

Ranking of Indian Research-Intensive Higher Education Institutions using Multiple Ranking Methodologies: A Correlation Analysis

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ABSTRACT

This article ranks the same set of Higher Education Institutions (HEIs) in India using four different ranking methodologies, namely, i) NIRF (Overall): used for Overall category of India Rankings; ii) NIRF (Only Research and Professional Practices parameters); iii) Research Ranking Methodology; a new methodology evolved for ranking of research-intensive institutions under NIRF; and vi) IFQ2A index developed by Spanish group of scientists. The four sets of ranked institutions were obtained using methodologies mentioned above and correlation analysis was carried out on these four sets using Pearson Bivariate Correlation. It was found that a very strong and positive correlation exists between ranking of HEIs using new methodology (R2M) evolved for ranking of research-intensive institutions and ranking by HEIs using IFQ2A Index.

Keywords: NIRF; India rankings; Research output; H-Index; Research institutions rankings; Higher education

1. INTRODUCTION

India has the second largest population in the world with 1.366 billion people in 2019¹. One-fifth, i.e. 19.1 per cent of India's total population consists of youth between 15-24 years which is expected to grow from 19.15 per cent² in 2011 to 34.33 per cent by 2020³. As per the AISHE report 2018-19, the total enrolment in higher education is estimated to be 37.4 million with 19.2 million male and 18.2 million females. Gross Enrolment Ratio (GER) in higher education in India is 26.3 per cent⁴.

The Ministry of Education (formerly Ministry of Human Resource Development) has taken several initiatives to promote quality in teaching and research. The National Institutional Ranking Framework (NIRF), launched in September 2015, was one of such initiatives. The NIRF is used in India rankings for ranking of institutions of higher education in different categories and subject domains. Basic aim of the India Rankings is to galvanise Indian institutions towards a competitive environment that exists internationally in the education marketplace. With release of India Rankings every year from 2016 onwards, Indian institutions receive their comparative position vis-a-vis their counter parts in India in different categories and subject domains giving them a sense of comparison and competitiveness. India rankings report also present comparative data on research output by the 100 top-ranked institutions vis-a-vis remaining eligible applicant institutions in comparison to research output of India and the

world. In addition to parameters used by popular global ranking systems, India rankings uses India-specific parameters and best practices prevalent in Indian HEIs.

This article describes criteria used for selection of a single set of research-intensive institutions that were ranked using multiple ranking methodologies. These ranking methodologies are: i) Overall methodology: used for ranking Overall category of India Rankings; ii) NIRF (Only Research and Professional Practices parameters); iii) Research Ranking Methodology; a new methodology evolved for ranking research-intensive institutions under NIRF; and vi) IFQ2A index⁵. Four sets of ranked institutions were obtained using methodologies mentioned above and correlation analysis was carried out on these four sets of ranked institutions using Pearson Bivariate Correlation method.

2. SELECTING RESEARCH-INTENSIVE INSTITUTIONS

The HEIs applicant to the Overall category of India Rankings for the year 2020 having more than 500 research publications indexed in Web of Science were considered for this study. Out of 1667 institutions in overall category in the year 2020, only 109 institutions that had published minimum 500 research papers in previous three calendar years, i.e. 2017, 2018, 2019 were selected for further study.

3. RANKING METHODOLOGIES

3.1 IFQ2A Index

This methodology considers qualitative and quantitative

Table 1. Sub-parameters used in IFQ2A metrics

Sub-Parameter	Character	Description
NDOC (I1)	Quantitative	The no. of research papers published by faculty in peer reviewed journals in three years
NCIT (I2)	Quantitative	Total no. of citations received in three years
H-Index (I3)	Quantitative	Proposed by Hirsch, relates no. of publications and citations in determining research output of institutions
% 1Q (I4)	Qualitative	Ratio of papers published top JCR quartile
ACIT (I5)	Qualitative	Citations per paper
TOPCIT (I6)	Qualitative	Ratio of Papers in Top25% Highly cited papers

measures to compare research output of institutions. This bidimensional bibliometric metrics was specifically developed to measure ranks of different institutions in Spain. IFQ2A methodology⁵ is based on bibliometric indicators than can be sourced from any third-party citation sources. It does not take elitist measures into consideration such as Nobel awards, field medals etc.

