

Bibliometric study of PhD theses in Mathematics of The University of Burdwan, 2005-2012

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***Abstract** - This article highlights on the citation analysis of doctoral theses of mathematics awarded to the University of Burdwan during 2005-2012. A total of 2007 references from 20 doctoral theses in Mathematics have been analyzed. The study analyzes citation pattern of all 2007 references against some selected parameters such as, literature use pattern, journal ranking, guide ranking, authorship pattern and half-life of citations in Mathematics. It reveals that the journals (64.18%) are the mostly cited source of literature, followed by other source of literatures like, books (33.03%), reports (0.66%), conferences or seminar papers (1.69%). The leading journals preferred by the researchers of Mathematics are 'Journal of Fluid Mechanics' with 46 citations (3.57%), followed by 'European Journal of operation research' with 42 citations (3.26%). The researchers have cited those journals published from USA (37.12%), followed by UK (18.84%). While studying the age of references, it is found that the half life period of Mathematics literature is nearly 21.6 years.*

Keywords: Age of references, authorship collaboration, authorship pattern, citation analysis, journal ranking, Mathematics.

Introduction

The term 'Bibliometrics' first appeared in 1969 (Hulme, 1923). It is a statistical approach for many studies where quantitative methods are used to investigate scientific communication process by measuring and analyzing various aspects of written documents (Glanzel, 2003). Now it is an accepted analytical tool to monitor and analyze the research performance of any institutions, individuals, etc. This type of studies is carried out for studying the growth pattern, progress and spread of any discipline or area of research. Citation analysis and content analysis are commonly used in bibliometric method and it deals with the relationships between the cited and citing documents (Smith, 1981). It is a simple statistic method of bibliography counting to evaluate and quantify the growth of a subject.

The University of Burdwan was established in 1960. Since then University has been engaged in research and its faculties, research scholars of various disciplines have been producing a good number of research outputs in the form of theses, projects etc. The present study is an

attempt to analyze the references cited to the theses on Mathematics submitted during the period 2005-2012 under The University of Burdwan. The objective is to show the trends of the subject against selected criteria such as literature use pattern, journal ranking, authorship pattern etc.

Review of literature

Several bibliometrics studies have already been conducted in different subject areas such as Veterinary medicine (De Oliveira, 1984); Mathematics (Korevaar & Moed, 1996; Asha & Anil, 2010); Bioscience (Das & Sen, 2001); Economic botany (Biswas, Roy & Sen, 2007); Physics (Pillai & Sudhier, 2007); Ecology (Thanuskodi & Vankatalakshi, 2012); Science (Rahaman, 2011); Psychology (Zafrunnisha & Pulla Reddy, 2011); Sociology (Zafrunnisha, 2012). After analyzing 737 articles of Pure and Applied Mathematics, Narang (2004) reported that multi authored articles were highly cited (47.76%), followed by single authored (35.14%) articles during the period 1998-2002. Some other authors (Mulla, 2011; Fanjul, Machado & Lopez, 2013) also supported this view. But another study (Maranna, 2016) showed that single authored articles were highly cited (87.23%), followed by joint authored articles (12.37%) in Mathematics. He also observed that journal articles were highly cited literature (47.18%), followed by books (29.70%). Another two studies (Narang, 2004; Fanjul, Machado, Lopez, 2013) are in support. In the study of obsolescence of literature in Social Science subjects, Sangam & Mogali (2013) observed that half-life of literature was 9.04. Narang & Kumar (2010) analyzed 400 articles and reported that foreign authors had contributed more than Indian authors. Veerabasavaiah & Padmavathi (2014) revealed that most of the cited journals were published from USA, followed by India and UK in Education. After analyzing the '*International Journal of Mathematics*' during the period 2004-2008, Harande & Laden (2013) revealed that the highest number of articles produced in the year 2008 (16 articles).

Objectives

The objectives of the study are

1. To analysis the main bibliographic forms used by mathematician;
2. To know authorship collaboration and degree of collaboration of Mathematics;
3. To determine the ranked list of core journals;
4. To know the country wise distribution of Mathematics journals;
5. To know the age of references and
6. To know the trend of research in Mathematics.

Scope of the study

A total of 2007 references from twenty doctoral theses in Mathematics during the said period have been considered for this purpose.

