



Research Productivity of Indian Space Research Organisation (ISRO): A Bibliometric Analysis

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Abstract

The bibliometric study has to analyze the research output of Indian space Research Organisation (ISRO) for 16 years from 1999 – 2014 for 16 years a total of 1720 records were downloaded to use the WoS core collection. For that the bibliometric tools of Histcite software and MS Excel have been applied and performed the results of the below all parameters. The results of the study indicate that the large number of publications on ISRO was in the year 2013 ranked at top with 157 publications. The analysis also reveals among the authors 'Pal PK', has ranked at first with 61(3.5%) of publications. Among the Journal "INTERNATIONAL JOURNAL OF REMOTE SENSING" has ranked at top with 138(8.0%) of records with 186 TLCS, 936 TLGS and 101TLCR. The analysis also shows that most of ISRO literature was in the form of article. The language wise analysis, English ranked at highest with 1719 publications. The Organisation wise collaborations of publications were ranked the ISRO ranked at top with 1001(58.2%) of publications. The Country wise collaboration of publications ranked, the India stood for top position with 1654(96.2%) of publications. The ranking of the Research Areas of ISRO publications, Engineering has ranked at highest with 476(27.674%). The study ranking the Funding Agencies, the Indian Space Research Organization ISRO, has ranked at top with 29(0.640%) of records stood at first. To rank the top 10 Web of Science categories, the Remote Sensing has ranked at top with 319(18.547%) of publications.

Keywords: Bibliometric Study; Indian Space Research Organisation (ISRO); Scientometric Study; Web of Science Database.

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Introduction

Bibliometric/ Scientometric study is applicable to all subjects and its branches. It may also suitable for any academic as well as research institutions also. The Indian Space Research Organisation (ISRO) Hindi: Bharatiya Antariksha Anusandhan Sangathan) is the space agency of the Indian government. It is among the largest government space agencies in the world. Its primary objective is to advance space technology and use its applications for national benefit. Established in 1969, ISRO superseded the erstwhile Indian National Committee for Space Research (INCOSPAR), thus institutionalizing space activities in India. It is managed by the Department of Space, which reports to the Prime Minister. ISRO built India's first satellite, Aryabhata, which was launched by the Soviet Union on 19 April in 1975. In 1980, Rohini became the first satellite to be placed in orbit by an Indian-made launch vehicle, SLV-3. ISRO subsequently developed two other rockets: the Polar Satellite Launch Vehicle (PSLV) for launching satellites into polar orbits and the Geosynchronous

Satellite Launch Vehicle (GSLV) for placing satellites into geostationary orbits. These rockets have launched numerous communications satellites and earth observation satellites. Satellite navigation systems like GAGAN and IRNSS have been deployed. In January 2014, ISRO successfully used an indigenous cryogenic engine in a GSLV-D5 launch of the GSAT-14. On 22 October 2008, ISRO sent its first mission to the Moon, Chandrayaan-1. On 5 November 2013, ISRO launched its Mars Orbiter Mission, which successfully entered the Mars orbit on 24 September 2014, making India the first nation to succeed on its maiden attempt, and ISRO the first Asian space agency to reach Mars orbit. Future plans include development of GSLV Mk III (for launch of heavier satellites), development of a reusable launch vehicle, human spaceflight, further lunar exploration, interplanetary probes, a satellite to study the Sun, etc. ISRO has conducted a variety of operations for both Indian and foreign clients. It has several field installations as assets, and co-operates with the international community as a part of several bilateral and multilateral agreements. Several foreign satellites have been launched by ISRO's launch vehicles, and several ISRO satellites have been launched by foreign launch vehicles.

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Objectives

The following main objectives were framed for the present study is:

- To measure the Year wise distribution of Indian Space Research Organisation Publications;
- To Identify the Author wise distribution of ISRO Publications;
- To know the Source wise Distributions of Publications
- To find out the various Document Types of ISRO Publications;
- To list the top ten Institutions wise Collaboration with ISRO Publications
- To identify the top ten Countries/Territories wise collaboration of research of the Scientists of ISRO.
- To analyse the Funding Agencies of ISRO Research Productivity
- To find the top ten major Research Areas of ISRO
- To know the languages wise distribution of ISRO publications
- To identify the Web of Science Categories of ISRO Research Productivity

Bibliometric study, which is used to analyze in details the bibliographic attributes of the research productivity in ISRO which indexed in Web of Science (WoS) database for the study period of 1999-2014 (16 years only) and the data have downloaded 1720 records using Core collection which tabulated and analyzed for the study to ranking the each category of research output of ISRO.

