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Contribution and Citation Impact of Panjab University in Mathematics Research during 2005-14

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Abstract

This paper analyzes 230 research publications of the Panjab University in mathematics during ten years (2005-14), as covered in Scopus International database. The study quantifies publication data in various aspects of performance, such as the publication growth, research impact and quality, national and international collaboration, contribution and impact of authors, major areas of research, preferred channels of research communications and characteristics of higher cited papers. The findings reveal that Panjab University total publications in mathematics has increased at an annual average growth rate of 17.15% and registered an average citation impact per paper of 2.92 and impact factor per paper of 0.89 during 2005-14. Of its total publications (230), 43.91% publications of Panjab University did not get any citations as against 56.09% getting 1 or more citations. 35.96% and 13.91% of the Panjab University publications in mathematics were involved in national and international collaboration during 2005-14. Among its performance in top 15 Indian universities, Panjab University registered 6th rank in share of national collaborative papers, 10th rank in publication output and 12th rank in average citation per paper, h-index, share of international collaborative papers and share of high cited papers during 2005-14. The major areas of research by Panjab University were algebra (with 28.7% publication share), followed by numerical analysis (20.9%), statistics & probability (19.1%), application of mathematics in different subjects (14.3%), number theory (7.39%), operations research (1.74%) and others (7.83%) during 2005-14. The top 20 authors of Panjab University in mathematics together contributed 95.65% and 96.72%

share to the total publications and citations during 2005-14. Of the 87 journals contributing to Panjab University mathematics research output, the top 25 journals together accounted for 61.74% share of the Panjab University output in mathematics during 2005-14. The top 15 comparatively higher cited papers received (11 and 29 citations) and together got 275 citations, with average citation per paper of 18.33.

Keywords: Mathematics; Mathematical Sciences; Citation Impact ; Bibliometrics ; Scientometrics ; Research Productivity; Publication Productivity; Panjab University

1. Introduction

The Panjab University has a long tradition of pursuing excellence in teaching & research in science and technology, humanities, social sciences, performing arts and sports. The seventy-eight Departments and four Chairs on the campus and the four Regional Centres are grouped under the Faculties of Arts, Science, Languages, Law, Education, Fine Arts, Business Management & Commerce, Engineering & Technology, Medical Sciences, Pharmaceutical Sciences and Dairying, Animal Husbandry & Agriculture. The University offers several diploma, degree, postgraduate and Ph.D. courses. The University Grants Commission and the Department of Science and Technology have recognized a large number of Departments of the university under various programmes, such as the Special Assistance Programme/Departmental Research Support (SAP/DRS), Centre for Advanced Study (CAS), Funds for Improvement of Science and Technology (FIST) and the Department of Special Assistance (DSA). The University is collaborating with several national and international organizations and also participating in major international multi-collaborative research projects [1].

The Department of Mathematics of Panjab University at Chandigarh is one of the leading departments of mathematics among the Indian universities. It began its journey as the Department of Computation at Hoshiarpur in 1950 under the stewardship of Dr. Hans Raj Gupta and it admitted students for M.A. in Mathematics and was renamed as “Department of Mathematics and Computation” in 1953. The department was shifted to Chandigarh in 1958. The department extended its activities and scope manifold since then. The University Grants Commission recognized the department as “Centre for Advanced Studies in Mathematics” in

1963. The department offers various courses like B.Sc. (Hons. School) in Mathematics and Mathematics & Computing and M.Sc. (Hons.) and Ph.D. The department has mushroomed as a centre of advanced research in numerous branches of pure and applied mathematics, such as number theory, algebra, continuum mechanics, nonlinear phenomena and applied mathematics. Currently, 14 research scholars are pursuing research under the guidance of faculty members. The department promotes research in mathematics by conducting various mathematical instructional schools, annual foundation schools, Olympiad courses, seminars, symposia etc with the financial assistance from National Board for Higher Mathematics. The department has conducted several funded national projects.

1.1 Literature Review

A number of studies have been published on the performance Indian organizations, including the universities in Mysore [2], Jammu [3], Orissa [4], Kerala [5] and Rohtak [6] based on their publications output and citations received covering different periods. Similar studies were also published on the performance of Indian universities in broad fields of science and technology [7-8], physical sciences [9] and life sciences [10]. In addition, quantitative studies were also published on the performance of Indian universities in chemistry [11-13], zoology [14] and mathematics [15-16].