Methodology

The references cited in the PhD theses in Mathematics have been taken as the source data. All the information relating to the references e.g., name of source document, type of document, year, number of author, self citation etc are noted first in various work sheets in 'Excel' against different fields. Then the references are analyzed against different aspect

such as bibliographic forms used, preparing ranked list of journals, age-wise distribution of references, authorship collaboration etc through dBaseIII plus programmer.

Data analysis

This section analyzes all the references appended in PhD theses against pre-defined parameters and finally data are presented through different tables and graphs.

6.1 Year wise distribution

Table 1 shows the year-wise outputs of theses in terms of number of doctoral degree awarded in the field of Mathematics during 2005-2012. From this table it is clear that the highest number of theses were awarded in the year 2012 (6 theses) and only 1 thesis was awarded in 2009.

Sl no	Year	No of theses
1	2005	2
2	2006	2
3	2007	3
4	2008	2
5	2009	1
6	2010	4
7	2012	6
	Total	20

Table -1: Year wise distribution

Fig. 1 is the graphical representation of the year-wise distribution of PhD theses during the period.

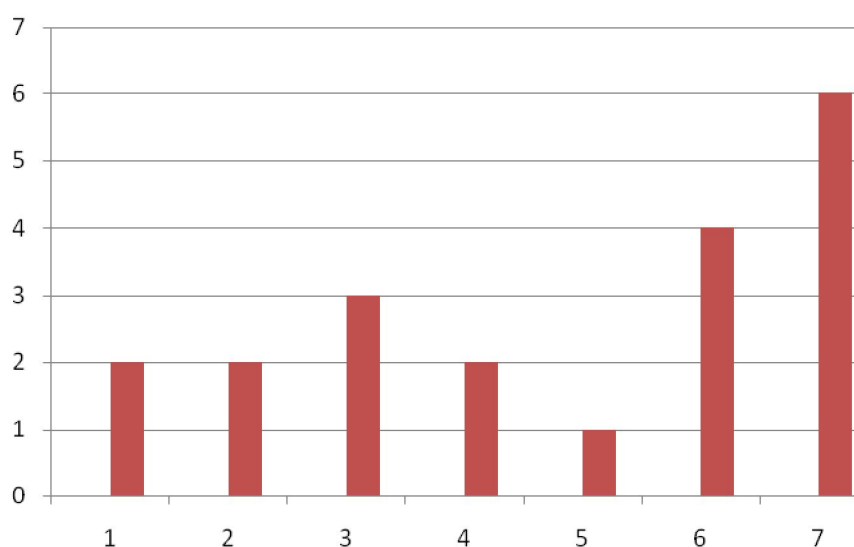


Fig-1: Year wise distribution

6.2 Bibliographic forms of literature

Table 2 presents the different forms of literature used by the research scholars of Mathematics. It is found that highest number of literature accounted for journal articles with 1284 citations (64.18%), followed by books with 663 citations (33.03%), Conference/seminar with 34 citations (1.69%).

Type of documents	No of citation	Percentage
Books, monographs, etc	663	33.03
Journals	1284	64.18
Conference/seminar	34	1.69
Reports	13	0.66
Thesis	11	0.55
Website	2	0.1
TOTAL	2007	100

Table-2: Type of documents used

6.3 Ranking of supervisors

As stated earlier, a total of 20 PhD theses have been awarded during the period in Mathematics. And, a total of 16 supervisors have been identified (Table 3). It is observed from this table that the highest number of theses were guided by Gora Chand Layek and A. K. Bhunia (4 theses each) followed by Mantu Saha (3 theses) having 3rd position.

Sl no	Rank no	Guide name	No of theses
1	1	Gora Chand Layek	4
2	1	A. K. Bhunia	4
3	3	Mantu Saha	3
4	4	Absos Ali Saikh	2
5	4	Rathindranath Mukherjee	2
6	4	Abhoy Pada Baisnab	2
7	7	Asim Mukhopadhyay	1
8	7	N. D. Chakraborty	1
9	7	Chhanda Bandyopadhyay	1
10	7	K. S. Chowdhury	1
11	7	S. K. Roy	1
12	7	Snehanshu Kumar Roy	1
13	7	Shakti Kanta Chakraborty	1
14	7	A. Samad	1
15	7	T. K. De	1
16	7	Dilip Roy	1

Table-3 : Ranking of supervisors

6.4 Authorship pattern

This table shows the authorship pattern of cited documents (Table 4). From the above table it is found that 46.44% of the total literatures were covered by single authored (932 citations),

followed by double authored articles with 725 citations (36.12%) and remaining 350 citations were covered by multi-authored.