The indicators considered in IFQ2A consists of two groups:

- Quantitative institutional field index (QNIF), based on number of publications, citations, and h-index
- Qualitative institution field index (QLIF), based on JCR journal first quartile, ratio of highly cited papers and average citations.

Table 1 lists quantitative and qualitative sub-parameters used in IFQ2A methodology with explanation:

The sub-parameters are normalised by setting the highest value to 1 to top-ranked institution followed by lower values to remaining institutions proportionally. The formula for calculating QNIF and QLIF is as follows:

$$QNIF = \sqrt[3]{I1 \times I2 \times I3}$$

$$QLIF = \sqrt[3]{I4 \times I5 \times I6}$$

$$IFQ2A \text{ index} = QNIF \times QLIF$$

3.2 Overall Methodology

The national institutional ranking framework (NIRF) methodology is used for ranking HEIs in India rankings. Every subject and every category have its own well-defined methodology, each consisting of five board categories of parameters, that is used for ranking institutions in the respective categories and subject domains. For this study, methodology used for ranking of HEIs in Overall category⁶ is used. The

parameters, sub-parameters and weightage assigned to them for all subjects and categories is given in the article entitled “Five years of India Rankings (2016 – 2020): An Evolutionary Study” published in this issue of the journal.

3.3 NIRF: Research and Professional Practices Only

In this method, HEIs are ranked based on their score on “Research and Professional Practice” parameters and sub-parameters of overall category by assigning 100 per cent weightage to them.

3.4 Research Ranking Methodology

Research ranking methodology (R2M) uses the quantitative and qualitative measures to calculate research score of an institution. The quantitative measures include Number of Research Publications (PUB), Number of citations (CIT) and Research Projects (RP). The qualitative measures include No. of research papers published in first quartile of JCR (JCRQ1), percent of highly cited papers in Top 25 (Top 25), patents published and granted (PPG) and H-Index. The detailed methodology is given in Table 2.

The final score is calculated by adding the score received in both measures and then rank is assigned based on the final score, i.e., $R2M = \frac{QnRM + Q}{RM}$.

4. METHODOLOGY: SEQUENCING THE PROCESSING OF RANKING

In the first step, the institutions with minimum 500 research papers published in three calendar years, i.e., 2017, 2018 and 2019 in Web of Science were selected. A total number of 109 HEIs were identified for this study out of 1667 institutions that were applicant for India Rankings 2020. The data related to student’s intake, student enrolled in various programs, teaching faculty, research funding, no. of publications, no. of citations, highly cited papers, patents published, patents granted, papers published in JCRQ1 and H-Index were collected for all 109 institutions. The data related to publications, citations, JCRQ1, H-index and Per cent of highly cited papers in Top 25 were retrieved from Web of Science, remaining data was sourced from the Data capturing system submitted by HEIs at the time of participating in India rankings 2020.

Data was compiled into relational databases as defined in above methodologies. Indicators / parameter wise calculation of score was done using methodologies and algorithms mentioned above. The institutions were given a composite score and ranks based on their respective methodology. Finally, correlation between four sets of rankings was carried out using Pearson Bivariate Correlation.

5. RESULTS AND DISCUSSIONS

Pearson Bivariate Correlation Coefficient matrix was computed to examine strength and degree of correlation between ranks assigned to HEIs using four methodologies described before. Figure 1, Fig. 2 and Fig. 3 provides Pearson Bivariate Correlation Coefficient matrix amongst top 25, 50 and 100 ranked HEIs. The left part of all the three Figures, positive correlations is shown in blue. Intensity of colour and size of the

Table 2. Research ranking methodology (R2M)

Quantitative research measures (QnRM)	
1. No. of Research Publications (PUB) $PUB = 50 \times (P/F)$ $PUB = 50 \times (P/F)$	P: Total no. of publications published in previous three years F: Total no. of teaching faculty in the institution which have taught for at least two semesters
2. No. of Citations (CIT) $CIT = 25 \times (C/F)$	C: The total no. of citations received in previous three Years F: Total no. of teaching faculty in the institution which have taught for at least two semesters
3. Research Projects (RP) $RP = 20 \times RF + 5 \times CF$	RF= Research funding received by faculty in previous three financial years CF=Consultancy funding received by faculty in previous three financial years
Qualitative research measures (QIRM)	
1. No. of research papers published in first quartile of JCR (JCRQ1) $JCRQ1 = 30 \times (PJCR/P)$	<i>PJCR</i> : No. of research papers in first quartile of JCR P: As calculated in PUB
2. Percentage of Highly Cited Papers in Top25 (HCP) $HCP = 30 \times (Top25/P)$	Top25: Papers published 25% highly Cited Journals P: As calculated in PUB
3. Patents Published and granted (PPG) $PPG = 5 \times PP + 20 \times PG$	PP: Patents Published in previous three years PG: Patents Granted in previous three years
4. H-Index	$H\text{-Index}=20 \times \text{Norm (H-index)}$