2. Objectives

The main objectives of this study are to study the performance of Panjab University in mathematics research during 2005-14, based on publications output, as indexed in Scopus database. In particular, the study focused on the following objectives –

- To study the growth of its publications and study its distribution by type of documents and sources;
- To study the impact of its publications using citations per paper and impact factor per paper;
- To study the citation pattern of its research output;
- To compare its performance with other leading universities;

- To study the distribution of its research output by broad subject areas and identification of significant keywords;
- To study the publication productivity and citation impact of its most productive authors;
- To study the leading medium of communication and to study the characteristics of high cited papers

3. Methodology

The study retrieved and downloaded the publication data of Panjab University in mathematics from the Scopus database (<http://www.scopus.com>) during 2005-14. We started first in “Affiliation Search” with first keyword “Chandigarh” and then the keyword “Panjab University” and then limited this search to years 2005 to 2014. Once we got all the publications of Panjab University (7057 publications), we further restricted it to “Mathematics” on “Subject Area” tag. Here we got 432 publications. Here we noticed too much of overlapping in mathematics publications with physics publications. Then we again revised our search strategy and excluded physics publications from this output. This we got 230 publications of Panjab University in mathematics during 2005-14. These publications were pertaining to mathematics only and were relevant. The Final search strategy string used is given below.

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(AF-ID("Panjab University" 60018526) OR AF-ID("University Institute of Pharmaceutical Sciences India" 60018483)) AND ( LIMIT-TO(PUBYEAR,2015) OR LIMIT-TO(PUBYEAR,2014) OR LIMIT-TO(PUBYEAR,2013) OR LIMIT-TO(PUBYEAR,2012) OR LIMIT-TO(PUBYEAR,2011) OR LIMIT-TO(PUBYEAR,2010) OR LIMIT-TO(PUBYEAR,2009) OR LIMIT-TO(PUBYEAR,2008) OR LIMIT-TO(PUBYEAR,2007) OR LIMIT-TO(PUBYEAR,2006) OR LIMIT-TO(PUBYEAR,2005) ) AND ( LIMIT-TO(SUBJAREA,"MATH" ) ) AND ( EXCLUDE(SUBJAREA,"PHYS" ) )
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When the main search string is further restricted to “author name tag”, “source title tag”, “keyword tag” “Affiliation tag” and “country/Territory tag”, we got information on distribution of publications by authors, source, significant keywords, collaborating organizations and countries, etc. The citation data was collected from date of publication till the end of

September 2015 for all publications. The study has used both quantitative and qualitative indicators to study the performance of Panjab University in mathematics research.

4. Analysis

The number of publications by Panjab University in mathematics comprised of 230 publications during 2005-14 and these increased from 13 publications in 2005 to 30 in 2014, witnessing an annual average growth rate of 17.15%. The cumulative number of publications by Panjab University in mathematics increased from 87 during 2005-09 to 143 during 2010-14, witnessing a growth rate of 64.37%. The average citation per paper registered by Panjab University publications in mathematics was 2.92 during 2005-14, which decreased from 4.57 during 2005-09 to 1.91 during 2010-14 (Table 1). Of the 230 publication by Panjab University in mathematics, 90.43% (208) appeared as articles, 6.96% (16) as conference papers, 0.87% (2 each) as book chapters and erratum and 0.43% (1 each) as editorial and article in press during 2005-14

Table 1. Growth of Publications and Citations of Panjab University in Mathematics during 2005-14

Publication Year	TP	TC	ACPP
2005	13	69	5.31
2006	9	92	10.2
2007	20	80	4.00
2008	20	110	5.50
2009	25	47	1.88
2010	19	74	3.89
2011	26	71	2.73
2012	38	83	2.18
2013	30	36	1.20
2014	30	9	0.30
2005-09	87	398	4.57
2010-14	143	273	1.91
2005-14	230	671	2.92
TP=Total Papers; TC=Total Citations; ACPP=Average Citation Per Paper			

4.1 Distribution of Publications by Citations

Of the total 230 publications by Panjab University in mathematics, 43.91% (101 publications) did not get any citation (zero citation) since their publication till August 2015. The remaining 56.09% (129) publications received 1 or more citations: 49.57% (114 publications) received 1 to 10 citations, 4.78% (11 publications) received 11 to 20 citations and 1.74% (4 publications) received 21 to 30 citations during 2005- 14. The average number of citations per paper was 2.92 (Table 2).

