

## **Bibliometric Study of Defence Science Journal during 1994-2020 Based on Web of Science Database**

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### **Abstract**

Defence Science Journal (DSJ) is the Defence Research & Development Organisation (DRDO), India's peer-reviewed research journal in defense science and technology research. This paper presents a bibliometric analysis of 1855 scholarly communications published in the journal during 1994 and 2020. The publications have been searched, identified, and downloaded from the Clarivate Analytics Web of Science Core Collection Database for 27 years, i.e., from 1994 to 2020. Software such as bibliometrix R-package Biblioshiny, VOSviewer, HistCite, and BibExcel have been successfully used to analyze the collected data. The study covers different features like types of documents, growth patterns, prolific authors, countries and institutions, and most cited sources. The majority of the publications were published in 2017. Researchers from the native country, India contributed the maximum number of articles (1405). The findings further indicate that the most prolific institution is the Indian Institute of Technology, which ranks top with 206 publications. The present study highlights the theoretical and empirical importance of the publications published in the DSJ over the past 27 years.

**Keywords:** Bibliometrics, Defence Science Journal, DRDO, Biblioshiny.

### **Introduction**

Professionals and scientists publish their ideas, discoveries, innovations, and findings of studies in scholarly journals. Studies in a single journal can give a comprehensive, in-depth picture of the traits of a single publication. Certain indicators can assess different aspects of articles published in a single journal. Bibliometric analysis is one search technique widely used in the study of published articles in the journal. Bibliometric indicators are often used as the assessment method to determine the characteristics, quality, and status of a single journal study (Tsay, Jou & Ma, 2000). It also constitutes an important Library and Information Science (LIS) research area. As a technique, the bibliometric analysis provides a macroscopic perspective of

enormous academic literature. The features and evolution of scientific output within a particular field of inquiry can be mapped using a quantitative analysis of information on the publication history (Jia, Dai & Guo, 2014; Li & Hale, 2016; van Nunen, Li, Reniers & Ponnet, 2018). The performance and research patterns of countries, authors, journals, and institutions can be evaluated using bibliometric approaches, and the patterns of cooperation between them can be identified and measured (Li & Zhao, 2015). The number of journals published on a specific subject and the specific topic categories can provide insight into the various research concepts and the interdisciplinary Nature of a research domain in which bibliometric analysis can reveal the most recent advances, future research directions, and hot topics in a given field (Wang, Pan, Ke, Wang & Wei, 2014; Gall, Nguyen & Cutter, 2015).

Since 1949, the Defence Science Journal (DSJ) has been a peer-reviewed, bi-monthly primary academic journal in Defence Science and Technology published by the Defence Research and Development Organisation (DRDO), Government of India. Among the key topics studied are aeronautics, armaments, combat vehicles and engineering, biomedical sciences, computer sciences, electronics, material sciences, missiles, naval systems, etc. The journal is indexed in the major international science and technology indexing and citation databases such as the Web of Science and Scopus database. Based on the Web of Science (WoS) Core Collection Database, the present bibliometric study has attempted to analyze the research productivity relating to the DSJ from 1994 to 2020 and its rise and growth as a core and primary research journal in the field. The study selected 27 years of DSJ to investigate the growth rate of publications, received citations, highly cited papers, authors, institutions, countries, and many other features as the focused areas of the study. Such studies are essential to identify and understand the status, trend, and quantum of research conducted in a specific field within a time frame.

### Literature Review

There is no shortage of literature on bibliometric studies. As an essential area of LIS research, large fields of study are covered by researchers in bibliometrics. A brief review of the recent past has shown us the truth. Gyanajeet and Ibohal (2021) recently studied 282 scholarly communications of the Malaysian Journal of Library and Information Science (MJLIS) from 2007 to 2020, extracting data from the Web of Science (WoS) Core Collection database. Yanbing, Ruifang, Chen, Shifan, Hua and Zhiguang (2020) explored the 1,913 scientific publications of the Journal of Nursing Management from the Scopus database from 1993 to 2018 and revealed that the UK, Canada, Finland, and Sweden contributed to the top prolific institutions. The forty-five years of the Journal of Business Research were explored by Donthu, Kumar and Pattnaik (2020) by revealing the impact of the journal, hot topics, and prolific authors, institutions, and countries. A bibliometric study of the Journal of Documentation from 1945 to 2018 was carried out by Mokhtari, Barkhan, Haseli and Saberi (2020). Again, Shilpa, Padmamma, Kumara and Walmiki (2019) revealed that the All-India Institute of Medical Sciences was the topmost contributing institution in India's Leukaemia research, and the main published articles were on oncology and hematology subjects. Again, Muthukrishnan and Senthilkumar (2018) discussed the Annals of Surgical Oncology's research productivity for 13 years. Self-Citation trends of SRELS Journal of Information Management were evaluated by Yadav, Singh and Verma (2018) from 2008 to 2017 and based on the Indian Journal of Cancer's thirty-nine issues, Santhanakarthykeyan, Grace and Jeysankar (2014) analyzed the journal's