Ranking the Year Wise Research Productivity of ISRO

The below diagram shows the year wise distributions of publication of Indian Space Research Organisation from 1999 - 2014. The total numbers of records were 1720 from the 16 years were analyzed. Among the years, 2013 ranked at top with 157(9.1%) of records with 28 TLCS, 164 TGLS; followed the year 2012 stood second rank has scored 134(7.8%) of records with 21 TLCS, 257 TGLS; the year 2011 has ranked at third and scored 121(7.0%) of records with 35 TLCS, 323 TGLS. The years 2009 and 2014 has shared the fourth rank with 112 (6.5%) of publications each and followed by the years and ranked their respective place of research output of ISRO. Hence, it also shows that clearly there is a fluctuation trend of publications.

Methodology

The methodology applicable in this study is

Table I. Ranking of top ten Author Wise Distributions of Indian Space Research Organisation

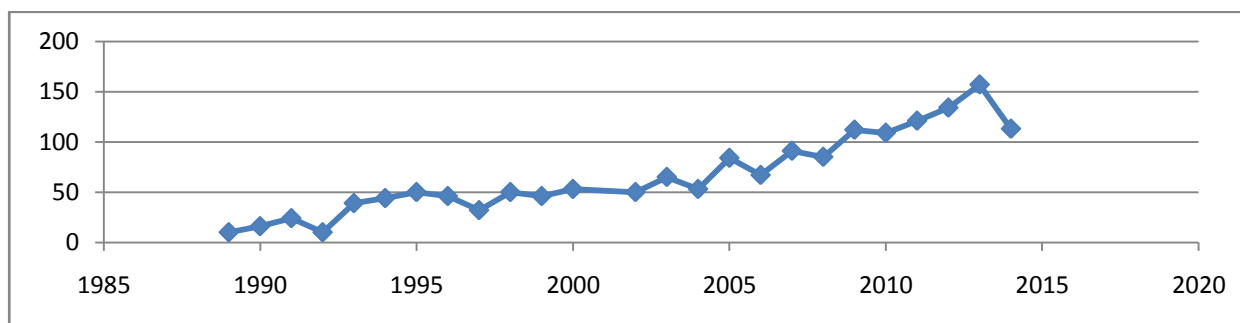


Figure I. Shows the Top 10 Authors Output of Indian Space Research Organisation

Sl.No	Author	Recs	Percent	TLCS	TGCS	TLCR
1	Pal PK	61	3.5	59	218	59
2	Dadhwai VK	54	3.1	62	399	41
3	Panigrahy S	54	3.1	51	309	48
4	Seetha S	47	2.7	60	918	51
5	Joshi PC	46	2.7	61	251	57
6	Parihar JS	42	2.4	44	175	39
7	Sharma AK	39	2.3	47	263	51
8	Majumdar TJ	38	2.2	51	163	51
9	Kishtawal CM	37	2.2	39	148	37
10	Gairola RM	35	2.0	35	119	38

The table -I shows that ranking the top ten Author wise distributions of Indian Space Research Organisation scientist's publications, a total 2952 authors were identified during the 16 years and were analysed. Among them 'Pal PK', has ranked at first with 61(3.5%) of publications with 59 TLCS, 218 TLGS 59 TLCR; followed by two authors 'Dadhwal VK' and 'Panigrahy S' has shared the second rank with 54 (3.1%) publications each with 399 TLGS each; and 'Seetha S' ranked at third with 47(2.7%) publications with 61 TLCS, 918 TLGS& 51 TLCR; and followed by others in their respective positions.

