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Study of Productivity, Citation Patterns and Changing Trends in *Defence Science Journal* during 2009-2014

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ABSTRACT

The paper presents bibliometric analysis of 10671 citations appearing in 471 papers published in *Defence Science Journal (*DSJ) during 2009-2014. Efforts have been made to study the productivity and citation patterns of researchers for their published papers based on various parameters. The paper studies the automation process taken place and significant changes occurred. The study reveals almost a constant trend of inflow of papers with increasing trend of multi-authored papers. Highest share of papers are being contributed by authors of Indian origin, majority being from DRDO, and journals being the predominant source of information cited by the researchers for their R&D works.

Keywords: Author productivity, citation patterns, *Defence Science Journal*

1. INTRODUCTION

Journals are considered a predominant channel of communication among researchers for their R&D activities on a global basis. They are taken as a primary source to explore the productivity and citation patterns of researchers through their published research papers in specific subject fields. There are a large number of journals published in almost every subject field in India. *Defence Science Journal* (DSJ) is a unique bi-monthly, multi-disciplinary primary defence research journal of Defence Research and Development Organisation (DRDO), Ministry of Defence, Government of India, published by the Defence Scientific Information and Documentation Centre (DESIDOC), Delhi since 1949. The journal covers basic and applied research and review papers from academic and research institutions including defence R&D institutions, having bearing on defence applications, both from India and abroad.

1.1 Changing Trends of DSJ

The DSJ has undergone many changes since its inception from 1949 till today. From the year 2007, the Journal started using Open Journal System (OJS) software to further speed up the editorial and refereeing processes thereby reducing by half the time taken from submission to acceptance of papers. The authors and referees register themselves on the Journals website and are able to track the progress of papers, online[1]. Using OJS, a user can register as a reader, an author, and as a referee.

- Readers can view abstract as well as full text paper of all the issues available at the DSJ site. Readers are asked to sign up for the 'publishing notification' service for DSJ. They can use the 'Register' link at the top of the homepage for the journal. The registered reader will receive the 'Table of Contents' by e-mail for each new issue of the journal.
- Authors are required to register for submitting manuscripts online and for checking the status of current submissions. The authors get auto acknowledgement through OJS and can also track the progress of their manuscript online. The information regarding acceptance/modification/ rejection of the manuscript is sent to the authors through OJS. The authors submit the modified manuscript online through OJS.
- One can register as a referee, giving details about his/her areas of expertise along with his name, affiliation, e-mail, etc. A database of referees is maintained through OJS. The title and abstract of the manuscript submitted by the authors are sent through OJS to the referees selected as per their areas of expertise, and after confirming their availability and willingness to review the manuscript, the complete manuscript is sent them with a request to give their comments on the 'Confidential Review Report Performa' which the reviewer sends back using OJS. This has considerably reduced the time in the refereeing process[2].

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The DSJ has undergone many changes since 2007, as observed while visiting the website of the Journal[3], such as, from 2007, the Journal has changed its frequency of publication from quarterly to bimonthly. The Journal is now covered by large number of indexing and abstracting agencies including Science Citation Index Expanded (Web of Science), Cambridge Scientific Abstracts, Chemical Abstracts, Elsevier databases (EMbase, Compendex, Geobase, EMbiology, Elsevier Biobase, Fluidex, World Textiles, Scopus), Scimago Journal Ranking, Indian Science Abstracts, International Aerospace Abstracts, ProQuest, Google Scholar, DOAJ, Indian Science Citation Index, Omnifile Full-text Mega, Omnifile Full-text Select, and NTIS database (World News Connection), Ulrich's International Periodical Directory, Open Academic Journals Index (OAJI), Bielefeld Academic Search Engine (BASE).

