

SCIENTOMETRIC ANALYSIS INTO RESEARCH OUTPUT OF IIT BOMBAY IN THE FIELD OF ENGINEERING DURING 2006-2016

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Abstract *This paper analyzes growth of research publications in the field of engineering produced from IIT Bombay during the period 2006 to 2016. Analysis has been made by taking into account the publication output of IIT Bombay as reflected in Scopus Database. Viable attempts has been made to find out the year wise growth of publications, preferred source for publication, national and international collaboration pattern, degree of collaboration. This paper highlights IIT Bombay's contribution to the field of engineering that is available in Scopus database.*

Keywords: *Scientometrics, Research Productivity, SCOPUS, IIT Bombay, Engineering*

INTRODUCTION

Research is predominant in every academic institution, because research output plays an important role in determining the academic credibility of an institution. Institutes of national importance like IITs plays a vital role in contributing to the national development through their research output in the field of science and technology. Therefore it is increasingly important to measure the research output carried out by these institutions. IIT Bombay is one among the premier institution dedicated largely to research and development in engineering science and technology. It was setup in the year 1958 with funding assistance from UNESCO and Soviet Union. IIT Bombay is the second oldest IITs in India globally known as one of the premier autonomous institutes dedicated to the field of engineering education and research. This paper aims to study the research output of IIT Bombay published during 2006-2016 in the domain of Engineering as reflected in Scopus database.

OBJECTIVES

This study has been undertaken with the following objectives:

- To measure the research publications produced from IIT Bombay in the field of Engineering.

- To examine authorship pattern.
- To assess year wise productivity.
- To find out the level of collaboration with national and international institutions.
- To ascertain the country wise collaboration.
- To study the preferred source for publication.
- To analyze most productive source for publication.

REVIEW OF LITERATURE

In order to have deep insight into current area of research and the authors have thoroughly studied bibliometrics and scientometrics research literature published in the related area. Few among the significant ones have been mentioned below.

Kademanli and others (2007) carried out a study on "Scientometric Profile And Publication Productivity of the Radiochemistry Division At Bhabha Atomic Research Centre" and performed Scientometric analysis of 1044 papers published by the scientists of Radiochemistry Division at Bhabha Atomic Research Centre (BARC) during 1958-2005 in diverse domains such as Actinide Chemistry (358), Analytical Chemistry (220), Nuclear Chemistry (215), Miscellaneous (148), Actinide Spectroscopy (55),

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High Temperature Superconductivity (27) and TL/ESR. Dosimetry (21) was carried out for year wise productivity, authorship pattern and collaboration.

Abramo and others (2014) in their paper “How do you define and measure research productivity” highlighted that productivity is the quintessential indicator of efficiency in any production system. It has become a norm in bibliometrics to define research productivity as the number of publications per researcher, distinguishing it from impact. In this work the authors have operationalized the economic concept of productivity for the specific context of research activity and show the limits of the commonly accepted definition.

Barik and Jena (2014) conducted a study on “Growth of LIS Research Articles in India seen through Scopus: A bibliometric analysis” to analyze the growth of Library and Information Science (LIS) research articles in India. 385 articles indexed by Scopus database during the period of 2004-2013 has been considered for the study and the authors have analyzed the annual growth of LIS research publications in India and to identify the authorship pattern, authors’ productivity and degree of collaboration. Lotka’s inverse square law has been applied to identify the productivity of authors and Bradford’s law has been applied to identify the scattering of core journals.

Nandi and Bandyopadhyay (2013) in a study on “Scientometric Dimensions of Research Productivity of the Botany Department, During 1960-2000” analysed 160 theses and 739 thesis articles collected from the Botany Department of University of Burdwan in eight subdivisions of Botany during 1960-2000 to determine year wise productivity, authorship pattern and collaboration.

Patel (2017)² performed a Scientometric analysis of publications of National Institute of Technology Kurukshetra during 2012 to 2016 as reflected in Web of Science database to analyze the growth and development of research activity of NIT Kurukshetra.

Thirumagal and others (2017) conducted a “Bibliometric Analysis of Research Literature On Piper Betle during 1997-2016” by using Web of Science as a source for data collection. This study is focused on publishing trend, authorship pattern, author’s productivity, h-index, co-authorship map, citation map.

Pradhan and Mohapatra (2017) evaluated “Growth of Research Publications in Social Sciences and Humanities in Odisha as Reflected in SCOPUS Database” to determine the year wise growth of publications, most productive authors, major subject areas of research, types of publications preferred by the researchers, preferred journals and the major productive institutions in the field of social science and humanities in Odisha during the period 1996 to 2015.

Marisha and others (2017) conducted a study on “Research performance of central universities in India” to identify productivity, productivity per capita, productivity per crore rupees grant, rate of growth of research output, authorship and collaboration pattern, citation impact and discipline-wise research strength of these institutions. The results also provide discipline-wise research strengths of all the universities.

