Mapping the research trend and international collaboration of IIT Delhi

Shankar B Chavan
Indian Institute of Technology Delhi, India

Kalyan Kumar Bhattacharjee
Indian Institute of Technology Delhi, India

Nabi Hasan
Indian Institute of Technology Delhi, India

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Abstract

Purpose: The primary purpose of this study is to find out the trend in research publications and the growth of international collaboration in the domain of science, engineering, technology, management, etc., of IIT Delhi from 2001 to 2022 within India and globally.

Methodology: Web of Science is one of the largest and most reputed bibliographic databases covering global publications in science, engineering, technology, etc. The publication records covered in the Web of Science database were extracted using the affiliation search for 22 years from 2001 to 2022, and the publications found are 24893. The scientometric techniques have been used to identify research trends, international collaborations, and research impact.

Findings: Almost all publications are in English, except two papers, and most are article types. The number of publications has consistently grown. The number of citations received also increased over time. The collaboration in research publications has consistently grown over the last 22 years. The difference in the average citations between with and without international collaborated publications is 5.14. The data shows that the USA is the leading country in research publications, but Canada has the highest average number of citations per publication.

Research limitations: The study is confined to the Indian Institute of Technology Delhi, and the period is restricted from 2001 to 2022.

Originality: A few studies have been found on institutions' global collaboration and impact on the scientific community. This study benefits the researchers, educationists, administration, and sponsoring bodies to make informed decisions and investments.

Keywords: Research trend analysis, scientometrics, bibliometrics, mapping research collaboration, Indian Institute of Technology Delhi.

1. Introduction

Indian Institute of Technology Delhi (IIT Delhi) is a leading educational institute in India in science, engineering, technology and management. Established in 1961, the institute significantly promotes and contributes to research in various fields and collaborates with many top academic and research institutes and corporate sectors within India and globally. Mapping the landscape of research output and collaboration with national and international bodies helps understand the strength, opportunities, and impact on the research community and society. It also helps identify the strength and weaknesses and suggest potential areas for future research collaborations.

2. Literature review

Many scientometric studies on the research productivity of the institutes and countries have been conducted. Garfield (1955) first gave the idea of an impact factor in science and the significance of an article, citation as a quantitative measure of the article's influence. That led to the science citation index in 1961. Krishnan et al. (2022) studied the pulses research publications in India from 2003 to 2016 and found a significant increase in the research quality and quantity. Tyagi (2022) explored the collaboration of IIMs for 11 years, who collaborated with 125 countries, with 81.03% of collaborated publications. Abad-Segura et al. (2020) studied the evolution of the number of articles on the sustainable management of digital transformation in higher education (1986–2019) and found the growth exponential. Shetar and Angadi (2018) studied the National Institute of Technology Karnataka, Surathkal's publication productivity from 2001 to 2017. The study analysed 4,038 publications and found that 98.07% were multi-authored. Avanesova and Shamliyan (2018) analysed comparative trends in the research performance of the Russian institutions' international collaboration, and found that the academic corporation collaboration and economic impact of Russian research remained low. Bhoomaiah et al. (2022) analysed the productivity of eight fisheries institutes for twenty years of data and inter-institutes and intra-institutes collaborations. Few studies have been found on the institute's international collaborations and the impact of the research on the scientific community. This study helps the institutes and funding bodies make informed decisions and investments based on outcomes.

3. Objectives of the study

The main objectives of the study are:

- To map the research trend of the scientific contributions of IIT Delhi in the domains of science, engineering, technology, management, etc., from 2001 to 2022.
- To identify the collaboration trends within India and globally.
- To identify potential areas of collaboration and suggest future collaborations, based on the research trends at IIT Delhi.

4. Methodology

Web of Science is one of the largest and most reputed bibliographic databases covering global scientific, engineering, and technology publications. The publication records covered in the Web of Science database were extracted using the affiliation search for 22 years from 2001 to 2022, and the total number of publications found was 24893. The research mapping applies scientometric techniques and various parameters to identify research trends, international collaborations, and research impact. The research has seen continuous growth, and the publications in 2022 are 6.65 times compared to 2001. The institute has partnerships with over 6000 universities and research institutions worldwide.