Table 2. Distribution of Panjab University Publications in Mathematics by Citations during 2005-14

Range of Citations	TP	Citations	% TP	%Citations
0 – 0	101	0	43.91	0
1 – 10	114	396	49.57	59.0
11-20	11	171	4.78	25.5
21-30	4	104	1.74	15.5
Total	230	671	100.00	100.0
TP=Total Publications				

4.2 Distribution of Publications by Impact Factor

Of the 230 publications by Panjab University in mathematics, 213 publications appeared in 95 journals. Of these 213 journal publications, only 178 publications appearing in 67 journals had impact factor information. The largest number of publications (121) appeared in 45 journals with impact factor range 0.01 to 1.00, 42 publications in 15 journals with impact factor range from 1.01 to 2.00, 15 publications in 7 journals with impact factor range 2.01 to 5.0. The average impact factor per publication was 0.89 for these 178 publications (Table 3).

Table 3. Distribution of Panjab University Publications in Mathematics by Impact Factor, 2005-14

Range of Impact Factor	No of Papers	No. of Journals	Total Impact Factor	Average Impact per Paper
0.01 – 1.00	121	45	56.143	
1.01 – 2.0	42	15	63.211	
2.010 – 3.00	12	5	27.664	
3.010 – 4.00	2	1	7.202	
4.010 – 5.00	1	1	4.035	
Total	178	67	158.255	0.89

4.3 Comparison of Panjab University with other Universities in Mathematics

Among the top 15 universities contributing to mathematics research during 2005-14, Panjab University was placed at 10th rank in terms of publications output, but had 12th rank in average citation per paper, h-index, share of international collaborative papers and share of high cited papers and 6th rank in share of national collaborative papers during 2005-14 (Table 4)

Table 4 . Scientometric Profile of Top 10 Universities in Mathematics during 2005-14

S.No	Name of the University	TP	TC	ACPP	HI	ICP	% ICP	NCP	%NCP	HCP	% HCP
1	Anna University, Chennai	1150	2475	2.15	20	89	7.74	493	42.87	0	0
2	Jadavpur University, Kolkata	854	6202	7.26	33	252	29.5	427	50.00	6	0.7
3	Aligarh Muslim University	711	3945	5.55	27	366	51.5	93	13.08	1	0.14
4	University of Delhi	644	2290	3.56	20	142	22.00	188	29.19	0	0
5	University of Calcutta	412	1522	3.69	19	64	15.5	206	50.00	0	0
6	SASTRA University	368	794	2.16	10	21	5.71	139	37.77	0	0
7	Banaras Hindu University	302	872	2.89	12	86	28.5	88	29.14	0	0

8	University of Hyderabad	264	757	2.87	12	60	22.7	40	15.15	0	0
9	Bharathiar University	250	1308	5.23	17	74	29.6	95	38.00	2	0.8
10	Panjab University, Chandigarh	230	671	2.88	12	32	13.91	85	36.96	0	0
11	Thapar University, Patiala	209	716	3.43	13	46	22	73	34.93	1	0.48
12	Annamalai University	208	358	1.72	8	7	3.37	53	25.48	0	0
13	University of Pune	193	1478	7.66	22	44	22.8	52	26.94	0	0
14	Cochin University of Science & Technology	188	631	3.36	13	44	23.4	49	26.06	0	0
15	University of Mysore	185	240	1.3	6	26	14.1	58	31.35	0	0
TP=Total Papers; TC=Total Citations; ACP=Average Citations Per Paper; HI-h-index; NCP=National Collaborative Papers; ICP=International Collaborative Papers											

4.4 Distribution of Publications by National Collaboration

Of the 230 publications by Panjab University in mathematics, 85 (36.96%) involve collaboration between Panjab University and other organizations from India. These 85 national collaborative publications received 248 citations, leading to the average citation impact per paper of 2.92, same as for overall publications of Panjab University (Table 5). It means the Panjab University has not benefited in terms of citation impact by way of national collaboration.