literature growth, author's productivity, length of articles, and country collaboration. The growth trends of Indian oncology cancer research outputs in the different study periods were analyzed by Lewison and Roe (2012) and Patra and Bhattacharya (2005). In their bibliometric analysis, Verma, Tamrakar and Sharma (2007) surveyed 131 articles published in ALIS journals during 1999-2005. They observed more single-author contributions in a journal than a joint author, with the source journal being the most cited. Bibliometrics studies in the Defence Science Journal were conducted by different researchers (Selvavinayagam, Muthu & Veerachamy, 2018; Muthumari & Raja, 2016; Verma & Tamrakar, 2009). The bibliometric studies covering subject areas are expected to continue in the future, too.

### Objectives

The objectives of the present study are to:

- study the types of documents, growth, and citation pattern of the DSJ;
- analyze the highly cited papers, most prolific authors, countries, and institutions;
- find out the authorship pattern and most cited sources of the journal, and
- find out frequently used key terms.

### Materials and Methods

The present study has covered the research papers published in the Defence Science Journal (DSJ). The data has been searched, identified, and retrieved from the Clarivate Analytics Web of Science (WoS) Core Collection Database ([www.webofscience.com](http://www.webofscience.com)) on 07<sup>th</sup> August 2021 using the advanced search technique of Publication Titles (TI) Search, i.e., Title = "Defence Science Journal". The study period has been specified from 1994 to 2020. A total of 1855 publications have been exported from the database in the plain text (.txt) file format, which has been used as a data source for the study. The analysis of these retrieved data has been carried out using various bibliometric statistical tools and software. Bibliometrix R-package *Biblioshiny* (v 4.0.0) (Aria & Cuccurullo, 2017) has been used in data extraction and cleaning from the database, VOSviewer (v 1.6.18) for mapping and data visualization (van Eck & Waltman, 2009), and BibExcel (v 2017) (Persson, Danell & Schneider, 2009) and HistCite (Garfield, 2009) for the analysis of citations indices such as total publication, total citation, h-index, and h-core. All these bibliometric tools are open-source educational software widely used for academic and research purposes worldwide. They are appropriate tools for the entire course of the study in data extraction and analysis.

### Data Analysis

#### Bibliometric Profile

The primary bibliometric information profile of the DSJ is represented in Table 1 for the period 1994 to 2020. For the study, the data sources have been imported using *biblioshiny*. There were 1855 different research documents contributed by DSJ, with 31452 references contributed by 3656 authors. However, the authors' appearance is found to be 5548. As shown, 231 authors of single-authored documents and 3245 authors of multi-authored documents exist. Regarding the author's collaboration, there are 297 single-authored documents with 0.507 documents per author, of which 1.97 constitute the author per document. The co-authors' per document is 2.99, and the collaborative index of DSJ is 2.2.

Table 1

*Bibliometric Profile on DSJ*

Description	Results	Description	Results
Main Information about Data		Authors	
Timespan	1994-2020	Authors	3656
Sources (Journals, Books, etc.)	1	Author Appearances	5548
Documents	1855	Authors of single-authored documents	231
Average years from publication	12.2	Authors of multi-authored documents	3425
Average citations per documents	4.173	<b>Authors Collaboration</b>	
Average citations per year per doc	0.3953	Single-authored documents	297
References	31452	Documents per Author	0.507
<b>Document Contents</b>		Authors per Document	1.97
Keywords Plus (ID)	2115	Co-Authors per Documents	2.99
Author's Keywords (DE)	6984	Collaboration Index	2.2

**Type of Documents**

Table 2 gives the distribution of the different types of documents of DSJ and its citation information. It is found that most of the published records are in the form of 'articles' with a TP of 1522 with the highest TC of 5446 and h-index of 23, followed by 'review' (TP = 167; TC = 1871; h-index = 22). The lowest publications were found from 'correction-addition,' 'book review,' and 'item about an individual' with only one publication each. However, it is noted that the average citation per publication (C/P = 11.20) of 'review' items are significantly greater than those of other formats such as 'article-proceedings paper' (C/P = 4.25) and 'article' (C/P = 3.58).

