

Indian Institute of Technology, Kharagpur: A Scientometric study of Research Output

Subhodip Bid

Library & Information Assistant, National Library, Kolkata- 700027
subhodipbid@gmail.com

ABSTRACT

The paper deals with the analysis of publications of Indian Institute of Technology Kharagpur (IIT Kharagpur) during 2000 to 2015 appeared in SCOPUS database. It attempts to analyze the growth and development of research activity of IIT Kharagpur as reflected in publications output. Data for a total of 18927 have been downloaded and analysed according to objectives. The study reveals that the growth of literature follows the exponential growth pattern, journal articles are the most published form of literature (74.37%), Journal of Applied Polymer Science and Journal of Applied Physics are top journals, Jadavpur University and National Institute of Technology are top collaborating institutions/university with Indian Institute of Technology, Kharagpur. The highly productive subject areas are engineering and materials science, computer science, physics and astronomy. US, Germany and UK are the most favored countries for collaborations and authorship pattern analysis shows that degree of collaboration (0.95) significantly high. Suggests that periodically this type of data be reflected along with institutional repositories of the respective institutions.

Keywords: IIT, Scientometrics, Research Output, Institutional Productivity; Institutional Repository

1. INTRODUCTION

The Indian Institute of Technology Kharagpur (IIT Kharagpur) also known as IIT, KGP is a public engineering institution established by the government of India in 1951. It was the first of the IITs to be established, and is recognized as an Institute of National Importance by the Government of India. IIT Kharagpur has 19 academic departments, eight multi-disciplinary

centres/schools, and 13 schools of excellence in addition to more than 25 central research and development units. IIT Kharagpur has been ranked as the top institution in India and among the top 100 in the world, between the ranking range of 71-80 in the first edition of the QS Graduate Employability Rankings. Internationally, IIT Kharagpur is ranked 286th in the QS World University Rankings (Quacquarelli Symonds) of 2015 and 60th in the QS Asian University Rankings of 2014 (Wikipedia. (n.d.).

Numerous studies have been reported earlier, which provide research output of various institutions/universities all over the world as reflected in international source [Courtesy: Web of Science]; Scopus (Chaurasia & Chavan, 2014; Singh, 2015; Balasubramani & Parameswaran, 2014; Maharana, 2013; Bid & Verma, 2011, Parameswaran 2015), but very few in terms of contribution of IIT Kharagpur except by Jeevan and Gupta (2002), who suggest a methodology for studying the quantitative profile of a research university, with a view to get idea about the performance and impact of research produced in each department, and the comparison of the impact of research in various departments. For building a more reliable and objective picture on the contribution of IIT Kharagpur and understanding how this picture has changed overtime, the present study attempts to analyze the growth and development of research activity of IIT Kharagpur as reflected in publications output.

2. OBJECTIVES

The specific objectives of the present study addresses the following aspects:

1. To examine the year-wise distribution of publications of IIT Kharagpur, India.
2. To identify the authorship pattern and prolific authors of IIT Kharagpur, India
3. To study the publication in which authors preferred to publish their work.
4. To analyse the geographical distribution of publications
5. To identify the journals which were most preferred by the researchers.

