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Five Years of India Rankings (NIRF) and its Impact on Performance Parameters of Engineering Institutions in India. Pt. 2. Research and Professional Practices

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ABSTRACT

This article analyses data on five years of India Rankings to assess its impact on performance parameters of institutions of higher education in terms of publications, citations, patents, highly-cited publications and research funding under broad category of parameter named "Research and Professional Practices". The analysis of data on five years of India Rankings, i.e. 2016 to 2020 on various performance parameters of HEIs provides an interesting insight and reveals that participating institutions are making strenuous effort to improve their performance on various parameters or sub-parameters identified by the NIRF for ranking of HEIs. It is note that the number of publications, citations, and highly-cited publications (HCP) by eligible applicant institutions have increased exponentially over a period of five years from 2016 to 2020. It is interesting to note that per cent of publications, citations, and HCP by the 100 top-ranked institutions has decreased with corresponding increase of publications, citations, and HCP of the remaining institutions. This trend indicates that a good number of remaining institutions have not only intensified their research and publications activities but are also attracting their share of citations. It is also observed that a significant number of NIRF eligible applicants did not have any publication, however, per cent of institutions having "0" publications have decreasing gradually every year from 2017 to 2020. Noticeable and consistent increase in total publications of India, NIRF Eligible Applicants, 100 top-ranked institutions and remaining institutions in Overall category was noticed during past four years, i.e. 2017 to 2020. However, per cent increase in publications of the 100 top-ranked institutions was the highest in overall category.

Keywords: Ranking parameters; Ranking indicators; India rankings; National institutional ranking framework; Higher education institutions – ranking; Research-based ranking parameters

1. INTRODUCTION

The academic world is accustomed to ranking of different types, forms and orders. Students are assigned ranks based on their performance in examination, teaching faculty are selected based on their performance in academics. Promotions are awarded to faculty based on their research and teaching performance. Moreover, journals are ranked according to their impact factors and even publishers are ranked based on their impressions by the scholarly community, on analyses of prize winners of scientific associations, discipline, a publisher's reputation, and its impact factor[(1)]. Using the same analogy, media houses and a few non-commercial organisations started publishing ranking tables based on indicators that are believed to represent quality of HEIs. These indicators are allocated different, predetermined weightage, that are added-up to give a total score, which, in turn, determines rank of an HEI. Primary aim of ranking it to facilitate stakeholders including students & their parents, policy makers, funding agencies and universities to take informed decision about qualities of HEIs and their performance on various indicators. The HEIs themselves can use these indicators to improve their own standing on various indicators.

With introduction of Academic Ranking of World University by Shanghai Jiao Tong Institute in 2003 and QS-Times Higher Education (THE) Rankings in 2004, the phrase "world-class university" caught attention of academicians, policy makers and political leaders around the world, which does not only represent excellence in teaching and research, but also signifies capacity of a university to compete in the global higher education marketplace. As a consequence, Governments of several countries have developed policies, regulations and framework, and have taken special initiatives to promote and support creation of world-class university and upgradation of the existing universities to the world class. An increasingly larger number of universities have included "world-class" as a target to achieve in their mission statements and have begun implementing various measures. The Indian higher education system needs a complete overhauling in terms of quality and clarity so as to prepare HEIs in India

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to compete with the best in the world in terms of quality of education. New parameters of quality have to be defined and implemented to upgrade the existing HEIs in India into world class institutions. These steps may require policy-level interventions in terms of provisioning for international faculty recruitment, liberal research grants, well-equipped laboratories, international students, multinational projects, provisioning of faculty exchange, etc. The new education policy released in 2020 (NEP 2020), setting up of National Research Funds (NRF) and National Institutional Ranking Framework (NIRF) can be considered as a step in this direction. Realizing the fact that a ranking of Indian HEIs at national level can play an important role in setting-up a culture of competition that would lead to improvement in performance and quality of academic institutions, National Institutional Ranking Framework[2] was released by the Ministry of Education (Formerly MHRD), Government of India in September 2015, which is being used for rankings HEIs in India from 2016 onwards.

The India Rankings source its data from participating institutions as well as from third party sources. The unitary data collected from participating institutions as well as from third-party sources is made available mostly in public domain, either through the NIRF web site or through web sites of participating institutions that are mandatorily required to host the data provided by them to NIRF for public scrutiny. While part I of the article analyses data on five years of India Rankings to assess its impact of performance on HEIs on broad categories of parameters, namely

- Teaching, Learning and Resources;
- Graduation Outcome;
- Outreach and Inclusivity; and
- Perception.

Part II of the article analyses impact of five years of India Rankings on performance of HEIs in terms of publications, citations, patents, highly-cited publications and research funding under broad category of parameter named "Research and Professional Practices". The analysis on data on various performance parameters of HEIs provides an interesting insight and reveals that participating institutions are making strenuous effort to improve their performance on various parameters or sub-parameters identified under NIRF with an aim to improve their ranking as well as for claiming their eligibility for research funds, scholarships and other amenities that can be availed only by students and faculty of ranked institutions as well as by ranked institutions themselves, as elaborated in this article. While there are a number of articles that describe impact of ranking on various aspects of university performance and functioning as reported in literature review, however, none of the studies deal with progressive impact of ranking on different performance parameters of HEIs over a period of time.

2. IMPACT OF RANKING ON INSTITUTIONS OF HIGHER EDUCATION: LITERATURE REVIEW

Literature review pertaining to influence of national and international ranking on performance and quality of academic institutions, their behaviour, as well as on their competitive spirit to achieve higher rank in given in the part I of this article. Literature review that specifically pertain to publications, citations, highly-cited publications, research funding, etc. are covered in this part of the article.

2.1 Highly-Cited Publications

Luckman et al classified performance indicators used for ranking of universities according to their positive or negative influence on ranking in THE and AWRU and concluded that increase in number of highly cited researchers has a positive impact on the research performance of a university, whereas increase in student to staff ratio has a negative influence on the educational process[3]. A comparison of intra-correlation of ranking systems in different rankings systems, it is found that strong correlation of their rankings exists between highly cited researchers in 21 broad subject categories of Web of Science and ''Articles published in Nature and Science'' in ARWU, and ''Research Excellence'' in THE-QS World University Ranking[4].

2.2 Patents

Bloom observed that potential for productive synergies between university research and industry is unequally distributed. "Rich countries, home to 15 per cent of the world's population, are responsible for over 90 per cent of the patents granted"[5]. However, scenario has changed considerably in past two decades as indicated in the Science and Engineering Indicators Report 2018 of the National Science Foundation[6]. The report quoting data from PATSTAT states that "inventors in China accounted for about half (49 %) of patent families in 2018. In contrast, U.S. Patent and Trademark Office (USPTO) patents show that geographic distribution of inventions protected in the U.S. market, continue to dominate by high-income countries and regions with U.S. inventors receiving nearly half of USPTO patents (47 %) followed by Japan (16 %), South Korea (6 %), and the EU (15 %), while China received only 5 per cent of US patents. However, Lukman et al (Ref. 3, p. 626) observed that there is a low correlation between patents and highly cited researchers, indicating a difference between knowledge creation mechanism and knowledge transfer to the industrial environment.

