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A Comprehensive Analysis on Effectiveness of Parameters in NIRF India Rankings 2023 for Top 100 Engineering Institutes

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Abstract : The National Institutional Ranking Framework (NIRF), evaluates universities and institutions based on key parameters such as "Teaching, Learning, and Resources (TLR)," "Research and Professional Practices (RPP)," "Graduation Outcomes (GO)," "Outreach and Inclusivity (OI)," and "Perception (PR)." The study examines the top 100 Engineering institutes of NIRF 2023, focusing on their major parameter categories and their effectiveness in ranking processes. The study will be useful to the engineering institutes to clearly understand the areas of improvement and to have an action plan for better rankings. Descriptive statistics reveal that among five major categories RPP & PR and in the sub-parameters Financial Resources and their Utilisation (FRU), Footprint of Projects and Professional Practice (FPPP), Metric for Number of Ph.D. Students Graduated (GPHD), and Economically and Socially Challenged Students (ESCS) have the lowest effectiveness among others, indicating their minimal contribution in the total score. Consequently, Institutes must focus on enhancing these parameters to enhance their total score and position in the NIRF rankings. The analysis of histograms and descriptive statistics reveals that 75% of ranked institutions score below 60% in RPP and PR parameters, indicating suboptimal performance in perception and research aspects. The study also highlights the importance of prioritizing efforts to improve RPP and PR scores to enhance the overall performance and rankings of engineering institutions in NIRF, as TLR, GO, and OI show relatively consistent performance.

Keywords: NIRF 2023, TLR, RPP, GO, OI, PR, Descriptive statistics, Histogram.

1. Introduction

It was in the early 20th century that university rankings began in the United States, and US News and World Report became the first organization to publish institutional rankings in the country in 1983 [1-3]. These rankings have become an important tool for universities to market themselves and create perceptions about their quality. Boulton [4] has noted that a university's ranking can influence funding and project priorities, leading many to prioritize high rankings for positive publicity. The main goal of implementing a ranking system is to enhance the overall quality of education, teaching & research.

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Accreditation and ranking agencies worldwide offer global ratings & rankings, with India's autonomous bodies like NAAC, and NBA, assessing institutions and granting accreditation for institutions and also for specific programs. The rankings, published by non-academic media, aim to improve education, scholarship, and research standards. However, their limited participation and focus on admission campaigns make them questionable [5-7]. The higher education system in a country is influenced by its history and vision, impacting its functioning and ranking. International university ranking systems have faced criticism for their methodology and bias towards certain cultural factors [8-10]. The Indian government introduced the National Institutional Ranking Framework (NIRF) in 2015 to improve higher education quality, despite accreditation agencies monitoring it. The Ministry of Human Resource Development focuses on human resources development, infrastructure improvement, and expanding access to higher education. The NIRF ranking methodology assesses institutions using five categories of parameters namely Teaching, Learning and Resources (TLR)," "Research and Professional Practices (RPP)," "Graduation Outcomes (GO)," "Outreach and Inclusivity (OI)," and "Perception (PR) [11]. The NIRF ranking in India improves competition, education, and research quality, aiding students, and parents in selecting institutions. However, it may overlook teaching quality and student experience.

In response, the Indian government introduced the National Institutional Ranking Framework (NIRF) in 2015, despite the presence of multiple accreditation agencies tasked with monitoring the quality of higher education within the country. The Ministry of Human Resource Development (MHRD) in India is responsible for developing human resources and improving basic infrastructure through policy and planning, with a specific focus on expanding access to higher education and improving its quality. The NIRF ranking methodology evaluates institutions based on five parameters: teaching, learning and resources (TLR), research and professional practice (RPP), graduation outcomes (GO), outreach and inclusivity (OI), and perception (PR). Each parameter has a specific weightage, with TLR and RP accounting for 30% each, GO accounting for 15%, OI accounting for 15%, and PR accounting for 10%. The ranking is based on a composite score calculated by assigning weights to each parameter and sub-parameter [12]. The NIRF ranking has been instrumental in promoting healthy competition among institutions, leading to an overall improvement in the quality of education and research in India. The ranking has also helped students and parents make informed decisions about choosing the right institution for higher education. However, there are certain limitations to the NIRF ranking methodology. One criticism is that it primarily focuses on research output and neglects other essential aspects of higher education, such as teaching quality and student experience. Another criticism is that the ranking methodology is subjective, and the perception parameter is given undue weightage, which may not accurately reflect the quality of an institution. Despite these limitations, the NIRF ranking has had a significant impact on the Indian higher education system. The ranking has encouraged institutions to focus on research and innovation, leading to a substantial increase in research output and patents filed. The ranking has also led to increased funding for institutions that have performed well, leading to further improvements in their overall performance. The NIRF ranking has also been beneficial in promoting inclusivity and diversity in the Indian higher education system. The outreach and inclusivity parameter of the ranking evaluates institutions' efforts to promote diversity and inclusion in their admission policies and student body. This has led to an increase in the representation of marginalized communities in higher education institutions. Another notable impact of the NIRF ranking is the increased focus on industry-academia collaboration. The ranking has incentivized institutions to engage with industry partners to promote research and innovation and to develop industry-relevant curricula. This has led to an increase in industry-academia partnerships, leading to improved employability for students [13,14].