3. METHODOLOGY

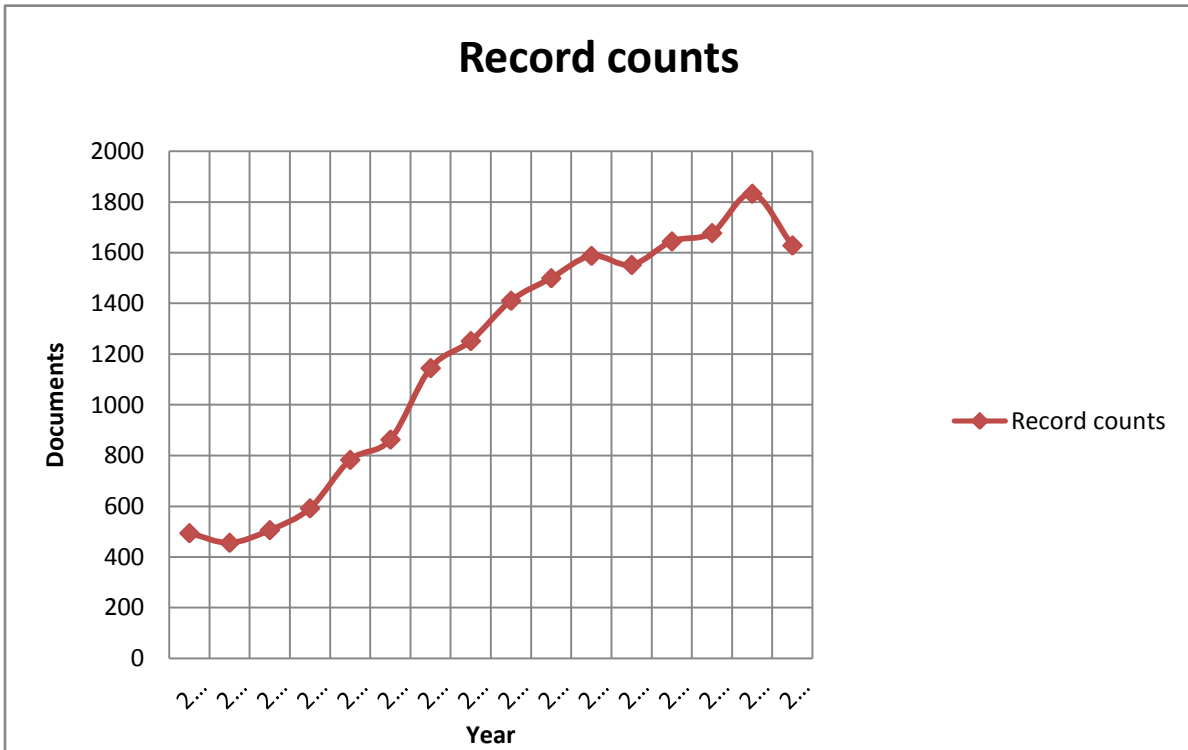
The contributions from Indian Institute of Technology, Kharagpur finds indexed in the data base [Courtesy: Scopus], owned by Elsevier. Scopus is a multidisciplinary bibliographic database. It has information from more than 20,500 of the most prestigious, high impact research journals in the world. It is used to map data on science and technology worldwide. The basic data from Indian Institute of Technology, Kharagpur [2000-15], were collected through advanced search option by using affiliation id (AF ID). Scopus provide individual ID for individual institute/author. By using AF ID of Indian Institute of Technology, Kharagpur (AF ID 60004750) within the time span between 2000 to 2015. As a result, 18927 journal articles were saved in text files and imported to Microsoft Excel for analysis. Citation counts received by the papers which were published and available in database have been used as qualitative measure.

4. DATA ANALYSIS AND INTERPRETATION

4.1 Growth of Literature:

Table 1
Year-wise Distribution of Publication with Citation

SI. No.	Year	Record counts	Percentage (%)	Citation	Impact citation/record
1	2000	494	2.61	63	0.12
2	2001	456	2.40	421	0.92
3	2002	506	2.67	808	1.59
4	2003	592	3.12	1381	2.33
5	2004	783	4.13	2234	2.85
6	2005	863	4.55	3397	3.93
7	2006	1145	6.04	4932	4.30
8	2007	1252	6.61	7021	5.60
9	2008	1411	7.45	9552	6.76
10	2009	1500	7.92	12543	8.362
11	2010	1588	8.39	15700	9.88
12	2011	1552	8.19	19959	12.86
13	2012	1645	8.69	23332	14.18
14	2013	1678	8.86	27458	16.36
15	2014	1833	9.68	30681	16.73
16	2015	1629	8.60	27850	17.09
	Total	18927	100		



