Assessment of Academic Research Output during 1996-2009: A Case Study of PEC University of Technology, Chandigarh

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ABSTRACT

The study investigates the contribution and impact of research output of PEC University of Technology as reflected in its publications covered in *Scopus* international multidisciplinary database. The study describes the broad characteristics of research publications of PEC during 1996-2009, its growth, format, media of communication, national and international collaboration profile and overall citation impact, distribution of research output and impact under broad subjects and under different subject departments, most productive authors, and highly cited papers. It also compares publications output and citation impact of PEC with select similar neighbouring engineering institutions.

Keywords: Scientometrics, academic research output assessment, PEC University of Technology

1. INTRODUCTION

The PEC University of Technology (PEC) was originally established as Mugalpura Engineering College at Lahore (now in Pakistan) on 9 November 1921. The name of the college was later changed to Maclogan Engineering College and it started functioning under this name from 19 March 1924. In 1931, the college migrated to Punjab University, Lahore. After partition in 1947, the college was shifted to Roorkee (India) and was renamed as East Punjab College of Engineering. In 1950 the word east was dropped and it came to be known by its present name Punjab Engineering College. In December 1953, the college shifted to its present campus in Chandigarh and started functioning here from January 1954. In October 2003, the Government of India notified the Punjab Engineering College as a deemed to be university. Deemed to be university is a status of autonomy granted to high performing institutes by University Grants Commission (UGC). These are institutions, which are not established as universities through legislations, but are declared as deemed to be universities by the UGC, a statutory body of the Government of India for the coordination, determination and maintenance of standards of university education in India. These institutions enjoy the same academic status and privileges as a university yet their organisational set-up need not be the replica of a university. A Board of Governors now manages the college. The college, in its new set up, has introduced policies and programmes, which are at par with those at IITs and other best institutions in the world. Recently in June 2009, the Institute switched over to its present name as PEC University of Technology. PEC offers graduate, postgraduate, and doctoral programmes in nine branches of sciences and engineering. It is ranked at 19th position amongst the top engineering institutions (both government and private) in India for the year 2010-11 (Outlook India Survey) and at 6th position amongst the top engineering colleges/institutions by CSR-GHRDC Engineering College Survey 2010.

Published academic research outputs have for a long time been used to appraise the credibility of faculty of any institution and also have a profound impact on its ability to deliver quality education. Present study focuses on academic output of PEC faculty and research scholars, consisting of the scholarly publications in the form of technical articles published in various technical journals, proceedings of the conferences/symposium ,etc. Few earlier studies have been undertaken on the evaluation of the research output of different institutions, both in India (including of IIT, Kharagpur[1-2], IIT, Roorkee[3], University of Mysore[4], and Government Medical College and Hospital, Chandigarh[5]). Studies had also been conducted at the broader level, which includes evaluation of research at the

group of institutes' level[6-7]. Still broader studies are available, which deals with evaluation of scientific activity, including institutional activities[8].

2. OBJECTIVES

The main objectives of the present study are: (i) to analyse the broad characteristics of PEC University of Technology, Chandigarh publications, (ii) to study the publication growth characteristics, format and media of communication of PEC, (iii) to analyse the national and international collaboration profile and major collaborating institutions and countries, (iv) to analyse the overall citation impact and the characters tics of highly cited papers; (v) to study the distribution of its research output and impact under broad subjects and under different subject departments, (vi) to analyse the contribution and impact of its most productive authors, and (vii) to compare its contribution and impact with select similar neighbouring engineering institutions.

3. METHODOLOGY AND DATA SOURCE

The present study analyses publications data from 1996 to 2009 for understanding the broad characteristics and impact of research of PEC. The study derives publications data for the study from *Scopus* international multidisciplinary bibliographical database. For analysing the subject scope, the total research output of PEC under eleven subjects as defined by Scopus and under nine subject departments.

For assessing the impact and quality of publications output of PEC, three-year citation window was used. For calculating the total international collaborative papers, a separate search strategy, which combines India's collaboration with 140 major countries (*Appendix I*), was prepared. For analysing authors and journals output, the separate search strategies for generating institutional, author and journal outputs were developed.

