A Biblometric Analysis of Collaborative Research Trends in Indian Institutes of Technology 1994 - 2004

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Abstract

This paper views the collaborative research trends contributions of IIT faculty in the field of science and technology by covering 14879 research papers published in International scholarly journals. Highlights from the angle of multiple authorship is degree of collaboration and the drastic changes that occurs. The research potentials through the distribution Institution and subject wise research output. Experiences that ups and down growth results un-uniformity suggest the ways and means to change the situation

Keywords

Bibliometric; Collaborative Research; IIT

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INTRODUCTION

The word bibliometrics was coined by Alan Pritchard (1969) in his article "Statistical bibliography or bibliometrics", He defined bibliometrics as the application of mathematics and statistical method to book and other media of communication. In the recent years there is an explosive growth in human knowledge. Every day there is a huge proliferation of literature gushing out of the press continuously that poses grave problems to everybody to organize and preserve the published literature. Factors such as remarkable progress made by science and technology, the popularization of education in all sections of the institution, the introduction of speedy means of communication, the competition in trade and industry among various nations etc. are some driving forces that served as sources and impetus for out pouring information. The growth rate analysis of publication could yield some useful results regarding growth pattern of literature and research productivity of authors in that discipline.

OBJECTIVES

The following are the important objectives of the study:

- To analyze the authorship pattern and examine the extent of research collaboration.
- To test the applicability of Lotka's Law of scientific productivity of authors.
- To assess the Degree of collaboration.

METHODOLOGY

This study attempts to examine the authorship pattern and author productivity of research concentration in the field of science and technology.

DATA COLLECTION

Indian Institute of Technology contributions in the field of Science and Technology covered in the annual version of Science Citation Index database were taken as the prime source for the present study. The papers published from 1994 to 2004 by IIT (Scientist) are accounted totally 14879. They were retrieved from SCI database, which is considered to be a prime source of data for the present study.

RESULTS AND DISCUSSION

Authorship pattern and Productivity

Table 1 indicates the authorship pattern and productivity in contribution of scientific research output. The authors are classified according to their contribution that they have published. The total contributions published by faculty members of IITs in India is calculated to 14879 over the study period.

It could be noted that two author papers ranks first in order to share 37.30 percent of the total research output. The year wise analysis shows that the performance of two author papers are better in almost all the years except the years 1997, 2000 and 2002. The three author papers follows the second in order taking 28.90 percent of the total research contributions. The year wise analysis reveals that, three author contributions have shown an increasing trend except in the year 1997. The four author contributions take the third in the order sharing 13.78 percent of the during the study period. The performance of research output in this case is more than 100 in all the years.Single author contribution states the fourth in the order sharing 7.18 percentage of the during the study period. The performance of research output in this case is more than 110 only in the years 1997 and 2004 and all the remaining years have recorded less than 110 contributions.

Five author papers ranks next in the order to share 969 contributions results in 6.52 percent of total scientific research output. The year wise analysis in its output performance is notable in the years from 2002 onwards and the remaining years lagged behind them. It is interesting to note that the six author papers retains sixth in order witnessing 454 contributions which represents only 3.05 percent of total scientific research output. The year wise analysis in its output performance is notable in the years from 2000 onwards and the remaining years lagged behind them. Seven author papers ranks next in the order reflecting 212 contributions 1.42%, the eight author contributed papers and nine author contributed papers follow the respective order of research output performance. It could be deduced from the above discussion, that the scientific research publication brought out by the faculty members of Indian Institute of Technology intended to take collective participation in research and problem solving activities. It has been proved from the analysis that single author papers declining trend and there by collective contributions have an increasing performance in scientific research output in Indian Institute of Technology.It is supported by the co-efficient variation which recorded the less level among two author contributions of 9.69 percent and the variation shown 20.36 by single author contribution is higher than the above.