Table 2

*Distribution of Documents by Types*

Documents	TP	%	TC	C/P	h-index	h-core
Article	1522	82.05	5446	3.58	23	1112
Review	167	9.003	1871	11.20	22	1119
Article-Proceedings Paper	93	5.013	395	4.25	10	181
Editorial Material	58	3.127	18	0.31	2	12
Note	7	0.377	9	1.29	2	8
Biographical-Item	5	0.27	0	0.00	0	0
Correction-Addition	1	0.054	1	1.00	1	1
Book Review	1	0.054	0	0.00	0	0
Item About an Individual	1	0.054	0	0.00	0	0

\*TP = Total Number of Publications; TC = Total Citations; C/P = Average Citations Per Publication; h-core = Citation Sum within the h-core

**Growth Pattern of DSJ**

Table 3 and Figure 1 represent the year-wise distribution of articles and their citations received by the year. The annual growth rate of DSJ given by biblioshiny is 3.05%, in which a maximum of 98 documents was published in 2017 and received a TC of 230 and a minimum of 39 documents in 1996 and 39 TC. The highest total citations (TC) were found in 2008, with a TC of 884, followed by 2009 (TC = 853) and 2010 (TC = 579). The lowest was in 2020, with

39 citations. The highest average of citations per publication (C/P), i.e.,  $C/P = 10.91$ , was in 2008, followed by 2009 ( $C/P = 9.80$ ). The highest average citations per cited publication were recorded in 2008, i.e.,  $C/CP = 13.60$ . The maximum h-index was found in 2008 with an h-index of 15, and the h-core was in 2009 with an h-core of 620. The findings show an increasing trend in the publication pattern of DSJ.

Table 3  
Growth and Citation Structure of DSJ from 1994 to 2020

Year	TP	TC	TCP	C/P	C/CP	h-index	h-core
1994	43	87	24	2.02	3.63	5	49
1995	47	93	23	1.98	4.04	5	54
1996	39	77	19	1.97	4.05	5	39
1997	57	80	28	1.40	2.86	4	26
1998	52	141	41	2.71	3.44	6	67
1999	51	184	28	3.61	6.57	7	113
2000	48	131	34	2.73	3.85	7	57
2001	48	134	26	2.79	5.15	7	92
2002	53	171	29	3.23	5.90	6	111
2003	46	251	33	5.46	7.61	7	159
2004	58	205	44	3.53	4.66	7	98
2005	46	313	39	6.80	8.03	9	200
2006	86	322	59	3.74	5.46	8	149
2007	96	372	69	3.88	5.39	10	177
2008	81	884	65	10.91	13.60	15	603
2009	87	853	68	9.80	12.54	14	620
2010	67	579	54	8.64	10.72	13	434
2011	80	505	61	6.31	8.28	12	315
2012	68	397	56	5.84	7.09	11	217
2013	93	384	69	4.13	5.57	10	164
2014	80	423	63	5.29	6.71	10	240
2015	72	263	60	3.65	4.38	8	108
2016	89	316	65	3.55	4.86	9	128
2017	98	230	63	2.35	3.65	7	75
2018	85	216	56	2.54	3.86	6	94
2019	91	90	42	0.99	2.14	4	24
2020	94	39	39	0.41	1.00	2	5

\*TP = Total Number of Publications; TCP = Total Cited Publications; TC = Total Citations; C/P = Average Citations

Per Publication; C/CP = Average Citations Per Cited Publication; h-core = Citation Sum within the h-core

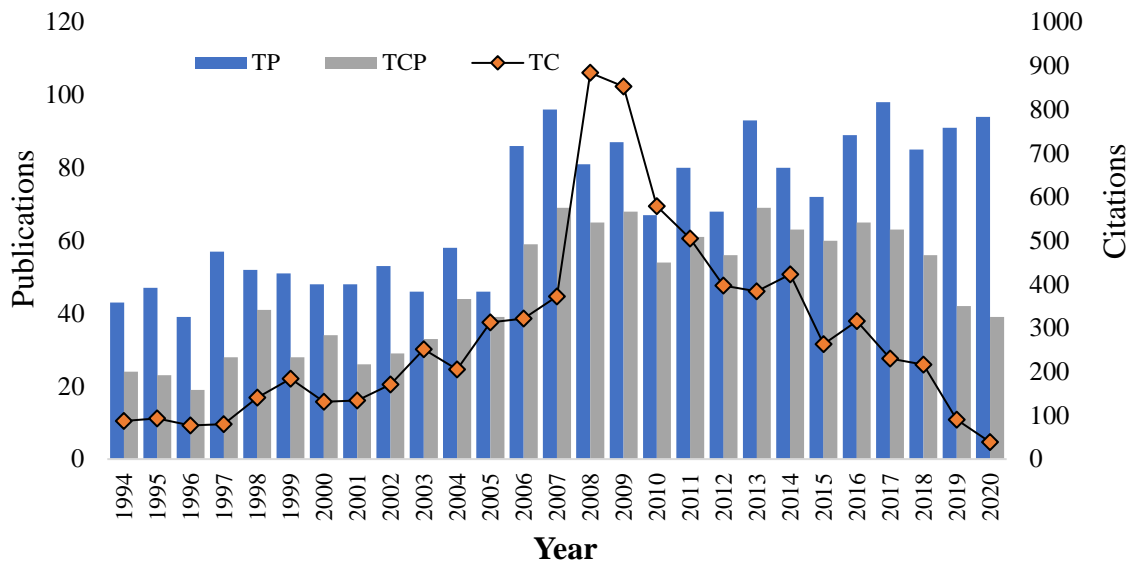


Figure 1: Growth and Total Citations Trends by Year of DSJ (1994-2020)