5. Analysis

5.1 Language of publication and type of documents

The preferred language for publications is English. Only two papers are in other languages, i.e., one in German and one in Esperanto. This analysis found that most documents are "Article" types, accounting for 92.094% of the total records. "Review Article" and "Proceeding Paper" also comprise a significant portion at 4.138% and 3.724%, respectively. The remaining document types contribute to less than 2%, with some having a negligible presence (0.016% or less).

5.2 Growth of internationally collaborated research publications from 2001 to 2022 and citations

Table 1 represents publication data from 2001 to 2022, including the number of records, the percentage of papers, the number of citations, and the average number of citations per record for each year. The data shows an increasing trend in publications over the years. However, the average number of citations per publication seems to vary, reaching its peak in 2006 (39.88) and gradually decreasing in recent years, with 2022 having the lowest average citations per publication (2.66). These observations suggest a growth in publication output over time but a decrease in citation impact, especially in recent years.

Table 1: Growth of internationally collaborated research publications from 2001 to 2022 and citations

Sl No	Publication Year	Record Count	% of 24893	Citations	Average Citations
1	2001	374	1.50	9697	25.93
2	2002	396	1.59	12015	30.34
3	2003	504	2.03	17311	34.35
4	2004	557	2.24	19632	35.25
5	2005	626	2.52	20751	33.15
6	2006	703	2.82	28034	39.88
7	2007	807	3.24	28019	34.72
8	2008	823	3.31	26490	32.19

9	2009	813	3.27	30114	37.04
10	2010	856	3.44	27093	31.65
11	2011	814	3.27	31159	38.28
12	2012	874	3.51	25460	29.13
13	2013	1004	4.03	28904	28.79
14	2014	1112	4.47	33648	30.26
15	2015	1143	4.59	27405	23.98
16	2016	1362	5.47	33564	24.64
17	2017	1561	6.27	32867	21.06
18	2018	1575	6.33	33469	21.25
19	2019	1868	7.50	28507	15.26
20	2020	2117	8.50	28021	13.24
21	2021	2490	10.00	22451	9.02
22	2022	2514	10.10	6699	2.66
	Total	24893	100	551326	22.15

5.3 Growth of research collaborations globally from 2001 to 2022 and average citations

Table 2 denotes the growth of research collaborations globally from 2001 to 2022 and the average citations received by these publications. A total of 6222 research publications were collaborated globally from 2001 to 2022, and the citations received are 161756. The number of publications has gradually grown over time, with the highest in 2022 (842) and the lowest in 2001 (80). The average number of citations per publication is 26. Data indicates a positive trend in research publication collaborations globally, with a considerable number of citations received by these publications, indicating their impact and visibility in the research community.

Table 2: Growth of Research Collaborations Globally from 2001 to 2022 and Average Citations

Sl No	Publication Year	Record Count	% of 6,222	Cumulative	Growth in %	Citations	Average Citations
1	2001	80	1.29	80		2349	29.36
2	2002	89	1.43	169	11.25	2905	32.64
3	2003	96	1.54	265	7.87	5664	59.00
4	2004	105	1.69	370	9.38	4827	45.97
5	2005	132	2.12	502	25.71	4137	31.34
6	2006	139	2.23	641	5.30	5938	42.72
7	2007	158	2.54	799	13.67	5259	33.28
8	2008	160	2.57	959	1.27	6427	40.17

9	2009	174	2.8	1133	8.75	7875	45.26
10	2010	204	3.28	1337	17.24	8718	42.74
11	2011	204	3.28	1541	0.00	8721	42.75
12	2012	198	3.18	1739	-2.94	7285	36.79
13	2013	209	3.36	1948	5.56	6,939	33.2
14	2014	257	4.13	2205	22.97	11624	45.23
15	2015	279	4.48	2484	8.56	7898	28.31
16	2016	339	5.45	2823	21.51	10994	32.43
17	2017	371	5.96	3194	9.44	9029	24.34
18	2018	366	5.88	3560	-1.35	12309	33.63
19	2019	475	7.63	4035	29.78	9792	20.61
20	2020	569	9.15	4604	19.79	9839	17.29
21	2021	776	12.47	5380	36.38	10188	13.13
22	2022	842	13.53	6222	8.51	3039	3.61
	Total	6222	100	6222		161756	26.00

Of 24893, 6222 (24.99%) publications have collaborations with international institutes. The difference in the average citations per publication between those with and without international collaboration is 5.14.