4. ANALYSIS OF PEC ACADEMIC RESEARCH OUTPUT

4.1. Comparison of PEC with Select Other Engineering Colleges

This research contribution and impact of PEC and other five neighbouring NITs/engineering colleges during 1996-09. A list of these colleges is presented in Table 1 along with their research output, citations received and h-index values. For assessing the impact, a three-year citation profile was considered. In terms of publications output during 1996-09 was assessed, Thaper University tops the list with 653 papers, followed by National Institute of Technology, Kurukshetra (431 papers), Sant Longwal Institute of Engineering and Technology, Sangrur (398 papers), Dr B.R. Ambedkar Institute of Technology, Jalandhar (312 papers), Punjab Engineering College, Chandigarh (177 papers), and National Institute of Technology, Hamirpur (173 papers). In terms of citation impact as measured by average citations per paper, National Institute of Technology, Hamirpur toped the list with average citation per paper of 2.67, followed by Sant Longwal Institute of Engineering and Technology, Sangrur (2.60), Thaper University, Patiala (1.54), Dr B.R. Ambedkar Institute of Technology, Jalandhar (0.89), National Institute of Technology, Kurukshetra (0.73) and Punjab Engineering College, Chandigarh (0.68). In terms of h-index, Thaper University, Patiala and Sant Longwal Institute of Engineering and Technology, Sangrur toped the list with h-index of 18, followed by National Institute of Technology, Kurukshetra (15), National Institute of Technology, Hamirpur (13), Dr B.R. Ambedkar Institute of Technology, Jalandhar (11), and Punjab Engineering College, Chandigarh (7) (Table 1).

4.2 Broad Characteristics of PEC Publications

In all 177 cumulative publications were published by PEC, Chandigarh during 1996 to 2009, showing an annual

Table 1. Comparative performance of six engineering colleges during 1996-2009

Name	1996-2009			
	TP	TC	ACPP	H-Index
Thaper University, Patiala	653	1004	1.54	18
National Institute of Technology, Kurukshetra	431	591	0.73	15
Sant Longwal Institute of Engineering & Technology, Sangrur	398	1035	2.60	18
Dr B.R. Ambedkar Institute of Technology, Jalandhar	312	277	0.89	11
Punjab Engineering College, Chandigarh	177	121	0.68	7
National Institute of Technology, Hamirpur	173	462	2.67	13

TP=Total Paper, TC= Total Citations, ACPP=Average Citations per Paper

average growth rate of 131.85 per cent. The cumulative publications of PEC increased from 36 during 1996-02 to 141 during 2003-09, showing a growth rate of 299.61 per cent. Of these total papers, 108 papers appeared as articles, 61 as conference papers, 7 as review papers, and 1 as editorial. On measuring impact, as measured by average citation per paper during a three years citations window, the impact of cumulative papers of PEC during 1996-09 was 0.67. The impact of cumulative PEC publications decreased from 0.81 during 1996-02 to 0.65 during 2003-09 (Table 2).

Table 2. Contribution impact of PEC Chandigarh

Period	TP	TC	ACPP
1996	3	2	0.67
1997	5	0	0.00
1998	4	2	0.50
1999	8	5	0.63
2000	5	2	0.40
2001	7	11	1.57
2002	4	7	1.75
2003	12	14	1.17
2004	16	10	0.63
2005	16	0	0.00
2006	16	12	0.75
2007	20	26	1.30
2008	34	24	0.71
2009	27	6	0.22
96-02	36	29	0.81
03-09	141	92	0.65
96-09	177	121	0.67

4.3 International and National Collaborations

Scientific collaborations impacts the quality of papers as it is possible to share and exchange knowledge and techniques. The share of international collaborative publications (11) of PEC in its total publications' output was 6.21 per cent and that of national collaborative publications (95) was 53.67 per cent (Table 3). Its share of international collaborative publications increased from 5.56 per cent (2 publications) during 1996-02 to 6.38% (9 publications) during 2003-09. (Table 3)

Table 3. International and national collaborations PEC Papers

Period	ICP	% ICP	NCP	% NCP
96-02	2	5.56	17	47.22
03-09	9	6.38	78	55.32
96-09	11	6.21	95	53.67

ICP=International Collaborative, NCP=National Collaborative Papers

Table 4 depicts the type of collaboration in PEC research output during 1996-2009. Out of 11 international collaborative publications, only one involves multilateral and 10 involve bilateral collaborations.