Table 1: Showing Authorship pattern and productivity

Authors	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total	%	Mean	S.D	CV	Rank
1.	79	86	80	141	94	80	102	104	78	104	121	1069	7.18	98.55	20.07	20.36	4th
2.	511	502	482	422	511	532	481	506	471	509	623	5550	37.30	504.54	48.88	9.69	1st
3.	342	341	360	283	362	369	382	411	425	503	522	4300	28.90	390.91	70.85	18.12	2nd
4.	136	136	150	136	187	177	183	188	224	252	282	2051	13.78	186.45	48.89	26.22	3rd
5.	58	61	66	79	80	64	76	91	134	117	143	969	6.51	88.09	29.95	33.99	5th
6.	28	16	38	23	31	42	36	39	58	62	81	454	3.05	40.16	18.46	45.96	6th
7.	16	8	16	19	11	17	18	27	16	26	38	212	1.42	19.27	8.31	43.12	7th
8.	9	8	13	10	6	17	9	9	13	12	22	128	0.86	11.64	4.57	39.26	8th
9.	4	4	4	7	6	2	12	3	7	10	16	75	0.50	6.82	4.28	62.76	9th
10 and above	2	5	5	8	3	7	3	9	14	6	9	71	0.48	6.45	3.47	53.80	10th
Total	1185	1167	1214	1128	1291	1307	1302	1387	1440	1601	1857	14879	100.00	1352.64	215.77	15.95	

Degree of Collaboration

To analyze the nature of the researcher participation in research activity, the res. activity is tested. In this context the researcher aims at analyzing the degree of collaboration on scientific output made by faculty members of IIT in India. It enables one to examine the research trends in terms of author productivity.

In order to determine the collaboration in quantitative forms, the formula suggested by K.Subramaniyam was tested. Table 5.23 explains the degree of collaboration in science research output during the study period. The second phase of the study period (1999 to 2004) has registered a great level of collaboration which is calculated to 0.94 percent. The first phase of the study period (1994 to 1998) has recorded 0.92 level of collaboration which is less to the second phase, where as the over all study period revealed 0.93 level of collaboration in scientific research output during the study period.

It could be understood from the above analysis that the degree of collaboration has shown an increasing trend from one phase of period to other phase of period.

Table 2: Showing Degree of collaboration

Year	Degree of Collaboration
1994-1998	0.92
1999-2004	0.94
Overall	0.93

Single Vs Multiple Authored output

Table 3 shows the distribution of single Vs multiple authored papers published in the field of Science and Technology by faculty members of IIT. For the purpose of this analysis, the researcher has classified the study period into two phase viz., first phase 1994 to 1998 and second phase 1999 to 2004. It is clear from the table that during the first phase of the study period the single authored contribution shares 8.02 percent, which has increased to 18.45 per cent during the second phase of the study period. The multi authored contributions during the first phase is 91.98 percent and during the second phase of the study period is 91.55 percent. On the whole, the single authored papers contributed only 8.28 percent and the remaining is covered by multi-authored contribution at 91.72 percent.

It could be deduced from the above discussion that among the total publications of Indian Institute of Technology, Multi-authored papers dominate with the highest percent of 91.72. The single authored papers are less which reflects the fact that the group activities have been increased in research and problem solving activities in the field of Science and Technology.

Table 3: Showing Single Vs Multiple Authored output

Year	Single Author		Multiple Author		Total
	Number of output	Percentage	Number of out put	Percentage	
1994-1998	480	8.02	5505	91.98	5985
1999-2004	752	18.45	8142	91.55	8894
Total	1232	8.28	13647	91.72	14879

Productivity of authors based on Lotka's Law

In the light of the above discussion, it is appropriate to examine and analyze the implications of Lotka's law in relation to author productivity on scientific research publications. Table 5.26 shows the Lotka's law of author productivity. Lotka's law explained that the number of persons making two contributions is about one fourth of those contributing one. It also explains that the number of authors making 'n' contributions is about $1/n^2$ of those making a single contribution and the proportion of contribution that makes a single contribution is about nearly 40 per cent. In other words, for every 100 authors making one contribution each. There would be 25 authors contributing 25 articles each ($100/2^2 = 25$) and about 11 contributing three articles each ($100/3^3 = 11.1$) and about 6 contributing four articles each ($100 / 4^4 = 6.25$). The productivity is so on.