5.4 Top 10 highly research collaborated countries

Table 3 provides the top 10 countries with the highest research collaborated publications. The United States leads with 7.67% of the 24,893 and received the highest number of citations (56315). The average citation count per collaboration is 29.52. Germany and England follow the US, contributing 2.84% and 2.62%. Despite having fewer collaborations, England's collaborations have a higher average citation count (32.61) than Germany (26.22), suggesting that English collaborations may have a more significant influence. Canada contributed only 1.72%, with the highest average citation count of 47.61. This means that while Canada's quantity of collaborations may be less, the impact of its collaborations is considerable. China contributes 1.59% of the total and has a high average citation count of 37.48, suggesting substantial impact or visibility. The remaining countries, Australia, Japan, South Korea, and Singapore, all contributed just over 1% of the total.

Table 3: Top 10 Highly Research Collaborated Countries

Sl No	Country/Region	Record Count	% of 24,893	Citations	Average Citations
1	USA	1908	7.67	56315	29.52
2	Germany	707	2.84	18540	26.22
3	England	652	2.62	21262	32.61
4	Canada	427	1.72	20328	47.61
5	France	419	1.68	12367	29.52
6	Peoples R China	395	1.59	14805	37.48
7	Australia	324	1.30	10949	33.79
8	Japan	317	1.27	8629	27.22
9	South Korea	265	1.07	7456	28.14
10	Singapore	216	0.87	6081	28.15

5.4 Most collaborated institutes in India

Table 4 presents India's top 10 most collaborated institutes based on the number of publications and their percentage contribution. Council of Scientific Industrial Research, India, is at the forefront, accounting for the highest number of collaborations with a record count of 936, making up 3.76%. The All India Institute of Medical Sciences, New Delhi, holds the second spot with 570 collaborations, comprising 2.29%. DRDO is at third rank with 523 (2.10%) publications.

Table 4: Top 10 most collaborated institutes in India

S No.	Affiliations	Record Count	% of 24,893
1	Council of Scientific Industrial Research, India	936	3.76
2	All India Institute of Medical Sciences, New Delhi	570	2.29
3	Defence Research & Development Organisation	523	2.10
4	University of Delhi	450	1.80
5	National Physical Laboratory, New Delhi	432	1.73
6	Jawaharlal Nehru University, New Delhi	291	1.16
7	Department of Science Technology, India	254	1.02
8	Indian Institute of Technology Roorkee	230	0.92
9	Indian Institute of Technology Kanpur	226	0.90
10	Jamia Millia Islamia, New Delhi	225	0.90

5.5 Most collaborated institutes globally

Table 5 demonstrates that these top collaborating institutes are spread across countries, including France, the USA, Germany, the UK, Switzerland, and Singapore. This indicates a global nature of scientific collaboration. Two French institutes, "Centre National De La Recherche Scientifique CNRS" and "Udice French Research

Universities," occupy the top two positions. This suggests a strong emphasis on collaboration in the French research community. The USA is well-represented, with three institutes in the top 10, including "The University of California System," "International Business Machines (IBM)," and "The United States Department of Energy (DOE)."

Table 5: Top 10 Most collaborated institutes globally

Sl No.	Affiliations	Country	Record Count	% of 24,893
1	Centre National De La Recherche Scientifique	France	181	0.727
2	Udice French Research Universities	France	162	0.651
3	University Of California System	USA	146	0.587
4	International Business Machines IBM	USA	136	0.546
5	Helmholtz Association	Germany	116	0.466
6	Max Planck Society	Germany	111	0.446
7	N8 Research Partnership	UK	111	0.446
8	Swiss Federal Institutes of Technology Domain	Switzerland	101	0.406
9	Nanyang Technological University	Singapore	96	0.386
10	United States Department of Energy DOE	USA	90	0.362

5.6 Authorship pattern of research publications

Table 6 illustrates the authorship pattern of the research publications, number of authors and average citations received. The single-authored publications are 822 (3.30%), and the average citation per paper is 13.50, received 11097 citations, resulting in a 13.50 average citation per paper. Most of the publications (96.7%) were multi-authored publications. Publications with two authors are 6,467 (25.98%) with 148906 citations and an average of 23.03 citations per paper. Publications with three authors are the most common, comprising 7,392 publications (29.70%) with 165,810 citations and an average of 22.43 citations per paper. 4,331 papers (17.40%) were written by four authors, and 418 papers (1.68%) with more than 10 authors, which received a total of 15,849 citations, resulting in the highest average citations per paper of 37.92. The degree of collaboration of authors is 0.03.