Table 4. Type of collaborations of PEC Papers

Format	Number of papers
Bilateral international collaboration	10
Multilateral collaboration	1
National collaborations	95
Zero collaborations	73
Total	177

Among international collaborative publications of PEC, the maximum (8 publications) was with United States (10 publications), followed by Iraq (2 publications), and China and Greece (1 publication each) (Table 5). In contrast to low share of international collaborative publications, a much higher share of PEC publications 95, 53.67 per cent involved national collaborations during 1996-2009. Out of total publications output the share of national collaboration of PEC increased from 46.22 per cent during 1996-2002 to 55.32 per cent during 2003-2009.

The maximum number (19) of national collaborative linkages of PEC during 1996-2009 were with Panjab University, Chandigarh, followed by National Metallurgical Laboratory, Jamshedpur (7); Thapar University, Patiala (6); IIT, Roorkee (4); Maharishi Markandeshwar University, Mullana (4); Indo Global College of Engineering, Mohali (4); Guru Nanak Dev Engineering College, Amritsar (3); Motilal Nehru National Institute of Technology, Allahabad (3); Punjab State Electricity Board (2); Indo-Swiss Training Centre, Chandigarh (2); Panjab University

Table 5. Country-wise international collaborative papers

Collaborating Country	Number of papers
United States	8
Iraq	2
China	1
Greece	1
Total	11

Regional Centre (2); C-DAC (2), College of Engineering (2) University of Delhi; Guru Gobind Singh Indraprastha University (2); Defence Research and Development Organisation (2); Sant Longwal Institute of Engineering and Technology, Sangrur (2); C.R. State College of Engineering (1); Cement Research Inst of India, Faridabad (1); Grewal Eye Institute, Chandigarh (1); Moradabad Institute of Technology (1).

4.4 Research Output and Impact under Broad Subjects

Research output of PEC was studied under 11 subject fields as defined by *Scopus* classification during 1996-2009. Table 6 specifies that among the eleven broad subjects, the major research output (108, 61.02 per cent)

Table 6. Contributions and performances of various subject areas

Name	TP	TC	ACPP	H-Index
Engineering	108	55	0.51	6
Computer Science	43	20	0.47	3
Materials Science	23	38	1.65	5
Physics	10	8	0.80	2
Mathematics	9	2	0.22	1
Environment Science	8	6	0.75	2
Energy	6	6	1.00	2
Medicine	5	3	0.60	2
Earth and Planetary Science	5	1	0.20	1
Chemical Engineering	3	1	0.33	1
Chemistry	2	4	2.00	1

Table 7. Contribution and performance of various departments

Name	TP	TC	ACPP	H-Index
Mechanical Engineering	33	47	1.42	4
Electrical Engineering	27	11	0.41	2
Metallurgical Engineering	20	24	1.20	3
Electronics & Electrical Communication	17	7	0.41	2
Computer Science & Engineering	16	7	0.44	2
Production Engineering	13	20	1.54	3
Civil Engineering	10	9	0.90	3
Applied Science	9	8	0.89	2
Aeronautics	1	0	0.00	0

of PEC comes from engineering field during 1996-09, followed by computer science (43, 24.29 per cent), materials science (23, 12.99 per cent), physics (10, 5.86 per cent), mathematics (9, 5.08 per cent), environment science (8, 4.52 per cent), energy (6, 3.39 per cent), etc. In terms of impact as measured by average citations per paper during three-year citation window, the maximum impact (2) was achieved by chemistry, followed by materials science (1.65), energy (1), physics (0.8), environmental science (0.75), medicine (0.60), engineering (0.51), computer science (0.47), *et al*. In terms of h-index, the maximum value (6) was achieved by engineering, followed by materials science (5), computer science (3), physics, environmental science, energy and medicine (2 each) and other subjects (1 each).

4.5 Research Output and Impact under Various Subject Departments

The publication output and impact of PEC was studied under 9 subject departments. If a publication has two authors from two departments, its output was considered under both the departments. The distribution of papers from the different subject departments of PEC, along with the number of citations received and their impact has been listed in Table 7. Under the 9 departments, the maximum research output during 1996-2009 came from mechanical engineering (33 papers), followed by electrical engineering (23 papers), metallurgical engineering (20 papers), electronics and electrical communication (17 papers), computer science and engineering (16 papers), production engineering (13 papers), civil engineering (10 papers), applied science (9 papers), and aeronautics (1 paper). In terms of impact of PEC publications, as reflected in average citation per paper during 1996-09, the maximum impact (1.54) was registered by production engineering, followed by mechanical engineering (1.42), metallurgical engineering (1.20), civil engineering (0.90), applied science (0.89), computer science and engineering (0.44), electrical

engineering (0.41), electronics and electrical communication (0.41) and aeronautical engineering (0.0). In terms of h-index, the maximum (4) was achieved by mechanical engineering, followed by metallurgical engineering, production and civil engineering (3 each), electrical, electronics and electrical communication, computer science and engineering, applied science (2 each), and aeronautical engineering (0).