In the present study the productivity of faculty members is examined. At the first observation the analyzed data invalidate Lotka's findings that the proportion of all contributions that make a single contribution is less than 40 percent. In the present study the single paper contributed authors contribute 37 percent of the total authors. Yet it is nearly calculated to Lotka's value. To probe further, Lotka's Chi-square model is applied. It is assumed that single paper contributed authors constitute about 40 percent of total authors. The computed x^2 value is 8344.77 as 5 percent level indicates the instability of Lotka's findings. It could be noted that the computed Chi-square value is much greater than the table value

at 5 percent level of significant. Yet the productivity is attributed to several factors. If complete publication details of an author is taken, the Lotka's law of testing may present a different picture.

Table 4: Showing Productivity of Authors based on Lotka's law

No. of Contribution	Observed no. of authors with 'n' publication (an) or F	Observed percentage of authors 100 x an/a1	Expected No. of authors $(an=a1/n^2)p$	Expected percentage of authors predicted by lotkas 100/n	$(F-p)^{2/p}$
1	2264	100.00	2264	100.00	0.00
2	1261	55.70	566.00	25.00	853.40
3	956	42.23	251.55	11.10	1972.77
4	733	32.38	141.50	6.25	2472.59
5	610	26.94	90.56	4.00	2979.44
6	35	1.55	62.88	2.78	12.36
7	31	1.37	46.20	2.04	5.00
8	16	0.71	35.37	1.56	5.79
9	13	0.57	27.95	1.23	7.10
10	7	0.31	22.64	1.00	10.80
11	19	0.84	18.71	0.83	4.49
12	14	0.62	15.72	0.69	0.19
13	9	0.40	13.40	0.59	1.44
14	9	0.40	11.55	0.51	1.56
15	4	0.18	10.06	0.44	3.65
16	7	0.31	8.84	0.39	0.38
17	6	0.26	7.83	0.35	0.43
18	1	0.04	6.99	0.31	5.13
19	2	0.09	6.27	0.28	2.91
20	4	0.18	5.66	0.25	0.49
21	1	0.04	5.13	0.23	3.32
22	5	0.22	4.68	0.21	0.02
23	2	0.09	4.28	0.19	1.22
24 and above	5	0.22	3.93	0.17	0.29
Total	6014	-	-	X^2	8344.77

FINDINGS AND CONCLUSION

The findings of authorship pattern on scientific literature focus the following facts: The science research publications brought out by the faculty members of IITs intend to take collective participation in research and problem solving activities. It has been proved from the study that single authored papers have declining trend and thereby collective contributions have an increasing trend, which is supported by the co-efficient variation data 9.69 percent for two authored contributions where as for single authored contribution it is 20.36 percent.The findings of degree of collaboration enlight the following facts: The degree of collaboration has shown an increasing trend from one phase of period to other phase of period. This brings out clearly the high level of prevalence of collaborative research in the field of Science and Technology is found in Indian IITs.

The findings of single Vs multiple authored output, put fourth the following facts: Among the total science publications of IITs multi authored papers dominate with the high percent 91.72. The single authored papers are less which reflect the fact that the group activity in research and problem solving activities in the field of Science and Technology is found high.The findings of productivity of authors based on Lotka's law bring out the following facts: The analyzed data regarding author productivity invalidate Lotka's findings. The proportion of all contributions that make a single contribution is less. Particularly the single paper contributed authors in

the present study contribute more percent of total authors which is nearly calculated to Lotka's value. Further Lotka's Chi-square conforms this fact. On the whole the present observation supports the fact that the number of contribution increases, the number of authors decreases.

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