2.3 Research

Research performance is considered as highway to achieve better global rankings[7]. Studies at the academic unit level suggest that increased incentives for research have altered the traditional roles of academic staff, affected the balance between teaching and research, encouraged more individualistic behaviour on the part of academic staff, and contributed to a more fragmented educational experience for students[8-11].

Lukman, *et al.*[3] classified performance indicators used for ranking of universities according to their positive or negative influence on ranking in THE and AWRU and concluded that research oriented indicators are the most important, followed by social and environmental ones.

Rolfe[12] reported that all universities that were surveyed in the sample, including newer universities with a regional focus, had intend to improve its research position, which, in turn,

lead to greater emphasis on recruitment of "research stars" or "research-only contracts" in order to enhance research ratings and increase research income. Focus on research became a motivation factor for experienced and well-qualified faculty members to seek positions at universities with high rankings. Marginson and van der Wende[7] observed that intensified competition amongst universities on the basis of research performance has increase demand for high-quality scientists, which, in turn, is effecting their mobility at increased hiring cost although its intensity and spread is a subject of detailed empirical investigation. Marginson and van der Wende (Ref. 7, p. 324) stated that one of the likely outcomes of the intensified global competition because of rankings is to increase the stratification of research labour and the academic professions both within national labour markets and between global and national labour markets.

Consistent with analysis put forth by Rolfe[12], Dolton *et al.*[13], Hare[14] and McNay[11] reported that the new competitive market for research funds has created stronger incentives for all faculty members to be more research active, particularly in the newer universities.

Based on empirical studies, several researchers have reported lack of correlation between research productivity and teaching. Both these activities are more or less independent (Coate *et al.*[15]; Fox[16]; Terenzini and Pascarella[17]; Marsh and Hattie[18]; Dill and Soo[19], Marginson and van der Wende[7] concluded that there is no necessary connection whatsoever between the quality of teaching and learning and the quantity and quality of research.

2.4 Research Funding

It has been observed that allocation of funds to universities is greatly influenced by their public perception, reputation and national & international rankings. Higher ranked universities are like institutional sponges that generally have greater opportunities to gain sustained public funding and private investments[20.] There are evidences to suggest that national ranking exercises were either initiated or were adopted later by government for disbursement of funds based on performance or output of universities on various ranking parameters[21]; Ref, 7, p. 319). Research Assessment Exercise in the UK[22,] Quantum Research Fund in Australia[23], and Performance-based Research Fund (PBRF) in New Zealand[24] are examples of such exercises that were introduced in a bid to ensure that excellence in research is encouraged and rewarded. An empirical study conducted by Bastedo and Bowman[25] links college rankings with an institutional ability to gain greater financial resources.

Income through research funding and research output, in terms of publications, citations and other bibliometric parameters are important parameters in most of the ranking systems. Feller[26] found evidences that universities in USA are increasingly utilizing funds towards providing conditional matching grants for getting federal research support by lowering their costs of other educational expenses. In other words, universities use funds meant for teaching to promote research in their pursuit of higher rankings in various ranking systems. However, the extent to which funds intended for teaching and instruction that are reallocated for research and for prestige cannot be ascertained.[23]

2.5 Policies

Marginson and van der Wende[7] observed that global rankings secured great prominence in higher education, policy, and public arenas and have already had discernible effects in institutional and policy behaviours. Rankings are influencing the decision-making and planning processes within higher education institutions. Marginson[27] emphasised that universities will adopt institutional policies and strategies in order to optimise their position in ranking systems.

The report entitled "The Future of European Universities: Renaissance or Decay"[28] by the Centre for European Reform emphasise on the need for policy reform in European universities considering their modest performance in the world rankings. The report recommends major changes in the governance, financing, research allocations and admissions policies of European universities. Lambert[29] in his article published in Financial Times states that "Europe's universities, taken as a group, are failing to provide the intellectual and creative energy that is required to improve the Continent's poor economic performance. Too few of them are world-class centres of research and teaching excellence".

Taking a cue from the report by the Centre for European Reform, several countries in Europe are focusing on building world-class research universities[7]. Moreover, European Institute of Innovation and Technology was set-up on the recommendation of European Union to empower innovators and entrepreneurs to develop world-class solutions to societal challenges and to create growth and skilled jobs[30].

2.6 Widening Gaps between Research-intensive HEIs and Others HEIs

Evidence indicate that rankings and competition are widening and enhancing gap between research-intensive HEIs and others universities imparting higher education to masses. Ranking systems are increasing greater institutional stratification and research concentration. HEIs that are unable to meet the criteria or have low "brand recognition" will be further de-valued and receive less importance.[31] Further, Clarke[32] opined that intensified global competition promotes comprehensive research-intensive university model of education which, in turn, might lead to flattening of national system typologies.

3. ABOUT NATIONAL INSTITUTIONAL RANKING FRAMEWORK (NIRF) AND INDIA RANKINGS

India Rankings is an annual exercise that ranks institutions of higher education in India in various categories and subject domains using National Institutional Ranking Framework (NIRF), released by the Ministry of Education, Government of India in September 2015. A detailed account of NIRF and India Rankings is given in Part I of this article.

4. SOURCE OF DATA

The data on research funding was obtained from the

Table 1. India rankings years: Publications, citations and academic activities data

India Rankings Year	Publications / Citations Considered for Calendar Years*
India Rankings 2016	2012, 2013 and 2014
India Rankings 2017	2013, 2014 and 2015
India Rankings 2018	2014, 2015 and 2016
India Rankings 2019	2015, 2016 and 2017
India Rankings 2020	2016, 2017 and 2018

*Data for publications, citations, highly cited articles and patents were rieved in month of February for each respective ranking year.

applicant institutions themselves through data capturing system accessible to registered HEIs through India Rankings (NIRF) website. Data on publications, citations, HCP and patents was taken from Scopus (Elsevier Science), Web of Science (Clarivate Analytics) and Derwent Innovation respectively. However, in the interest of simplicity, data on publications and citations for this article is taken only from citation databases hosted on Web of Science which comprise of: i) Science Citation Index Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index - Science (CPCI-S), Conference Proceedings Citation Index - Social Sciences & Humanities (CPCI-SSH), Book Citation Index–Science (BKCI-S), Book Citation Index– Social Sciences & Humanities (BKCI-SSH), Emerging Sources Citation Index

Table 2. Number of publications by 100 top-ranked and remaining institutions in India Rankings 2017-2020

Category / Subject Domains	Number of publications in Top 100 and remaining institutions								% Increase 2017 to 2020 (Top 100)	% Increase 2017 to 2020 (Remaining)
	IR-2017 (2013 to 2015)		IR-2018 (2014 to 2016)		IR-2019 (2015 to 2017)		IR-2020 (2016 to 2018)			
	Top 100	Remaining	Top 100	Remaining	Top 100	Remaining	Top 100	Remaining		
Overall	119360	59333	154757	91020	179727	85203	200756	85161	68.19	43.53
Universities	94182	15132	117373	36342	126188	55041	139041	39481	47.63	-62.58
Engineering	65027	17480	79729	33119	91280	42705	105704	46339	62.55	165.10
Management	701	0	1339	111	1998	187	2358	287	236.38	-
Pharmacy	2795	251	3261	686	3888	885	4113	1070	47.16	326.29
Colleges	2395	181	4428	3559	5451	6513	5852	7712	144.34	4160.77