4.6 Contribution and Impact of Productive Authors

In terms of productivity of individual authors, it was found that only 9 authors of PEC have contributed at least 6 and above papers during 1996-2009 (Table 8). The cumulative research output of these 9 most prolific authors of PEC during 1996-2009 varied from 6 to 11 papers, with an average of 7.78 papers per author. Three authors have published more than the average productivity of all authors. These are N.B. Gupta with 12 papers, followed by P.B. Mahapatra (11 papers) and U. Batra (9 papers). Similarly, the impact in terms of the average citation per paper scored by these 9 authors was 0.8. Four authors have scored more than average impact of all the authors. These are P.B. Mahapatra, S.R. Prabhakar and D.R. Prajapati with citations per paper of 1.4 each, followed by S. Ray (1.3) and U. Batra (0.9). Similarly the average h-index achieved by these 11 authors was 1.55. Four authors have scored more than the average h-index of all authors. These are P.B. Mahapatra with h-index of 3, followed by U. Batra, S.R. Prabhakar and D.R. Prajapati, and S. John (2 each).

4.7 Media of Communication

The total research output (177 papers) of PEC during 1996-2009 was published in number of Indian and foreign journals. Table 9 gives a list of top 10 Indian and foreign journals, where PEC staff published their papers. The cumulative output of top these journals accounted for 27.12 per cent share (48 papers) in the total research output of PEC during 1996-2009.

Table 8. Contribution and performance of top nine authors of PEC

Name	Department	TP	TC	ACPP	H-Index
N. B. Gupta	Electronics & Electrical Communication	12	0	0.0	0
P.B. Mahapatra	Mechanical Engineering	11	15	1.4	3
U. Batra	Metallurgical Engineering	9	8	0.9	2
S. R. Prabhakar	Metallurgical Engineering	7	8	1.1	2
D.R. Prajpati	Mechanical Engineering	7	10	1.4	2
T.C. Aseri	Computer Science & Engineering	6	1	0.2	1
S. Ray	Metallurgical Engineering	6	8	1.3	2
T. Thakur	Electrical Engineering	6	0	0.0	0
S. John	Civil Engineering	6	3	0.5	2
Total		**70**	**53**	**0.8**	**1.55**

Table 9. Media of communications of PEC Authors during 1996-2009

Name	No. of Papers 1996-2009
Journal of the Institution of Engineers (India): Mechanical Engineering Division	9
Modelling, measurement and control. A, general physics, electronics, electrical engineering	8
Journal of Materials Engineering and Performance	6
Journal of Materials Processing Technology	5
Journal of the Institution of Engineers (India), Part CP: Computer Engineering Division	4
International Journal of Advanced Manufacturing Technology	4
Journal of the Institution of Engineers (India): Civil Engineering Division	3
Journal of the Institution of Engineers (India), Part PR: Production Engineering Division	3
International Journal of Productivity and Quality Management	3
IETE Technical Review (Institution of Electronics and Telecommunication Engineers, India)	3

4.8 Citation Profile and Highly Cited Papers

The impact of research was ascertained in terms of citations received by the papers published by PEC. Table 10 shows that only 53 papers of PEC out of 177 papers during 1996-2009 received one or more citations since their publications till July 2010. Of these 53 papers, one paper received citations between 21-30, one between 11-20p and the rest 50 papers between 1-10 citations.

Table 10. Citation profile of PEC papers during 1996-2009

No. of citations	No. of papers	No. of citations	No. of papers
29	1	5	1
17	1	4	2
10	2	3	10
8	2	2	11
7	2	1	17
6	4	**Total**	**53**

The list of 12 highly cited papers, receiving 6 and more citations is enclosed shown in Table 11. These 12 highly cited papers were published in 11 journals and one as conference papers. Out of these 12 highly cited papers, one involves international collaboration and 9 national collaborations. These highly cited papers involved contribution from mechanical engineering department (4 papers), metallurgical engineering department (3 papers), civil engineering department (2 papers), and computer science and engineering, electrical engineering and production engineering departments (1 paper each).