Table 6: Authorship pattern of research publications

No of Authors	No of Publications	Percentage (%)	Citations	Citations Per Paper
1	822	3.30	11097	13.50
2	6467	25.98	148906	23.03
3	7392	29.70	165810	22.43
4	4331	17.40	92871	21.44
5	2358	9.47	53704	22.78
6	1361	5.47	29167	21.43
7	796	3.20	16665	20.94
8	478	1.92	8224	17.21
9	297	1.19	5576	18.77
10	173	0.69	3457	19.98
>10	418	1.68	15849	37.92
Total	24893	100.00	551326	22.15

6. Findings

- The number of publications gradually increased over the years, with occasional fluctuations.
- The total number of citations also increased over time, peaking at 33,648 in 2014.
- The average number of citations per publication varies but tends to decrease as the years' progress.
- The year 2022 had the lowest average citations (2.66), indicating lower impact or visibility of the publications that year. However, this year could receive more citations in the time to come.
- The highest average citations were observed in 2006 (39.88).
- The number of collaborations in research publications has consistently grown over the 22 years. In 2001, the record count was 80, and by 2022 it had increased to 842, indicating a substantial increase in global collaboration in research.
- The average number of citations for the internationally collaborated publications from 2001 to 2022 was 26.
- The difference in the average citations between with and without international collaborated publications is 5.14.
- The data shows that the USA is the leading country in research publications, but Canada has the highest average citations per publication, indicating a high impact on its research. China, Australia, and England also have notably high average citations, reflecting the significance and influence of their research output.
- Most research publications involve multiple authors, with three-authored papers being the most common. The number of citations per paper tends to be higher

for papers with multiple authors, particularly for those with more than 10 authors.

- The degree of collaboration of authors is 0.03.

7. Conclusion

IIT Delhi is India's one of the top engineering, technology and management institutes and is in the top two hundred in the global QS ranking. This study covered the mapping of research and international collaboration trends at IIT Delhi from 2001-2022. The trend of research growth and international collaboration is continuously progressing. One-fourth of the publications were authored in collaboration with global researchers. The percentage of research publications with solo authors is much less than the multi-authored publications, and the degree of collaboration is 0.33. This study helps the researchers and authorities access the institutes and funding bodies to make informed policy decisions to promote research and innovation at IIT Delhi. The study will also serve as a helping tool for other similar institutions for such work.

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Author biography

Shankar B. Chavan is an Assistant Librarian (SG) at the Indian Institute of Technology Delhi. Before joining IIT Delhi, he served in esteemed academic and corporate sectors. He has been conferred with the 'SLA – Asian Information Professional Award 2021' by the Special Libraries Association USA. His areas of interest include library automation & RFID technology, digital library, knowledge management, content management systems, web technologies, e-resources consortia, scientometrics, research analysis and novelty search, usage analysis, and statistics.

Kalyan Kumar Bhattacharjee is the Joint Registrar at the Indian Institute of Technology Delhi. Earlier, he served as an Assistant Professor at Lal Bahadur Shastri Institute of Management. He is the in-charge of the establishment section, planning unit, and Institute Ranking Cell. He has expertise in academic administration, human resource management, and knowledge management. His area of interest is knowledge management, research analysis, institute ranking, and human resource management.

Nabi Hasan is the Head Librarian at the Indian Institute of Technology Delhi. Earlier, he served as the University Librarian at Aligarh Muslim University. He is the First Norman E. Borlaug Fellow from India in Library Information Systems, trained at Cornell University, New York, USA. Dr. Hasan has been honored with many awards, including the Fellow of the Special Libraries Association, SLA Engineering Librarian of the Year Award, Bonnie Hilditch International Librarian Award, Royal Society of Chemistry's Librarians' Choice Award, and SALIS Dr. Harish Chandra-Sushila Chandra National Best Librarian Award. He has 17 Books and over 175 articles to his credit. His area of interest includes but is not limited to innovative library services, ICT applications in libraries, RFID applications, digital libraries, e-resources, and consortia management, and library administration.

Corresponding author

Shankar B. Chavan can be contacted at: shankar.chavan@library.iitd.ac.in