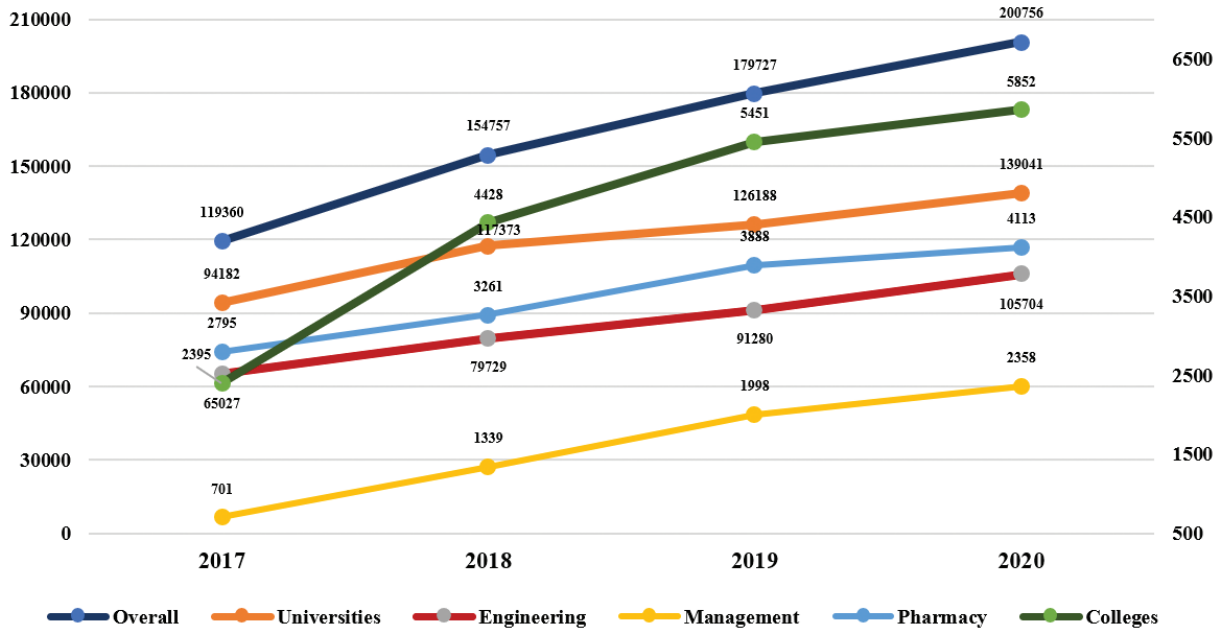

Figure 1. Increase in number of publications of the 100 top-ranked institutions by India rankings years 2017-2020 in different categories / subject domains.

Table 3. Research publications of the 100 top-ranked institutions in comparison to the rest of the eligible institutions in various categories and subject domains for India rankings 2017-2020

Discipline / Category	IR-2016 (2012-2014)		IR-2017 (2013-2015)		IR-2018 (2014-016)		2019 (2015-2017)		2020 (2016-2018)	
	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.
Overall	-	-	66.80	33.20	68.91	31.09	67.84	32.16	70.21	29.79
Universities	91.56	8.44	89.96	10.04	76.36	23.64	69.63	30.37	77.88	22.12
Engineering	94.50	5.50	78.81	21.19	70.65	29.35	68.13	31.87	69.52	30.48
Management	-	-	100	0	92.34	7.66	91.44	8.56	89.15	10.85
Pharmacy	-	-	91.76	8.24	82.62	17.38	81.46	18.54	79.36	20.64
Colleges	-	-	92.97	7.03	55.44	44.56	45.56	54.44	43.14	56.86

Table 4. Research publications of eligible institutions in comparison to total research publications of India for India rankings 2016-2020

Categories / Subject Domains	IR-2016 (2012-2014)		IR-2017 (2013-2015)		IR-2018 (2014-016)		IR-2019 (2015-2017)		IR-2020 (2016-2018)	
	India	% of Pubs. by NIRF Eligible Insts.	India	% of Pubs. by NIRF Eligible Insts.	India	% of Pubs. by NIRF Eligible Insts.	India	% of Pubs. by NIRF Eligible Insts.	India	% of Pubs. by NIRF Eligible Insts.
Overall	*	*	263125	67.91	336978	66.64	383803	69.03	404953	70.60
Engineering	106658	36.11	121615	67.84	151884	74.30	171074	78.32	182221	83.44
Management	**	**	1704	41.14	2701	53.68	3681	59.36	4042	65.44
Pharmacy	**	**	8593	35.45	10766	36.66	11991	39.80	12379	41.87

*Data not available since Overall category was introduced in 2017; ** Data not available

(ESCI) and Current Chemical Reactions (CCR-EXPANDED). These databases were searched to determine the quantitative productivity of all eligible applicant institutions in terms of number of publications, citations and highly cited publications for a span of three calendar years for each ranking exercise. A common time window was used to obtain this data covering a short span of two weeks in the month of February every year to ensure fairness.(Ref.35, P.6 and 7)

Publications and citations data were retrieved from citation databases hosted on Web of Science (Clarivate Analytics) for applicant institutions without any subject-wise and discipline-wise restrictions for the Overall ranking of institutions. However, subject/discipline-specific searches were made for all other discipline-wise rankings in the interest of uniformity and fairness. Care was taken to design the restriction so as to get the widest possible coverage of sub-disciplines within each broad discipline. (Ref. 35, P.7).

5. IMPACT ON INDIA RANKINGS ON PERFORMANCE PARAMETERS OF HEI FROM 2017 TO 2020

This part of the article presents an analyses of data retrieved on five years of India Rankings to assess impact of ranking on collective performance of HEIs on broad generic groups of parameters named "Research and Professional Practice (RP)" over a period of five years, i.e. 2016 to 2020. Since India Rankings considers three years of data for every sub-parameters, likewise three years of data was considered for publications, citations, highly cited articles, patents, research funding and other academic parameters as mentioned in Table 1.

Research performance in terms of number of publications, citations, h-index, highly-cited papers, etc. have always been important factors for appointments and promotion of faculty in all universities. Likewise, publications counts are used for measuring the research output of a university published in a given list of academic journals or indexed in a given citation database. Taylor and Braddock[33] argued that publications are indeed an objective criteria since i) it is focused on research performance of a university, which, in turn, can be rationally justified as an indication of university excellence; ii) 'score' of a given university can be automatically calculated by simply counting number of publications that minimises human error by avoiding any reliance on inference or judgement; and iii) it

Table 5. Number and % of NIRF eligible institutions having "0" Publications for India rankings 2017-2020

Year (No. of Inst. in 2020)	IR-2016 (2012-2014)	IR-2017 (2013-2015)	IR-2018 (2014-2016)	IR-2019 (2015-2017)	IR-2020 (2016-2018)
	Per cent of Institutions having "0" Publications				
Overall (955)	*	15.23	13.59	7.53	7.54
Universities (273)	13.08	0.013	2.03	7.64	0.37
Engineering (1007)	20.00	23.18	9.76	6.31	6.65
Management (579)	65.33	84.04	69.78	66.27	63.56
Pharmacy (319)	23.33	34.43	20.73	14.88	15.36
College (1036)	*	60.31	39.79	31.47	31.76

*Categories Introduced in India Rankings 2017.