**Highly-Cited Papers of DSJ**

From 1994 to 2020, 1885 research papers were published in DSJ. Table 4 lists the top 10 highly cited publications with over 62 citations or more. As seen in Table 4, the article of Naidu and Raol (2008), “Pixel-level image fusion using wavelets and principal component analysis”, has received a TC of 207, TCPY of 14.79, and NTC of 18.97 and is considered the most highly cited article in the publications of DSJ, followed by the review articles “Microencapsulation Technology and Applications” of Dubey (2009) (TC = 186; TCPY = 14.31 and NTC = 18.97). In the third rank, two papers share the same TC of 104 each, i.e., the article of Naidu (2011), “Image Fusion Technique using Multi-resolution Singular Value Decomposition”, and the review papers of Nair, Asthana, Rao and Gandhe (2010), “Advances in High Energy Materials”. The lowest TC in the list is shared by the review papers of Bhan, Saxena Jalwania and Lomash (2009) and the article of Joshi, Patil and Krishnamurthy (2008), with a TC 62 each.

Table 4  
Highly Cited Research Papers of DSJ

Title	Author & Year	DT	TC	TCPY	NTC
Pixel-level image fusion using wavelets and principal component analysis. (Naidu & Raol, 2008)	Naidu and Raol (2008)	Article	207	14.79	18.97
Microencapsulation Technology and Applications. (Dubey, 2009)	Dubey (2009)	Review	186	14.31	18.97
Image Fusion Technique using Multi-resolution Singular Value Decomposition. (Naidu, 2011)	Naidu (2011)	Article	104	9.45	16.48
Advances in High Energy Materials. (Nair et al., 2010)	Nair et al. (2010)	Review	104	8.67	12.03
Thermal conductivity of nanofluids. (Singh, 2008)	Singh (2008)	Review	89	6.36	8.16

Title	Author & Year	DT	TC	TCPY	NTC
Defence Applications of Polymer Nanocomposites. (Kurahatt et al., 2010)	Kurahatti et al. (2010)	Review	79	6.58	9.14
High-temperature titanium alloys. (Gogia, 2005)	Gogia (2005)	Review	76	4.47	11.17
Motion state of fuel within shell in projection acceleration process. (Zhang et al., 2003)	Zhang et al. (2003)	Article	67	3.53	12.28
Uncooled Infrared Microbolometer Arrays and their Characterisation Techniques. (Bhan et al., 2009)	Bhan et al. (2009)	Review	62	4.77	6.32
Thermal Decomposition of Ammonium Perchlorate in the Presence of Nanosized Ferric Oxide. (Joshi et al., 2008)	Joshi et al. (2008)	Article	62	4.43	5.68

\*DT = Document Types; TC = Total Citations; TCPY = Total Citations Per Year; NTC = Normalized Total Citations

## Most Prolific Authors, Institutions and Countries

### Prolific Authors

From 1994 to 2020, the ten (10) most prolific and productive authors contributed papers on DSJ, as shown in Table 5. Regarding the authors' most paper productivity, 'Kumar A' ranks first in terms of publication with a TP of 34, which started published in 2007 and received a GCS of 82, LCS of 8 and h-index of 5, followed by the author 'Chakraborty D' (TP = 19; GCS = 70; LCS = 11 and h-index = 5) and 'Singh AK' (TP = 18; GCS = 186; LCS = 7 and h-index = 4). However, the author 'Singh H' has the highest average citation per publication (C/P = 10.75), followed by 'Singh AK' (C/P = 10.33). All of these top 10 authors are from India's institutions.

Table 5

Most Prolific Author of DSJ

Author	TP	GCS	LCS	C/P	h-index	PY-Start
Kumar A	34	82	8	2.41	5	2007
Chakraborty D	19	70	11	3.68	5	2010
Singh AK	18	186	7	10.33	4	1996
Kumar S	17	70	5	4.12	4	2004
Vijayaraghavan R	17	90	8	5.29	6	1994
Kumar R	16	91	5	5.69	5	1996
Singh H	16	172	6	10.75	8	1994
Singh A	15	91	3	6.07	5	1998
Gupta NK	13	69	1	5.31	5	2003
Kumar P	13	40	4	3.08	4	1998

\*TP = Total Number of Publications; LCS = Local Citation Scores; GCS = Global Citations Score; PY Start= Publications Year-Start, C/P = Average citations per publication

### Prolific Institutions

The top 20 prolific institutions involved in DSJ publication from 1994 to 2020 are shown in Table 6. The table shows that the Indian Institute of Technologies (IITs) is tops in publications with a TP of 206 with a TC of 689, followed by the High Energy Materials

Research Laboratory (TP = 88) and Defence Research and Development Laboratory (TP = 69). The lowest number of publications comes from the two institutions, i.e., Defence Institute of Physiology & Allied Sciences, and Laser Science and Technology Centre, with a TP of 21 each. However, the highest total citations came from the High Energy Materials Research Laboratory, with a TC of 703. It is seen that the High Energy Materials Research Laboratory has the highest average citations per publication (C/P = 7.99), followed by the Defence Research and Development Establishment (C/P = 7.22) and Defence Institute of Advanced Technology (C/P = 6.50). The results show the dominance of Indian Institutions in the research publications of DSJ.

