



## Scientometric Analysis of Space Debris Research Publications

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**ABSTRACT**

The present study discusses on Scientometric Analysis of Space debris research publications. This study reveals that, totally 430 records were found in this research during the study period, 2014 has occupies first position with 10.70 percent of papers in this research, 2015 has occupied second place with 9.30 percent of papers, 2013 has 7.21 percent of papers with third place, and remaining years have published 6.00 percent of papers, among the nine document types Article has occupies first place with 91.16 percent. It clears that, single authors contributions are less compare with collaborative research, collaborative author papers were published 71.63 percent. Totally 1130 authors ware contributing in Space debris research, among the 1130 authors Klinkrad, H, and Flury, W, each author respectively has contributed 2.79 percent paper in this research, totally 40 countries contribution in this research among the 40 countries USA occupies with first position with 14.65 percent of papers

**KEYWORDS**

Space debris, Space junk, old spacecraft, Space trash, dead satellites.

**INTRODUCTION**

Space debris is a specific type of space object that is human-made, no longer functional, and in Earth's orbit. Space debris ranges in mass from several grams to many tons, and in diameter from a few millimeters to tens of meters. Fragments exist from roughly 100 to more than 36,000 kilometers above the Earth's surface (NASA 2010). There are approximately 6% are operational spacecraft, 21% are old spacecraft, 17% are rocket upper stages, 13% are mission-related debris, and 43% are fragments from (mostly) explosions or collisions. In addition, there are a large number of smaller objects that are not routinely tracked, with estimates for the number of objects larger than 1 cm ranging from 100 000 to 200 000 (Mehrholtz, D. et al., 2002).

There are two ways to reduce space debris: mitigation and removal. Mitigation refers to reducing the creation of new debris, while removal refers to either natural removal by atmospheric drag or active removal by human-made systems (Ansdell M. 2010). Debris poses a growing threat to satellites and could prevent the use of valuable orbits in the future. Many pieces of debris are too small to monitor but too large to shield satellites against (Griffiths M 2010).

**METHODOLOGY**

The data have been collected from Web of Science Database, Search string were used "Space debris" in title search box, time span field were select from 1991 to 2015. Totally 430 records were retrieved, the data downloaded and analyzed as per objectives of the present study. Moreover, Journal Rank, Source Normalized Impact per Paper (SNIP), and SCImago Journal Rank (SJR) also has been used for Impact factor and H Index value.

**OBJECTIVES**

The following objectives of the present study are:

- To find out Space debris research publications during 1991 to 2015
- To find top ten author's contributions in Space debris Research
- To identify the top ten sources published in Space debris Research
- To examine top ten Space debris published source's Impact Factor and H Index value

**ANALYSIS AND INTERPRETATIONS**

**Table 1 year wise research output in Space debris**

Sl. No.	Years	No. of records	Percentages
1	1991	4	0.93
2	1992	13	3.02
3	1993	23	5.35
4	1994	8	1.86
5	1995	16	3.72
6	1996	4	0.93
7	1997	26	6.05
8	1998	10	2.33
9	1999	18	4.19
10	2000	4	0.93
11	2001	20	4.65
12	2002	7	1.63
13	2003	11	2.56
14	2004	24	5.58
15	2005	9	2.09
16	2006	12	2.79
17	2007	15	3.49
18	2008	20	4.65
19	2009	16	3.72
20	2010	18	4.19
21	2011	19	4.42
22	2012	16	3.72
23	2013	31	7.21
24	2014	46	10.70

25	2015	40	9.30
	Total	430	100.00

Table 1 shows that, year wise publications in Space debris research during 1991- 2015, among the twenty five years, 2014 has occupies first position with 10.70 percent of papers in this research, 2015 has occupied second place with 9.30 percent of papers, 2013 has 7.21 percent of papers with third place, followed by 1997 have published 6.05 percent, 2004 have published 5.58 percent of papers, 1993 has 5.35.percent, 2001 and 2008 each has 4.65 percent, 2011 has 4.42 percent, 1999 and 2010 each year has 4.19 percent, 1995, 2009, and 2012 each year have published 3.72 percent of papers, 2007 has 3.49 percent, 1992 has 3.02 percent, 2006 has 2.79 percent, 2003 has 2.56 percent, 1998 has 2.33 percent, 2.09 percent of papers published in 2005, 1994 has 1.86 percent, 2002 has 1.63 percent of papers, moreover 1991, 1996 and 2000 each year have published 0.93 percent of papers in Space debris research .