About 44 Indian organizations (including 10 institutes of national importance, 12 universities, 7 research institutes, 8 engineering & technical colleges, 6 colleges and 2 others) collaborated with Panjab University in mathematics research during 2005-14. Of the 44 collaborative organizations, 21 organizations collaborated in 1 publications, 10 organizations in 2 publications each, 5 organizations in 3 publications each, 2 organizations each in 4 and 5 publications, 1 organization in 6, 8, 12 and 16 publications each during 2005-14.

Table 5. Distribution of Publications of Panjab University in Mathematics by National Collaboration during 2005-14

Publication Year	TP	NCP	%NCP
2005	13	1	7.69
2006	9	2	22.2
2007	20	3	15.00
2008	20	8	40.00
2009	25	11	44.00
2010	19	9	47.4
2011	26	7	26.9
2012	38	14	36.8
2013	30	17	56.7
2014	30	13	43.3
2005-09	87	25	28.7
2010-14	143	60	42.00
2005-14	230	85	37.00
TP=Total Papers; NCP=National Collaborative Papers			

Among 13 collaborating universities, the largest collaboration (12 papers) of the Panjab University was with Guru Nanak Dev University, Amritsar, followed by Thapar University, Patiala (8 papers), Kurukshetra University (5 papers), Maharishi Markandeshwar University, Sadopur Ambala and South Asia University, Delhi (3 papers each), Himachal Pradesh University, Shimla, University of Delhi, Karunya University, Coimbatore, Lovely Professional University, Jalandhar, University of Hyderabad, Guru Gobind Singh Indraprastha University, Delhi, University of Jammu and Jayee Univ of Technology, Himachal (1 paper each).

Among 10 collaborating institutes of national importance, the largest collaboration (16 papers) of Panjab University was with Indian Institute of Science Education & Research, Mohali, followed by IIT-New Delhi (4 papers), IIT-Kanpur (3 papers), Indian Statistical Institute, Delhi and IIT-Roorkee (2 papers each), IIT-Mandi, IIT-Ropar, IIT-Bombay and Indian Statistical Institute, Kolkata (1 paper each). Among 7 collaborative research institutes, the largest collaboration (6 papers) of Panjab University was with Central Scientific Instrument Organization, Chandigarh, followed by Institute of Microbial Technology, Chandigarh (4 papers), Reserve Bank of India, Mumbai, Institute of Mathematical Sciences, Chennai. Harish Chandra Research Institute,

Allahabad, National Institute of Pharmaceutical Education & Research, Mohali and Tata Institute of Fundamental Research--CAM, Bangalore

Among 8 collaborating engineering and technical institutions, the largest collaboration (6 papers) of Panjab University was with Panjab Engineering College (PEC)/PEC University of Technology, Chandigarh followed by Sant Longowal Institute of Engineering and Technology, Longowal (5 papers), Indo Global College of Engineering, Abhipur, Mohali and National Institute of Technical Teachers' Training and Research, Chandigarh (2 papers) each, Indian Institute of Information Technology, Hyderabad, National Institute of Technology, Hamirpur, Jayee University of Technology, Yadavindra College of Engineering, Punjabi University, Guru Kashi Campus, Talwandi Sabo-Bathinda, Punjab, and BBSB Engg College Fatehgarh Sahib (1 paper each). Among 6 collaborating colleges, the largest collaboration (2 papers each) of Panjab University was with Govt. Postgraduate College, Nalagarh, MCM DAV College, Chandigarh, DAV College, Jalandhar, Lord Shiva College of Pharmacy, Sirsa and JH Govt Postgraduate College, Betul, GGD-SD College, Chandigarh

4.5 Distribution of Publications by International Collaboration

Of the 230 publications by Panjab University in mathematics, 32 (13.91%) involve international collaboration and these have received 144 citations, leading to average citation impact per paper of 4.5, much better than for overall publications of Panjab University [Table 6] . It means the Panjab University benefited substantially in terms of citation impact by way of international collaboration. A large number of organizations and scholars from 15 foreign countries collaborated in research with Panjab University, of which the largest number of papers (12) came from USA, followed by China (4), Canada and Russia Federation (3), Brazil, Germany and South Africa (2 each), France, Greece, Iran, Nepal, Serbia, Singapore, Spain and U.K. (1 each).