Several researchers are discussing how research performance plays a role in ranking universities. It mentions that previous studies have shown the importance of research performance as an indicator for university rankings. The research article on comparative studies of international academic ranking of universities, points out that four selected international rankings contained an indicator of research quality, which was the most important indicator of international university ranking [15]. The various studies conducted on the National Institutional Ranking Framework (NIRF) in India. One study found that the parameters used in NIRF are comparable to world ranking systems like Times World University Ranking and QS Ranking. Another study identified that research output is the major

parameter that influences the NIRF ranking, and there is a positive correlation between capital expenditure and national ranking score. The NIRF ranking system has encouraged universities to improve their research performance, resulting in exponential growth in publication count and citations of top-ranked universities [16]. The article also outlines the objectives and methodology of a new study focused on the top 100 universities in NIRF-2020, which aims to identify the key parameters that determine the ranking of universities and their correlation with research output and library expenditure. The NIRF ranking serves as a significant initiative in enhancing the quality of higher education and research within India. Its positive influence is observed in encouraging institutions to prioritize research, innovation, inclusivity, and collaboration between academia and industry. Despite certain limitations in its methodology, the ranking system has effectively spurred healthy competition among institutions, thereby contributing to the overall advancement of education and research quality in the country. This study examines the effect of sub-parameters on the five prime parameters and their collective effect on the total score of the NIRF 2023 ranking.

2. Methodology:

This research study analyses the top 100 engineering institutions ranked in the NIRF-2023, focusing on the parameters and sub-parameters that significantly influence their rankings. A descriptive cross-sectional research approach is used, and data is sourced from the official NIRF website [6]. Minitab software is used to derive meaningful insights and trends. The results of the current work can be used to classify and prioritise important metrics as institutions attempt to improve their rankings. Through the use of focused approaches in the NIRF assessment, it is possible to improve rankings and improve overall performance. As shown in Table I, there are five prime parameters and sub-parameters for analysing engineering ranking metrics.

Table 1 :Parameters And Sub-parameters of Engineering Ranking (NIRF 2023) [6].

Parameters / Category	Sub-Parameters
1. Teaching, Learning & Resources (TLR)	Student Strength including Doctoral Students (SS)
	Faculty-student ratio with emphasis on permanent faculty (FSR)
	Combined metric for Faculty with PhD (or equivalent) and Experience (FQE)
	Financial Resources and their Utilisation (FRU)
2. Research and Professional Practice (RPP)	Combined metric for Publications (PU)
	Combined metric for Quality of Publications (QP)
	IPR and Patents: Published and Granted (IPR)
	Footprint of Projects and Professional Practice (FPPP)
3. Graduation Outcomes (GO)	Combined metric for Placement and Higher Studies (GPH)
	Metric for University Examinations (GUE)
	Median Salary (GMS)
	Metric for Number of Ph.D. Students Graduated (GPHD)
4. Outreach and Inclusivity (OI)	Percentage of Students from other States/Countries (Region Diversity RD)
	Percentage of Women (Women Diversity WD)
	Economically and Socially Challenged Students (ESCS)
	Facilities for Physically Challenged Students (PCS)
5. Perception (PR)	Peer Perception: Employers & Academic Peer (PR)

In the current work, descriptive statistics of the composed data are analysed, and the percentage of effectiveness is calculated by using (1). This percentage helps as a valued metric, revealing the degree of influence that each parameter has on its respective score.

$$\%\ \text{of Effectiveness} = \frac{\text{Mean value}}{\text{Maximum score attained}} \times 100 \qquad (1)$$

3. Discussion and Analysis:

A. Descriptive Statistics of Sub-parameters of Category TLR:

The TLR parameter assesses engineering institutions' efforts towards the improvement of quality educational, by considering factors such as faculty-student ratio, Ph.D qualified faculty, full-time faculty members, financial resources and student strength. The best educational opportunities, innovative teaching techniques, and adequate resources for student growth and development are prioritized by institutions that excel in this parameter.