**Table 2 Document type wise space debris research publications**

Sl. No.	Document types	No. of records	Percent-ages
1	Article	392	91.16
2	Editorial Material	17	3.95
3	News Item	9	2.09
4	Letter	6	1.40
5	Review	2	0.47
6	Poetry	1	0.23
7	Meeting Abstract	1	0.23
8	Correction	1	0.23
9	Book Review	1	0.23
	Total	430	100.00

Table 2 shows that, document type wise research publications in space debris, nine document types were published 430 papers in this research. Among the nine document types Article has occupies first place with 392 papers, second place has Editorial Material with 17 papers, third place News Item has 9 papers, followed by Letter has 6 papers, Review has 2 papers, Poetry, Meeting Abstract, Correction, and Book Review each has 1 record have published.

**Table 3 Language wise research publications**

Sl. No.	Languages	No. of records	Percentages
1	English	423	98.37
2	Chinese	5	1.16
3	Slovenian	1	0.23
4	Russian	1	0.23
	Total	430	100.00

Table 3 shows that, Language wise research publications in space debris, among the 430 papers, 98.37 percent of papers published in English language, followed by in Chinese has 1.16 percent, in Slovenian and Russian each language has 0.23 percent.

**Table 4 Authorship pattern in Space debris research publications**

Sl. No.	No. of Authors	No. of papers	Percentages
1	Single	122	28.37

2	Double	80	18.60
3	Three	63	14.65
4	Four	50	11.63
5	Five	44	10.23
6	Six	24	5.58
7	Seven and Above	47	10.93
	Total	430	100.00

Table 4 indicates that, authorship pattern in Space debris research publications, among the 430 papers, 122 papers were contributed by the single contributions are high, Double were contributed 80 papers, three authors were contributed 63 papers, Four authors were contributed 50 papers, Seven and above authors were contributed 47 papers, Five authors were contributed 44 papers, six authors were contributed only 24 papers. This table clears that, single authors contributions are less compare with collaborative research, collaborative author papers were published 71.63 percent.

**Table 5 Author productivity in Space debris research**

Sl. No.	Number of Contribution	No. of Authors	Percentage	Cumulative Percentage
1	1	879	77.79	77.79
2	2	149	13.19	90.98
3	3	49	4.34	95.31
4	4	22	1.95	97.26
5	5	8	0.71	97.97
6	6	9	0.80	98.76
7	7	1	0.09	98.85
8	8	9	0.80	99.65
9	11	2	0.18	99.83
10	12	2	0.18	100.00
	Total	1130	100.00	

Table 5 shows that, Author productivity in Space debris research, 879 (77.79%) of the authors who contributed single publications in Space debris research. Totally 1130 authors were contributed in this research followed by, 149 authors contributed two publications. Followed by 49 authors contributed three papers, 22 authors were contributed 4 papers, 8 authors were contributed 5 papers, 9 authors were contributed 6 papers, one authors were contributed 7 papers, 9 authors were contributed 8 papers, 2 authors were contributed 11 papers, and 2 authors were contributed 12 papers in this research. It reveals that, majority of authors were contributed in single time only.

**Table 6 top 10 authors' contribute in Space debris research**

Sl. No.	Authors	No. of records	% of 430
1	Klinkrad, H	12	2.79
2	Flury, W	12	2.79
3	Rossi, A	11	2.56
4	Anselmo, L	11	2.56
5	Zhao, C Y	8	1.86
6	Sdunnus, H	8	1.86
7	Schildknecht, T	8	1.86
8	Pardini, C	8	1.86
9	Mcdonnell JAM	8	1.86

10	Lemaitre, A	8	1.86
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Table 6 indicates that, top 10 authors' contribute in Space debris research, totally 1130 authors were contributing in Space debris research during the study period, top ten authors' are listed in table 6, among the 1130 authors Klinkrad, H, and Flury, W, each author respectively has contributed 2.79 percent paper in this research, followed by Rossi, A and Anselmo, L respectively published 11 papers, Zhao, C Y, Sdunnus, H, Schildknecht, T, Pardini, C, McDonnell JAM and Lemaitre, A are respectively published 8 papers in Space debris research, moreover remaining 1120 authors are contribute 8 and below 8 papers in this research.