As indicated in the Table 1 authors from IIT Kharagpur have contributed as many as 18927 papers in different disciplines during the year 2000 to 2015. The average annual rate of the study period is 1182.93 items. In 2000, a total of 494 items published against 1629 in 2015. There was steady growth in number of items published except those of 2001, 2011 and 2015. In 2009, the numbers of articles finds tripled (1500) from the start (494) of the study i.e. 2000 and quadruple (four times) in 2012 (1645)

The study has been carried out from 2000 to 2015 based on number of cited references used by the author of 18927 research articles. The number of references cited by the scientists were studied and changing trend was observed. The total number of citations, citations per article for the last 16 years is shown in the Table 1. Number of citations vary from article to article. Table shows the citations per article, which varies from 0.12 to 17.09 to in different year, the trend shows steady rate.187332 citation were received with average of 9.89 citations per paper with h index of 119. In 2015 citations per article attained the maximum.

Table 2
 Quadruple Publication Output (2000-2015)

Year	Paper	Quadruple growth rate, Percentage (%)
2000-03	2048	
2004-07	4043	97.41
2008-11	6051	49.66
2012-15	6785	12.13

Quadruple publication output by IIT Kharagpur authors/ contributors published 2048 in 2000-03, 4043 in 2004-07, 6051 in 2008-11 and 6885 in 2002-15. Thus the publication growth has been 97.41% for the quadruple period 2000-03 to 2004-07, which decreases to 49.66% during 2004-07 to 2008-11 and 12.13% for the period 2008-11 to 2012-15.

4.2 Authors Pattern

Table 3
 Authorship Pattern of Papers Published

Year	One	Two	Three	Four	Five	Six	Seven	Eight	Nine	Ten	Ten>	Total	%
2000	42	172	170	74	12	12	5	2	2	2	1	494	2.61
2001	36	160	152	66	24	12	4	2				456	2.41
2002	32	175	153	88	42	11	3	1		1		506	2.67
2003	31	222	172	83	48	17	6	4	5	3	1	592	3.13
2004	46	248	238	137	62	22	8	11	5	3	3	783	4.14
2005	39	295	293	135	58	16	12	8	2		5	863	4.56
2006	47	389	368	187	73	37	18	12	8	2	4	1145	6.05
2007	51	411	434	205	76	38	17	11	7		2	1252	6.61
2008	46	456	459	243	106	51	28	9	3	4	6	1411	7.45
2009	53	475	502	228	107	68	24	25	11	2	5	1500	7.93
2010	86	469	509	257	131	60	36	19	8	3	10	1588	8.39
2011	54	505	490	248	121	72	23	18	10	4	7	1552	8.2
2012	56	486	482	283	179	65	38	16	12	6	22	1645	8.69
2013	37	489	488	325	150	93	34	17	22	7	16	1678	8.87
2014	55	569	500	304	173	107	61	21	19	7	17	1833	9.68
2015	53	480	434	291	159	82	47	39	14	9	21	1629	8.61
total	764	6001	5844	3154	1521	763	364	215	128	53	120	18927	100
%	4.04	31.71	30.88	16.66	8.04	4.03	1.92	1.14	0.68	0.28	0.63	100	

Table 3 shows the authorship pattern. Out of 18927 papers, the maximum number of papers were 6001(31.71per cent) from two authors followed by three authors 5844 (30.88%), four authors 3154(16.66), five authors 1521 (8.04%), one author 764 (4.04) and so on. Data reveals that authors from IIT Kharagpur have tendency to publish their work with two or more authors.