circle are proportionate to the value of correlation coefficient and the right part shows value of correlation along with level of significance as denoted in stars “****”, “***”, “**”, “*” & ” with p-value \leq 0,0.001,0.01,0.005 and 0.1 respectively.

5.1 Significance of Correlation Analysis for Top 25 Institutions

A positive, linear and strong correlation is found between IFQ2A and Overall as well as between Overall and NIRF-RP with $n=25$ and correlation coefficient (r) ranging from 0.67 to 0.99 amongst rankings using four methodologies described above. The strongest and positive linear correlation is found with $r=0.99$ between ranking by R2M and NIRF-RP followed by $r=0.93$ between rankings by IFQ2A and NIRF-RP. The lowest correlation at $n=25$ was observed with $r=0.67$ between rankings by Overall and IFQ2A as depicted in Fig. 1.

5.2 Significance of Correlation Analysis for Top 50 Institutions

A positive, linear and strong correlation is found between IFQ2A and Overall as well as between Overall and NIRF-RP at $n=50$ and value of correlation coefficient (r) ranging from 0.71 to 0.99 amongst rankings using four methodologies described above. The strongest and positive linear correlation is found with $r=0.99$ between ranking by R2M and NIRF-RP followed by $r=0.93$ between rankings by IFQ2A and NIRF-RP. The lowest correlation at $n=50$ was observed with $r=0.71$ between rankings by IFQ2A and Overall as depicted in Fig. 2.

5.3 Significance of Correlation Analysis for Top 100 institutions

A positive, linear and strong correlation is found between IFQ2A and Overall as well as between Overall and NIRF-RP at $n=100$ and value of r ranging from 0.81 to 0.99 amongst rankings using four methodologies described above. The strongest and positive linear correlation is found with $r=0.99$ between ranking by R2M and NIRF(RP) followed by $r=0.93$ between rankings by IFQ2A and R2M as well as NIRF-RP. The lowest correlation at $n=100$ was observed with $r=0.81$ between rankings by IFQ2A and Overall as depicted in Fig. 3.

6. CONCLUDING REMARKS

This article ranks a single set of research-intensive institutions using multiple ranking methodologies. Strong, positive and linear correlation was found between ranks of research-intensive HEIs by all the four methodologies. Significant correlation was found between rankings of research-intensive HEIs using following methodologies since p-value in these cases was less than 0.05:

- IFQ2A with Overall (NIRF) and research ranking (R2M) methodology;
- Overall (NIRF) with research ranking (R2M) and overall (RP) methodology; and
- Research ranking (R2M) and overall (RP) methodology.

It is observed that the new methodology namely, Research Ranking Methodology (R2M) has a significant relationship

