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Mapping of Spacecraft Research Publications in India: A Scientometric Analysis

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Abstract **- This paper presents a scientometric analysis of the scholastic research papers published on spacecraft. The main purpose is to provide an overview of the research productivity in India on the subject during the period of the study (2012-2016), exploring different subdivisions of the spacecraft research. Ever since India sent a spacecraft to Mars in 2014, India has earned its place in the top ranking space-faring nations which include the USA, Europe Russia, China and Japan. This study highlights a quantitative analysis on the authorship pattern and collaborative trends during the past five years in the newly emerged the growing field of spacecraft in Engineering. This study reveals almost a constant trend of inflow of papers with increasing trend of multi authored papers year by year. Highest share of Papers are being contributed by authors from India, written in English and the results of degree of collaboration C= 0.91 of collaborative author's articles is published during the study period.**
Keywords: **Spacecraft, Scientometric, Collaboration Trends, Authorship pattern**

I. INTRODUCTION

The effectiveness of scientific research performance could be realised only through a proper communication system. Communication in science could be viewed from the standpoint of a historian, an economist, a sociologist, and a library professional, and so on. Thus, science and scientific communication are so interrelated that one influences the other for the generation of information. Among scientists and social scientists, it is widely accepted that public research performed in academic and governmental research institutions are driving force behind high technology and economic growth. It is true that research makes an important contribution to the economic growth of a nation. Such research output is used as the yardstick for measuring the quality and quantity of research done in a country. It is interesting to note that during the last few years, Bibliometric/ Scientometric tools and techniques have been increasingly used and being used to evaluate the research performance of the scientists and the growth of various disciplines of science. Hence, it im plies and induces to examine the nature and extent of the contribution made by the scientists of a particular discipline of a country or a few major countries or for a particular period of time by using primary or secondary sources, that facilitates the proper and effective analysis.

Bibliometric research methodologies of library and information science have always been used to provide tools for understanding the dynamics of disciplines, developing policy, and justifying research funding. It is a branch of library and information science makes quantitative analysis of 'library and library use patterns' Pritchard (1969)[1] defined Bibliometric as "the application of mathematical and statistical methods to books and other media of communication", while Nalimov and Mulchenko (1969)[2] defined Scientometrics as "the application of those quantitative methods which are dealing with the analysis of science viewed as an information process".

II. REVIEW OF LITERATURE

Smith D. R., (2010)[3], has aimed to investigate, from a bibliometrics perspective, the progression and trends of core international nursing journals. The analysis were undertaken among 7 core international nursing periodicals using custom historical data sourced from the Thomson Reuters Journal Citation Reports.

Biswas, S K. and Akhtaruzzaman, M (2012)[4], have found that, a d etail Scientometric analysis of medical research performance of Bangladesh and its comparison with other countries is very important to obtain a clear picture and to take necessary measures to upgrade our research performance. At the same time it is also very important to evaluate the research performance of major medical research institutes of the country and to compare their performance among themselves and similar institutes of other countries.

Gupta. B. M, and Adarsh Bala, (2011)[5], analyzed the research activities of India in medicine during 1999–2008, the publication data on medicine has been retrieved by using SCOPUS database. The study found that, India holds 12th rank among the productive countries in medicine research consisting of 65,745 papers with a global publication share of 1.59 s.

Prathap. G and Gupta, B M, (2011)[6], analyzed the performance of education and research institutes in India in medical and allied sciences during 1999-2008, based on their research output, using robust quantitative and

qualitative indicators which give a more rational procedure for ranking their research performance. The data was collected from the SCOPUS database and a new composite performance indicator, the p-index, is used to measure performance.

Cantos-Mateos. G, *et al.,* (2012)[7], found the dual analysis of Spain's scientific output in this field during the period 1997-2007. This study provides an overview of Spanish research involving stem cells, detecting and representing the main areas of research.