**Table 7 top 10 Countries' participated in Space debris research**

Sl. No.	Countries	No. of records	Percentages
1	USA	63	14.65
2	Germany	42	9.77
3	England	39	9.07
4	France	32	7.44
5	Italy	31	7.21
6	Peoples Republic China	30	6.98
7	Japan	29	6.74
8	Russia	28	6.51
9	Netherlands	21	4.88
10	Belgium	12	2.79
	30 Countries	103	23.95

Table 7 shows that top 10 Countries' participated in Space debris research during 1991 – 2015, totally 40 countries contribution in this research, in this table ten countries only listed. Among the ten countries USA occupies with first position with 14.65 percent, Germany has second place with 9.77 percent, England occupies third place with 9.07 percent, followed by France has 7.44 percent, Italy has 7.21 percent, Peoples R China has 6.98 percent, Japan has 6.74 percent, Russia has 6.51 percent, Netherlands has 4.88 percent, Belgium has occupies tenth position with 2.79 percent. Moreover, the remaining 30 countries are contributing below 12 papers in this research.

**Table 8 Top 10 sources published Space debris research papers**

Sl. No.	Source Titles	No. of records	% of 430
1	Advances in Space Research	111	25.81
2	Acta Astronautica	60	13.95
3	International Journal of Impact Engineering	24	5.58
4	Journal of Spacecraft and Rockets	13	3.02
5	Celestial Mechanics Dynamical Astronomy	10	2.33
6	Astronomical Journal	9	2.09
7	Planetary and Space Science	6	1.40
8	Aerospace America	6	1.40
9	Space Policy	5	1.16
10	Research in Astronomy and Astrophysics	5	1.16
	68 Source	130	30.23

Table 8 shows that, Top 10 sources published in Space debris research papers. Totally 78 sources were published 430 pa-

pers in this research, among the sources "Advances in Space Research" has occupies first position with 25.81 percent of papers, "Acta Astronautica" has second position with 13.95 percent of papers, "International Journal of Impact Engineering" has occupies third place with 5.58 percent, followed by "Journal of Spacecraft and Rockets" has 3.02 percent, "Celestial Mechanics Dynamical Astronomy" has 2.33 percent, "Astronomical Journal" has 2.09 percent, "Planetary and Space Science", "Aerospace America" has seventh and eight position respectively, "Space Policy" and "Research in Astronomy and Astrophysics" each has 1.16 percent of papers with ninth and tenth position respectively, remaining 68 sources were published 5 and below papers in this research.

**Table 9 top ten Space debris published source's Impact factor and h-Index**

Sl. No.	Title	No. of outputs	Total Cites (last 3years)	SNIP	SJR	Impact Factor	h-index
1	Advances in Space Research	162	1845	1.07	0.726	1.409	43
2	Acta Astronautica	60	1465	1.24	0.726	1.095	43
3	International Journal of Impact Engineering	24	1153	2.87	1.976	2.201	80
4	Journal of Spacecraft and Rockets	13	441	1.28	0.74	0.93	55
5	Celestial Mechanics and Dynamical Astronomy	10	342	1.781	1.017	1.6	41
6	Astronomical Journal	9	3607	1.25	3.069	4.617	191
7	Planetary and Space Science	6	1365	0.96	1.072	1.942	69
8	Aerospace America	6	10	0	0.101	0.03	9
9	Space Policy	5	65	0.59	0.309	0.596	16
10	Research in Astronomy and Astrophysics	5	667	0.86	0.883	1.292	22

Sources: SCImago Journal Rank

In the table 9 shows that, top ten Space debris papers published source's Impact factor and H Index. The h - Index value is minimum 9 to a maximum of 191. The Impact Factor of first ten journals represented in this study, "Astronomical Journal" got the first position in the rank by Impact Factor of 4.617 and followed by others. Moreover, 'Celestial Mechanics and Dynamical Astronomy' has highest value of Source Normalized Impact Per Paper (SNIP) is 1.781; 'Astronomical Journal' has highest SCImago Journal Rank (SJR) value is 3.069, and Advances in Space Research's last three years Total Cites value is 1845.

**CONCLUSION**

Concluded from this study, Space debris research shows on growth of publication during the study period in 1991 starting with 4 papers and in year 2015 has 40 papers. Among the document types journals articles has occupies predominate place, majority of papers have published in English language, multi authored papers are more compare with single author papers in this research. During the study period Klinkrad, H, and Flury, W they have published highly papers. Totally 80 sources were published 430 papers in this research, among the sources "Advances in Space Research" has occupies first position with 21.63percent of papers, remaining sources published less than 20.00 percent papers.

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