Table II presents the descriptive statistics of the sub-parameters of TLR, along with the corresponding effectiveness percentages. The percentage of effectiveness of the four sub-parameters of TLR in Engineering Institutes at NIRF 2023 ranges from 44.18% to 66.40%. Based on the percentage of effectiveness, it can be concluded that Financial Resources & their utilization (FRU) (44.18%) are the least effective sub-parameters in TLR among other sub-parameters & indicate that they contribute the least in TLR score. Therefore, it is evident that more attention and effort should be directed towards improving the FRU score. That is enhancing annual capital expenditure per student (excluding

expenditure on new building construction) and annual operational expenditure per student (excluding hostel maintenance and related services). The action plan includes more funding to improve library facilities, to upgrade existing laboratories& workshops with industry collaboration, to encourage more seminars &conferences, and professors of practice & to enhance faculty members' salary in alignment with state/central government scale of pay.

Table2:Descriptive Statistics of Sub-parameters of TLR

Sub-parameters	N	Mean	St. Dev.	Min.	Max.	% of Effectiveness
SS	20	13.28	4.01	2.89	20.00	66.40
FSR	30	25.30	4.35	15.12	30.00	84.33
FQE	20	15.10	2.28	9.23	19.48	77.52
FRU	30	12.99	4.91	4.12	29.40	44.18

The overlaid histogram in Fig. 1 presents the data distribution for four sub-parameters: SS, FSR, FQE, and FRU. The X-axis represents the score of sub-parameters, while the Y-axis represents the number of institutes. FRU has an average score of 12.99 and a standard deviation of 4.91, indicating variability in the performance of institutes in this area. SS has an average score of 13.28 and a standard deviation of 4.01, displaying a range of performance levels among institutes. FQE and FSR show relatively good scores across ranked institutes, with minor variations in mean scores, suggesting more consistent performance among institutions. The mean score of FRU is 12.99, achieved by 17 out of 100 ranked engineering institutes, making it crucial to improve FRU. Therefore, it is recommended to prioritize efforts towards improving sub-parameters of FRU to improve the TLR category score in the NIRF rankings.

B. Descriptive Statistics of Sub-parameters of Category RPP:

The Research and Professional Practice (RPP) parameter of NIRF engineering institutions evaluates research output and professional practices, identifying strengths and weaknesses in research output and their development. It helps enhance research & consultancy quality. The parameter is divided into four sub-parameters: Combined metric for Publications (PU), Combined metric for Quality of Publications (QP), IPR and Patents: Published and Granted (IPR), and Footprint of Projects and Professional Practice (FPPP).

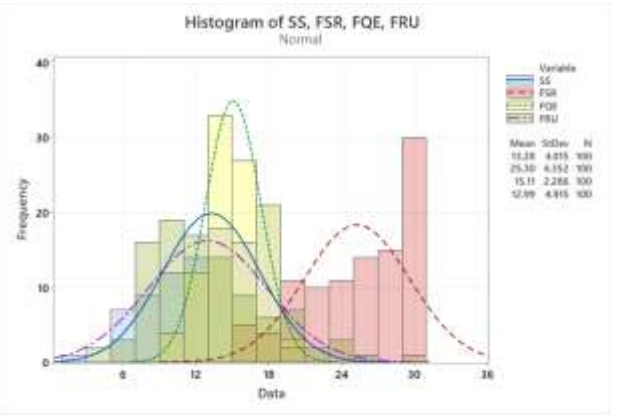

Fig.1 : Shows an overlaid histogram of the TLR sub-parameter.