Sl no	Number of authors	Citations	Total Citations	%	Cumulative %
1	One	932	932	46.44	46.44
2	Two	725	1657	36.12	82.56
3	Three	269	1926	13.4	95.96
4	Four	65	1991	3.24	99.2
5	Five	14	2005	0.7	99.9
6	Six	1	2006	0.05	99.95
7	Seven	1	2007	0.05	100

Table-4: Authorship characteristics

6.5 Degree of collaboration

The degree of collaboration indicates the multi authorship trend. It is measured by the following formula suggested by K. Subramanyam (1983).

$$C = \frac{Nm}{Nm + Ns}$$

Where C = Degree of Collaboration.

Nm = Number of multi authored article.

Ns = Number of single authored article.

In this study, it is observed that the Degree of Collaboration is 0.54 during the whole period.

6.6 Rank list of journals

Table 6 shows the ranking of journals used by the researchers. For this purpose, a total of 264 journals have been identified and 1284 citations have been counted.

Sl no	Rank no.	Journals name	Cit no.	Cumu no.	%	Cumu %	Coutry
1	1	Jl fluid mech	46	46	3.57	3.57	UK
2	2	European jl of operation research	42	88	3.26	6.83	Netherlands
3	3	IEEE transaction realiability	41	129	3.18	10.01	USA
4	4	Jl tensor society	37	166	2.87	12.88	India
5	5	Proceedings of the American mathematical society	36	202	2.79	15.67	USA
6	6	Jl of operation research society	35	237	2.71	18.38	UK
7	7	Int jl engineering mathematics	28	265	2.17	20.55	UK
8	7	Int j heat & mass tr	28	293	2.17	22.72	UK
9	9	Publ math Debrecen	27	320	2.09	24.81	Europe
10	10	Appl math & comp	23	343	1.78	26.59	USA
11	11	Ind jl of pu & ap mat	22	365	1.71	28.3	India
12	12	Amer math soc	21	386	1.63	29.93	USA
13	13	Operations research	19	405	1.47	31.4	USA
14	14	Phys rev	17	422	1.32	32.72	USA

15	14	Bull cal math soc	17	439	1.32	34.04	India
16	16	Jl biomech	16	455	1.24	35.28	U K
17	16	Int jl of prod eco	16	471	1.24	36.52	Netherlands
18	18	Jl of global optimization	15	486	1.16	37.68	Netherlands
19	19	Trans am math soc	14	500	1.09	38.77	U.S.A
20	19	Management science	14	514	1.09	39.86	U S A
21	21	Math nachr	13	527	1.01	40.87	Germany
22	21	Jl math anal appl	13	540	1.01	41.88	U S A
23	21	Jl of sou & vibr	13	553	1.01	42.89	U S A
24	24	Fundamental app math	12	565	0.93	43.82	Russian
25	24	Jl elasticity	12	577	0.93	44.75	Netherlands
26	24	Phys fluids	12	589	0.93	45.68	U S A
27	24	Colloq math	12	601	0.93	46.61	Poland
28	28	Amer math monthly	11	612	0.85	47.46	U S A
29	28	Jl math of fluid mech	11	623	0.85	48.31	Switzerland
30	28	Tohoku math j	11	634	0.85	49.16	Japan
31	28	Soochow jr math	11	645	0.85	50.01	U S A
32	32	Fuzzy sets & sys	10	655	0.78	50.79	Netherlands
33	32	Vehicle sys dynamics	10	665	0.78	51.57	U K
34	34	Proc 348hem.348 math soc	9	674	0.7	52.27	U K
35	34	Proc math science	9	683	0.7	52.97	India
36	34	Publ de l'inst math	9	692	0.7	53.67	Serbia
37	34	Czech math jl	9	701	0.7	54.37	U S A
38	34	Pacific j math	9	710	0.7	55.07	U S A
39	34	Int jl of enginee sc	9	719	0.7	55.77	U K
40	40	Z Angew Math Phys	8	727	0.62	56.39	Switzerland
41	40	Comp & indu eng	8	735	0.62	57.01	U K
42	40	Opsearch	8	743	0.62	57.63	India
43	40	Jl of thermal stress	8	751	0.62	58.25	U K
44	40	Chem eng commun	8	759	0.62	58.87	U K
45	40	Int j math & math sc	8	767	0.62	59.49	U S A
46	46	Arch der mathematic	7	774	0.54	60.03	Switzerland
47	46	Jl math phys sci	7	781	0.54	60.57	U S A
48	46	Int jl non linear mec	7	788	0.54	61.11	U K
49	46	Rev math phys	7	795	0.54	61.65	Singapore
50	46	Naval res logistic	7	802	0.54	62.19	U S A
51	46	Advances non linear anal	7	809	0.54	62.73	Germany
52	46	Math of operation research	7	816	0.54	63.27	U S A
53	53	Comp rendus Mathematique	6	822	0.47	63.74	France
54	53	Asian jl math	6	828	0.47	64.21	U S A
55	53	Acta math hungarica	6	834	0.47	64.68	Netherlands
56	53	Acta mech	6	840	0.47	65.15	Australia
57	53	hem. eng sci	6	846	0.47	65.62	U K
58	53	Kobe jl math	6	852	0.47	66.09	Japan
59	53	Asme j fluids eng	6	858	0.47	66.56	U S A
60	53	Int j numer analysis and model	6	864	0.47	67.03	Canada
61	53	Int j of system scie	6	870	0.47	67.5	U K
62	53	Annu rev fluid mech	6	876	0.47	67.97	U S A
63	53	Asme j heat transfer	6	882	0.47	68.44	U S A
64	53	Novi sad jr math	6	888	0.47	68.91	Serbia
65	53	Mathematical prog computation	6	894	0.47	69.38	Germany
66	66	Math proc camb phill soc	5	899	0.39	69.77	U S A
...	...	11 Journals	...	...	...	...	...
78	66	Indiana university math jl	5	959	0.39	74.45	U S A
79	79	Duke math journal	4	963	0.31	74.76	U S A
...	...	15 Journals	...	...	...	...	...
95	79	Bull amer math soc	4	1027	0.31	79.72	U S A
96	96	IEEE trans evo com	3	1030	0.23	79.95	U S A