Banshal and others (2017) have assessed the “Research performance of Indian Institutes of Technology” and identified productivity, productivity per capita, rate of growth of research output, authorship and collaboration pattern, citation impact and discipline-wise research strengths of the different IITs. The research performances of the IITs have been compared with those of two top ranking engineering and technology institutions of the world (MIT-USA and NTU-Singapore) and most cited papers from these IITs have also been identified.

Mukherjee (2017) in a bibliometric study on “Research in Indian CSIR Laboratories evaluated the quality and quantity of research output at current state-of-the-art CSIR laboratories using publications output data as reflected in Web of Science and Scopus.

Nandi and Mondal (2017) in their study on “Research Productivity in the Departments of Chemistry and Physics of University of Burdwan during 1960 – 2000” have analyzed year wise productivity, authorship pattern and collaboration, Co-authorship pattern, Impact of authors, the citation scenario of the outstanding authors and ranked list of journals

Khanna and others (2017) conducted a “Scientometric Analysis of the Research Output of Department of Physics and Astronomy of Guru Nanak Dev University during 2006-15” to analyze research contributions by extracting data from Scopus. The study analyses the year-wise research productivity, national and international collaborations, top collaborating institutions, most prolific authors, journals used for communication, most preferred journals for publication, number of citations received by the University during the period undertaken for study. This study indicates that journals are the most preferred form of publication to communicate research works by the researchers.

Pradhan and Ramesh (2017) in their study “Scientometrics of Engineering Research at Indian Institute of Technology Madras and Bombay during 2006-2015” made an assessment of 5378 papers published by Indian Institute of Technology Madras and 4430 papers published by Indian Institute of Technology Bombay respectively indexed by the Scopus database in the field of Engineering Sciences and its subfield during 2006–2015. The study summarizes that the number of papers grew during the period of study.

SCOPE OF THE STUDY

The present study is limited to the research publications in the field of engineering produced from IIT Bombay during the period 2006-2016 and the source of data collection is restricted to Scopus database.

METHODOLOGY

The publication data of IIT Bombay was retrieved from SCOPUS. "IIT Bombay" was used as an affiliation search and then the search results were limited to the subject area of "Engineering" with publication year limited to the span of "2006-2016". MS-Excel is used for the analysis of data.

ANALYSIS, SUGGESTION, RECOMMENDATION

Authorship Pattern

Table 1 Depicts authorship pattern of publication output of engineering research produced from IIT Bombay. It is found that collaborative authorship with more than three authors is in the rise. Highest 23(50%) of publications appeared with more than three authors followed by publications with two authors i.e. 15(32.60 %). This indicates that there is a growing precedence of collaborative authorship. On the other hand single authorship and publications with three authors are on the lower side which only 4(8.69%).

Table 1: Authorship Pattern of Publications During 2006-2016

Year	NP=Single	NP=Two	NP=Three	NP≥Three	TP (%)
2006	--	2	--	--	2(4.34)
2007	2	--	--	1	3(6.52)
2008	--	2	--	1	3(6.52)
2009	--	--	--	3	3(6.52)
2010	--	--	--	--	0(0)
2011	--	1	--	2	3(6.52)
2012	--	2	1	1	4(8.69)
2013	--	4	--	4	8(17.39)
2014	1	2	--	3	6(13.04)
2015	1	2	3	2	8(17.39)
2016	--	--	--	6	6(13.04)
Grand Total	4(8.69)	15(32.60)	4(8.69)	23(50)	46(100)

Figures in parenthesis denote percentage.

NP = Number of publications

TP = Total Publications

% = $(NP \div TP) \times 100$

Degree of Collaboration

Degree of collaboration is essential to study the potency of Co-authorship pattern. Co-authorship is type of collaboration in which two or more authors share their ideas and resources to write a paper. The degree of collaboration among the

researchers in IIT Bombay in the field of Engineering has been calculated with the help of Subramanyam's formula (1983) and is reflected in Table-2. The degree of collaboration "DC" is 1 that indicates that collaborative publications are more prominent than that of publications with single authors.

$$DC = \frac{NM}{NM + NS}$$

DC = Degree of collaboration

NM = Number of Multiple authors

NS = Number of Single authors

Table 2: Degree of Collaboration

Year	Papers with Single Author (N _S)	Publications with Multiple Authors (N _M)	N _M + N _S	Degree of Collaboration
2006	--	2	2	1
2007	2		2	0

Year	Papers with Single Author (N_S)	Publications with Multiple Authors (N_M)	$N_M + N_S$	Degree of Collaboration
2008	--	3	3	1
2009	--	--		0
2010	--	--		0
2011	--	3	3	1
2012	--	4	4	1
2013	--	8	8	1
2014	1	5	6	0.83
2015	1	7	8	0.87
2016	--	6	6	1