4.3 Degree of Collaboration (DC)

Table 4
 Authorship Pattern with Degree of Collaboration Measures (DC)

	Number of publication	Percentage (%) of total publication	Nm+N _s	DC
Total number of Single/Multi-Authored Publications	18927	100		
Number of Co-Authored Publication (NM)	18163		18927	0.95
Number of Single-Authored Publication (NS)	764	4.03		
Number of two-Authored Publication	6001	31.70	6765	0.88
Number of three-Authored Publication	5844	30.87	6608	0.88
Number of Four-Authored Publication	3154	16.66	3918	0.80
Number of Five-Authored Publication	1521	8.03	2285	0.66
Number of Six-Authored Publication	763	4.03	1527	0.49
Number of Seven-Authored Publication	364	1.92	1128	0.32
Number of Eight-Authored Publication	215	1.13	979	0.21
Number of Nine-Authored Publication	128	0.67	892	0.14
Number of Ten Authored Publication	53	0.28	817	0.06
Number of Eleven and above-Authored Publication	120	0.63	884	0.13

DC calculates the proportion of co-author publications among total publications. In order to determine the degree of collaboration or the collaborative research pattern in quantitative terms, an indicator or the formula suggested by Subramanyam (1982) has been used and results are given in Table 4. The formula is

$$DC = Nm / Nm + Ns$$

Where C is degree of collaboration in a discipline, “Nm” is number of multi-authored papers during specific period in some discipline, “Ns” is number of single authored papers in a discipline during the same period of time. For calculation of DC, the data is shown in Table 5. The computed data in the column of the Table 4 shows 0.9 as the highest degree of collaboration [2000-15]. The value of DC is lowest among ten-author publications, which is 0.06 and second highest of 0.88 two- authored publications, indicating the trend towards multi-authorship papers.

Calculation: $DC = Nm / (Nm + Ns)$

Based on the data in the Table 5, DC for two authored publications;

$Nm = 6001 \text{ \& } Ns = 764$

$DC = 6001 / (6001 + 764) = 0.887$

4.4 Most Prolific Authors

Table 5
 Most Prolific Contributors

Author Name	No. of publication	Percentage (%)	Department/Centres
Bhowmick, A.K.	289	1.52	Department Rubber Technology Centre
Chakraborty, S.	287	1.51	Mechanical Engineering
Choudhary, R.N.P.	251	1.32	Department of Physics, Institute of Technical Education and Research, Bhubaneswar
Pal, T.	218	1.15	Department of Chemistry
Das, C.K.	207	1.09	Materials Science Center
Chattaraj, P.K.	204	1.07	Department of Chemistry
Ray, S.K.	186	0.98	Department of Physics
De, S.	178	0.94	Department of Chemical Engineering
Maiti, C.K.	175	0.92	Department of Electrical & Computer Engineering,
Ram, S.	172	0.90	Materials Science
Misra, S.	171	0.90	School of Information Technology
Maiti, T.K.	163	0.86	Department of Biotechnology
Manna, I.	161	0.85	Department of Materials Science and Engineering, IIT Kanpur
Pramanik, P.	155	0.81	Department of Chemistry
Chakraborty, C.	139	0.73	Medical Science & Technology
Adhikari, B.	135	0.71	Materials Science
Ray, K.K.	127	0.67	Department of Metallurgy and Material Engineering

Tiwari, M.K.	125	0.66	Department of Industrial and Systems Engineering
Pal, A.	124	0.65	Department of Civil Engineering
Banthia, A.K.	121	0.63	Materials Science Centre
Das, P.K.	120	0.63	Department of Mechanical Engineering
Chakrabarti, P.P.	119	0.62	Department of Computer Science and Engineering
Nath, T.K.	112	0.59	Department of Physics
Patra, A.	112	0.59	Department of Electrical Engineering
Dasgupta, P.	112	0.59	Department of Computer Science and Engineering

Table 5 presents a list of most productive/ prolific authors from IIT Kharagpur. From this table it has been found that Bhowmick, A.K. of Department of Rubber Technology, IIT Kharagpur, published highest numbers of articles, i.e. 289 followed by Chakraborty, S. of Department of Mechanical Engineering published 287 articles with second position, Choudhary, R.N.P., Department of physics with 251 articles with third position. Now Choudhary, R.N.P. is working in Department of Physics, Institute of Technical Education and Research, Bhubaneswar. Pal, T. of Department of Chemistry published 218 articles with fourth position, Das, C.K. of Material Science Center published 207 articles with fifth position. Dasgupta, P. of Department of Computer Science and Engineering get lowest rank with 112 articles.

