of journals found in each database varies slightly due to the indexing policies and other factors. Also, in the Scopus database same source title recorded variant name, for example, the journal ‘Pramana

– journal of physics’ is entered in the database namely as Pramana - Journal of Physics, Pramana, Pramana: Journal of Physics. Possible efforts were put to merge all variants of titles in a single title to calculate this parameter. The Scopus included more open access journals and other publications are the main reasons for more papers being observed.

Distribution of papers in journals according to (Bradford, 1934 & 1948) law of scattering three zone-wise was calculated. The total number of journal papers was divided into three equal

groups and calculated the number of journals for each group/zone. As per the SCI-E, distributions of papers in the nucleus i.e. zone 1 journal that covers 1/3 of articles was only 14 (3.13%) and 14 (2.23%) as per Scopus database. **Table3** explains the number and percentage of journals/other sources in each zone. In zone 1, journal titles identified were almost identical, except a slight difference in the number of articles. Though the total number of journals/sources in each database was different, the zone-wise percentage of journals measured for each database was almost equal

Table 14: Bradford's Three Zone Wise Scattering of Papers

Bradford zone	No. & % of RRCAT publications in SCI-E	1/3 of total SCI-E RRCAT papers	No. & % of RRCAT publications in Scopus	1/3 of total Scopus RRCAT papers
Zone 1	14 (3.13%)	1167 (34.32%)	14 (2.23%)	1398 (33.64%)
Zone 2	60 (13.42%)	1227 (36.09%)	61 (9.71%)	1371 (32.99%)
Zone 3	373 (83.45%)	1006 (32.01%)	553 (88.06%)	1387 (33.37%)
	447 (100%)	3400 (100%)	628 (100%)	4156 (100%)

5.4 Preferred Journals

Researchers prefer to publish papers based on journal reputation, peer review processes, impact factor, publisher reputation, indexing in citation databases, etc. Here, the Zone 1 journals were treated as the most preferred journals of RRCAT authors. **Table 4** present the list of the most preferred journals of RRCAT authors. Though the number of papers for each journal varies

marginally it was observed that most of the journals ranked equal position. ‘Pramana - Journal of Physics’ is the only Indian journal found in the list. From the top 14 preferred journals, 8 journals published by non-profit publishers, namely American Physical Society(1), American Institute of Physics(3), Institute of Physics-UK(2), Optical Society of America(1), Indian Academy of Sciences(1) and remaining Six titles were published by Elsevier alone.

Table 15: Preferred Journals of RRCAT authors

Rank	Zone 1 Journals - Scopus	No. of Papers	Zone 1 Journals - SCI-E	No. of Papers
1	Journal of Applied Physics	155	JOURNAL OF APPLIED PHYSICS	151

2	Pramana - Journal of Physics	125	PRAMANA-JOURNAL OF PHYSICS	125
3	Physical Review B	122	PHYSICAL REVIEW B	116
4	Applied Optics	95	APPLIED OPTICS	93
5	Review of Scientific Instruments	90	REVIEW OF SCIENTIFIC INSTRUMENTS	91
6	Applied Physics Letters	87	OPTICS COMMUNICATIONS	87
7	Optics Communications	87	APPLIED PHYSICS LETTERS	85
8	Optics and Laser Technology	83	OPTICS AND LASER TECHNOLOGY	84
9	Journal of Alloys and Compounds	70	JOURNAL OF ALLOYS AND COMPOUNDS	74
10	Journal of Physics Condensed Matter	62	JOURNAL OF PHYSICS-CONDENSED MATTER	62
11	Nuclear Instruments and Methods in Physics Research, Section A: Accelerators, Spectrometers, Detectors and Associated Equipment	54	NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SECTION A-ACCELERATORS SPECTROMETERS DETECTORS AND ASSOCIATED EQUIPMENT	53
12	SolidState Communications	49	SOLID STATE COMMUNICATIONS	50
13	Journal of Physics D: Applied Physics	47	JOURNAL OF PHYSICS D-APPLIED PHYSICS	49
14	Applied Surface Science	46	APPLIED SURFACE SCIENCE	47

Publication Title Word Analysis

Researchers use a set of scientific and technical terms to form the paper's title. Assigning proper title to a research paper is an important task for the researchers during the publication process. The title in turn reflects the content of a paper. Terms used by RRCAT researchers to form paper titles for 3400 papers were analyzed. The analysis shows that 'laser' was the top-ranked and most widely and frequently used word. It occurred in 724 (24.2%) papers; followed by 'optical' word

used in 330 (11.04%) papers. A total of 4514 words are used to form the paper title was observed. Total occurrences of these 4514 words for the formation of 3400 titles were 31051 times. The result drawn was after excluding the grammatical article, preposition and numerical characters and wild card not applied. The frequency of words to form title plotted in log-log scale shows repeated use of most words and the same is visualized in **Figure 2**. Results found that large number of papers title words appeared in the core research field.