Full-text of Defence Science Journal from 1949 to 2015 (volumes 1 to 65), searchable by author, subject, keywords, and volume is also available free on internet at http://www.publications.drdo.gov.in/index.php/dsj for Open Access regular, announcements are created and made available on site time to time. Feedback is asked from all readers, authors and reviewers. Data regarding the h-index of the journal and individual citations received by the articles published in DSJ as measured by Google Scholar is being provided. Author guidelines for online submission are available, Digital Object Identifier is assigned for each paper, to give it unique identification. Changes are noticed in Editorial Board also. Various polices of the Journal are available on its site. Each published paper is available as pdf format on internet alongwith the abstract and keywords. Article tools such as indexing metadata, how to cite item, e-mail the article, e-mail the author, abstract, etc., are available along with the article.

2. LITERATURE REVIEW

Bibliometric studies of journals has remained a key methodology to measure productivity of researchers, information sources used or cited by them, institutions, countries or any other level of performance during a specific period of time. In India alone, a large number of bibliometric studies of several journals based on citation analysis have been carried out by many researchers during the last two decades. For instance, Mete and Deshmukh[4] analysed 1824 citations appeared in 202 papers published in *Annals of Library Science and Documentation* published during 1984-1993.Vij & Bedi[5] carried out a bibliometric study of the contents and citations of papers published in *Defence Science Journal* during 1987-1996. Narang[6] conducted a bibliometric study and analysed 8396 citations appeared in 736 papers published in *Indian Journal of Pure and Applied Mathematics* during 1998-2002. Jena[7] made a bibliometric study of the *Indian Journal of Fibre and Textile Research*, wherein 8114 citations from 507 papers published during 1996-2004 were analysed through citation patterns. Other studies undertaken are by Kumar & Kumar[8] who analysed 8093 citations from various papers published in *Journal of Oil Seed Research* during 1993-2004. Kulkarni[9], *et al.* conducted citation analysis of papers published in *Indian Journal of Pharmaceutical Education and Research* during 1996-2006 and found journals as the leading information source of citations preferred by authors.

Verma & Tamrakar[10] conducted bibliometric analysis of 524 papers published in the *Defence Science Journal* during 1997-2006. Hadimani & Rajgoli[11] analysed 10553 citations appeared in 538 papers published in *Applied Engineering in Agriculture* during 2004-2008 and found authorship pattern and ranked list of information sources cited by authors, besides many other patterns. Recently, Deshmukh[12] analysed 4141 citations appended to papers published in *Annals of Library and Information Studies* during 1997-2010 and found that journals were the most cited information sources by the authors for their research works. Kumar & Moorthy[13] analysed 3428 citations appeared in 271 papers published in *DESIDOC Journal of Library and Information Technology* during 2001-2010, based on various parameters, like authorship pattern, productive pattern, citation pattern, etc. Bansal[14] conducted a comprehensive bibliometric study involving 5416 citations appeared in 391 papers published in *DESIDOC Journal of Library & Information Technology* during 2001-2012. The analysis provided growth pattern, authorship pattern, geographic distribution pattern, subject pattern, length pattern and citation pattern of papers published in the Journal. Garg & Anjana[15] analysed 13738 citations appended to 605 papers published in *Journal of Intellectual Property Rights* during 1996-2012.The bibliometric study analysed various patterns, like productive pattern, authorship pattern, institution based pattern, prolific authors pattern and citation pattern of papers published in the journal. The present paper makes a bibliometric study of 10671 citations appended to 471 papers published in *Defence Science Journal* during 2009-2014.

3. AIMS AND OBJECTIVES

Journals are the key channels or media of communication among researchers all over the world. The present study is aimed at conducting in-depth study of the productivity and citation patterns of researchers as reflected through their papers published in DSJ during 2009-2014. The study has been carried out with the following objectives:

(a) To study the productive pattern of papers published in DSJ based on such parameters as, growth pattern, authorship pattern institutions pattern and nationality pattern as exhibited by authors.