III. OBJECTIVES

The major objectives are framed with the exclusive notion of the present study as mentioned below:

1. To examine the growth of research productivity of Spacecraft during 2012- 2016
2. To classify the most productive authors and authorship patterns and author productivity
3. To identify the nature of collaborator, co-authorship patterns and determines the DC.
4. To identify the Document type of publications
5. To find out the Document Type and Keyword distribution of publications in Spacecraft
6. To study the Affiliation wise breakup of publications and
7. To identify country-wise distribution of publications.

IV. METHODOLOGY

The present study observed the authorship pattern in publications from all over world researchers in the concept of Spacecraft research during the period of 2012-2016. Data was collected from SCOPUS databases covering all aspects of spacecraft. A total of 1601 records were downloaded and analyzed by using spreadsheet application as per the objective of the study.

A. Degree of Collaboration

The degree of collaboration 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 suggested by Subramanyam(1983)[8] is used. It is expressed as

$$C = \frac{N_m}{N_m + N_s}$$

Where, C is the degree of collaboration in a discipline. N_m is the number of multi-authored research papers in the discipline published during a year. N_s is the number of single authored papers in the discipline published during the same year. Using this formula, the degree of collaboration is determined.

Based on this study, the result of degree of collaboration C = 0.91. i.e, 91 % of collaborative authors' articles is published in this study.

V. RESULTS AND DISCUSSIONS

A. Year Wise Distribution

Figure 1 indicates that the year wise distribution of research articles published in the Scopus database on spacecraft. It is observed that the highest number of articles 388(24.23%) in 2016, followed by 365(22.79%) articles in 2015. The less number of research articles 232 (14.49 %) have been published in 2012.

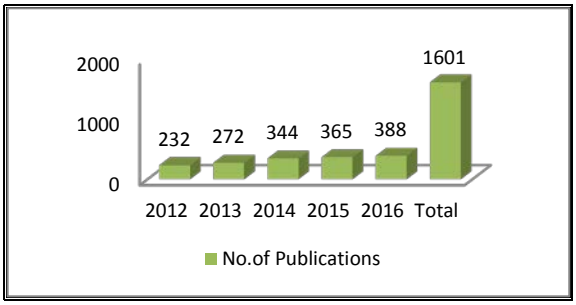

Fig. 1 Publication Distribution (Year wise)

B. Collaboration Trends (Author)

A total of 1601 records were downloaded and analysed during the period of 2012-2016, the search yield a result of 1601 articles published by Indian researchers. It is to be noted that the distributing the data with respect to authorship pattern. It is evident that from the Table I Figure 2), that the single authorship pattern is on decline. The collaborative papers produced by group of authors, number ranging from 2 to 11, giving 92.6% of the total publications. The multiple authorship papers of the collaborative author group number 3 and above contribute to a maximum of 76.14% of the total papers whereas, 16.5% of the papers were of joint collaboration.

TABLE I COLLABORATION TRENDS

S.No.	Authorship	No. of Papers	Percentage
1.	Single	118	7.37
2	Joint	264	16.49
3	Multiple	1219	76.14
Total		1601	100.00

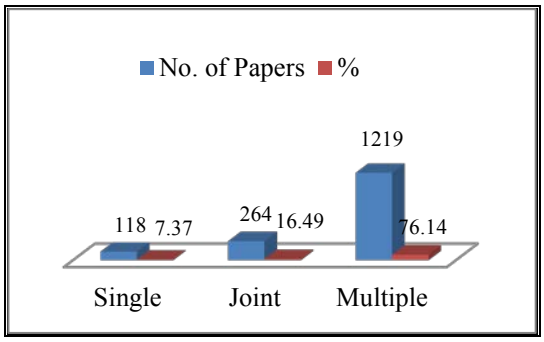

Fig.2 Collaboration Trends

C. Authorship Pattern

Table II explains that the authorship pattern on Spacecraft research publications in India.