4.5 Type of Publications:

Table 6
Types of Publication

Document Type	Records Count	Percentage (%)
Article	14077	74.37
Conference Paper	3906	20.63
Review	344	1.81
Article in Press	205	1.08
Book Chapter	146	0.77
Editorial	77	0.40
Erratum	65	0.34
Letter	48	0.25
Note	39	0.20

Book	14	0.07
Short Survey	6	0.03

Table 6 presents the distribution of published literature according to type. The researchers output was in the form of journal articles with 14077 (74.37) followed by conference papers 3906 (20.63), reviews with 344 (1.81) and so on. The majority of literature appeared in scholarly journals by means of which they disseminate their research findings.

4.6 Subject-wise Distribution of Publications

Table 7
 Subject-wise Number of Papers Produced

Subject Area	Record Count	Percentage (%)
Engineering	6994	36.95
Materials Science	5038	26.61
Computer Science	3677	19.42
Physics and Astronomy	3642	19.24
Chemistry	3054	16.13
Chemical Engineering	2086	11.02
Mathematics	1651	8.72
Biochemistry, Genetics and Molecular Biology	1314	6.94
Environmental Science	1189	6.28
Earth and Planetary Sciences	1109	5.85
Agricultural and Biological Sciences	1080	5.70
Energy	733	3.87
Medicine	707	3.73
Social Sciences	536	2.83
Pharmacology, Toxicology and Pharmaceutics	369	1.94
Decision Sciences	306	1.61
Business, Management and Accounting	277	1.46
Immunology and Microbiology	239	1.26
Multidisciplinary	194	1.02
Arts and Humanities	104	0.54
Economics, Econometrics and Finance	83	0.43
Health Professions	74	0.39
Psychology	57	0.30
Neuroscience	38	0.20
Nursing	16	0.08

Table 7 shows that the research output studied during 2000-2015 under various subjects as defined by Scopus. The table lists the Top twenty five subjects regarding which the authors of IIT Kharagpur have mostly contributed articles. From the data in the table, it is clearly understood that Engineering is the most favoured area of research among the contributors of IIT Kharagpur with 6994 (36.95%) followed Materials Science with 5038(26.61), Computer Science with 3677(19.42), Physics and astronomy 3642 (19.24), Chemistry with 3054(16.13) publications and followed by other subjects.

4.7 Collaboration with other Countries

Table 8
Geographical Distribution of Publications

Sl. No.	Country/Territory	Record Count	Percentage (%)
1	India	18776	99.20
2	United States	1109	5.85
3	Germany	550	2.90
4	United Kingdom	344	1.81
5	Canada	288	1.52
6	Japan	202	1.06
7	South Korea	200	1.05
8	Italy	157	0.82
9	France	152	0.80
10	Australia	146	0.77
11	Spain	101	0.53
12	Singapore	94	0.49
13	Malaysia	91	0.48
14	South Africa	82	0.43
15	Taiwan	79	0.41
16	China	72	0.38
17	Sweden	71	0.37
18	Hong Kong	53	0.28
19	Brazil	45	0.23
20	Mexico	44	0.23

It is evident from the above Table 8 that authors/ contributors of IIT Kharagpur were collaborating with many countries to publish their papers. United States is at the top with 1109 documents followed by Germany with 550 papers, with, United Kingdom 344 papers, Canada with 288 papers, Japan with 202 papers, South Korea with 200 papers. It shows that contributors of IIT Kharagpur not only collaborated within the country but also with most developed countries like United States, Germany, United Kingdom, Australia, Asian countries like, Japan, Singapore and South Korea.