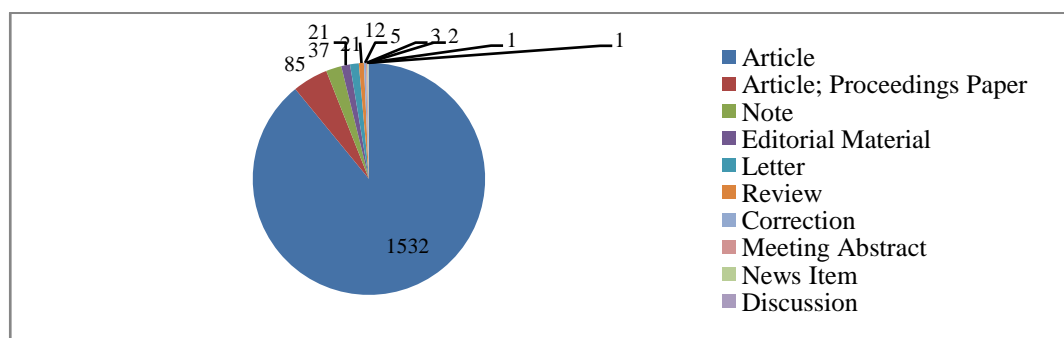
Ranking the top ten Source Title (Journal) Wise Distributions of ISRO Publications

The table-II shows the source title publications of Indian Space Research Organisation during the study period and analyse a total of 425 journals. Among them "INTERNATIONAL JOURNAL OF REMOTE SENSING" has ranked at top with 138(8.0%) of records with 186TLCS, 936 TLGS and 101TLCR, followed by the Current Science has ranked at second with 125(7.3%) of records with 103TLCS, 480 TLGS and 68TLCR. The JOURNAL OF SPACECRAFT TECHNOLOGY has ranked at third with 64(3.7%) of records with 3TLCS, 11TLGS and 10 TLCR and followed by others.

Table II. Shows the Top 10 Source Wise Research Output of Indian Space Research Organisation

Sl.No	Journals	Recs	%	TLCS	TGCS	TLCR
1	International Journal of Remote Sensing	138	8.0	186	936	101
2	Current Science	125	7.3	103	480	68
3	Journal of Spacecraft Technology	64	3.7	3	11	10
4	Journal of the Indian Society of Remote Sensing	63	3.7	15	70	55
5	IETE Technical Review	41	2.4	3	8	1
6	Journal of earth system science	38	2.2	14	81	24
7	Advances in space research	35	2.0	9	77	24
8	Indian journal of marine sciences	35	2.0	48	115	39
9	Actaastronautica	28	1.6	6	129	6
10	Photonirvachak-journal of the indian society of remote sensing	25	1.5	13	62	22

Figure II. Ranking the Various Document Types of ISRO Publications



The above pie-diagram indicates the various document types of publications of Indian Space Research Organisation scientist during the study period of 16 years and found a total of 11 items of documents types in which the 'Article' alone scored 1532 (89.1%)with 996 TLCS, 9968 TGLS ranked at first and the second place were occupied by 'Article; Proceedings Paper' with 85(4.9%) of publications, the third place has occupied by the "Note" with 37 (2.2%) of publications and followed by the remaining items of document types Indian Space Research Organisation.

Ranking the Languages Distributions of ISRO Research Productivity

The below table -III shows the Languages distributions of ISRO Research Productivity during study period of 16 years and found only two languages appeared and ranked accordingly. The main medium of language used by ISRO scientist was preferred only English and ranked at highest with 1719 (99.9%) with 1080 TLCS, 10563 TGLS; and the language German appeared in 01(0.1%) records and ranked at second. There is no more language used by the scientists of ISRO except the above two languages.