Table 6  
Prolific Institutions of DSJ

Institutions	TP	TC	C/P
Indian Institute of Technologies (IITs)	206	689	3.34
High Energy Materials Research Laboratory	88	703	7.99
Defence Research and Development Laboratory	69	199	2.88
Defence Metallurgical Research Laboratory	56	339	6.05
Defence Research and Development Establishment	46	332	7.22
National Institute of Technology	41	119	2.90
Solid State Physics Laboratory	37	195	5.27
Vikram Sarabhai Space Centre	30	55	1.83
Indian Institute of Sciences	29	74	2.55
Defence Institute of Advanced Technology	28	182	6.50
Research Centre Imarat	27	60	2.22
Combat Vehicles Research and Development Establishment	26	79	3.04
Naval Physical and Oceanographic Laboratory	26	19	0.73
National University of Defense Technology	25	56	2.24
Armament Research & Development Establishment	24	60	2.50
Institute of Armament Technology	24	48	2.00
Anna University	22	69	3.14
Beijing Institute of Technology	22	114	5.18
Defence Institute of Physiology & Allied Sciences	21	20	0.95
Laser Science and Technology Centre	21	46	2.19

\*TP= Total Number of Publications; TC= Total Citations, C/P = Average Citations Per Publication

### Prolific Countries

The top 20 prolific countries are shown in Table 7. As seen in the table, India is the most prolific and productive country with a TP of 1405 and a TC of 6144, followed by China (TP = 105; TC = 446) and the USA (TP = 29; TC = 137). The lowest publications come from Australia, Malaysia, Brazil, and Israel, with a TP of 4 (0.23%) each, in which these four countries received TC of 50, 30, 24 and 49, respectively. However, Australia is at the top in citation impact (C/P = 12.50), followed by Israel (C/P = 12.25) and Germany (C/P = 9.86). But Russia has the lowest average citation per publication (C/P = 1.22). While India received a maximum h-index of 42 and an h-core of 1661.



Table 7  
Most Prolific Countries of DSJ

Country	TP	TC	C/P	h-index	h-core
India	1405	6144	4.37	27	1661
China	105	446	4.25	11	279
USA	29	137	4.72	6	108
Czech Republic	22	151	6.86	7	121
Turkey	21	104	4.95	7	88
South Korea	19	47	2.47	4	25
Taiwan	14	41	2.93	4	32
UK	10	68	6.80	3	64
Serbia	9	26	2.89	3	17
Russia	9	11	1.22	3	10
Poland	8	39	4.88	4	39
South Africa	8	39	4.88	3	34
Iran	8	29	3.63	3	26
Germany	7	69	9.86	3	65
Japan	6	36	6.00	3	32
France	5	25	5.00	3	23
Israel	4	49	12.25	4	49
Brazil	4	24	6.00	2	24
Malaysia	4	30	7.50	2	28
Australia	4	50	12.50	1	49

\*TP = Total Number of Publications; TC= Total Citations, C/P = Average Citations Per Publication; h-core = Citation Sum within the h-core

Figure 2 depicts the visualization and collaboration of the most prolific countries contributing to the publications of DSJ. From the figure, India is the most significant contributor to research articles compared to other countries in the DSJ.