4.8 Institution-wise Distribution of Papers

Table 9
 Most Prolific Institution/University

Rank	Affiliation	Record Count	Percentage (%)
1	Indian Institute of Technology, Kharagpur	18927	100
2	Jadavpur University	277	1.46
3	National Institute of Technology Rourkela	196	1.03
4	Bengal Engineering and Science University	193	1.01
5	Vidyasagar University	165	0.87
6	Bhabha Atomic Research Centre	151	0.79
7	University of Calcutta	147	0.77
8	Indian Statistical Institute, Kolkata	144	0.76
9	Indian Institute of Technology, Guwahati	129	0.68
10	Indian Institute of Technology, Kanpur	129	0.68
11	National Institute of Technology, Durgapur	120	0.63
12	Indian Institute of Technology, Madras	118	0.62
13	National Metallurgical Laboratory India	118	0.62
14	Indian Institute of Technology Delhi	117	0.61
15	Indian Institute of Science	105	0.55
16	Indian Institute of Technology Roorkee	94	0.49
17	IEEE	90	0.47
18	Indian Institute of Technology Patna	90	0.47
19	Indian Space Research Organization	87	0.45
20	Defence Metallurgical Research Lab India	86	0.45
21	Indian School of Mines University	83	0.43
22	Tata Iron & Steel Company Limited	83	0.43

23	University of Delhi	79	0.41
24	Indian Institute of Technology, Bombay	73	0.38
25	Monmouth University	69	0.36

It is observed from the above figure and Table 9 that authors/ contributors of IIT Kharagpur were collaborating with many institutions to publish their papers with Jadavpur University 277 documents, 196 papers with National Institute of Technology Rourkela, 193 papers with Bengal Engineering and Science University, 165 papers with Vidyasagar University, 151 papers with Vidyasagar University and followed by other institutions. It has been found that within top 10 institutions 5 institutions/ university are from West Bengal and two from neighboring states Orissa and Assam.

4.9 Journal-wise Distribution of Papers

Table 10

Journals (top 20) Preferred by Contributors of IIT Kharagpur for Publication (2000-2015)

Rank	Source Title	Record count	Percentage (%)	IF
1	Journal of Applied Polymer Science	262	1.38	1.76
2	Journal of Applied Physics	151	0.79	2.18
3	Rsc Advances	134	0.70	3.84
4	Journal of Materials Science	117	0.61	2.37
5	Journal of Alloys and Compounds	113	0.59	2.99
6	Tetrahedron Letters	101	0.53	2.37
7	Proceedings of the IEEE International Conference on VLSI Design	88	0.46	4.93
8	Current Science	88	0.46	0.92
9	Materials Letters	87	0.45	2.48
10	Langmuir	86	0.45	4.45
11	International Journal of Heat and Mass Transfer	84	0.44	2.38
12	Journal of Physical Chemistry B	84	0.44	3.30
13	IEEE Region 10 Annual International Conference Proceedings TENCON	83	0.43	-
14	Aip Conference Proceedings	78	0.41	-
15	Applied Physics Letters	77	0.40	3.30
16	Bioresource Technology	75	0.39	4.49
17	Journal of Nanoscience and Nanotechnology	75	0.39	1.55
18	Proceedings of SPIE the International Society for Optical Engineering	74	0.39	0.20

19	Materials and Manufacturing Processes	74	0.39	1.62
20	Industrial and Engineering Chemistry Research	72	0.38	2.58

Table 10 shows the top 20 publication sources in which the contributors from IIT Kharagpur published their papers. It is found that Journal of Applied Polymer Science gets the highest number of publications with 262 titles followed by Journal of Applied Physics with 151 titles, Rsc Advances with 134 titles, Journal of Materials Science with 117 titles and followed by other sources. It is found that within top 20 sources there is only one journal i.e. Current Science from India. It shows that authors from IIT Kharagpur have tendency to publish their work in reputed and international journals with more impact factor.

