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A study of research publications of top NIRF ranked engineering institutions in Karnataka

Shivaram BS[a], Uma M[b] and Satya Ranjan Sahu[c]

[a]Senior Technical Officer, CSIR-National Aerospace Laboratories (CSIR-NAL), Bangalore, Email: shivaram@nal.res.in

[b]Assistant Professor, Department of Mathematics, MS Ramaiah Institute of Technology, Bangalore, Email: uma.m@msrit.edu

[c]Satya Ranjan Sahu, Principal Scientist, CSIR-Institute of Minerals and Materials Technology (IMMT), Bhubaneswar, Email: srsahu@immt.res.in

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The study evaluates the research performance of top-six NIRF ranked engineering institutions in Karnataka. The study uses scientometrics indicators like publication and citation growth, AGR, RGR, DT, citation productivity of open access publications, and document types. The analysis revealed that publication productivity increased after the introduction of NIRF in 2016. The average citations of all the institutions increased, and MS Ramaiah Institute of Technology (MSRIT) recorded the highest 1.7 citations per paper, followed by Visvesvaraya Technological University (VTU) with 1.69 citations per paper. The decreasing trend of relative growth and increased doubling time reveal that the institutes are reaching their saturation point in their publication productivity. The open-access articles' average citations are higher than non-OA articles. The Rashtreeya Vidyalaya College of Engineering (RVCE) open access articles received the highest citations, 11.8 average citations—nearly four times higher than closed access articles, with 2.58 average citations.

Keywords: Institution ranking; Scientometrics indicators; NIRF; Publication productivity; Open access publishing

Introduction

Research publications indexed in Science Citation Index (SCI) are considered one of the primary performance indicators of research to assess organizations or individuals[1]. Publication metrics are used by accrediting, funding and institution ranking agencies to evaluate higher education institutions. Various scientometrics indicators are used to identify the research fronts[2]. The institutions ranking frameworks such as the 'Academic Ranking of World Universities (ARWU)' by Shanghai Jiao Tong University, Times Higher Education Supplement 'World University Rankings (THE Rankings), and Quacquarelli Symonds (QS) 'World University Rankings' are the well known instutional rankings[3].

In 2016,the Government of India introduced the National Institutional Ranking Framework (NIRF) to encourage a healthy competitive atmosphere among Indian higher education institutions. The ranking of institutions are made by drawing metrics from five different aspects, namely, Teaching, Learning & Resources (TLR), Research and Professional Practice (RP), Graduation Outcomes (GO), Outreach and Inclusivity (OI), and Peer Perception (PR)[4]. The scientometrics techniques are used to assess the research excellence of institutions in terms of research productivity[5].

Karnataka, a province in the Republic of India, is an education hub for technical education. More than 200 engineering institutions are affiliated with Visvesvaraya Technological University (VTU), more than 20 private and public universities offer engineering courses at both bachelors and masters. The degrees are awarded in a broad spectrum of contemporary engineering domains and sub-domains to meet the market demands. The institutions are giving importance to research along with their academic activities. The faculty and students are encouraged to take up research problems, solving which will benefit of society.

It is known that the methodologies of ranking agencies consider macro-level data points of SCI publications. A deeper understanding of publication and citation potentials will help institutions focus on policies and encourage their researchers. The present scientometrics study aims to assess the research publication productivity of six engineering institutions ranked in the National Institutional Ranking Framework (NIRF 2021), India 2021.

Review of literature

The ranking of research and higher education institutes has become a global phenomenon[6]. According to Hazelkorn[7], the ARWU, THE, and QS ranking frameworks are most frequently used by administrators, funding agencies, policymakers, peers in the domain, and students. The methodologies adopted by ranking frameworks areanalyzed in detail in the study and have research productivity as an essentialcriterionin all three.

Institutions, especially from developing countries, often fail to make it into global ranking systems. It necessitated several countries to initiate country-specific ranking frameworks to encourage HEIs towards imparting quality education. NIRF is one such initiative by the Government of India to rank Indian HEIs and prepare them for global competitiveness. Sheeja et al. analyzed 2017 NIRF ranked institutions from all domains, including 232 universities, 1,024 engineering institutions, 546 management institutions, 318 pharmacy institutions, and 637 general degree colleges and others. The study highlighted the parameters adopted by NIRF on par with global ranking frameworks and identified the Indian institutions listed in global ranking[8].

Research productivity and webometric study of fifteen NIRF ranked universities revealed no correlation between research productivity and simple web impact factor (SWIF)[9]. Scientometrics data points can assess the performance of HEIs and assist ranking agencies in computing research productivity scores. Periodic scientometrics studies identify the weakness of an institution and give directions to formulate policies to improve research indicators[10].