Table 6. Number & Share of International Collaborative Papers of Panjab University in Mathematics during 2005-014

Publication year	TP	ICP	%ICP
2005	13	2	15.38
2006	9	3	33.33
2007	20	3	15.00
2008	20	5	25.00
2009	25	3	12.00
2010	19	3	15.79
2011	26	3	11.54
2012	38	2	5.263
2013	30	1	3.333
2014	30	7	23.33
2005-09	87	16	18.39
2010-14	143	16	11.19
2005-14	230	32	13.91
TP=Total Papers; ICP=International Collaborative Papers			

Twenty nine foreign organizations collaborated with Panjab University in mathematics, of which the largest number of collaborative papers (4) was with University of California, Berkeley, USA followed by Steklov Mathematical Institute, Moscow, Russia Federation (3 papers), Brigham Young University, USA, Ohio University, USA, Center for Communications Research, San Diego, USA, University of Pretoria, South. Africa and Honghe University, Mengzi, Yunnan, China (2 papers) and 1 paper each with University of Iowa, USA, Wichita State University, Wichita, KS USA, Quintiles Inc., Kansas City, MO, USA, Wellesley College, Wellesley, USA, University of Calgary, Canada, University of Guelph, Canada, Memorial University of Newfoundland, Canada, University of Manitoba, Winnipeg, Canada, Universität Bremen, Germany, University of Bristol, U.K., . Universitat Politècnica de València, Valencia, Spain, Institut für Informatik, Humboldt-Universität zu Berlin, Berlin, Germany Université Pierre et Marie Curie, Paris, France, University of Nis, Aleksandra, Serbia, Khaje Nassir-Al-Deen Toosi University, Tehran, Iran. Universidade de São Paulo (IME-USP), , São Paulo, Brazil, IMECC-UNICAMP, Campinas, Brazil, National University of Singapore, Singapore, Tribhuvan University, PN Campus, Pokhara, Nepal,

Southeast University, Nanjing , China, Hubei Engineering University, Xiaogan, Hubei, China and Baoshan University, Baoshan, China

4.6 Subject-Wise Distribution of Publications

A subject-wise analysis of publications of Panjab University in mathematics during 2005-14 revealed that the maximum share and number of publications (28.7%, 66) were published in algebra, followed by numerical analysis (20.9%, 48), statistics & probability (19.1%, 44), application of mathematics in different subjects (14.3%, 33), number theory (7.39%, 17), operations research (1.74%, 4) and others (7.83%, 18) during 2005-14. Except miscellaneous publications, operations research registered the highest citation impact per paper (5.25), followed by numerical analysis (4.10), algebra (2.74), number theory (2.35), and statistics & probability (2.34) during 2005-14 (Table 7)

Table 7. Subject-Wise Distribution of Publications of Panjab University in Mathematics during 2005-14

S.No	Subject Area	TP	TC	ACPP	%TP
1	Algebra	66	181	2.74	28.7
2	Numerical Analysis	48	197	4.10	20.9
3	Statistics & Probability	44	103	2.34	19.1
4	Number Theory	17	40	2.35	7.39
5	Application of Mathematics in Different Subjects	33	62	1.88	14.3
6	Operations Research	4	21	5.25	1.74
7	Miscellaneous	18	67	3.72	7.83
	Total	230	671	2.92	28.7
TP=Total Papers; TC=Total Citations; ACPP=Average Citation Per Paper					

4.7 Significant Keywords

A list of 25 significant keywords (along with their frequency of occurrence) appearing in publications of Panjab University in mathematics during 2005-14 is shown in Table 8. These keywords through some light on the trends of research in differential subject fields.