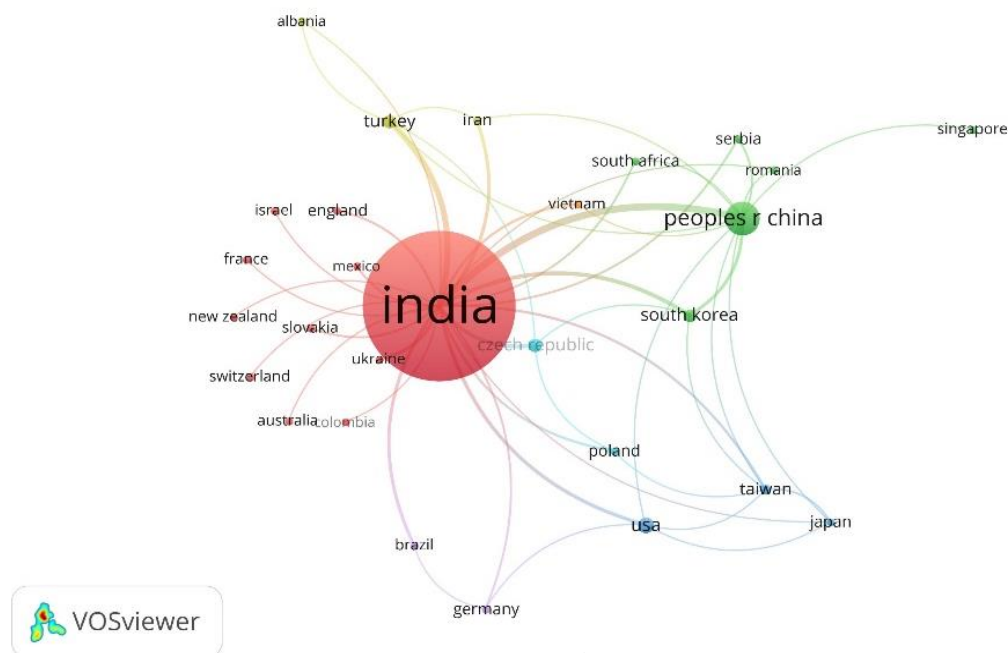


Figure 2: Most Productive Countries of DSJ

### Authorship Pattern

The data analysis in Figure 3 shows that the collaboration work of authors is predominant in the DSJ publications as 83.99%, i.e., 1558 out of 1855 research papers, came from collaborative research works of authors. The highest number of papers (n= 498; 26.85%) is produced by two authorships with the second-highest citation score (TC = 1863), followed by three authors (n = 479; 25.82%) with a maximum citation score (TC = 2006), fours authors (n = 298, 16.06%), and single authors (n = 297, 16.01%). Only 3 (0.16 %) research is contributed by 10> authors.

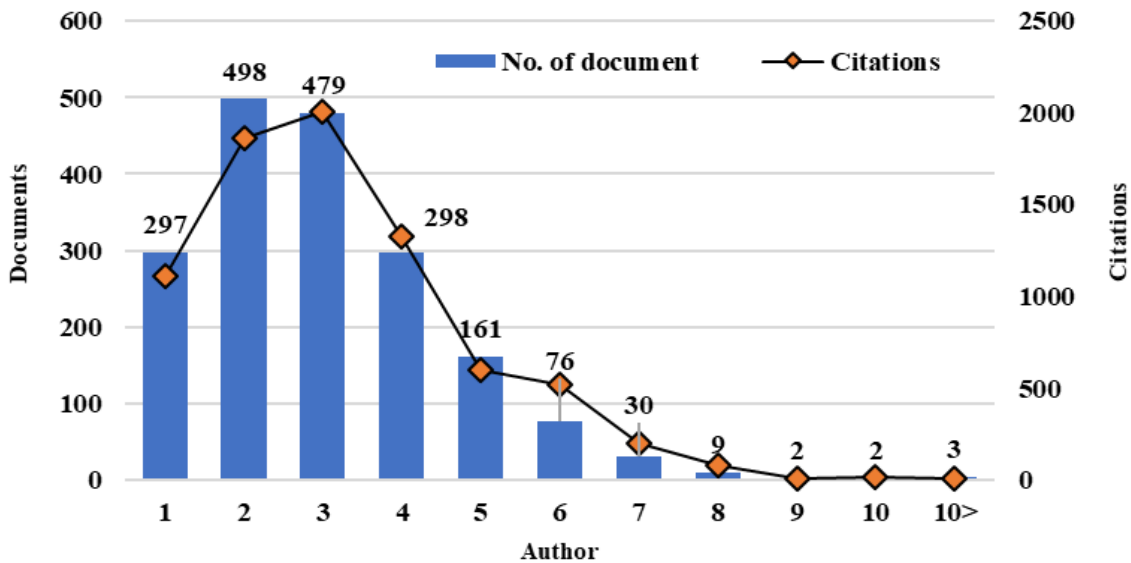


Figure 3: Authorship Pattern of DSJ

### Cited Sources

Table 8 highlighted the 20 most cited sources in the reference list of the articles of DSJ with their Journal Impact Factor (JIF) of 2020. The highest cited source was the present journal itself, i.e., *Defence Science Journal*, which was cited in the 530 articles having an IF of 0.707, followed by the *International Journal of Impact Engineering*, cited in 323 articles, and *Proceedings of the Society of Photo-optical Instrumentation Engineers*, cited in 323 articles. The lowest cited source is found in the *Journal of Materials Science*, which cited 97 articles. The highest impact factor cited source was found in two sources, i.e., *Nature* with an IF of 49.962 and *Science* with an IF of 47.728. However, *Defence Science Journal* has the lowest IF of 0.707 compared to other journals. There is a need to increase the citation impacts of the articles published in the Defence Science Journal.