Year wise Productivity

Table 3 reveals the chronological distribution of 46 papers published in the field of engineering during the period of study i.e. 2006-2016 along with citation counts. It is noticed that highest 8(17.39%) has been published in the year 2015 and 2013 followed by 6(13.04%) in the year 2014 and 2016, 4(8.69%) in the year 2012 respectively. The years 2015 and

2013 remains the most productive year, whereas the years 2006 to 2011 remains less productive with less number of publication outputs of 3(6.52%). In terms of citations the year 2007 remains most productive with highest number of citations i.e. 20(29.41%) recorded followed by the year 2013 that is 15(22.05%). On the other hand, papers published in the year 2014 and 2016 have low citation counts.

Table 3: Year Wise Productivity

SI No	Year	Publications	Percentage (%)	Number of Citations	Percentage
1	2016	6	13.04	2	2.94
2	2015	8	17.39	7	10.29
3	2014	6	13.04	1	1.47
4	2013	8	17.39	15	22.05
5	2012	4	8.69	5	7.35
6	2011	3	6.52	6	8.82
7	2010	--	--	--	00
8	2009	3	6.52	5	7.35
9	2008	3	6.52	7	10.29
10	2007	3	6.52	20	29.41
11	2006	2	4.34	--	00
Total		46		68	

Institution Wise Collaboration

Table 4 deals with national level collaboration. In terms of collaboration at national level, only internal collaboration has been found to be more pragmatic. Majority of publications 34(73.91%) has been published collaboratively by authors from IIT Bombay itself, this indicates that

the degree of institutional collaboration is on the peak although the publications has collaborative authorship from 20 different institutions viz. 2(4.34%) with Veermata Jijabai Technological Institute, Mumbai and NTPC Ltd. Collaboration at National level is found to be negligible with only 2.17% publication output.

Table 4: National Level Collaboration

Sl. No	National Institutions	No. of Publications	Percentage (%)
1	Indian Institute of Technology, Bombay	34	73.91
2	Veermata Jijabai Technological Institute, Mumbai	2	4.34
3	NTPC Ltd.	2	4.34
4	Walchand Institute of Technology, Solapur, Maharashtra	1	2.17
5	Centre for Ecological Sciences, IISc, Bangalore	1	2.17
6	DDIT(Dharmsinh Desai Institute of Technology), Gujarat	1	2.17
7	Sardar Vallabhbhai Patel Institute of Technology (SVIT), Gujarat	1	2.17
8	Fr.C.Rodrigues Institute of Technology, Vashi, Navi Mumbai	1	2.17
9	GCET(G. H. Patel College of Engineering & Technology), Gujarat	1	2.17
10	LTA Systems Laboratory, Dept. of Aerospace Engineering, IIT Bombay	1	2.17
11	Navayuga Engineering Company Ltd., Hyderabad	1	2.17
12	Thapar University, Patiala, Punjab	1	2.17
13	The Maharaja Sayajirao University of Baroda, Gujarat	1	2.17
14	Indian Institute of Technology, Guwahati	1	2.17
15	Gujarat University	1	2.17
16	National Aerospace Laboratories, Bangalore	1	2.17
17	Society for Applied Microwave Electronics Engineering & Research (SAMEER), Mumbai	1	2.17
18	Central Scientific Instruments Organization, Chandigarh	1	2.17
19	Siksha O Anusandhan University, Bhubaneswar, Odisha	1	2.17
20	Graphic Era University, Dehradun, India	1	2.17

Table 4.1 indicates the status of foreign collaboration. It is observed that less number of publications are appeared with authors from foreign institutions. International collaborations during the course of study are also found to be negligible. However it is found that the authors from IIT Bombay have

collaboration with authors from foreign institutions such as University of Illinois, Purdue University, Applied Materials Inc, Eaton Corporation and Ecole Nationale d, Ingenieurs and most of institutions are from USA.

Table 4.1: International Collaborating Institutions

Sl. No	International Institutions	No. of Publications	Percentage(%)
1	University of Illinois at Urbana-Champaign	1	1
2	Purdue University, Indiana, USA	1	1
3	Applied Materials Inc., USA	1	1
4	Eaton Corporation, Dublin	1	1
5	Ecole Nationale d'Ingenieurs de Sfax	1	1

Country Wise Collaboration

Table 5 shows IIT Bombay's research collaborations at country level and depicts that large number of collaborations

are found with in India, followed by USA and least collaboration with Tunisia.