Table 8. List of Significant Keywords appearing in Papers of Panjab University in Mathematics, 2005-14

Keywords	# of Papers	Keywords	# of Papers	Keywords	# of Papers
Nonlinear Equations	14	Perturbation Techniques	7	Combinatorial Interpretations	4
Valued Fields	14	Algorithms	7	Computer Simulation	4
Numerical Methods	13	Finite Element Method	6	Differential (Calculus)	4
Newton's Method	12	Halley's Method	6	Field Theory & Polynomials	4
Non-Archimedean Valued Fields	11	Mathematical Models	6	Finite Fields	4
Differential Equations	9	Optimization	6	Partial Differential Equations	4
Singular Perturbations	9	Differential Equations	5	Banach Algebra	3
Cyclotomic Cosets	7	Newton-Raphson Method	5		
Finite Differences Methods	7	Chebyshev's Method	4		

4.8 Contribution and Citation Impact of Top 20 Authors

In all, 160 authors participated in mathematics research by Panjab University during 2005-14, of which 63 authors contributed 1 paper each, 41 authors 2 papers each, 19 and 10 authors 3 and 4 papers each, 7 and 3 authors 5 and 6 papers each, 4 and 2 authors 7 and 9 papers each, 3, 1 and 1 authors 10, 11 and 12 papers each, 3, 1, 1 and 1 authors 13, 19, 24 and 26 papers each. The average number of papers per author was 3.14. The top 20 most productive authors individually had published 5 to 26 papers and together contributed 220 papers and 649 citations, accounting for 95.65% and 96.72% share of total publications and citations by Panjab University in mathematics during 2005-14.

Seven authors have published more than the average productivity (11) per author: Sudesh K Khanduja (36 papers), K.K. Sharma (24 papers), V. Kanwar (19 papers), M. Raka, G.K. Bakshi and I.B.S. Passi (13 papers each) and S.K. Tomar (12 papers) during 2005-14. Nine authors have registered higher impact than the average citation per paper (2.95) of all authors: K.K. Sharma (6.0), S.K. Tomar (5.92), D. Khurana (5.30), M. Raka (3.92), G.K. Bakshi (3.77), V. Kanwar (3.37),

A. Sharma (3.33), A.Kaushik (3.29) and R.Sehmi (3.0) during 2005-14. Six authors have achieved more than the average h-index (3) of all authors: K.K. Sharma (7), S.K. Tomar, M. Raka, V. Kanwar and Sudesh K Khanduja (5 each) . Nine authors had higher share of national collaborative papers than the average share (30.0%) of all authors: R. Sehmi (100.0%), A.Kaushik (85.71%), S.K. Tomar (66.67%), I. B. S. Passi (61.54%), A.N.Gill (44.44%), A.Goyal (42.86%), V. Kanwar (42.11%), M. Raka (38.46%) and G.K. Bakshi (30.0%) during 2005-14. Six authors have registered more share of international collaborative papers (ICP) than the average (12.73%) of all authors: D. Khurana (80.0%), I. B. S. Passi (53.85%), N. Kumar (30.0%), A.Kaushik (28.75%), G.P.Mehta (20.0%) and K.K. Sharma (16.67%) during 2005-14 (Table 9).

Table 9. Scientometric Profile of Top 20 Most Productive Authors of Panjab University in Mathematics during 2005-14