...	...	23 Journals	...	...	...	...	...
120	96	Jl biomechanics	3	1102	0.23	85.47	U K
121	121	Int j engineering sci	2	1104	0.16	85.63	U K
...	...	36 Journals	...	...	...	...	...
158	121	Appl math tech phy	2	1178	0.16	91.55	U S A
159	159	Jl ecole polytech	1	1179	0.08	91.63	Switzerland
...	...	104 Journals	...	...	...	...	...
264	159	Jl de psysique	1	1284	0.08	100.03	U S A

Table-5: Rank list of journals

It is found that the journal entitled “*Jr Fluid Mech*” tops the list with 46 citations (3.57%), followed by “*European Jl opp res*” with 42 citations (3.26%), “*IEEE Trans real*” with 41 citations (3.18%) and stands in the 3rd position. There are some journals having same number of citations and thus shares the same position.

6.7 Country-wise distribution

Sl no.	Rank No.	Country Name	Total no. of Journal	Percentage
1	1	U S A	98	37.12
2	2	U K	49	18.84
3	3	Netherlands	22	8.33
4	4	India	17	6.43
5	5	Japan	9	3.4
6	5	Germany	9	3.4
7	7	Switzerland	8	3.03
8	8	Singapore	7	2.65
9	8	Poland	7	2.65
10	10	Croatia	4	1.51
11	11	South koria	3	1.13
12	11	France	3	1.13
13	11	Serbia	3	1.13
14	11	China	3	1.13
15	15	Bulgaria	2	0.75
16	15	Canada	2	0.75
17	15	England	2	0.75
18	15	Malaysia	2	0.75
19	19	Australia	1	0.37
20	19	Russian	1	0.37
21	19	Europe	1	0.37
22	19	Kuwait	1	0.37
23	19	Slovakia	1	0.37
24	19	Holland	1	0.37
25	19	Lemgo	1	0.37
26	19	Hungary	1	0.37
27	19	Denmark	1	0.37
28	19	Romania	1	0.37
29	19	Sweden	1	0.37
30	19	Greece	1	0.37
31	19	Belgium	1	0.37
32	19	Italy	1	0.37
TOTAL			264	100

Table-6: Country wise distribution

Table 7 shows the geographical distribution of journals. A total of 32 countries have been identified. USA ranks 1st position by contributing 98 (37.12%) journals. UK stands in the 2nd place with 49 (18.84%) journals, followed by Netherlands 22 (8.33%) journals, India 17 (6.43%) journals. It is also found that last 14 countries contribute only one journal.