Table IV. Shows the Languages Wise Distribution of ISRO Research Productivity

Sl. No.	Language	Recs	Percent	TLCS	TGCS
1	English	1719	99.9	1081	10563
2	German	1	0.1	0	0

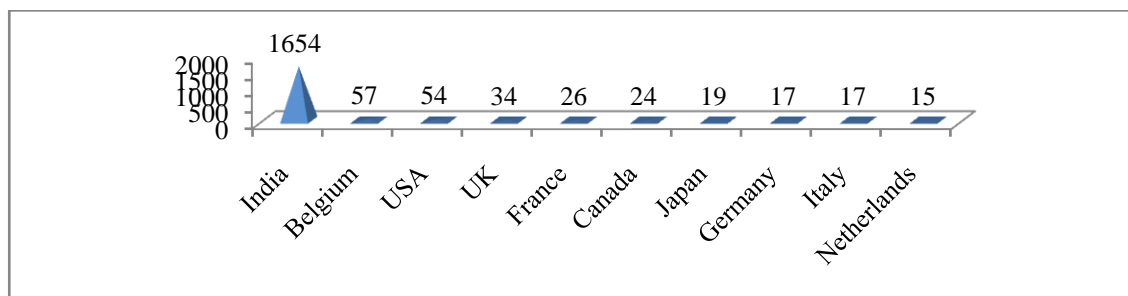
Ranking the Organizations Collaboration with ISRO Publications

The table -IV shows that the ranking the top ten organizations collaboration of publications of Indian Space Research Organisation with its affiliated institutions during the study period. A total of 829 institutions were identified and ranked accordingly. Among them the 'Indian Space Research Organisation'

has stood its first place with 1001(58.2%) of publications alone with 764 TCLS and 6061 TGLS. The second place has been occupied by the 'ISRO Satellite Centre' with 247(14.4%) of publications with 114 TCLS and 1415 TGLS and the Indian Institute of Technology, Delhi ranked at third with 136 (7.9%) of publications with 128 TCLS and 1591 TGLS and followed by others.

Table IV. Shows the Top 10 Institutions wise Distribution of ISRO

Sl. No	Institutions	Recs	%	TLCS	TLGS
1	ISRO	1001	58.2	764	6061
2	ISRO Satellite Centre	247	14.4	114	1415
3	Indian Institute of Science	136	7.9	128	1591
4	Indian Institute of Technology	97	5.6	59	691
5	Space Application Centre ISRO	93	5.4	31	166
6	Vikram Sarabhai Space Centre	65	3.8	31	311
7	Free University Brussels	48	2.8	30	1245
8	Tata Institute of Fundamental Research	31	1.8	23	271
9	ISRO Headquarters	30	1.7	32	156
10	Physics Research Laboratory	27	1.6	31	248

Figure III. The top ten Country wise Distribution of ISRO Publications

The above bar diagram shows that the top ten country wise collaborations of publication of Indian Space Research Organisation for the study period of 16 years and found a total of 47 countries. Among them India alone has secured the highest position with 1654(96.2%) of publications with 1044 TCLS and 9546 TGLS. Followed by the Belgium 57(3.3%) of publications with 26TLCS and 968TLGS which occupied the second rank. The country USA has stood at third slot with 54(3.1%) of publications with 28 TCLS and 1268 TGLS and followed by UK and others. The table clearly shows that the predominantly preferred maximum publications were in India though they have been contributed as many as other countries in the world.

Ranking the Web of Science Subject Categories of ISRO Research Productivity

The below table -V shows the top ten Web of Science Categories of ISRO Research Productivity during study period of 16 years were analyse the 1720 records for this study. Among them Remote Sensing has ranked at top with 319(18.547%) of publications and followed by Engineering Electrical Electronic has ranked at second with 227(13.198%) of publications and Imaging Science Photographic Technology has occupied the third rank with 200(11.628%) of publications and followed by others in their respective positions.

Table V. Shows Top 10 Web of Science Subject Categories

Web of Science Categories	Records	% of 1720
Remote Sensing	319	18.547 %
Engineering Electrical Electronic	227	13.198 %
Imaging Science Photographic Technology	200	11.628 %
Meteorology Atmospheric Sciences	182	10.581 %
Multidisciplinary Sciences	176	10.233 %
Geosciences Multidisciplinary	175	10.174 %
Astronomy Astrophysics	171	9.942 %
Environmental Sciences	132	7.674 %
Engineering Aerospace	122	7.093 %
Telecommunications	121	7.035 %

Ranking the Major Research Areas of ISRO Research Productivity

The below table -VI shows the top ten Major Research Areas of ISRO Research Productivity during study period of 16 years the total of 111 analyzed. Among the Research Areas, the Engineering has ranked

at highest with 476(27.674%) as major areas; the Remote Sensing has ranked at second with 319(18.547%) of publications; the Imaging Science photographic Technology has ranked at third with 200(11.628%) of records and followed by others. The 15 records were found as undefined.