Table 6. Share of publications of the 100 Top-ranked engineering institutions for India Rankings 2017-2020

Categories of Institutions	IR-2017 (2013-2015)	IR-2018 (2014-2016)	IR-2019 (2015-2017)	IR-2020 (2016-2018)
	Per cent of Publications			
IITs	35	38	35	37
State Universities	15	13	12	10
NITs	15	17	17	18
Deemed Universities	12	16	20	21
Colleges	7	7	8	7
Private Universities	3	3	3	3
Other CFTIs	3	2	3	2

allows for a comprehensive survey of all universities, resulting in an exact performance ranking for each university using the identical data source in each case.

Four sub-parameters under the "Research and Professional Practice", the second broad categories of parameters, used for India Rankings are given weightage of 0.30. These four sub-parameters are Publications (35 marks), Citations (40 marks), IPR and Patents: Published and Granted (15 marks), and Projects and Professional Practice (10 marks).

5.1 Publications

Although data on publications, citations and highly-cited publications is taken from Scopus and Web of Science, however, for this analyses data from Web of Science is considered for simplicity. (Ref. 35, P.11)

5.1.1 Publications Count

Number of publications and number of publications per faculty is used as an output indicator by a total no. of 10 (5 each) out of 12 national rankings and 3 (publications) and 2 (publications per faculty) out of 8 international rankings systems respectively surveyed by Cakir *et al.*[34].

Table 2 and Fig. 1 reveal exponential increase in cumulative number of publications of top 100 as well as remaining institutions in different ranking categories and subject domains over a period of four years, i.e. from 2017 to 2020. The increase is to the tune of 236.38 per cent, 144.34 per cent, 68.19 per cent, 62.55 per cent and 47.63 per cent in case of Management, Colleges, Overall, Engineering and Universities, respectively over a period of four years, i.e. 2017 to 2020 for the top 100 institutions. Moreover, per cent of increase in publications of remaining eligible institutions in general is much higher than that of publications of 100 top-ranked institutions as given in Table 2. It may be noted that three years publications are considered for every year's ranking exercise as mentioned in Table 1.

5.1.2 Publications by the100 Top-Ranked Institutions V/s Remaining Institutions

Table 3 provides ratio of publications by the 100 top-ranked institutions viz.-a-viz. rest of the eligible institutions in the same domain / category for India Rankings from 2016 to 2020. It is interesting to note that while in 2016 (first year of India Rankings) 91.56 per cent and 94.50 per cent of publications came from the 100 top-ranked HEIs, remaining 8.44 per cent and 5.50 per cent publications came from remaining HEIs respectively. Similar trend can be observed in other categories / disciplines.

However, Pareto's principle and proportion prescribed by it is not maintained in subsequent years, since publications of first 100 institutions have decreased and publications by remaining institutions have increased in every subsequent year across all categories and subject domains. This trend indicates that a good number of remaining institutions have started publishing more and more research articles to fair better in the subsequent ranking exercise.

5.1.3 Comparison of Publications from India V/s NIRF Eligible Applicants

Table 4 shows numbers of publications from India as

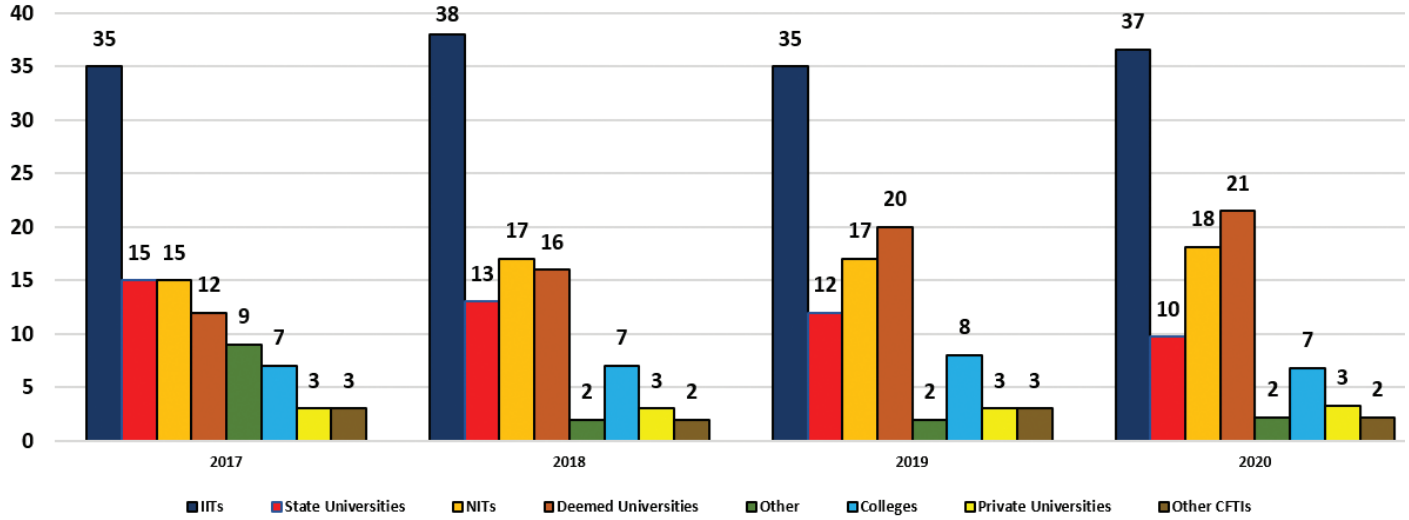

Figure 2. Share of publications from the 100 top-ranked engineering Institutions for India rankings years 2017 to 2020.

Table 7. Share of publications of NIRF eligible applicants V/s other institutions in engineering for India rankings 2017-2020

Institutions	IR-2017 (2013-2015)	IR-2018 (2014-2016)	IR-2019 (2015-2017)	IR-2020 (2016-2018)
NIRF Eligible Applicants	82,507	1,12,848	1,33,985	1,52,043
NIRF Eligible Applicants (%)	67.84	74.30	78.32	83.44
Other Institutions	39108	39,036	37,089	30,178
Other Institutions (%)	32.16	25.70	21.68	16.56