Age of references

The cited references have further examined to observe Half-life period of the documents and has been calculated by analyzing the age of the cited documents. Half-life is the period of time during which a half of the currently cited literature was published (Line & Sandison, 1974). Table 8 shows the year wise age distribution of references.

Sl no	Ref age	Citation number	Cumulative number	%	Cumulative %
1	0	18	18	0.9	0.9
2	1	22	40	1.1	2
3	2	42	82	2.09	4.09
4	3	51	133	2.54	6.63
5	4	40	173	1.99	8.62
6	5	65	238	3.24	11.86
7	6	52	290	2.59	14.45
8	7	56	346	2.79	17.24
9	8	60	406	2.99	20.23
10	9	53	459	2.64	22.87
11	10	47	506	2.34	25.21
12	11	54	560	2.69	27.9
13	12	52	612	2.59	30.49
14	13	38	650	1.89	32.38
15	14	36	686	1.79	34.17
16	15	58	744	2.89	37.06
17	16	55	799	2.74	39.8
18	17	45	844	2.24	42.04
19	18	43	887	2.14	44.18
20	19	46	933	2.29	46.47
21	20	42	975	2.09	48.56
22	21	44	1019	2.19	50.75
23	22	34	1053	1.69	52.44
24	23	38	1091	1.89	54.33
25	24	33	1124	1.64	55.97
26	25	37	1161	1.84	57.81
27	26	30	1191	1.49	59.3
28	27	33	1224	1.64	60.94
29	28	30	1254	1.49	62.43
30	29	32	1286	1.59	64.02
31	30	36	1322	1.79	65.81
32	31	37	1359	1.84	67.65
33	32	32	1391	1.59	69.24
34	33	39	1430	1.94	71.18
35	34	46	1476	2.29	73.47
36	35	44	1520	2.19	75.66
37	36	35	1555	1.74	77.4
38	37	37	1592	1.84	79.24
39	38	38	1630	1.89	81.13
40	39	27	1657	1.35	82.48
41	40	29	1686	1.44	83.92
42	41	22	1708	1.1	85.02
43	42	30	1738	1.49	86.51

44	43	33	1771	1.64	88.15
45	44	12	1783	0.6	88.75
46	45	24	1807	1.2	89.95
47	46	23	1830	1.15	91.1
48	47	16	1846	0.8	91.9
49	48	16	1862	0.8	92.7
50	49	6	1868	0.3	93
51	50	13	1881	0.65	93.65
52	51	9	1890	0.45	94.1
53	52	10	1900	0.5	94.6
54	53	7	1907	0.35	94.95
55	54	12	1919	0.6	95.55
56	55	9	1928	0.45	96
57	56	9	1937	0.45	96.45
58	57	5	1942	0.25	96.7
59	58	3	1945	0.15	96.85
60	59	8	1953	0.4	97.25
61	60	1	1954	0.05	97.3
62	61	4	1958	0.2	97.5
63	62	3	1961	0.15	97.65
64	63	2	1963	0.1	97.75
65	64	3	1966	0.15	97.9
66	68	3	1969	0.15	98.05
67	73	1	1970	0.05	98.1
68	74	6	1976	0.3	98.4
69	75	2	1978	0.1	98.5
70	76	2	1980	0.1	98.6
71	77	1	1981	0.05	98.65
72	78	5	1986	0.25	98.9
73	81	1	1987	0.05	98.95
74	82	2	1989	0.1	99.05
75	83	1	1990	0.05	99.1
76	84	1	1991	0.05	99.15
77	85	1	1992	0.05	99.2
78	87	2	1994	0.1	99.3
79	89	1	1995	0.05	99.35
80	90	1	1996	0.05	99.4
81	98	3	1999	0.15	99.55
82	100	1	2000	0.05	99.6
83	101	1	2001	0.05	99.65
84	102	3	2004	0.15	99.8
85	104	1	2005	0.05	99.85
86	107	1	2006	0.05	99.9
87	108	1	2007	0.05	99.95

Table-7: Age distribution of references

It is found that it has taken 108 years to cite 2007 citations. It is also found that the half-life period of documents cited is 21.4 year.

Conclusion

Citation analysis is one of the valuable tools for analyzing and measuring the scholarly works. The present study observed that journals were more preferable source than other literatures in this field. The geographical distribution of the cited journals indicate that majority of the users have cited international journals (e.g. published outside India) in the

field of Mathematics. Majority of the publications were contributed by single authored. The results also indicate that single authored articles are predominant in this field.

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