TABLE II AUTHORSHIP PATTERNS

S.No.	Authorship	No. of Papers	Percentage	Total Authorship Credits
1	1	118	7.37	118
2	2	264	16.48	528
3	3	219	13.67	657
4	4	200	12.48	800
5	5	97	6.05	485
6	6	75	4.68	450
7	7	30	1.94	210
8	8	32	1.99	256
9	9	20	1.25	180
10	10	41	2.56	369
11	11 & above	505	31.54	5555
Total		1601	100.00	9608

A least proportions 7.4% of the papers is produced by single authors. Based on the survey Chemical Abstract, Price (1963)[8] observed "a steady increase in the multiple authorship trends and stated that…. If it c ontinues at the Present rate, by 1980, the single authored papers will be extent". It is obvious from the table that the single authorship trend is on decline.

TABLE III AUTHORSHIP PRODUCTIVITY

S. No.	No. of Authors	Productivity	Total Authorship Credits
1	129	4	516
2	774	3	1548
3	1666	2	3332
4	4212	1	4212
Total	6781	Total Credits	9608

Due to the complex nature of the subject Spacecraft Research publication, collaborating research contributions, only 7.37% (with 118 c redits) of the papers are independently produced by single authorship credits.16.5% (with 528 c redits) of the papers are produced by joint authorship collaboration 13.7% (with 657 credits) are produced by 3 authorship collaboration.

There exist 505(with 5555 credits articles of 11 and above authors. Table III (Figure 2) gives the authorship productivity of the present study.

D. Authorship Productivity

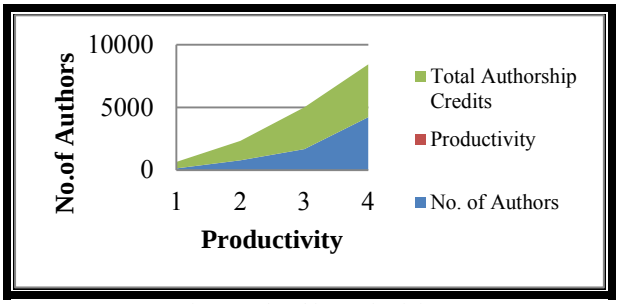

Fig. 3 Authorship Productivity

From Table III (Figure 3), it is learnt that, altogether 9608 authorship credits produced 1601 papers. Among 6781 distinct authors, 4212 a uthors produced only one article each. Rest of them, were produced more than one article.

E. Degree of Collaboration

Table IV reveals that the year wise distribution of authorship patterns with Degree of Collaboration.

TABLE IV DEGREE OF COLLABORATION (YEAR WISE)

S.No.	Year	Single	Double	Multiple	Total	Degree of Collaboration
1	2012	17	47	168	232	0.91
2	2013	29	41	202	272	0.87
3	2014	29	61	344	344	0.89
4	2015	18	77	365	365	0.94
5	2016	25	38	388	388	0.93
Total		118	264	1219	1601	0.91

To study the extent of collaboration, Degree of Collaboration, is calculated using Subamaniyam's formula. The ratio of multi- authored papers to that of the total number of papers. The mean degree of Collaboration is 0.91.

F. Document Type

TABLE V DOCUMENT TYPE

S. No.	Document type	No.of Publications	Percentage
1	Article	991	61.89
2	Conference Paper	552	34.47
3	Review	29	1.82
4	Book Chapter	21	1.32
5	Book	5	0.32
6	Editorial	1	0.06
7	Letter	1	0.06
8	Note	1	0.06
Total		1601	100

The above Table V provides the distribution of publication on spacecraft research by document type. It is clearly notice from the table that the major source of publications in spacecraft research comes in the form of Journal articles (991) records, followed by Conference Proceedings and Reviews 552 & 29 publication respectively.

G. Keyword Distribution

Table VI presents that the top ten keywords used by the researchers in their publications. It is clearly noticed from the table that the keyword "spacecraft" has been used in 177 publications recorded by the researchers during the study period.