The scientometrics indicators such as citations, Impact Factors (IF), Cite Score, Hirsch index, SJR Score and so on are important in research evaluation[11]. Numerous scientometrics studies are reported every year focusing on literature growth in particular subject areas, measuring the productivity of institutions, authors, collaborative works, etc.

Mahala et al. assessed the research productivity of Indian institutes during the period 2015-2019. Thy revealed that Indian universities published 26173 articles in science disciplines, out of which 92.7% were journal articles, followed by 5% review papers. The study also noted that 13.6% of articles did not receive any citations, 42.2% of research publications received 1-5 citations, 34.2% were cited between 6-20 times, and highly productive papers were 1.9%[12].

A scientometrics study carried out by Pradhan et al. to assess six Indian Institutes of Technology (IITs) from 2006 to 2015 calculated the compound average growth rate (CAGR) for all six IITs, the lowest being IIT Delhi with 2.77% and highest IIT Roorkee with 7.24%. The authors also attempted to measure citation productivity and noted papers published by IIT Bombay received the highest citation average of 10.04[13]. Ray et al. studied the publication productivity of 316 Indian medical institutes from 2005 to 2014. The study notes that only 4.3% of institutes contributed 40.3% of total output by contributing more than 100 papers each.Region-wise assessment based on publication productivity per institute revealed the highest contribution with 108.75 came from the New Delhi region, followed by Maharashtra with 54.23[14].

Pradhan et al. also carried out a quantitative assessment of Sambalpur University research output for the period 1990-2019. The University published 1527 SCI publications with a maximum AGR of 140 in 1996 and a doubling time of 10.13 in 2004. The authors noted that AGR, RGR and DT are inversely proportional. A more significantcollaborative coefficient was noted during 2013 and 2019. Authors opined the research productivity of Sambalpur University showed gradual improvement and successfully added quality publication to the domain of knowledge[15].

The literature review shows that quantitative analysis of publications helps in understanding the features and characteristics of science and scientific research. Our attempt is to interpret the publication growth pattern five years before and after the introduction of NIRF in 2016. The study also focuses on analyzing citation potential on two important parameters, i.e. journal vs conference papers and closed vs open access papers.

Objective of the study

- To analyze the NIRF rank position with RP scores, the year-wise growth rate of publications and citations, AGR, RGR, DT, citation potential of Open Access (OA) publications, and journal articles against conference papers.

Methodology

The top six engineering institutions from Karnataka state were selected based on the NIRF-2021 ranking. The institutions are: Manipal Institute of Technology

(MIT); Visvesvaraya Technological University (VTU); Public Education Society University (PES); MS Ramaiah Institute of Technology (MSRIT); RashtreeyaVidyalaya College of Engineering (RVCE); and BMS College of Engineering (BMSCE).The ranking positions with RP scores for the previous five years are retrieved from the NIRF ranking web portal and tabulated using MS Excel. SCOPUS was accessed from 25th to 30th September 2021 to retrieve publications and citations for ten years (2011 to 2020). An affiliation search feature with ID was used, for example (AF-ID ("Ramaiah Institute of Technology" 6007872)), to retrieve publication data for each institution. The data was tabulated using MS Excel for further analysis as per the objective of the study.

Analysis

NIRF rank and RP Score distribution for the period 2017-2021

The Research and Professional Practice (RP) of NIRF focus on research productivity in SCI research publication, citations, patents, and projects executed with a weightage of 100 marks. Table 1 gives the rank and RP score of the engineering institutes over five years. VTU with 31.03 recorded the highest RP score in 2021 and BMSCE with 5.48 lowest in 2017. All institutions' RP scores gradually increased year after year except in the year 2019, when MSRIT, PES, and RVCE recorded a marginal decline in the score with 11.85, 8.61, and 10.81, respectively. The RP score significantly contributes to the higher ranking of the institutions (Fig. 1) .

Year-wise growth of publications and citationswith average citations per paper

The research performance of higher education and research institutes is often measured based on the growth in the volume of publications and citations. These quantitative and qualitative measures help get better ranks, accreditations, and research funding from the agencies[16]. The publications trend shows that the pattern is similar in the 1st half of the study period. But the growth pattern changed in the 2nd half (Fig. 2a). The cumulative publications (CP) and the total number of citations (TNC)gives (Table 2) the average citation trend (Fig. 2b).

MIT, with 3970, published the highest number of papers and received 17769 citations. The lowest publication productivity is observed with BMSCE, where it published 1420 publications and received 5268 citations. MSRIT recorded the highest citations per paper (1.7), followed by VTU with 1.69 and lowest by PES with 0.94.