(b) To study the citation pattern of researchers for their papers published in DSJ based on such parameters as, quantum pattern, currency pattern, information sources pattern, journals pattern as followed by authors.

(c) To understand the changing trends in DSJ.

4. METHODOLOGY

For the purpose of this study, DSJ has been selected as the source journal. To observe consistency in results of the study on a longitudinal basis, papers published during the six-year period (2009-2014) are taken into consideration for bibliometric analysis. Study is done regarding Indian/foreign authors, author(s) affiliations (name of organisation, country), number of cited references, country of foreign cited references, period of cited references, etc. Finally, the data was analysed for exploring various types of productivity and citation patterns of researchers of their published papers.

5. RESULTS AND DISCUSSIONS

All the papers published in DSJ during 2009-2014 have been physically scanned to analyse their contents and citations. In all, 471 papers, comprising of 10671 citations, authored by 1386 researchers published in DSJ during 2009-2014. The analysis of the productivity and citation patterns of researchers for their papers published in DSJ during 2009-2014 based on various parameters, as stated in the objectives, are presented as under:

5.1 Growth-based Productivity Pattern

Table 1 presents the data on growth-based productive pattern of papers published by the researchers and no. of researchers publishing in DSJ during the period, 2009-2014.

In all, 471 papers are published by 1386 researchers in the DSJ during 2009-2014. Maximum papers are published by 261 researchers in 2013 (18.90 %) and the minimum are published by 201 researchers in 2012 (13.80 %). In other years, the productivity of the journal remains almost constant. It may be mainly due to the strict peer review policy followed by the publishing agency in order to maintain quality standard of the journal.

Table 1. Growth-based productivity pattern of DSJ during 2009-2014

Year	No. of researchers	No. of papers	Productivity %
2009	246	83	17.62
2010	217	79	16.77
2011	230	77	16.35
2012	201	65	13.80
2013	261	89	18.90
2014	231	78	16.56
Total	**1386**	**471**	**100.00**

5.2 Authorship-based Productivity Pattern

Table 2 shows the authorship-based productivity pattern of researchers for their papers published in DSJ during 2009-2014. As seen in Table 2, two-authored papers comprised the highest percentage i.e. 127 (26.96 %), followed by three-authored papers, 119 (25.26 %), four-authored, 94 (19.96 %), five or more authored, 67 (14.23 %) and single-authored, 64 (13.59 %). This indicates that proportion of two or multi-authored papers published in DSJ is quite large (86.41 %) compared to single-authored papers (13.59 %).

5.3 Institution-based Productivity Pattern

Table 3 shows the institution-based productivity pattern of research output or papers published in DSJ during 2009-2014. The share of papers published in DSJ during 2009-2014 is contributed predominantly by R&D laboratories/institutions of DRDO (38.16 %), followed by Indian academic institutions, IITs (33.64 %), foreign academic and R&D institutions (18.70 %) and Indian civilian R&D institutions, like CSIR, ICAR, BARC, ISRO, etc. (9.50 %). The possible reasons for more papers contributed by DRDO institutions may be due to the fact that, (a) DSJ is a primary channel for exchange of information among defence scientists working in DRDO and, (b) its scope provides fast communication among researchers by way of publishing Special Issues on areas of defence interest.

5.4 Nationality-based Productivity Pattern

Table 4 presents the data on nationality-based productivity pattern of research output or papers published in DSJ during 2009-2014.

Based on complete count of papers, as shown in Table 4, 1386 authors or researchers contributed papers for DSJ during 2009-2014. Among them, majority of authors (81.67 %) are from India and the remaining authors (18.33 %) are from abroad like USA, China, Russia, Czech, Germany, Israel, Australia, etc. From this, it is evident that DSJ is the most popular channel of communication among researchers on areas of research relevant to defence in India and to a considerable extent for researchers geographically spread all over the world.

5.5 Quantum-based Citation Pattern

Table 5 presents the data on number of references or citations cited by researchers in their 471 papers published in DSJ during 2009-2014.