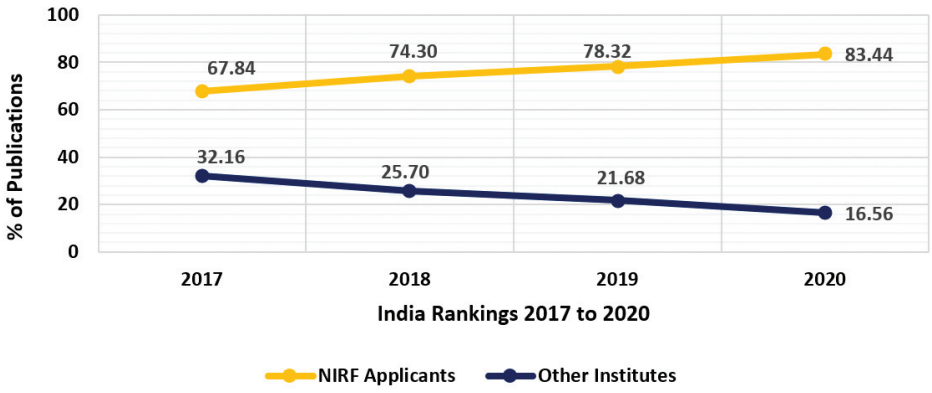

Figure 3. Share of publications of NIRF applicants V/s other institutions in engineering for India rankings years 2017-2020.

compared to that of all NIRF eligible institutions in their respective categories / subject domains. It can be seen that per cent of publications by NIRF eligible institutions has increased in linear proportion every year from 2016 to 2020. This essentially indicates the followings:

- NIRF eligible institutions have intensified their research publications activity so as to secure better rank in subsequent years;
- NIRF eligible institutions are increasingly publishing in good-quality journals that are indexed in Web of Science or Scopus; and
- More and more institutions are now participating in India Rankings.

5.1.4 Proportion of Eligible Applicant Institutions having "0" Publications

It was observed in the 2017 edition of India Rankings that a significant number of NIRF eligible institutions did not have any publication[35]. Table 5, however, reveals that percentage of institutions having "0" publications are decreasing gradually every year with a few exceptions. It can be observed that a sizable percentage of colleges (last row in the Table 5) did not have any publications which can be linked to their primary role of imparting education at undergraduate level. It is indeed intriguing that a sizable number of management institutions (ranging from 64.59 per cent in 2020 to 84.04 per cent in 2017) have "0" publication possibly because their focus is on "case studies" rather than on research publications.

5.1.5 Publications Contributions of Various Engineering Institutions

A closer examination of research publications of the top ranked 100 institutions in Engineering discipline over past four years, i.e. from 2017 to 2020 reveals that IITs, predictably have been contributing the most in terms of percentage of publications with their contribution ranging from 35 per cent in 2017 to 38 per cent in 2018 followed by deemed-to-be-universities with their contribution ranging from 12 per cent in 2017 to 21.46 per cent in 2020 and NITs with their contribution

Table 8. Comparative research publications of India, NIRF eligible applicants and other institutions in engineering for India rankings 2017-2020

Years / Entity	IR-2017 (2013-2015)	IR-2018 (2014-2016)	IR-2019 (2015-2017)	IR-2020 (2016-2018)	% Increase from 2017-2020
India	1,21,615	1,51,884	1,71,074	1,82,221	49.83
NIRF Applicants	82,507	1,12,848	1,33,985	1,52,043	84.28
Other Institutions	39,108	39,036	37,089	30,178	-22.83

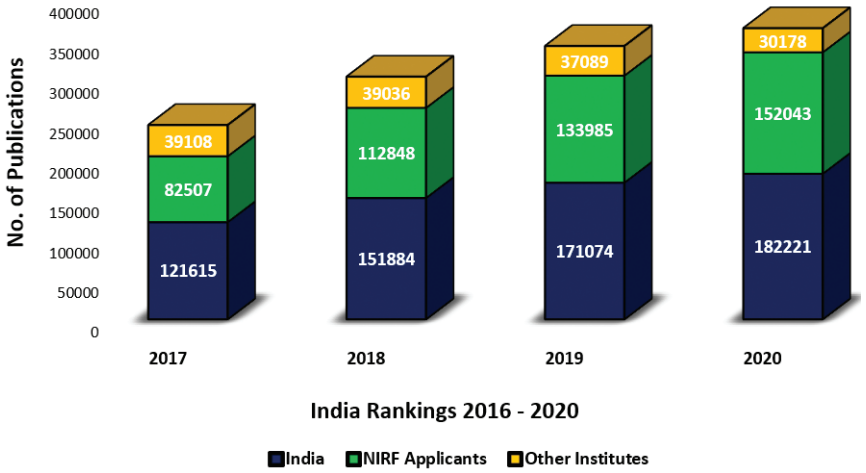

Figure 4. Comparative research publications of India, NIRF eligible applicants and other institutions in engineering for India rankings years 2017-2020.

Table 9. Comparative research publications of world, India, NIRF applicants and the top 100 ranked institutions in overall category for India rankings 2017–2020

Year / Entity	IR-2017 (2013-2015)	IR-2018 (2014-2016)	IR-2019 (2015-2017)	IR-2020 (2016-2018)	% Increase from 2016-2020
			No. of Publications		
World	74,91,367	83,09,449	90,31,073	93,63,011	24.98
India	2,63,125	3,36,978	3,83,803	4,04,953	53.90
All Eligible Inst.	1,78,693	2,24,577	2,64,930	2,85,917	60.00
Top 100 Inst.	1,19,360	1,54,757	1,79,727	2,00,756	68.19
Remaining Inst.	84,432	1,12,401	1,18,873	1,19,036	40.98

ranging from 15 per cent in 2017 to 18.12 per cent in 2020 as depicted in Table 6 and Fig. 2.

5.1.6 Increase in Publications of NIRF Eligible Institutions V/s Other Institutions

Table 7 and Fig. 3 depict increase in research publications of NIRF eligible institutions with decrease in publications output of other institutions in engineering over a period of four years, i.e. from India Rankings Years 2017 to 2020. It is evident that the no. of research publications of NIRF eligible institutions has increased from 67.84 per cent in India Rankings 2017 to 83.44 per cent in India Rankings 2020 whereas other institutions have registered decrease in number of publications from 32.16 per cent in India Rankings 2017 to 16.56 per cent in India Rankings 2020.

5.1.7 Increase in Publications of India and NIRF Eligible Institutions

Table 8 and Fig. 4 depict linear and gradual increase in publication of India as well as that of NIRF eligible applicants in Engineering category over a period of four years of India Rankings, i.e. from 2017 to 2020. The overall increase is to the tune of 49.82 per cent for India, whereas, the increase is to the tune of 84.28 per cent in Engineering discipline during the corresponding years of India Rankings. Persistent and linear decrease in number of publications in case of other institutions is also evident from Fig. 4 and Table 8. Predictably the increase could be because of increase in number of institutions participating in India Rankings or because applicants of India Rankings are putting in extra efforts to increase their research output.

5.1.8 Increase in Publications of the World, India and NIRF Eligible Institutions

Table 9 and Fig. 5 depict consistent increase in total publications of India, NIRF Eligible Applicants, 100 top-ranked institutions and remaining institutions in Overall category from 2017 to 2020 as compared to the increase in research publications of the World. The increase is to the tune of 24.98 per cent (the world), 53.90 per cent (India), 60.00 per cent (All Eligible Applicants), 68.19 per cent (100 Top-Ranked Institutions) and 40.98 per cent (Remaining Institutions) for India Rankings Years 2017 to 2020. Increase is shown in Overall category instead of Engineering for a fair comparison.