Table VI. Shows Top 10 Research Areas of ISRO Research Productivity

Sl. No.	Research Areas	Record	% of 1720
1	Engineering	476	27.674 %
2	Remote Sensing	319	18.547 %
3	Imaging Science Photographic Technology	200	11.628 %
4	Science Technology Other Topics	190	11.047 %
5	Meteorology Atmospheric Sciences	182	10.581 %
6	Geology	175	10.174 %
7	Astronomy Astrophysics	171	9.942 %
8	Environmental Sciences Ecology	147	8.547 %
9	Materials Science	133	7.733 %
10	Telecommunications	121	7.035 %

Ranking the Funding Agencies of ISRO Research Productivity

The below table-VII shows the top ten Funding Agencies of ISRO Research Productivity during study period of 16 years the total number is 1475 records (85.756%). Among the funding agencies, the INDIAN SPACE RESEARCH ORGANIZATION ISRO, has ranked at top with 29(0.640%) of records and followed

by MESOSCALE AND MICROSCALE METEOROLOGY DIVISION AT THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH NCAR has ranked at second with 10(0.581%) records and the COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR NEW DELHI has ranked at third with 19 (0.523%) records and followed by others.

Table VII. Shows Top 10 Funding Agencies of ISRO Research Productivity

Funding Agencies	Record	% of 1720
Indian Space Research Organization (ISRO)	29	0.640 %
Mesoscale and Microscale Meteorology Division at the National Center for Atmospheric Research (NCAR)	10	0.581 %
Council of Scientific and Industrial Research (CSIR) New Delhi	19	0.523 %
Department of Space, Government of India	8	0.465 %
NASA	7	0.407 %
University Grant Commission (UGC) India	6	0.349 %
ESA	6	0.349 %
Space Applications Centre, (SAC) ISRO	11	0.233 %
ISRO Satellite Centre Department of Space Government of India	7	0.233 %
Defence Research and Development Organisation, Government of India	4	0.233 %

Conclusion

The bibliometric study has performed and complete that the total number of research productivity is 1720 for 16 years from 1999 - 2014 and revealed the year 2013 ranked at top with 157 publications with 28 TLCS, 164 TLGS. Ranking the Author wise distributions of Indian Space Research Organisation scientist's publications, a total 2952 authors were identified during the 16 years and were analyzed. Among them 'Pal PK', has ranked at first with 61(3.5%) of publications with 59 TLCS, 218 TLGS 59 TLCS; the source title publications of Indian Space Research Organisation during the study period and analyse a total of 425 journals. Among them "INTERNATIONAL JOURNAL OF REMOTE SENSING" has ranked at top with 138(8.0%) of records with 186 TLCS, 936 TLGS and 101 TLCS; The Document type of publications of Indian Space Research Organisation scientist during the study period of 16 years and found a total of 11 items of documents types in which the 'Article' alone scored 1532 (89.1%) with 996 TLCS, 9968 TGLS ranked at first. The main medium of language used by ISRO scientist was preferred only English and ranked at highest with 1719 (99.9%) with 1080 TLCS, 10563 TGLS.

The Organisation wise collaborations of publications were ranked the ISRO ranked at top with 1001(58.2%) of publications alone with 764 TLCS and 6061 TGLS. To rank the institution and subdivision The ISRO, Centre Space Application has ranked at Top with 478(27.8%) of records with 448 TLCS, 2539 TGLS; The Country wise collaboration of publications ranked, the India stood for top position with 1654(96.2%) of publications with 1044 TLCS and 9546 TGLS. The ranking of the Research Areas of ISRO publications,

Engineering has ranked at highest with 476(27.674%); The study ranking the Funding Agencies, the Indian Space Research Organization ISRO, has ranked at top with 29(0.640%) of records stood at first. To rank the top 10 Web of Science categories, the Remote Sensing has ranked at top with 319(18.547%) of publications.

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