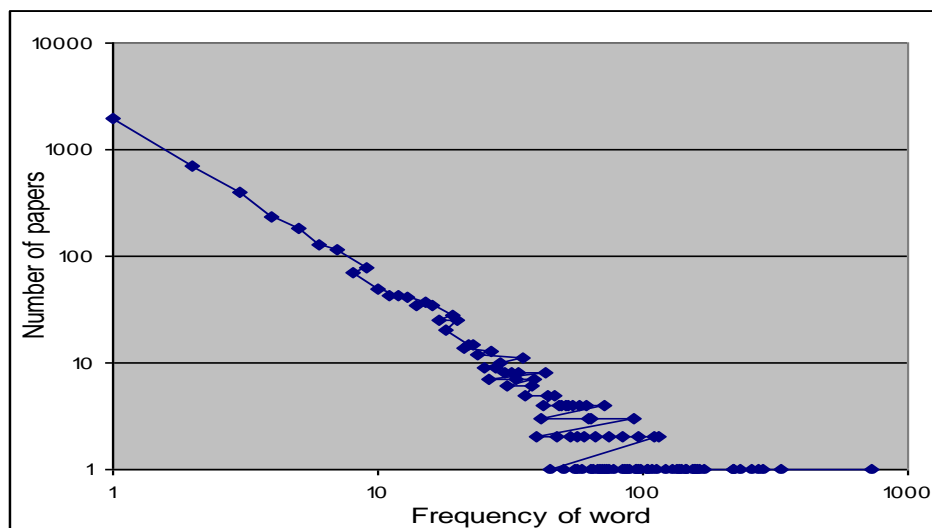


Figure 2: Words Used to Form Articles Title

Authorship Pattern

The collaborative nature of researchers is studied in this parameter and SCI-E 3400 papers were taken up for the purpose. **Figure 3** shows the collaborative pattern of authors. It is obvious from the graph that four authored papers were the highest among all, followed by three, five, and six authored papers. The four authored papers alone

account for 17.12% of total papers, followed by three authored that account for 16.18% of total papers. Two to six authored papers together account for 73.82% of total papers. Eleven plus authored papers were only 6.41%. The percentage of single-authored papers was 4.03%. From the result, it is clear that the researchers prefer team and collaborative work over independent research.

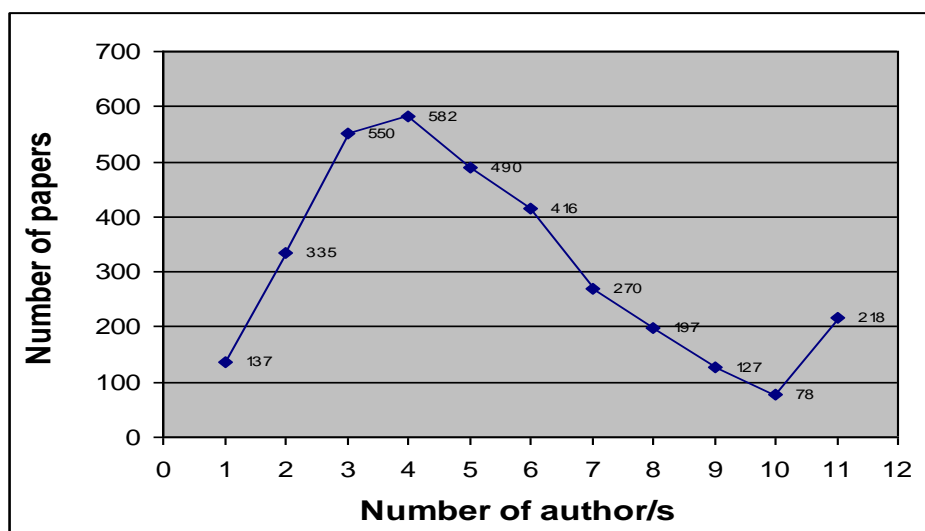


Figure 3: Collaborative Pattern of RRCAT Authors

CONCLUSION

The publications from RRCAT are steadily increasing every year, the average increase as per Scopus and SCI-E during the study period was 18.99% and 18.83%. 90.88% of SCI-E papers 'document type' was journal 'article' whereas in Scopus 79.74% papers were only 'article'. The Scopus indexed more number of conference proceedings papers that are not part of journals issue and other open access publications. SCI-E indexed only journals/serials publication papers. As per Scopus 628 different source publications in which 4156 papers appeared such as journals, conference proceedings, and book chapter. In SCI-E 447 source publications that cover 3400 papers were identified. Bradford's law scattering zone-1 journals were taken as the most preferred one among RRCAT authors. The title word analysis result reveals that 'laser' and 'optical' were frequently used terms in the title of RRCAT authored papers. The authorship pattern reveals that teamwork is predominant among the RRCAT authors, the percentage of co-authored papers was 95.97% and only 4.03% of papers were single-authored. This study also helped to prepare a comprehensive list of RRCAT journal publications from both databases.

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