Table 8

Most Cited Sources of DSJ

Sources	TC	IF (2020)
Defence Science Journal	530	0.707
International Journal of Impact Engineering	323	NA
Proceedings of the Society of Photo-optical Instrumentation Engineers	252	NA
Applied Physics Letters	231	3.791
Journal of Applied Physics	213	2.546
AIAA Journal	208	2.127

Sources	TC	IF (2020)
Propellants Explosives Pyrotechnics	194	1.887
IEEE Transactions on Aerospace and Electronic Systems	162	1.594
Carbon	147	9.594
Journal of Propulsion and Power	137	1.500
Science	135	47.728
Journal of Applied Polymer Science	134	3.125
Nature	134	49.962
Lecture Notes in Computer Science	125	NA
Composite Structures	123	5.407
IEEE Transactions on Antennas and Propagation	115	2.593
Journal of the American Ceramic Society	113	3.784
Journal of Guidance, Control, and Dynamics	113	2.048
Materials Science and Engineering: A Structural Materials: Properties, Microstructure and Processing	99	5.234
Journal of Materials Science	97	4.220

\* TC= Total Citations, JIF= Journal Impact Factor, NA= Not Available

### Keywords Analysis

Statistical analysis of keywords may also indicate how successful the field is in recognizing and advancing limits to identify emerging advancements in the study. Two keywords, Author keywords and KeyWords Plus, are being used for this research (Table 9).

Table 9

Top 20 Most Representative Author keywords and KeyWords Plus

Author keywords	Occurrences	TLS	KeyWords Plus	Occurrences	TLS
computational fluid dynamics	23	6	design	29	8
simulation	21	10	model	28	12
numerical simulation	20	4	behavior	27	21
sensors	17	5	mechanical-properties	18	13
genetic algorithm	15	3	penetration	17	16
mechanical properties	13	3	performance	17	14
finite element analysis	12	2	combustion	15	1
kalman filter	11	3	microstructure	14	15
target tracking	11	4	system	14	3
image processing	10	1	composites	13	12
microstructure	10	3	growth	13	9
calibration	9	0	impact	13	10
fluid flow	9	1	simulation	13	3
fuzzy logic	9	4	stress	12	7
modelling	9	6	temperature	12	7
nanotechnology	9	0	damage	11	8
ballistic limit	8	2	exposure	11	1
detection	8	2	thin-films	11	1
mems	8	4	deformation	10	5
synthesis	8	1	fabrication	10	6

\*TLS= Total Link Strength

There are a set of 6984 Author keywords from the data, of which 846 meet the threshold. Table 9 and Figure 4(A) reveal that ‘computational fluid dynamics’, ‘simulation’, and ‘numerical simulation’ are the top three author keywords with the occurrence of 23, 21, and 20, respectively, with their total link strength (TLS). These are the main research area hotspots that published a maximum number in DSJ. Again, as understood from Table 9 and Figure 4(B), out of 2115 sets of KeyWords Plus that appeared, 450 met the threshold from this KeyWords Plus, such as ‘design,’ ‘model,’ and ‘behavior’ being the top three KeyWords Plus hotspots research areas.