Table 1 — NIRF rank and RP score of engineering institutions

Institution Name	RP Score					NIRF Rank				
	2017	2018	2019	2020	2021	2017	2018	2019	2020	2021
MIT	11.94	18.47	20.68	24.86	29	43	39	43	45	51
VTU	NA	NA	NA	30.98	31.03	NA	NA	NA	55	57
PES	8.51	12.16	11.85	12	13.35	86	87	149	93	83
MSRIT	13.09	13.01	8.61	13.98	16.84	45	60	64	59	65
RVCE	12.13	13.67	10.81	13.29	14.45	49	58	63	70	77
BMSCE	5.48	7.95	8.01	11.92	12.33	52	67	69	73	98

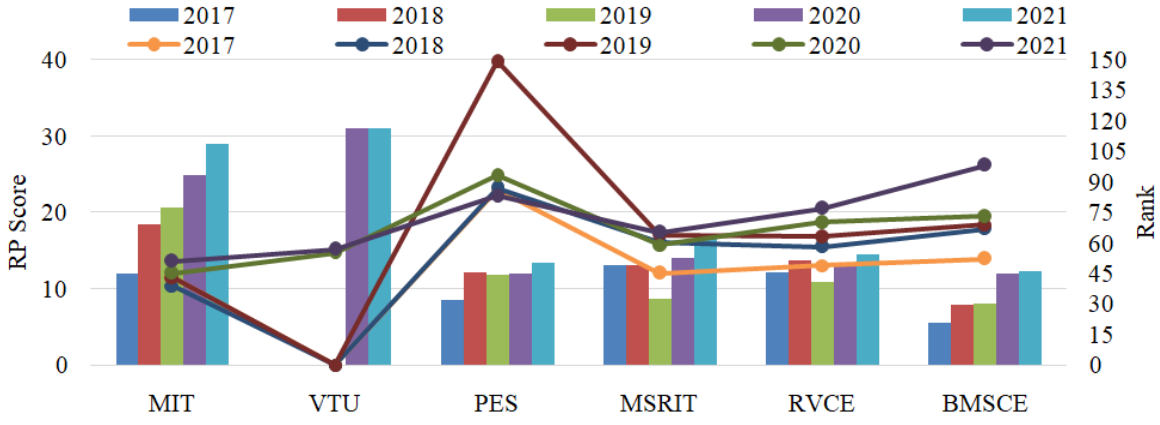

Fig. 1 — NIRF rank and RP score of engineering institutions

Table 2 — Year-wise growth of publications, citations and average citations

Year	MIT		VTU		PES		MSRIT		RVCE		BMSCE	
	CP	TNC	CP	TNC	CP	TNC	CP	TNC	CP	TNC	CP	TNC
2011	151	20	30	2	71	6	96	22	69	2	63	12
2012	307	102	70	17	150	38	222	141	146	25	113	27
2013	474	272	133	63	255	105	368	318	265	90	173	94
2014	645	470	203	201	376	202	551	666	396	228	268	109
2015	849	688	335	178	514	255	702	995	537	378	365	213
2016	1196	975	568	316	711	452	846	1033	735	555	482	366
2017	1703	1592	864	716	956	688	1076	1403	952	799	627	559
2018	2405	2693	1316	1391	1277	1008	1388	1769	1364	1323	926	844
2019	3174	4293	1909	2649	1606	1351	1711	2573	1711	1845	1141	1256
2020	3970	6664	2663	4523	1990	1889	2049	3498	2008	2267	1420	1788

CP: cumulative publication TNC: Total number of citations ACPP: Average citations per paper

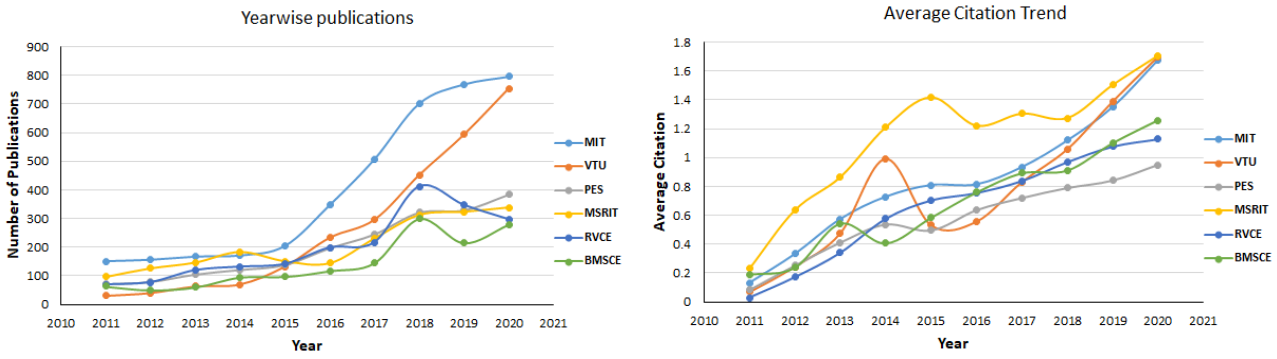

Fig. 2 — (a)The publication trend over the decade (b)Average citation trend over the decade