5.2 Quality of Publications (QP)

5.2.1 Citations

Number of citations is used as an output indicator by a total no. of 3 out of 12 national rankings and 4 out of 8 international rankings systems surveyed by Çakır *et al.*[34] In addition, one

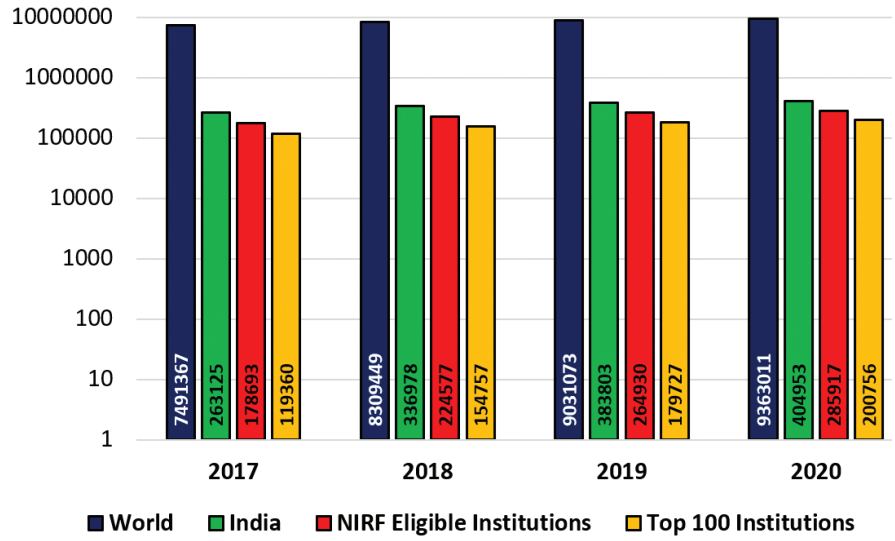

Figure 5. Comparative research publications of world, India, NIRF applicants and 100 top-ranked institutions in overall category for India rankings years 2017–2020.

institutions across different ranking categories and subject domains over a period of four years, i.e. from 2017 to 2020. The increase is to the tune of 353.01 per cent, 334.36 per cent, 146.97 per cent, 142.92 per cent, 117.37 per cent and 106.63 per cent in case of Colleges, Management, Overall, Engineering, Pharmacy and Universities, respectively over a period of four India Rankings years, i.e. 2017 to 2020. It may, however, be noted that three years citations are considered for every year's ranking exercise as mentioned in Table 1.

5.2.2 Citations of 100 Top-Ranked Institutions V/s Remaining Institutions

Table 11 provides ratio of citations to publications by the 100 top-ranked institutions viz.-a-viz. citations to publications by rest of the eligible institutions in the different

Table 10. Number of citations to publications of the 100 top-ranked V/s remaining institutions in India rankings year 2017-2020

Category / Subject Domains	Number of citations								
	IR-2017 (2013-2015)		IR-2018 (2014-2016)		IR-2019 (2015-2017)		IR-2020 (2016-2018)		% Increase 2017-2020 (Top 100)
	Top 100	Remaining	Top 100	Remaining	Top 100	Remaining	Top 100	Remaining	
Overall	477016	160803	675390	215820	863144	269206	1178063	340468	146.97
Universities	358322	406744	460241	589039	574059	718040	740390	912899	106.63
Engineering	181099	39005	244538	53286	323819	83633	439922	132261	142.92
Management	2314	96	4864	234	7443	443	10051	685	334.36
Pharmacy	11096	1335	15595	1607	19225	2441	24119	2702	117.37
Colleges	6423	2533	16546	12731	22962	22624	29097	32251	353.01

international ranking uses citations per faculty as an output indicator out of 8 international rankings systems surveyed.

Citations are considered as signposts left behind after information has been utilised[36]. It is assumed that the number of citations received by a published work is positively correlated with its scientific value. Number of times a paper authored by an academic at a university is cited by another researchers in their works, can be considered as a core criterion of university achievement and offers a relatively objective measure of that achievement, especially when total number of citations received by a university is normalised by dividing it with the number of faculty in an institution. Counting citations on a per capita basis, therefore, can be considered as a reasonable criteria to measure excellence of an institution[33].

Table 10 and Fig. 6 depict exponential increase in cumulative number of citations to publications by top 100 domains / categories of India Rankings from 2017 to 2020. It can be observed that citations to publications by first 100 institutions have increased with corresponding decrease in citations to publications by the remaining institutions in case of Universities, Engineering, Management and Colleges. However, this trend is not visible in case of Overall, Pharmacy, and College category. This indicates that a good number of remaining institutions have started publishing more and more research articles which, in turn, have claimed its share of citations.

5.2.3 Highly Cited Publications (HCP)

The most significant works of science are almost invariably highly cited[37]. The parameter Highly Cited Publications (HCP) are a fraction of the top score citations in percent (top 25 % in case of India Rankings) calculated for 256 sub-domains in Web