5. SUMMARY AND CONCLUSION

High quality academic research output in an institution craft a knowledge hub and motivates the faculty and students to cater a learning environment par excellence. In all 177 research papers were published during 14 years period, i.e., from 1996 to 2009, by the nine departments of the PEC showing an annual average

Table 11. List of highly cited papers of PEC during 1996-2009

Authors	Title	Source title	No. of citations
Rao, S.S., Gupta, R.S.	Finite element vibration analysis of rotating timoshenko beams (Article)	*Journal of Sound and Vibration,* 2001, **242**(1), 103-24.	29
Halder, S.; Victor P., Laha, A.; Bhattacharya, S.; Krupanidhi, S.B.; Agarwal, G.; Singh, A.K.	Pulsed excimer laser ablation growth and characterization of $Ba(Sn_{0.1}Ti_{0.9})O_3$ thin films	*Solid State Communications,* 2002, **121**, 329-32.	17
Rajinikanth, V.; Arora, G.; Narasaiah, N.; Venkateswarlu, K.	Effect of repetitive corrugation and straightening on Al and Al-0.25Sc alloy (Article)	*Materials Letters,* 2008, **62**(2), 3101-04.	10
Mehrotra, R.; Kapoor, B.S.; Narayan B.	Defluoridation of Drinking Water Using Low Cost Adsorbent (Article)	*Indian Journal of Environmental Health,*1999, **41**(1), 53-58.	10
Kapoor, R.; Bagai, D.; Kamal, T.S.	A new algorithm for skew detection and correction (Review)	*Pattern Recognition Letters*, 2004, **25**(11), 1215-29.	8
Sinha, S.; Bose, P.; Jawed, M.; John, S.; Tare, V.	Application of neural network for simulation of upflow anaerobic sludge blanket (UASB) reactor performance (Article)	*Biotechnology and Bioengineering*, 2002, **77**(7), 806-81.	8
Prajapati, D.R.; Mahapatra, P.B.	An effective joint X̄, and R chart to monitor the process mean and variance (Article)	*International Journal of Productivity and Quality Management*, 2007, **2**(4), 459-74.	7
Seedher, H.R.; Arora, J.K.; Soni, S.K.	A practical approach for computation of grid current (Article)	*IEEE Transactions on Power Delivery*, 1999, 14 (3), 897-902.	7
Manna, A.; Bhattacharyya, B.	Taguchi and Gauss elimination method: A dual response approach for parametric optimization of CNC wire cut EDM of PRAlSiCMMC(Article)	*International Journal of Advanced Manufacturing Technology*, 2006, **28**, 67-75.	6
Kalra, P.; Prakash, N.R.	A neuro-genetic algorithm approach for solving the inverse kinematics of robotic manipulators (Conference Paper)	*Proceedings of the IEEE International Conference on Systems, Man and Cybernetics,* 2003, **2**, 1979-84.	6
Batra, U.; Ray, S.; Prabhakar, S.R.	Austempering and austempered ductile iron microstructure in copper alloyed ductile iron (Article)	*Journal of Materials Engineering and Performance*, 2003, **12**(4), 426-29.	6
Satsangi, P.S.; Sharma, P.C.; Prakash, R.	An elastic-plastic finite element method for the analysis of powder metal forging (Article)	*Journal of Materials Processing Technology*, 2003, 136, 80-87.	6

growth rate of 131.85 per cent. Growth in the academic research output is seen after the PEC has acquired the deemed university status. Contribution to engineering and technology literature from this institute is steadily increasing since then. It was 3 articles in 1996 and 27 in 2009. But the international collaborative research activity in the university is still very small, accounting for just 6.21 per cent share. Also as compared to the neighboring NITs/engineering institutions, the research output of PEC needs to be substantially improved. There is intense requirement to develop suitable research environment and upgrading infrastructural facilities.

Some of the suggestions to develop appropriate management strategies to attain the objective of increasing the impact of PEC academic research output are:

◆ There is need to explore new opportunities for collaborative research with all the countries from the developed and developing world especially in the emerging areas of research in engineering and technology.

◆ Faculty should be encouraged to do research projects in collaboration of institutions of higher learning and industrial research laboratories in India, which will give them the vital exposure to the work-culture and state-of-the-art facilities available with such institutions.

◆ Channelising and attracting research support from external faculty and to develop multi-disciplinary research departments.

◆ Draw short term and long term plans for future research endeavours.

◆ Motivation and incentive for faculty for exceptional research capabilities and output activities.

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