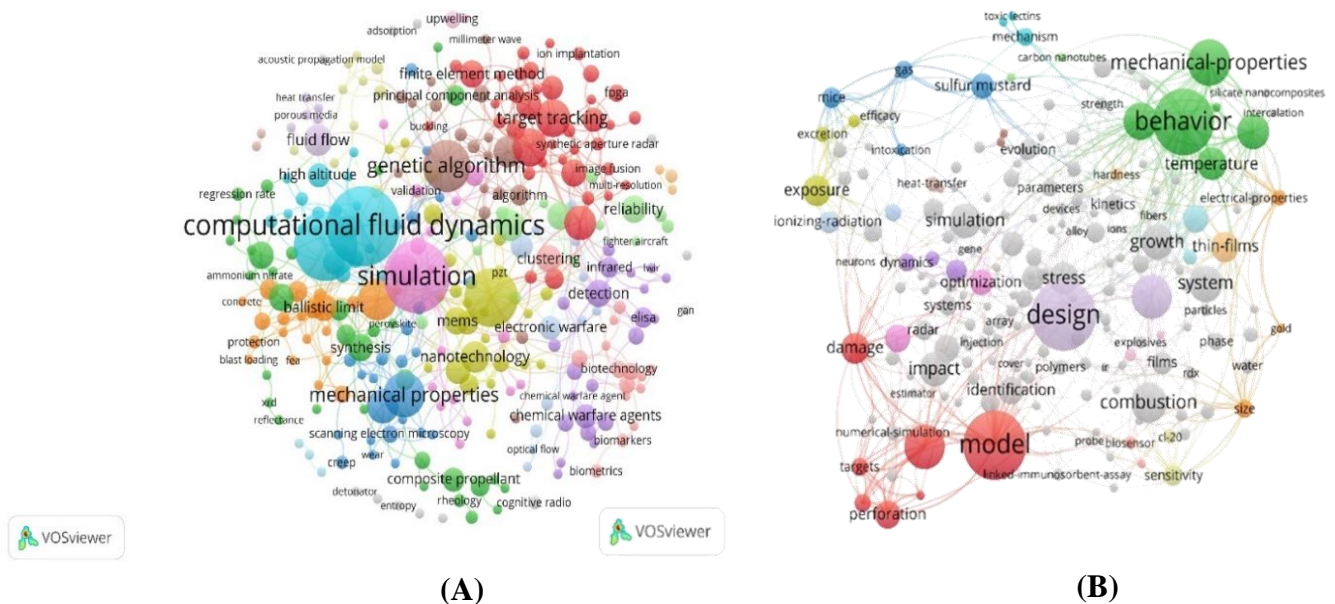


Figure 4: Keywords Analysis: (A) Author keywords (B) KeyWords Plus

## Discussion

The bibliometric analysis presented in this study offers valuable insights into the Defence Science Journal (DSJ) research landscape from 1994 to 2020. It comprehensively overviews this journal’s publication patterns, authorship trends, citation metrics, and keyword analysis. First, the study reveals that DSJ has published 1855 research documents with 31452 references from 3656 authors. These numbers indicate a vibrant and collaborative research community. The Defence Science Journal (DSJ) published 1,855 publications from 1994 to 2020, with an annual growth rate of 3.05%. This is higher than the annual growth rate reported in previous similar studies (Singh, 2015; Rajput, Teli & Chaparwal, 2020). This growth trajectory is consistent with the broader trend of increased research output in science and technology over the past few decades. However, it is essential to consider factors such as funding, technological advancements, and global events that may influence publication trends.

Regarding document types, most publications in DSJ are articles, with the highest total citations (TC) and an impressive h-index of 23. Similar findings are obtained from the study of Muthumari and Raja (2016), which found that articles accounted for 77.91% of the total publications in the DSJ. Also, review articles have a significantly higher average citation per publication (C/P), suggesting their impact in synthesizing and consolidating knowledge. This

finding aligns with previous research that emphasizes the role of review articles in shaping research directions. Kumar A. is the most prolific author of publications during the period under study (Rajput et al., 2020). Institutional analysis reveals that the Indian Institute of Technologies (IITs) leads in publications (Maharana et al., 2014), followed closely by the High Energy Materials Research Laboratory and Defence Research and Development Laboratory. High Energy Materials Research Laboratory also stands out for its high average citations per publication, indicating the quality of research coming from this institution. These findings differ from previous studies (Muthumari & Raja, 2016). Collaboration is a critical theme in DSJ, with most papers resulting from collaborative efforts.

The prevalence of two and three-author papers is noteworthy, suggesting that small research teams may be highly productive and impactful in this field. These findings align with the previous literature (Singh, 2015). DSJ predominantly cites its journal, and while it is the most cited source, its Impact Factor (IF) is relatively low compared to other journals. This suggests a potential area for improvement in increasing the citation impact of DSJ articles. The study also identifies sources with high Impact Factors, indicating the journals DSJ authors frequently reference. These high-impact sources play a vital role in shaping the quality and relevance of DSJ's research. The study employs keyword analysis to identify research hotspots in DSJ. Author keywords like 'computational fluid dynamics,' 'simulation,' and 'numerical simulation' are identified as significant areas of research interest. This mirrors the evolving defense science and technology trends, where computational and simulation techniques are gaining prominence.

Additionally, KeyWords Plus, such as 'design,' 'model,' and 'behavior,' reveal areas of research focus within DSJ, indicating the multidisciplinary nature of contributions. The bibliometric analysis of DSJ from 1994 to 2020 demonstrates its growth, collaborative nature, and impact within the defense science and technology field. The study's findings are consistent with previous research, affirming the journal's continued importance as a platform for disseminating cutting-edge research.

### **Conclusion**

The work accounts for the most important theoretical and empirical references published in DSJ over 27 years. Nevertheless, it also gives a mechanism that researchers can use to gather up-to-date data from their various fields of study. The quantitative analysis of DSJ journals' publications reveals that the journal has consistently published research results. The contributions from researchers from many countries demonstrate its global recognition. The publication trend of the journal is still maintaining a considerable level of pattern, while the citation counts are comparatively decreasing. The wide circulation of the DSJ needs to be furthered so that accessibility to the same can be improved in many ways. The study benefits researchers from various fields, especially those who follow the DSJ journal and those researchers or scientists who work in defense. The study, as such, has contributed to the further expansion of scholarship in the field.

### **Data Availability**

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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### Conflict of Interest

There is no conflict of interest.

### Author Contributions

**Gyanajeet Yumnam:** Conceptualisation, Methodology, Software, Data Curation, Writing-Original Draft, Ch. Ibohal Singh: Supervision, Validation, Review & Editing. Rajkumari Sofia Devi: Review & Editing

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