Table 3:Descriptive Statistics of Sub-parameters of RPP

Sub-parameters	N	Mean	St. Dev.	Min.	Max.	% of Effectiveness
PU	35	16.51	7.70	0.49	35.00	47.17
QP	40	18.32	8.21	1.84	38.72	47.31
IPR	15	4.99	3.83	0.00	15.00	33.27
FPPP	10	1.97	1.97	0.04	10.00	19.70

Table III displays RPP sub-parameters effectiveness percentages for evaluating engineering institute performance. By analyzing the data in Table III, the effectiveness percentages in the table range from 19.70% to 47.31%, representing the extent of influence these sub-parameters have on the respective score. Among the sub-parameters of RPP, FPPP exhibits the lowest effectiveness percentage (19.70%), suggesting that it contributes the least to the RPP score. Therefore, based on the information provided in Table III, it is evident that more attention and effort should be directed toward improving the FPPP score. Improving average annual research funding earnings per faculty and average annual consultancy amount per faculty is crucial for improving the FPP score. This necessitates creating a conducive research ecosystem through the identification of research-inclined faculty members, conducting structured training programs, augmenting research infrastructure, strengthening the research policies & encouraging inter & intra-disciplinary research collaboration. The above initiatives will encourage faculty members to acquire more external research grants, and consultancy projects and to improve the FPPP score. This, in turn, leads to an improvement in the overall RPP score for engineering institutes.

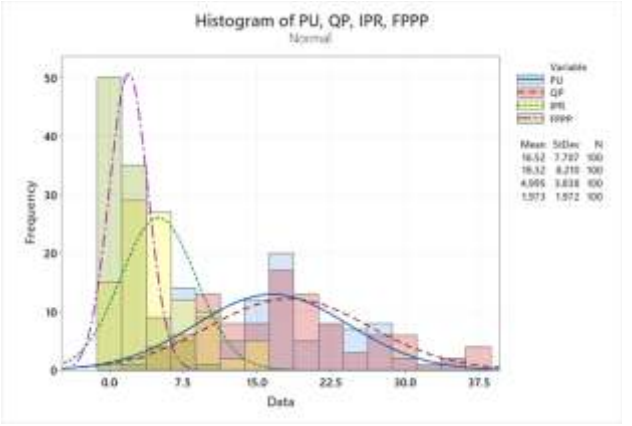

Fig.2:Shows an overlaid histogram of RPP sub-parameters.

Fig. 2 shows a histogram showing sub-parameter scores for RPP, showing over 60% of top-ranked engineering institutes have scores below 2 in FPPP. The mean and standard deviation align with the overall score distribution. However, only a limited number of institutions have achieved a commendable score in FPPP. For the sub-parameter IPR, the mean score is comparatively lower than that of QP and PU. Over 25 institutions have obtained scores below 5 in IPR, indicating below-average performance in this aspect, with only a few institutions managing to attain a good score. In terms of PU and QP, the scores are widely scattered across a range of 0.5 to 38 among the top 100 institutions in NIRF 2023. This signifies significant variation in the performance of these sub-parameters, with some institutions scoring very low and others achieving relatively higher scores. Overall, Fig. 2 highlighted the variation in the performance of the top-ranked engineering institutes, in the sub-parameter FPPP. It underscores the need for improvement in the FPPP score to enhance the overall RPP score for better rankings of the institutions.

C. Descriptive Statistics of Sub-parameters of Category GO:

Graduation Outcomes (GO) is a crucial NIRF engineering parameter that evaluates graduating students' employability-related skills and success in placements, higher education pursuits, and entrepreneurship initiatives. It includes sub-parameters like Combined metric for Placement and Higher Studies (GPH), Metric for University Examinations (GUE), Median Salary (GMS), and Metric for Number of Ph.D. Students Graduated (GPHD). GO focuses on the effectiveness of education and training programs in preparing graduates for the real world, emphasizing practical skills, industry exposure, and entrepreneurial spirit.

Table IV shows effectiveness percentages for GO sub-parameters, ranging from 30.65% to 97.07%, evaluating engineering institute performance. GPHD has the lowest effectiveness percentage, suggesting more attention and efforts should be directed towards improving its score. To achieve this, focus on recruiting competent research faculty, forming partnerships, increasing research stipends, establishing scholarships, investing in modern facilities, and offering research support services such as research methodology workshops, data analysis assistance, and grant application support.

Table 4:Descriptive Statistics of Sub-parameters of GO.