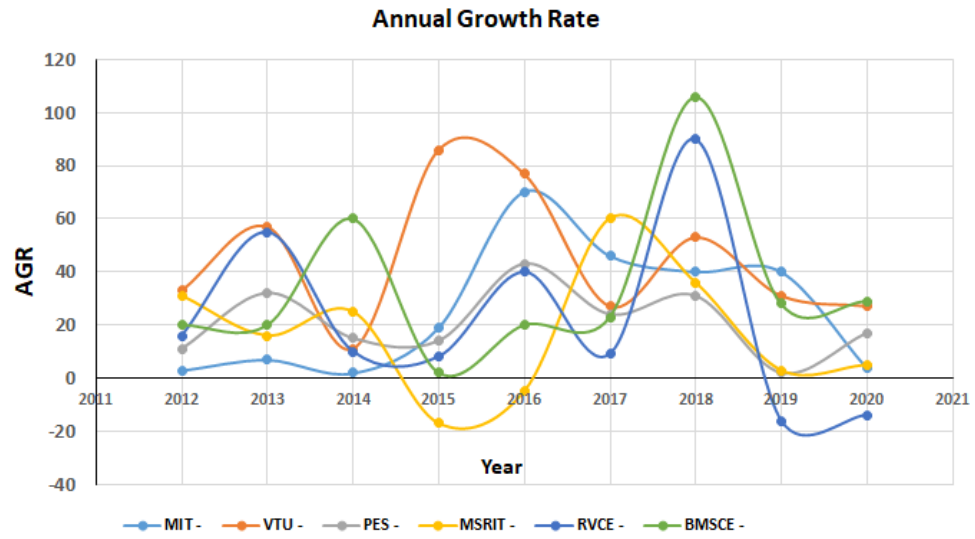

Fig. 3 — Annual growth rate of publication productivity

The overall constant increase of citation per paper is observed from all six institutions during the period.But the comparison of publications trend and average citations trend shows that increase in publications doesnot have reflected in citation.

Annual Growth Rate (AGR)

The annual growth rate is widely used in scientometric studies to determine the change in the volume of value in a year. The annual growth rate of total publications shows fluctuationsamong all institutes' throughout the study period (Fig. 3).

Table 3 — Relative growth rate and doubling time

Year	MIT		VTU		PES		MSRIT		RVCE		BMSCE	
	RGR	DT	RGR	DT	RGR	DT	RGR	DT	RGR	DT	RGR	DT
2011	-	-	-	-	-	-	-	-	-	-	-	-
2012	0.71	0.97	0.85	0.81	0.71	0.98	0.8	0.87	0.76	0.91	0.59	1.17
2013	0.43	1.6	0.65	1.06	0.53	1.3	0.51	1.36	0.59	1.17	0.42	1.65
2014	0.3	2.24	0.41	1.69	0.38	1.82	0.4	1.73	0.4	1.73	0.45	1.54
2015	0.27	2.56	0.5	1.38	0.32	2.16	0.25	2.8	0.32	2.17	0.3	2.31
2016	0.35	1.98	0.53	1.3	0.32	2.16	0.18	3.85	0.3	2.31	0.3	2.31
2017	0.35	1.98	0.42	1.65	0.3	2.31	0.24	2.89	0.3	2.31	0.24	2.88
2018	0.34	2.03	0.42	1.65	0.29	2.39	0.26	2.67	0.32	2.17	0.39	1.78
2019	0.28	2.47	0.37	1.87	0.23	3.01	0.2	3.47	0.22	3.15	0.21	3.3
2020	0.23	3.01	0.33	2.1	0.21	3.3	0.19	3.65	016	4.33	0.22	3.15

RGR: Relative growth rate, DT: Doubling time

Institutes have reached the peak AGR between the period of 2015-18. BMSCE recorded highest with 106, and PES recorded lowest with 43. However, MSRIT and RVCE recorded negative AGR during 2015-2016 and 2019-2020, respectively.