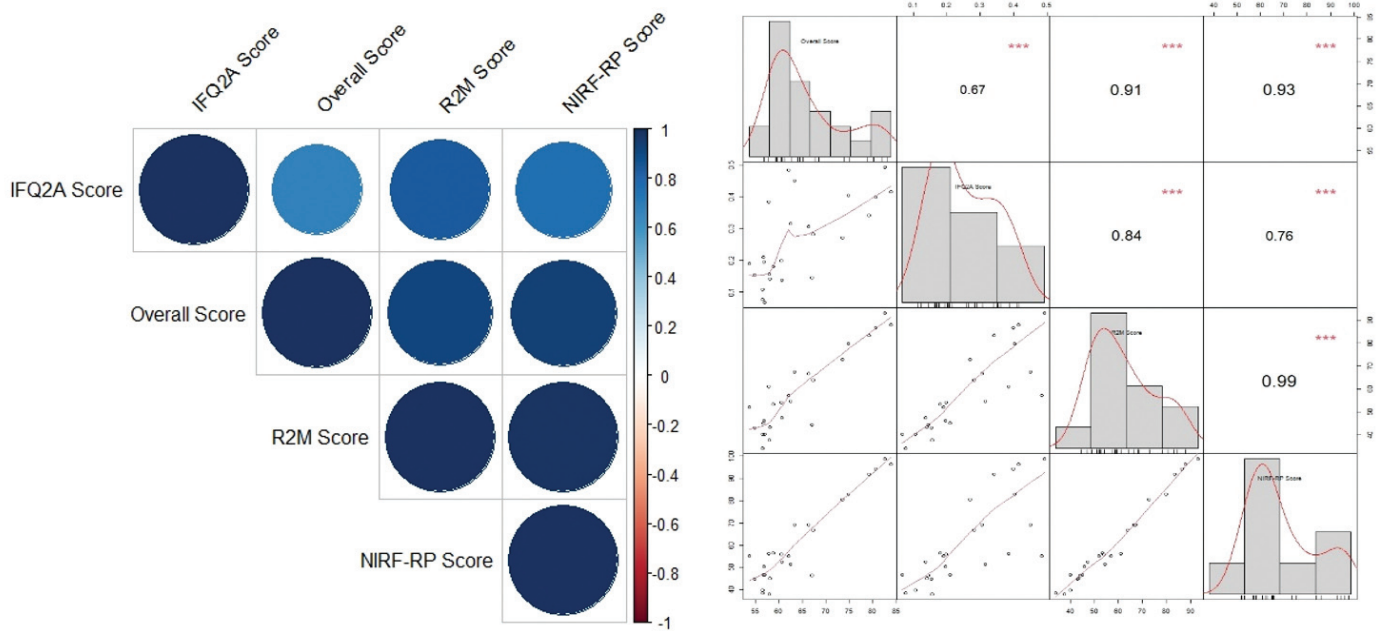


Figure 1. Pearson correlation for top 25 institutions.

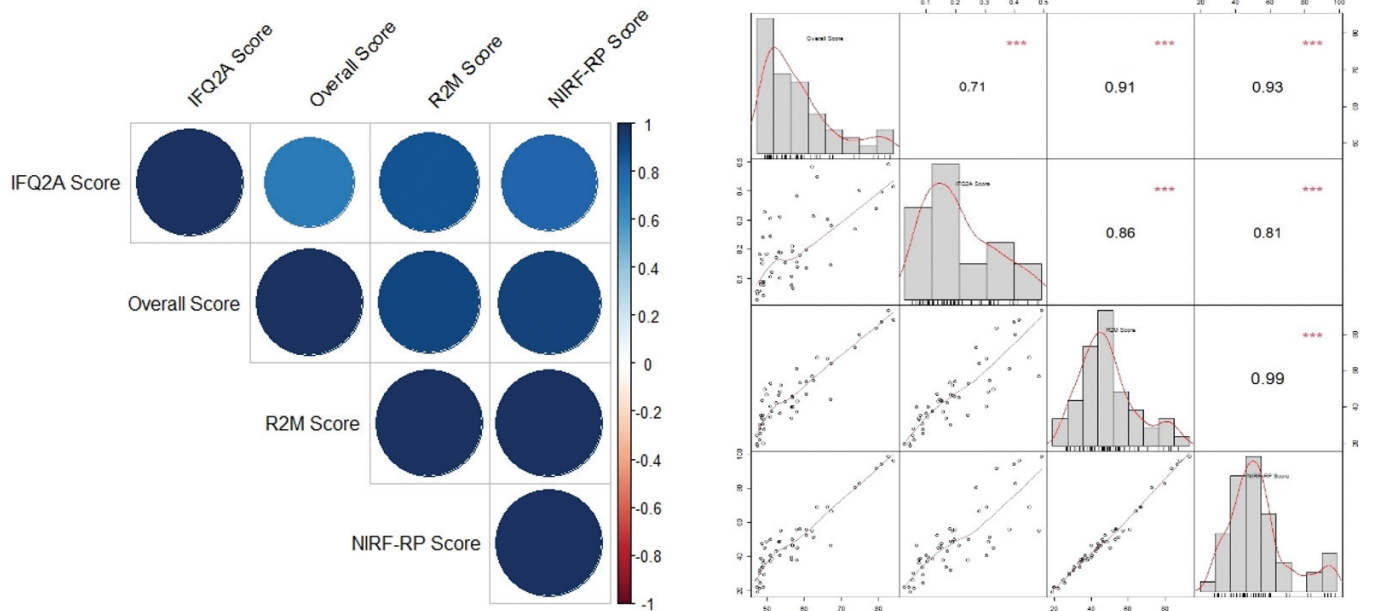


Figure 2. Pearson correlation for top 50 institutions.