Table 2. Authorship-based productivity pattern of DSJ during 2009-2014

Year	No. of papers	No. of authors				
		One	Two	Three	Four	Five and above
2009	83	17	15	18	20	13
2010	79	16	25	12	15	11
2011	77	8	23	20	14	12
2012	65	7	16	18	12	12
2013	89	11	24	23	22	9
2014	78	5	24	28	11	10
Total	471	64	127	119	94	67
Productivity (%)	**100 %**	**13.59 %**	**26.96 %**	**25.26 %**	**19.96 %**	**14.23 %**

Table 3. Institution-based productivity pattern of DSJ during 2009-2014

Year	No. of academic/ R&D institutions	Indian academic institutions	Indian civilian R&D institutions	Indian defence R&D institutions	Foreign academic/ R&D institutions
2009	118	36	12	48	22
2010	107	33	11	42	21
2011	98	31	9	39	19
2012	93	29	8	34	21
2013	128	37	13	54	24
2014	119	57	10	36	17
Total	**663**	**223**	**63**	**253**	**124**
Productivity (%)	**100 %**	**33.64 %**	**9.50 %**	**38.16 %**	**18.70 %**

Table 4. Nationality-based productivity pattern of DSJ during 2009-2014

Year	No. of authors	Nationality	
		Indian	Foreign
2009	246	204	42
2010	217	184	33
2011	230	191	39
2012	201	158	43
2013	261	202	59
2014	231	193	38
Total	**1386**	**1132**	**254**
Productivity (%)	**100.00**	**81.67**	**18.33**

Table 5. Quantum-based citation pattern of DSJ during 2009-2014

Year	Total	No. of papers having citation between				
		0-10	11-20	21-30	31-50	>= 51
2009	83	20	33	15	7	8
2010	79	16	27	14	17	5
2011	78	9	36	19	8	6
2012	65	8	34	16	5	2
2013	89	21	38	18	8	4
2014	77	10	35	22	7	3
Total	**471**	**84**	**203**	**104**	**52**	**28**
Citation (%)	**100**	**17.83**	**43.10**	**22.08**	**11.04**	**5.95**

As seen in Table 5, out of 471 papers published by researchers during 2009-2014 in DSJ, the highest number of papers i.e. 203 (43.10 %) have referred to 11-20 citations per paper and lowest number of papers i.e. 28 (5.95 %) having citations cited 51 or more per paper. This variation of citations per paper indicated that DSJ cover both, research and review papers to a considerable extent.

5.6 Currency-based Citation Pattern

Table 6 presents data on references/citations based on their currency or period cited by the researchers during 2009-2014. The purpose of this segment of study was to explore to what extent the researchers refer or cite current (taken as 5-years) and retrospective (taken as more than 5-years) information sources in context of their research works published in DSJ.

The analysis of citation data shown in Table 6 indicates that out of 2101 references cited by researchers in 2009, only 18.80 % of references cited are five-years old (2005-2009, assumed to be current) followed by 30.79 % being 20-years old, 29.89 % being 10-years old, and 20.52 % being more than 20 years old (before 1989) from the current year 2009.

However, after a gap of six-years, i.e. in 2014, the analysis of citation data showed an increasing

Table 6. Currency-based citation patterns of papers published in DSJ during 2009-2014

Year	Total	No. of citations cited (%)			
		Current to past 5-years	Next past 5-years	Next past 10 years	Next past 20 years)
2009		**2005-2009 (%)**	**2000-2004 (%)**	**1990-1999 (%)**	**Before 1989 (%**
	2101 (100)	395 (18.80)	628 (29.89)	647 (30.79)	431 (20.52)
2014		**2010-2014 (%)**	**2005-2009 (%)**	**1995-2004 (%)**	**Before 1995 (%)**
	1850 (100)	475 (25.68)	502 (27.13)	498 (26.92)	375 (20.27)