Sub-parameters	N	Mean	St. Dev.	Min.	Max.	% of Effectiveness
GPH	40	30.00	5.57	9.75	38.72	77.48
GUE	15	14.56	0.91	9.87	15.00	97.07
MS	25	14.93	3.95	8.72	25.00	59.72
GPHD	20	6.13	4.55	0.15	20.00	30.65

Fig. 3 shows a histogram of GO sub-parameters, with the X-axis representing scores and Y axis representing the number of institutes. Most institutions have scores below 50% for GPHD, while MS has a normal distribution pattern, indicating a more balanced score distribution. Over 85% of institutions have achieved favorable scores in GUE and GPHE sub-parameters, indicating higher performance. The histogram in Fig. 3 suggests focusing on improving GPHD sub-parameters. A significant number of institutions are not scoring well in GPHD, indicating the need for targeted efforts and interventions. Prioritizing initiatives to improve GPHD can help institutions achieve a more balanced and higher overall score in the GO domain.

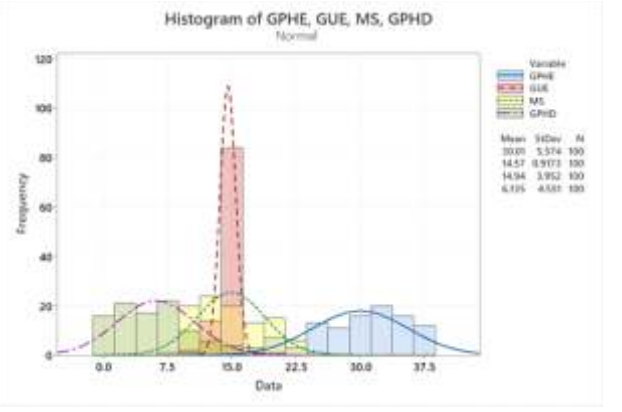

Fig. 3 : Shows overlaid histogram of sub-parameters of GO.

D. Descriptive Statistics of Sub-parameters of Category OI:

The 'Outreach and Inclusivity (OI)' parameter in NIRF engineering institutions evaluates an institution's efforts to promote inclusivity in education and engage with diverse communities. It considers factors such as Regional Diversity (RD), Women's Diversity (WD), Economic and Socially Challenged Students (ESCS), and facilities for Physically Challenged Students (PCS). An institution's sub-parameters, which represent its dedication to offering assistance and equal opportunities to students from diverse backgrounds, regulate its inclusiveness and outreach focus.

Table 5 : Descriptive Statistics of Sub-parameters of OI.

Sub-parameters	N	Mean	St.Dev.	Min.	Max.	% of Effectiveness
RD	30	15.16	6.35	0.36	25.66	59.08
WD	30	19.28	5.86	8.99	30.00	64.27
ESCS	20	4.85	3.33	0.00	12.68	38.25
PCS	20	19.78	2.00	0.00	20.00	98.90

Table V shows descriptive statistics and effectiveness percentages of OI sub-parameters, assessing engineering institute performance. The percentages range from 38.25% to 98.90%, indicating the influence these parameters have on scores. Among the sub-parameters of OI, ESCS has the lowest effectiveness percentage among OI sub-parameters, contributing the least to the overall score. To improve the ESCS score, more focus and effort are required, as shown in Table V. Educational institutions can help students facing economic and social challenges by offering financial aid and scholarships to make education more accessible. They can also create outreach initiatives like career counselling, workshops, and mentorship programs. Collaborations with local schools, NGOs, and community groups can help identify talented students who may need extra support. This approach promotes diversity and inclusivity in the student community.

The overlaid histogram in Fig. 4 shows that 90% of ranked institutions have scores below 75% for the ESCS sub-parameter, indicating poor inclusivity and support for economically and socially challenged students. The histogram also shows a scattered distribution pattern for regional diversity (RD) and women diversity (WD). This suggests that the institutions' performance in diversity and inclusion varies, with some demonstrating stronger efforts.

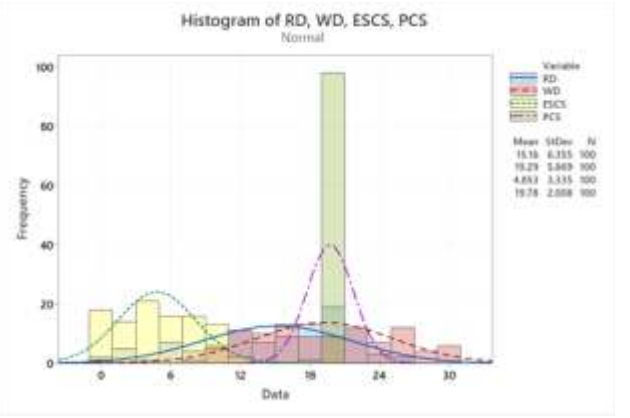

Fig.4: Shows an Overlaid Histogram of Sub-parameters of OI.