S.No	Name of Author	Affiliating Deptt.	TP	TC	ACPP	HI	NCP	%NCP	ICP	%ICP
1	Sudesh K Khanduja	Math	26	53	2.04	5	6	23.08	2	7.69
2	K.K. Sharma	Math	24	144	6.00	7	7	29.17	4	16.67
3	V. Kanwar	UIET	19	64	3.37	5	8	42.11	1	5.26
4	M. Raka	Math	13	51	3.92	5	5	38.46	0	0.00
5	G. K. Bakshi	Math	13	49	3.77	4	5	38.46	0	0.00
6	I. B. S. Passi	Math	13	25	1.92	3	8	61.54	7	53.85
7	S.K. Tomar	Math	12	71	5.92	5	8	66.67	0	0.00
8	A.K. Agarwal	Math	11	18	1.64	2	1	9.09	0	0.00
9	N. Kumar	Stat	10	4	0.40	1	3	30.00	3	30.00
10	S. Arora	Math	10	9	0.90	1	1	10.00	0	0.00
11	D. Khurana	Math	10	53	5.30	3	3	30.00	8	80.00
12	A.N.Gill	Stat	9	11	1.22	2	4	44.44	0	0.00
13	A.Kaushik	Math	7	23	3.29	3	6	85.71	2	28.57
14	A.Goyal	Stat	7	13	1.86	2	3	42.86	0	0.00
15	K K Mahajan	Stat	7	3	0.43	1	1	14.29	0	0.00
16	R. Behl	UIET	7	12	1.71	2	2	28.57	0	0.00
17	K. Jain	Stat	6	10	1.67	2	0	0.00	0	0.00
18	A. Sharma	Math	6	20	3.33	3	1	16.67	0	0.00
19	G.P.Mehta	Stat	5	1	0.20	1	0	0.00	1	20.00
20	R.Sehmi	Math	5	15	3.00	3	5	100.00	0	0.00
	Total of 20 authors		220	649	2.95	3	77	35.00	28	
	Total papers of Panjab University		230	671						

Share of 20 authors in total output of Panjab University		95.65	96.72						
TP=Total Papers; TC=Total Citations; ACPP=Average Citations Per Paper; HI-h-index; NCP=National Collaborative Papers; ICP=International Collaborative Papers; UIET=University Institute of Engineering & Technology									

4.9 Medium of Communication

Out of 230 papers by Panjab University in mathematics, 213 papers appeared in journals, 9 in book series, 6 in conference proceedings and 2 as books during 2005-14. These 213 papers appeared in 87 journals, of which 48 journals published 1 paper each, 14 journals 2 paper each, 8 journals 3 papers each, 4 and 5 journals 4 and 5 papers each, 2 journals each 6, 7 and 8 papers and 1 journal each 11 and 19 papers during 2005-14. A list of 25 most productive journals publishing 3 and more papers are given in Table 10. The top 25 journals together contributed 142 papers, accounting for 61.74% share of the total output of Panjab University in mathematics during 2005-14. The largest number of papers (19) was published in *Applied Mathematics & Computation* (IF=1.60), followed by *Communications in Algebra* (11 papers, IF=0.388), *Finite Fields and Their Applications* and *Statistics & Probability* (8 papers each, IF=0.459 and 0.531), *Journal of Algebra* and *Journal of Pure & Applied Algebra* (6 papers each, IF=0.604 and 0.578), etc. (Table 10)

Table 10. List of Top 25 Most Productive Journals of Panjab University in Mathematics during 2005-14

S.No	Name of the Journal	TP	IF2013	S.No	Name of the Journal	TP	IF2013
1	Applied Mathematics and Computation	19	1.600	14	Communications in Statistics Stimulation & Computation	4	0.288
2	Communications in Algebra	11	0.388	15	International Journal of Computational Mathematics	4	0.721
3	Finite Fields and Their Applications	8	0.459	16	International Journal of Pure & Applied Mathematics	4	0.379
4	Statistics & Probability	8	0.531	17	Proceedings of the Indian Academy of Sciences-Mathematical Sciences	4	0.380

5	Journal of Algebra	7	0.604	18	Chemical Product & Process Modeling	3	NA
6	Journal of Pure & Applied Algebra	7	0.578	19	Computers & Mathematics with Applications	3	1.996
7	Advance Science Letters	6	1.253	20	Algebra Colloquim	3	0.272
8	Indian Journal of Pure & Applied Mathematics	6	0.206	21	Utilitas Mathematica	3	0.316A
9	Ars Combinatoria	5	0.204	22	Asian European Journal of Mathematics	3	NA
10	American Journal of Mathematics & Management Science	5	Nil	23	MBC Bioinformatics	3	2.672
11	Applied Mathematics Modelling	5	2.158	24	International Journal of Mathematical Education in Science & Technology	3	0.460
12	Journal of Algebra and its Applications	5	0.373	25	Journal of Number Theory	3	0.392
13	Model Assisted Statistics & Applications	5	NA	Total	Total of 20 journals	142	
13	Model Assisted Statistics & Applications	5	NA			61.74	