Table 5: Country wise Collaboration

SI No	Country	Articles	Percentage
1	India	42	87.5
2	United States	5	10.41
3	Tunisia	1	

Types of Documents Preferred for Publication

Table 6 indicates various types of documents preferred by the researchers to publish their research outputs. It is seen that the researchers have published their papers in five type of sources viz. Conference Proceedings followed by journals, Book Series, books and trade publications. Large number of publications 32(69.56%) has been published in Conference Proceedings, followed by 10(21.73%) in journals, 2(4.34%) in Book Series, whereas only 1 (2.17%) publications appeared in books and trade publications.

Table 6: Preferred Source of Publications

SI.No	Publication Type	Numbers	Percentage (%)
1	Conference Proceedings	32	69.56
2	Journals	10	21.73
3	Book Series	2	4.34
4	Books	1	2.17
5	Trade Publications	1	2.17

Most Preferred Source for Publication

Table-7 traces the top sources, where the researchers of IIT Bombay has preferred to publish their research papers during the period of study. Highest i.e. 5 papers has been published in Proceedings of the International Astronautical Congress (IAC) followed by 3 i.e. 2nd highest in ISH Journal of Hydraulic Engineering published by Indian Society for Hydraulics and Proceedings of International Conference On Learning And Teaching In Computing And Engineering LATICE-2016.

Table 7: Most Preferred Source

SI. No	Source Title	Number of Publications	Rank
1	Proceedings of The International Astronautical Congress (IAC)	5	1
2	ISH Journal of Hydraulic Engineering	3	2
3	Proceedings of International Conference On Learning And Teaching In Computing And Engineering LATICE 2016	3	2
4	Geotechnical Special Publication	2	3
5	IET (Institute of Engineering & Technology) Conference Publications	2	3
6	12th International Multi Conference On Systems Signals And Devices SSD-2015	1	4
7	2009 2nd International Workshop On Electron Devices And Semiconductor Technology IEDST 09	1	4
8	2009 6th IEEE Annual Communications Society Conference On Sensor Mesh And Ad Hoc Communications And Networks Workshops Second Workshops 2009	1	
9	2013 International Conference On Engineering Technology And Innovation ICE 2013 And IEEE International Technology Management Conference ITMC 2013	1	
10	62nd International Astronautical Congress 2011 IAC 2011	1	
11	AIAA Lighter Than Air Systems Technology LTA Conference 2013	1	
12	Act 2009 International Conference On Advances In Computing Control And Telecommunication Technologies	1	
13	Advanced Materials Research	1	
14	Advances In The Astronautical Sciences	1	
15	Advances In Vibration Engineering	1	
16	Applied Mechanics And Materials	1	
17	Conference Record of The IEEE Photovoltaic Specialists Conference	1	
18	Educational Technology And Society	1	
19	Electronic Engineering Times	1	

20	Geotechnical Engineering	1	
21	IEEE Global Engineering Education Conference (EDUCON)	1	
22	IEEE International Conference On Control And Automation (ICCA)	1	
23	IEEE Power And Energy Society 2008 General Meeting Conversion And Delivery Of Electrical Energy In The 21st Century.	1	
24	IEEE Robotics And Automation Magazine	1	
25	Journal Of Electrical Engineering	1	
26	Journal Of The Franklin Institute	1	
27	Journal Of Zhejiang University Science C	1	
28	Mind Of An Engineer	1	
29	5th Nirma University International Conference On Engineering (NUICONE 2015)	1	
30	Procedia Engineering	1	
31	Proceedings Of 2011 2nd International Conference On Instrumentation Control And Automation (ICA 2011)	1	
32	Proceedings Of The 14th International Conference On Engineering And Product Design Education Design Education For Future Wellbeing Epde 2012	1	
33	Proceedings Of The 2014 IEEE International Conference On Moocs Innovation And Technology In Education IEEE Mite 2014	1	
34	Proceedings Of The 4th International Conference On Nanochannels Microchannels And Minichannels (ICNMM2006)	1	
35	Proceedings Of The ASME Turbo Expo	1	
36	Proceedings Of The IEEE International Conference On VLSI Design	1	

FINDINGS AND CONCLUSIONS

- Research collaboration among the researchers of IIT Bombay in the field of Engineering is more predominant with publication with more than three authors.
- The year 2015 and 2013 is seen as a most productive year with large number of publications on the other hand in terms citation counts, the year 2007 is the most productive. It is also evident that less number of publications published in a given year has highest citations; therefore there is a correlation between years having fewer publications but achieved high citations.
- Intra-institutional collaboration among the authors is pragmatic.
- Negligible amount of foreign collaboration during the period of study is being found. Major chunk of research collaborations are made with institutions from U.S.A
- It is observed that the researchers of IIT Bombay in the field of Engineering has preferred to publish their research in Conference proceedings during the period of study undertaken by the authors and the Proceedings of The International Astronautical Congress (IAC) has been traced as the most preferred choice for publication.

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