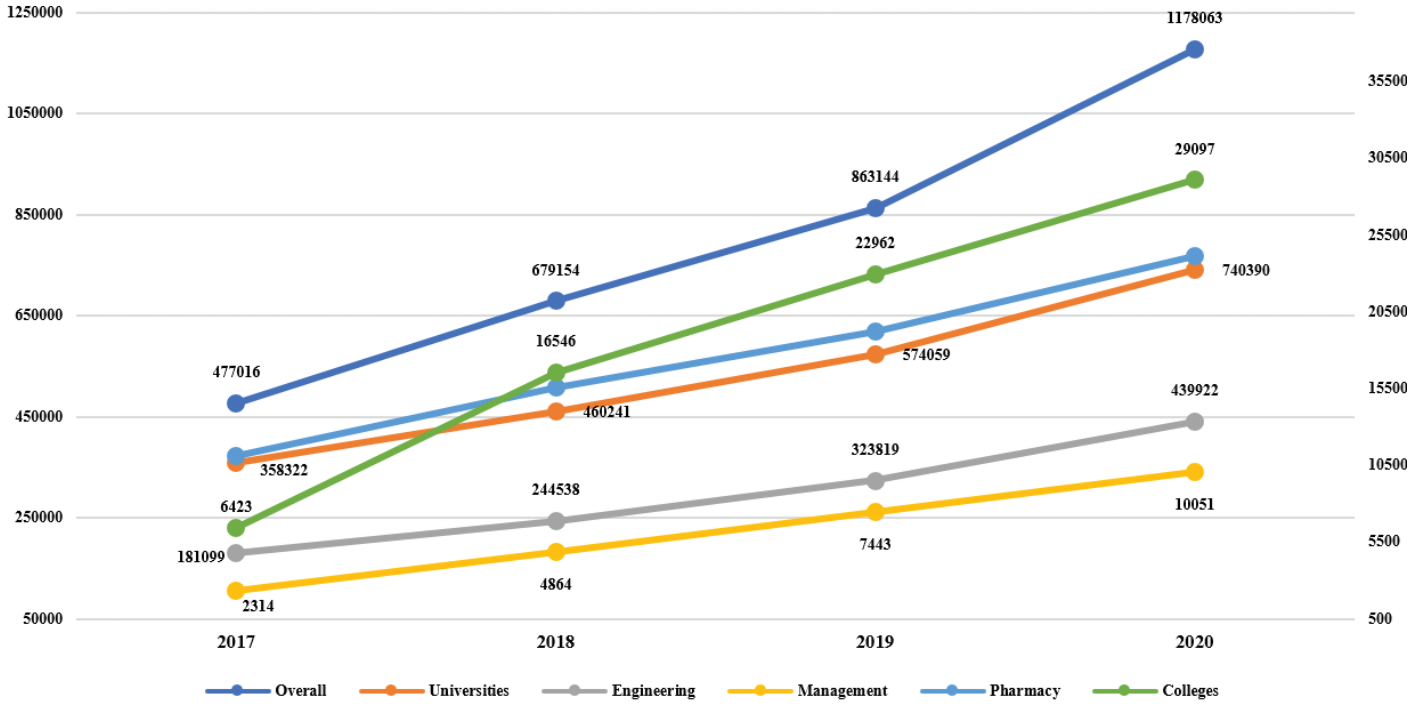

Figure 6. Number of citations to publications of top 100 institutions ranked in India rankings year from 2017-2020.

Table 11. Per cent citations to publications of top the 100 institutions V/s No. of citations to publications by top 100 ranked in India rankings year from 2017-2020

Discipline / Category	IR-2017 (2013-2015)		IR-2018 (2014-2016)		IR-2019 (2015-2017)		IR-2020 (2016-2018)	
	Per cent of Citation in							
	<= 100 Inst.	Remaining Inst.	<=100 Inst.	Remaining Inst.	<= 100 Inst.	Remaining Inst.	<= 100 Inst.	Remaining Inst.
Overall	74.79	25.21	75.78	24.22	76.23	23.77	77.58	22.42
Universities	88.10	11.90	78.13	21.87	79.95	20.05	81.10	18.90
Engineering	82.28	17.72	82.11	17.89	79.47	20.53	76.88	23.12
Management	96.02	3.98	95.41	4.59	94.38	5.62	93.62	6.38
Pharmacy	89.26	10.74	90.66	9.34	88.73	11.27	89.93	10.07
Colleges	71.72	28.28	56.52	43.48	50.37	49.63	47.43	52.57

Table 12. Highly-cited publication of the 100 top-ranked institutions in comparison to the rest of the eligible institutions in various domains / categories for India rankings 2017-2020

Discipline / Category	IR-2017 (2013-2015)		IR-2018 (2014-2016)		IR-2019 (2015-2017)		IR-2020 (2016-2018)	
	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.	% of Pubs. in <= 100 Inst.	% of P Pubs. in Remaining Inst.	% of Pubs. in <= 100 Inst.	% of Pubs. in Remaining Inst.
Overall	73.63	26.37	73.27	26.73	73.81	26.19	76.45	23.55
Universities	93.44	6.56	78.42	21.58	70.58	29.42	80.00	20.00
Engineering	85.36	14.64	78.03	21.97	79.74	20.26	78.72	21.28
Management	100	0	94.65	5.35	94.6	5.4	92.64	7.36
Pharmacy	100	0	90.44	9.56	90.65	9.35	91.75	8.25

Table 13. No. of patents in engineering discipline for the 100 top-ranked and remaining eligible institutions

No. of Patents in Engineering Discipline for Top 100 Institutions					
	India Rankings Year (Academic Year)				
Total No. of Patents (Granted + Published)	**2017 (2015-2016)**	**2018 (2016-2017)**	**2019 (2017-2018)**	**2020 (2018-2019)**	**% Increase (2017 to 2020)**
Top 100	1801	2558	2795	4099	127.60
Remaining	329	236	1092	3735	1035.26

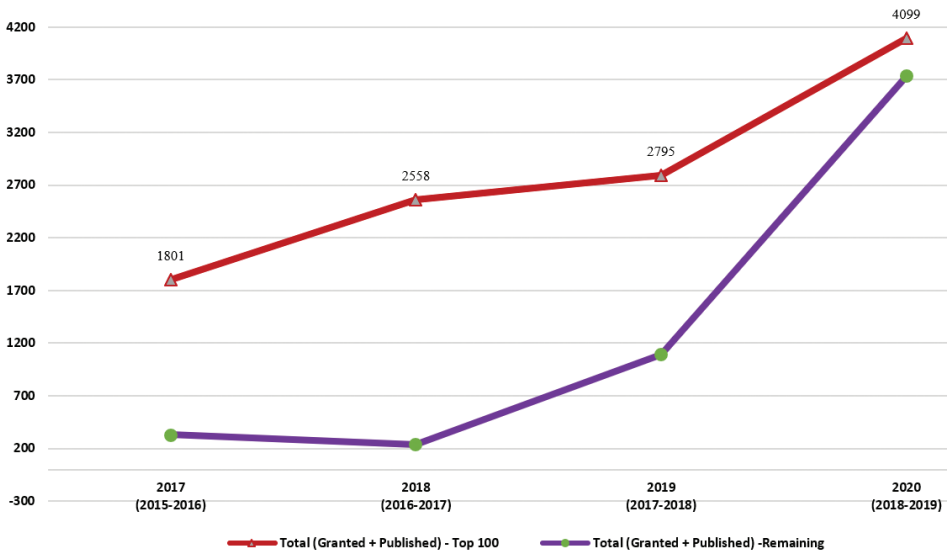

Figure 7. No. of patents in engineering discipline for the 100 top-ranked and remaining eligible institutions.

of Science. This indicator identifies collective publications of an institution that have received the highest number of citations over past three years in 256 sub-domains to their published articles. Highly cited publications (HCP) indicate high-quality research work done by faculty and researchers in a university, which, in turn, attract research students for doctoral and post-doctoral programs of a university. HCP thus attends to the important question of a university's ability to attract outstanding researchers in various fields. HCP, therefore, can be considered as highly objective criteria that targets quality of research work done by a university. Citations and HCP, specially normalised by number of faculty as prescribed by NIRF for India Rankings, is relatively objective measure of achievement of HEIs[33]. Number of Highly-cited publications is used as an output indicator by a total no. of 2 out of 8 international rankings systems surveyed by Çakır *et al.*[34]

Table 12 provides ratio of highly cited publications of top 100 institutions viz.-a-viz. rest of the eligible institutions in the different categories or subject domains for India Rankings from India Rankings Years 2017 to 2020. As in case of publications, first 100 universities and engineering institutions account for 93.44 per cent and 85.36 per cent of the HCP and remaining universities and engineering institutions accounts for 6.56 per cent and 14.64 per cent of HCP respectively in India Rankings 2017. In case of Management and Pharmacy, first 100 institutions account for 100 per cent HCP whereas contributions of remaining institutions is "0" in India Rankings 2017. However, as in case of publications, this proportion is not maintained in subsequent years, as HCP of first 100 institutions has decreased whereas HCP for remaining institutions have registered increase in HCP in every subsequent year across all categories and subject domains. This trend indicates that a good number of remaining institutions are not only publishing their research works but also attracting their share of citations.