Relative Growth Rate (RGR) and Doubling Time (DT) of publications

The relative growth rate indicates increased publications per unit time[17]. Table 3 shows the relative growth rate gradually decreased. The highest RGR was recorded by VTU (0.85), followed by MSRIT (0.8). The lowest RGR is observed for MSRIT(0.19) in the year 2020. The doubling time indicates the time taken to double the publications, and the result shows doubling time is increasing. Theprolonged doubling period is for RVCE(4.33), followed by MSRIT (3.65). The VTU recorded the shortest period of doubling time (2.1), followed by MIT (3.01).

Citation potential of open access articles

Open access journals and repositoriesplay a vital role in enhancing the access and visibility of research publications. It is challenging for researchers to select quality sources to showcase research work. OA journals and platforms serve as incentives without compromising the quality[18].

It is evident from Table 4 that all institutions have published a significant amount of their papers on OA platforms. MIT hasthe highest OA papers (760), followed by VTU (545). Several studies have shown that OA papers may receive more citations than papers published in conventional channels[18,19,20]. A comparison of average citations received by both OA and closed access articles (Fig. 4) shows that the OA articles' average citations are significantly higher than non-OA articles. The RVCE OA articles received the

Table 4 — Number of publications to open access publication and their respective citations

	MIT	VTU	PES	MSRIT	RVCE	BMSCE
TNP	3970	2663	1990	2049	2008	1420
TOAP	760	545	290	357	251	290
TNC	17769	10056	5994	12418	7512	5268
TOAC	5127	2733	2090	3905	2967	1414

TNP: Total number of publications, TOAP: Total open access publications, TNC: Total number of citations TOAC: Total open access citations

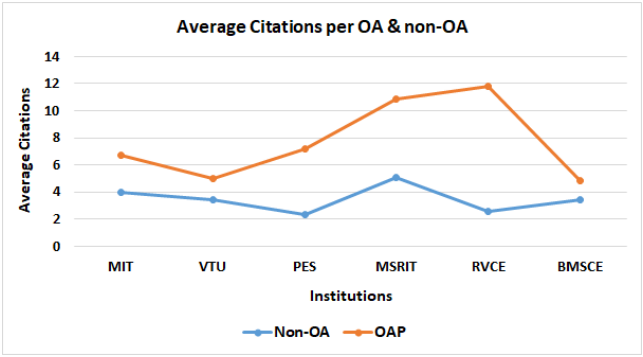

Fig. 4 — Open access publications and average citations per OA papers

OA average citations (11.8), nearly four times higher than closed access papers, with 2.58 average citations.

Document type share and citations potential for the period 2011-2020

Researchers publish their shorter or part of their research findings as conference papers and eventually develop these into complete journal papers. A large body of scientometric studies has shown that journal papers receive more citations than conference papers. Table 5 shows that citations trend of journal and conference papers.

Table 5 — Citationstrend of journal and conference papers

	MIT	VTU	PES	MSRIT	RVCE	BMSCE
TJP	2513	1427	580	1025	637	559
TCP	1346	1121	1338	928	1288	802
TCJP	13889	12391	5085	12649	6187	5045
TCCP	3880	2822	2610	2924	3309	1960

TJP: Total journal publications, TCP: Total conference publications, TCJP: Total citations for journal publicationsTCCP: Total citations for conference publications

Discussion

The analysis and interpretation of data obtained from the NIRF web portal and SCOPUS database give some insightsinto the publication productivity of top engineering institutions of Karnataka.All six institutions continuously increased RP scores. The study period showed gradual growth in publication productivity with a sharp spike from 2016 onwards.MIT & VTU registered higher growth but the a slower growth of average citations. MSRIT publications trend is slow and steady, but the average citations values over the years are comparatively high.

The delining trends of relative growth rate (RGR) for all the institutions indicate that their publications growth is progressing towards saturation. The decreasing trend of RGR has been reflected in the doubling time increase. One of the criteria of NIRF ranking is the student and faculty ratio. Researchers age and experience is a critical factor for research productivity and young researchers' need to be groomed by seniors[21]. Regular recruitment of young faculties would positively raise NIRF ranking as young and more faculties enhance values of two criteria[22].

The results indicate that the researchers or faculties of these institutions publish in open access modes. Some of the institutions seem to prefer to publish conference papers over journal articles.

Conclusion

It is evident from the study that the six institutions gradually increased in their publication productivity over time. Except for MIT and VTU, the others unable to reach one-quarter of the total RP score of NIRF ranking except. The institutions should give importance to both the quantity and quality of publications. OA publications of all the institutions have received better citations. While it cannot be generalized that OA publications will always received higher citations, researchers should be encouragedto practice green open access.

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