However, over 95% of institutions achieve favorable scores in the PCS sub-parameter, indicating higher OI performance. Fig. 4 shows that ESCS sub-parameter improvement is crucial for institutions to enhance support and inclusivity for economically and socially challenged students. Targeted interventions can improve overall OI domain scores, promoting a more supportive educational environment.

E. Perception (PR):

Perception (PR) is a valuable parameter in the NIRF ranking of engineering institutions. It directs on the perception of an institution amongst different stakeholders, including students, parents, alumni, and industry experts. The perception of an institution shows a vital role in deciding its reputation and image. It indicates how the institution is perceived in terms of its academic environment, research output, faculty quality, industry collaborations, infrastructure, and overall performance. The objective of the perception parameter is to capture the subjective viewpoints and

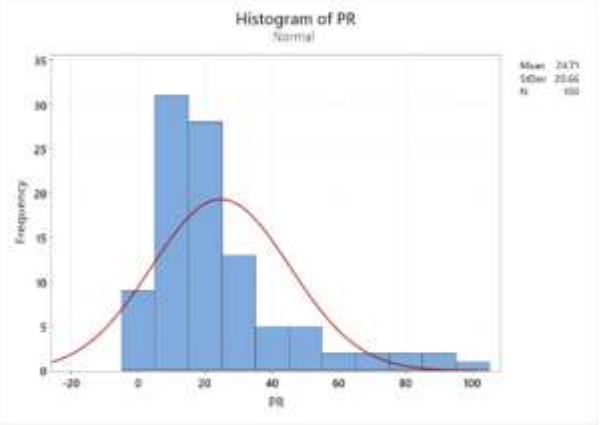

Fig.5 : Shows a histogram of perception.

perspectives of individuals involved in the field of engineering education with regards to the quality and reputation of the institution. The assessment of the PR parameter is conducted through the administration of surveys and the collection of feedback from various individuals, including students, alumni, industry professionals, and other stakeholders. These gathered opinions and perceptions are then thoroughly analysed in order to assess the institution's standing and reputation. The scores obtained in this particular parameter serve as an indication of the overall perception of the institution and its ability to positively influence both students and the industry.

Perception analysis evaluates institutions' perceptions by stakeholders. The mean score is 24.71, with over 80% of NIRF 2023 ranked institutes having scores below 75% of the total perception parameter. Fig. 5 shows this disparity. Most institutes have potential for improvement in their brand image and stakeholder perception. To improve rankings and perception scores, they should prioritize building a positive brand image through communication, academic achievements, collaborative research contributions, industry partnerships, and community outreach. This will help them achieve higher scores in perception parameters in future assessments.

F. NIRF rankings on five prime Parameters of Engineering Institutions:

The NIRF ranking system uses five parameters to rank engineering institutions: TLR, RPP, GO, OI, and Perception. Each parameter is weighted differently, and rankings are assigned based on performance relative to others. A comparison on NIRF 2021, 2022 and 2023 is carried out.

Table VI presents the descriptive statistics and effectiveness percentages for the parameters utilized in NIRF 2021 for the assessment of engineering institute performance. The effectiveness percentages range from 25.39% to 72.84%, illustrating the impact of each parameter on its respective score. Notably, PR and RPP exhibit the lowest effectiveness percentages among the parameters, signifying their minimal contribution to the overall NIRF 2021 score.

Table 6 : Descriptive Statistics of NIRF 2021: TLR, RPP, GO, OI, Perception.