5.3 IPR and Patents: Published and Granted (IPR)

Patents by education institutions are indicators about transfer of knowledge and innovations into industry. Patents demonstrate economic relevance of research and development activities conducted by universities. (Ref.3 P.622)As such, patents can be considered as an object measure of excellence of a university.

Table 13 and Fig. 7 depict persistent and gradual increase in number of patents granted or published by top 100 as well as for remaining engineering institutions in India. It can be observed that while the total number of patents for the Top 100 and remaining institutions have increased from 1801 and 329 in 2017 to 4099 and 3735 in 2020 respectively. It may be noted that per cent of increase in number of patents for remaining institutions, i.e. 1035.26 per cent is almost 10 times higher than per cent of increase in number of patents for the 100 top-ranked institutions i.e. 127.60 per cent. Resultantly, total number of patents has increased to around 4,000 for top 100 as well as for remaining institutions. This reveals increase in research and development activities in remaining institutions resulting in exponential increase publications, citations, highly-cited publications and patents.

5.4 Footprints of Projects (Research Funds) and Professional Practice (FPPP)

Research funding (including industry funds) is an important parameter to judge academic excellence in almost all global rankings systems. Research funds can be considered as

Table 14. Comparison of sponsored research funding in engineering and pharmacy in past four, i.e. 2017–2020

Median SP	India Rankings 2017	India Rankings 2018	India Rankings 2019	India Rankings 2020	% Increase
	Amount in Rupees				
Overall	23,50,395	20,05,961	14,53,200	14,47,833	-38.40
Engineering	3,69,333	6,26,333	8,67,333	8,61,200	133.18
Pharmacy	1,04,167	2,11,993	2,32,667	1,91,667	84.00

an indicator of peer reviews of research proposals submitted by academia on an institution to funding agencies. As such, it can be considered as an objective indicator of academic excellence. Research funding was found to be positively correlated with research productivity in terms of number of articles indexed in Science Citation Index for various institutions across most of the disciplines[38] confirming the findings of previous studies regarding the impact of funding on research productivity by Jacob and Lefgren[39]. Kwon further observed that the correlation coefficient values for research funding (government-funded, enterprise-funded, or university-funded) differed according to disciplines, it was significantly positive for most fields of study and promulgated that more research funds would result in increase in research output in terms of article indexed in Science Citation Index.[38]

Jacob and Lefgren[39] estimated the causal impact of NIH funding on scientific output and found that NIH postdoctoral fellowships increase research publications and citations by about 20 per cent in the five years following grant application.

The amount of external research funding received by a university is an influential indicator of academic prestige in university league tables. Universities are, therefore consistently seeking to increase their potential for research funding by investing in Ph.D. programs, in laboratories, libraries, computer facilities, and research management as well as by attracting more research-oriented faculty.[23] There are evidences that indicate that US universities are subsidizing their federal research support through increased investment in grant matching funds and /or by attempting to lower their indirect cost rate.[26]

Table 14 provide median amount of sponsored research funding in Overall, Engineering and Pharmacy. Although marginal increase over a period of 3 years, i.e. from 2017 to 2019 can be observed in case of Engineering and Pharmacy, however, decrease in median amount of sponsored research funding across all field in the year 2020 is evident that indicates lack of funding opportunities for research across discipline. Government of India has taken note of this and announced setting-up of National Research Foundation (NRF) to fill-in this gap.

6. MAJOR OBSERVATIONS

- Number of publications and citations by the 100 top-ranked institutions as well as remaining institutions have registered exponential increase over a period of 4 years, i.e. from 2017 to 2020. However, percentage of increase in publications and citations by the remaining institutions is much higher in comparison to the 100 top-ranked institutions.
- Per cent of publications, citations, highly cited publications and patents (only in engineering) by the remaining institutions (baring the 100 top-ranked institutions) have increased in every subsequent years across all categories and subject domains with its corresponding decrease by the 100 top-ranked institutions. However, in case of Overall category No. of citations to the publications by the 100 top-ranked institutions have increased with corresponding decrease in citations to publications by the remaining HEIs.
- Per cent of publications by NIRF applicant HEIs have increased in linear proportion every year from 2016 to 2020 with corresponding decrease in per cent of publications by non-applicants.
- A significant number of NIRF eligible applicants did not have any publication, however, per cent of institutions having "0" publications have decreasing gradually every year from 2017 to 2020.
- The IIT's contribution to the publications out-put of the top 100-ranked institutions was between 35 per cent to 38 per cent during 2017 to 2020.
- Publication output of India as well as that of NIRF eligible applicants in Engineering have increased during the past four years of India Rankings, i.e. from 2017 to 2020. The overall increase is to the tune of 49.82 per cent for India, whereas, the increase in case of Engineering discipline is 84.28 per cent. Predictably the increase could be because of increase in number of institutions participating in India Rankings or because applicants of India Rankings are putting in extra efforts to increase their research output.
- Noticeable and consistent increase in total publications of India, NIRF Eligible Applicants, 100 top-ranked institutions and remaining institutions in Overall category was noticed during past four years, i.e. 2017 to 2020. However, per cent increase in publications of 100 top-ranked institutions was the highest.
- Marginal increase in sponsored research funding was observed in case of Engineering and Pharmacy, however, decrease in median amount of sponsored research funding across all years in case of overall category and in all categories and disciplines in the year 2020 is evident which indicates lack of funding opportunities for research across disciplines. The Government of India has taken note of this shortcoming and has announced setting-up of National Research Foundation (NRF) to fill-in this gap.

7. CONCLUSIONS

This article analyses data on five years of India Rankings to assess its impact on performance parameters of institutions

of higher education in terms of publications, citations, patents, highly-cited publications and research funding under broad category of parameter named "Research and Professional Practices". The analysis on data on five years of India Rankings, i.e. 2016 to 2020 on various performance parameters of HEIs provides an interesting insight and reveals that participating institutions are making strenuous effort to improve their performance on various parameters or sub-parameters identified by the NIRF for ranking of HEIs. It was observed that the number of publications, citations, and highly-cited publications (HCP) by eligible applicant institutions have increased exponentially over a period of five years from 2016 to 2020. Moreover, per cent of publications, citations, and HCP by the 100 top-ranked institutions has decreased with corresponding increase in number of publications, citations, and HCP of the remaining institutions. This trend indicates that a good number of remaining institutions have not only intensified their research and publications activities but are also attracting their share of citations. It is also observed that a significant number of NIRF eligible applicants did not have any publication, however, per cent of institutions having "0" publications have decreasing gradually every year from 2017 to 2020. Noticeable and consistent increase in total publications of India, NIRF Eligible Applicants, 100 top-ranked institutions and remaining institutions in Overall category was noticed during past four years, i.e. 2017 to 2020. However, per cent increase in publications of the 100 top-ranked institutions was the highest in overall category.

Most ranking system allocate larger weightage to bibliometric parameters including publications, citations, HCP, patents, etc. Moreover, it is a well-accepted fact that increase in high-quality publications by an HEI would invariably result in improvement of its ranking. This study reflect that ranking has influenced the performance of HEIs in a positive way.

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