4.10 Higher Cited Papers

The top 15 comparatively higher cited papers (11 papers with 11 to 20 citations range and 4 papers with 21 to 30 citations range) together account for 275 citations, leading to average citation per paper of 18.33. Among 15 higher cited papers, 3 had the participation of single institution (zero collaboration), 7 involve national collaboration (participation 2 or more Indian organizations) and 5 involve international collaboration (participation of 2 or more Indian and foreign organization). These 15 higher cited papers involve 26 authors and 30 Indian and foreign organizations and were published in 9 journals. The largest number of papers (6) were published in *Applied Mathematics & Computation* (IF=1.60), followed by 2 papers each in *Journal of Algebra* (IF=0,604) and *BMC Bioinformatics* (if=2,672), and 1 paper each in *Algebra Colloquiam* (IF=0.272), *European Journal of Operations Research* (IF=1.843), *Finite Fields & their Applications*(IF=0.459), *International Journal of Numerical Methods in Engineering* (IF=1.961) and *Reliability Engineering & Systems Safety*.

5. Summary & Conclusions

The Panjab University in mathematics published 230 publications during 2005-14, increasing from 13 publications in 2005 to 30 in 2014, leading to an annual average growth rate of 17.15%. Its cumulative publications had increased from 87 to 143, witnessing a growth rate of 64.37% from 2005-09 to 2010-14. The university publications had registered the average citation impact per paper of 2.92 and the average impact factor per publication of 0.89 during 2005-14. Only 56.09% publications of Panjab University in mathematics received 1 or more citations: 49.57% received 1 to 10 citations, 4.78% received 11 to 20 citations and 1.74% received 21 to 30 citations during 2005- 14. Of the 230 publications by Panjab University in mathematics, 213 publications appeared in 95 journals. Of these 213 journal publications, only 178 publications appearing in 67 journals had impact factor information.

Around 36.96% publications of Panjab University were involved in national collaboration between Panjab University and 44 other Indian organizations (including 10 institutes of national importance, 12 universities, 7 research institutes, 8 engineering & technical colleges, 6 colleges and 2 others) collaborated with Panjab University in mathematics research during 2005-14. In contrast, only 13.91% of publications of Panjab University in mathematics involved international collaboration with 15 countries (29 organizations): USA (12 publications), China (4), Canada and Russia Federation (3), Brazil, Germany and South Africa (2 each), France, Greece, Iran, Nepal, Serbia, Singapore, Spain and U.K during 2005-14.

The largest share (28.7%) of publications of Panjab University in mathematics were in algebra, followed by numerical analysis (20.9%), statistics & probability (19.1%), application of mathematics in different subjects (14.3%), number theory (7.39%), operations research (1.74%) and others (7.83%) during 2005-14. About 160 authors participated in mathematics research by Panjab University, of which the top 20 most productive authors accounting for 95.65% and 96.72% share of its publications and citations during 2005-14.

The top 25 journals publishing papers by Panjab University in mathematics together accounted for 61.74% share of the total output of Panjab University during 2005-14. *Applied Mathematics & Computation* (IF=1.60) published the largest number (19) of papers, followed by

Communications in Algebra (11 papers, IF=0.388), *Finite Fields and Their Applications* and *Statistics & Probability* (8 papers each, IF=0.459 and 0.531), *Journal of Algebra* and *Journal of Pure & Applied Algebra* (6 papers each, IF=0.604 and 0.578), etc.

The top 15 comparatively higher cited papers together got 275 citations, leading to average citation per paper of 18.33. Among 15 higher cited papers, 3 had the participation of single institution (zero collaboration), 7 involve national collaboration and 5 involve international collaboration. These 15 higher cited papers involve 26 authors and 30 Indian and foreign organizations and were published in 9 journals.

6. Conclusion

From the above analysis, it is clear that Panjab University contribution in mathematics research lags far behind with other leading universities, in terms of both publications output and citation impact. The University must seriously think in terms of increasing its research output by way of enlarging the size of qualified faculty and intake of serious Ph.D. students and also improving its citation impact through enlarged participation of its faculty in national and international collaborative projects and increasing participation of its Ph.D. students in international conferences and workshops. In addition, more efforts should be made to attract extra-mural grants for getting research projects from different major Indian funding agencies.

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