H. Affiliation Distribution

Table VII deals with Affiliation wise analysis of spacecraft research. Indian Space Research Organisation is having the first rank among the overall Affiliation with the output of 320 publications.

TABLE VI KEYWORD DISTRIBUTION

S. No.	Keyword	No.of Publications	% of 1601
1	Spacecraft	177	11.05
2	Orbits	132	8.24
3	Satellites	103	6.43
4	Controllers	72	4.49
5	Algorithms	58	3.62
6	Space Flight	54	3.37
7	Attitude Control	50	3.12
8	Rockets	49	3.06
9	Communication Satellites	45	2.81
10	Design	44	2.74

TABLE VII AFFILIATION DISTRIBUTION

S. No.	Affiliation	No.of Publications	Rank
1	Indian Space Research Organization	320	1
2	Indian Institute of Science	84	2
3	Indian Institute of Technology, Bombay	64	3
4	Indian Institute of Technology Delhi	59	4
5	Physical Research Laboratory India	54	5
6	Indian Institute of Technology, Madras	46	6
7	Indian Institute of Technology, Kharagpur	37	7
8	Indian Institute of Geomagnetism	32	8
9	National Aerospace Laboratories India	27	9
10	NASA Goddard Space Flight Centre	26	10
11	Indian Institute of Astrophysics	26	10
12	Indian Institute of Technology, Kanpur	26	10

TABLE VIII COLLABORATION COUNTRIES

S. No.	Country	No. of Publications	Rank
1	India	1601	
2	United States	159	1
3	Germany	51	2
4	United Kingdom	51	3
5	South Korea	46	4
6	Japan	44	5
7	Russian Federation	38	6
8	Canada	34	7
9	Italy	33	8
10	France	31	9
11	China	26	10

I. Collaboration Countries

It is evident from the table 8 spacecraft scientist published their articles collaborated with the other country scientist. It is shown that 159 articles were published with US collaboration followed by Germany and UK as 51 papers.

J. Physical Form of Distribution

Figure 4 depict that the physical form of the space research output.

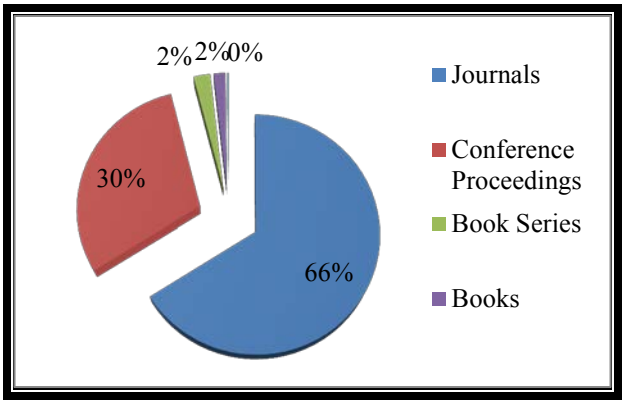

Fig.4 Physical Form

Indian research output on spacecraft had been analysed for its distribution pattern of physical forms of publications. This figure presents the various forms, in which spacecraft literature published. This includes Journals (66%), Conference Proceedings (30%), Book Series and Books were 2%.

VII. CONCLUSION

This study revealed that maximum publications published in the year 2016 and US is a significant collaborated country which is dominating spacecraft research and development. Spacecraft is the main keyword used by the research scientist. Collaboration trends are very high in Spacecraft Research Publication "Multi author grouped contributions are more productivity than others. The highest productivity in Spacecraft is yielded by the collaborations of two and multi authorship groups. Price's prediction about becoming extent nature of single authorship publications is proved to be true. The investigations in these authorship patterns would be, very useful in understanding the patterns in Research and Communication in the field of Spacecraft Research Publication in India. This type of scientometric research study is the helping tool to analyse the research areas to bridge the gap.

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