with IFQ2A index in spite of the fact that the new methodology use additional parameters, i.e. patents and research funds. Moreover, it also normalises bibliometric parameters, namely publications and citations with number of faculty and highly cited publications with total number of publications. Similarly, R2M also have a significant relationship with overall methodology and NIRF-Overall (RP) which indicates that R2M is much more suitable for ranking Indian higher education institutions.

It may be concluded that Research Ranking Methodology (R2M) is most suitable to rank Research-Intensive HEIs in

India. R2M is size and age independent of institutions and can be used effectively to rank young institutions even if their score is zero on one or more parameters. For example, if highly-cited papers is zero for a recently established institution, it cannot be ranked using IFQ2A index since IFQ2A is a product of multiplication of qualitative and quantitative indicators, whereas in case of Research Ranking Methodology (R2M), bibliometric and well as other indicators, after normalisation, are added to get a final score. It is, therefore, recommended that Research Ranking Methodology (R2M) may be used to rank research-intensive HEIs.

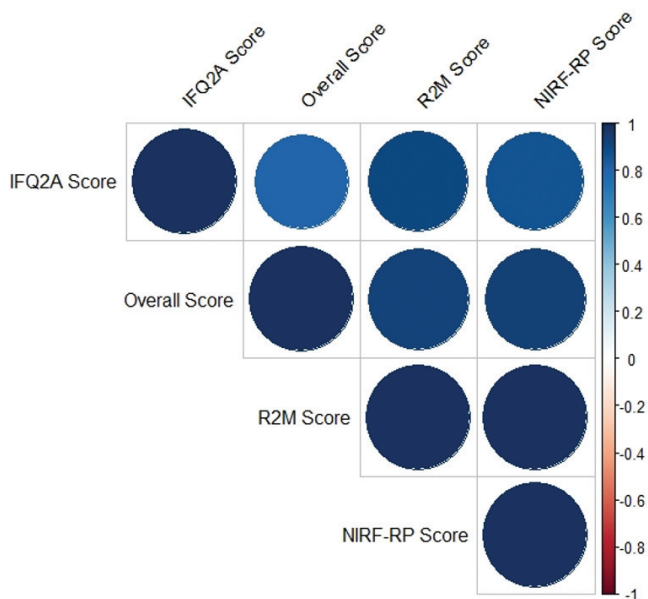
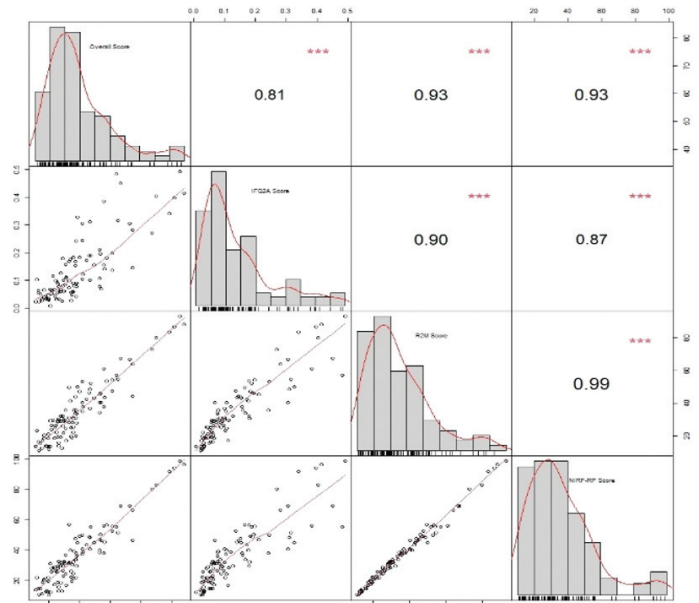


Figure 3. Pearson correlation coefficient for top 100 institutions.



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CONTRIBUTORS

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In this study, she has contributed by designing the research concept, research methodology and devising the new research ranking methodology.

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