5. CONCLUSION

The study shows that IIT Kharagpur has contributed 18927 papers with average annual rate 1182.93 papers. It shows steady growth rate and it was found that contribution of papers become double in 9 years and tripled in next 3 years. It received 187322 citations with 9.89 average citation per paper. The contributors of IIT Kharagpur have tendency to publish their work with two or more authors which indicates the multi author pattern and shows that the contributors of IIT Kharagpur is collaborative in nature. The ranking of authors based on their publication shows that Bhowmick, A.K. ranked first with 289 papers. Contributors from IIT Kharagpur have a tendency to publish their papers in scholarly journals followed by conference proceedings. Engineering is the top priority subject followed by material science, computer science, physics and astronomy in which the contributors contribute their paper. The US was at the top position in the list of collaborating countries with IIT Kharagpur. It not only collaborates with developed countries but also with Asian countries like Japan, Singapore and South Korea. As in terms of institutional collaboration, Jadavpur University ranked first with 277 documents. It has been found that within top 10 institutions 5 institutions/ university are from West Bengal and two each from neighboring states i.e. Orissa and Assam. The source title Applied Polymer Science gets the highest number of publications. It has been found that contributors from IIT Kharagpur have tendency to publish their work in international journals having more impact factor. It is suggested that such types of studies be carried out periodically and data reflected along with the

institutional repositories of the respective institution. This step would ensure value addition and scope for better collaboration with other institutions.

REFERENCES

- Balasubramani, R. & Parameswaran, R. (2014) Mapping the research productivity of Banaras Hindu University: A scientometric analysis. *Journal of Theoretical and Applied Information Technology*, 59(2), 367-371. Retrieved from <http://www.jatit.org/volumes/Vol59No2/16Vol59No2.pdf>
- Bid, S. & Verma, R.K. (2011). Indian publication output 1998-09: Quantitative analysis based on web of science. *Journal of Indian Library Association*, 47(4), 29- 40.
- Chaurasia, N.K. & Chavan, S.B. (2014). Research output of Indian Institute of Technology Delhi (IIT Delhi) during 2001-2010: A bibliometric analysis. *International Journal of Information Dissemination and Technology*, 4(2), 141-147. Retrieved from <http://www.ijidt.com/index.php/ijidt/article/view/4.2.8/198>
- Jeevan, V.K.Y & Gupta, B.M. (2002). A scientometric analysis of research output from Indian Institute of Technology, Kharagpur. *Scientometrics*, 53(1), 165-168.
- Maharana, R.K. (2013). Bibliometric analysis of Orissa University of Agricultural Technology's research output as indexed in scopus in 2008-2012. *Chinese Librarianship: an International Electronic Journal*, 36. Retrieved from <http://www.iclc.us/cliej/cl36maharana.pdf>
- Parameswaran, R. (2015), Research output of Anna University: A scientometric study, *Knowledge Librarian*, 2(2), 85-100. Retrieved from <http://www.klibjilis.com/2.2.5.pdf>
- Singh, V.K. (2015), A scientometric analysis of research output of Indian Institute of Technology Mandi. *Indian Journal Scientific Research*, 11(2), 193-196 Retrieved from

<http://www.ijsr.in/upload/735155039IIT%20Mandi.pdf>

Subramanyam K & Stephens Elsie M (1982), Research collaboration and funding in biochemistry and chemical engineering, International Forum on Information and Documentation, 7(4), pp26-29

Wikipedia. (n.d.). Indian Institute of Technology Kharagpur. Retrieved from https://en.wikipedia.org/wiki/Indian_Institute_of_Technology_Kharagpur