Table 7. Information sources-based citation pattern of papers published in DSJ during 2009-2014

Year	No. of papers	No. of citations	Information sources/citations cited in papers							
			J	B	C	R	P	Th	S	Misc
2009	83	2101	1425	307	193	69	23	7	2	75
2010	79	1932	1117	272	265	110	52	39	8	69
2011	78	1783	1166	229	208	71	9	17	11	72
2012	65	1307	809	152	178	67	3	16	14	68
2013	89	1698	953	247	275	81	20	21	22	79
2014	77	1850	1245	223	234	52	14	13	6	63
Total	471	10671	6715	1430	1353	450	121	113	63	426
(%)	-	100	62.93	13.40	12.68	4.22	1.13	1.06	0.59	3.99
No. of citations per paper		**22.65**	**14.26**	**3.04**	**2.88**	**0.95**	**0.26**	**0.24**	**0.13**	**0.90**

J-Journals; B-Books; C-Conf. Proceedings; R-Reports; P-Patents; Th-Theses; S-Standards/Specifications; Misc-Web sources, Personal Communications.

trend of referring or citing more current references (25.68 %) during 2010-2014, followed by 27.13 % being 10-years old, 26.92 % being 20-years old and remaining 20.27 % being more than 20-years old from the current year, 2014 as compared to citation pattern during the year 2009 .

5.7 Information Sources-based Citation Pattern

Table 7 presents data on information sources or references cited by researchers for their papers published in DSJ during 2009-2014.

As shown in Table 7, journals are the most preferred information sources referred or cited by researchers (62.93 %), followed by books (13.40 %), Conf. proceedings (12.68 %), reports (4.22 %), misc. sources, mainly web sources (3.99 %), patents (1.13 %), theses (1.06 %) and standards/specifications (0.59 %).

On analysis of citations further, it is found that, on an average, the number of citations per paper published in DSJ during 2009-2014 is 22.65, which is quite appreciable for a research paper. The number of citations of journals per article is found to be the highest, 14.26, followed by books (3.04), conf. Proceedings (2.88), reports (0.95), web sources (0.90), patents (0.26), theses (0.24) and standards/specifications (0.13).

5.8 Indian vs Foreign Journals-based Citation Pattern

Table 8 presents data on citation pattern of journals, both of Indian and Foreign origin, as cited by the researchers in their papers published in DSJ during 2009-2014.

On analysis of data, shown in Table 8, it is found that researchers refer or cite predominantly journals of foreign origin (96.60 %) compared to journals of Indian origin (3.40 %). The higher citation or use rate of foreign journals by researchers is an indicative of the fact that research is a global phenomenon which is communicated to researchers

Table 8. Indian vs foreign journals citation pattern of papers published in DSJ during 2009-2014

Year	Total	No. of source journals cited	
		Indian	Foreign
2009	1425	41	1384
2010	1117	39	1078
2011	1166	46	1120
2012	787	18	769
2013	964	36	928
2014	1268	49	1219
Total (%)	**6727 (100)**	**229 (3.40)**	**6498 (96.60)**

largely through foreign journals, and mostly through predominant use of internet on world-wide basis.

6. CONCLUSIONS

The study reveals an increasing trend of multi-authored papers. On global level it is a unique Indian journal for research contributions from academic and R&D institutions on world-wide basis with particular relevance to defence research. Researchers predominantly cite reputed journal of foreign origin, mostly from USA and UK and few from China, Israel, Japan, Germany, France, Australia, Czchoslovakia, Poland, Spain and India. Highest share of papers are being contributed by authors from India, majority being from DRDO, and journals being the preferred source of information cited by the researchers for their R&D works. *Defence Science Journal* of DRDO, India has marched a long journey from its inception in 1949 till today in terms of its contents, periodicity, readership coverage, editing, reviewing publishing, storage, access and delivery practices.

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