Sub-parameters	N	Mean	St. Dev.	Min.	Max.	% of Effectiveness
TLR	100	65.76	9.765	39.72	95.47	68.88
RPP	100	35.45	20.67	3.02	96.43	36.76
GO	100	63.37	10.77	38.54	90.74	69.83
OI	100	55.86	7.142	39.40	76.68	72.84
PR	100	25.39	22.41	0.00	100	25.39

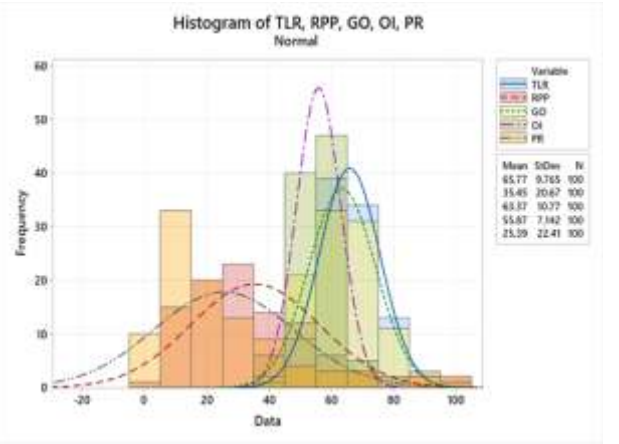

Fig.6 : Shows overlaid histogram of NIRF 2021 Engineering Parameters.

Figure 6 presents a histogram analysis of NIRF 2021 engineering parameters. The illustration reveals that a significant majority, approximately 80% of the ranked institutions, have achieved scores below 60% for parameters PR and RPP, indicating suboptimal performance in perception and research domains. Conversely, the histogram depicts comparable distribution patterns for parameters TLR, GO, and OI, with slight variations in mean scores. This implies a consistent performance across the ranked institutions in these specific parameters.

Table 8 : Descriptive Statistics of NIRF 2022: TLR, RPP, GO, OI, Perception.

Sub-parameters	N	Mean	St. Dev.	Min.	Max.	% of Effectiveness
TLR	100	65.49	10.21	38.30	94.61	69.22
RPP	100	38.36	20.42	5.32	97.66	39.27
GO	100	64.34	10.36	44.02	90.13	71.38
OI	100	57.14	7.34	41.34	79.48	71.89
PR	100	25.17	21.34	1.60	100	25.17

Table VII exhibits the descriptive statistics and effectiveness percentages pertaining to the parameters employed in the evaluation of engineering institute performance within the NIRF 2022 framework. The data spans a range from 25.17% to 71.89%, reflecting the impact of each parameter on its respective score. Notably, among these parameters, PR and RPP demonstrate the least effectiveness percentages, implying their minimal contribution to the overall NIRF 2022 score.

Figure 7 illustrates a overlaid histogram analysis of

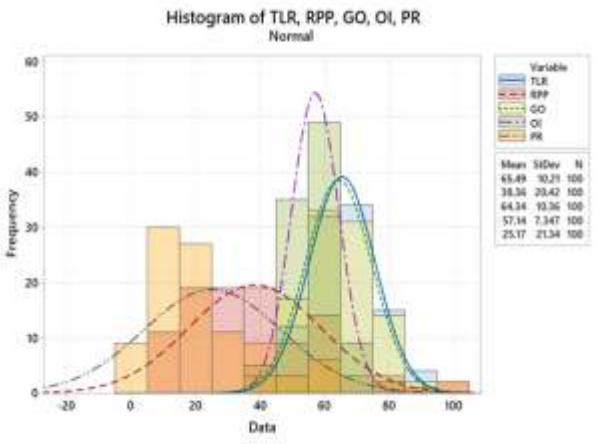

Fig.7 : Shows overlaid histogram of NIRF 2022 Engineering Parameters.

NIRF 2022 engineering parameters. The depiction reveals that a considerable proportion, approximately 70% of the ranked institutions, have attained scores below 60 % for parameters PR and RPP, signifying suboptimal performance in perception and research domains. Conversely, the histogram demonstrates comparable distribution patterns for parameters TLR, GO, and OI, with slight variations in mean scores. This suggests a consistent performance across the ranked institutions in these specific parameters.

Table 8 : Descriptive Statistics of NIRF 2023: TLR, RPP, GO, OI, Perception.

Sub-parameters	N	Mean	St. Dev.	Min.	Max.	% of Effectiveness
TLR	100	66.68	8.66	44.65	95.20	70.04
RPP	100	41.81	19.11	5.70	96.41	43.37
GO	100	65.64	10.73	34.86	88.99	73.76
OI	100	59.08	7.307	39.17	79.56	74.26
PR	100	24.71	20.66	0.40	100.00	24.71

Table VIII displays the effectiveness percentages and descriptive statistics of parameters used in NIRF 2023 to evaluate engineering institute performance. The data ranges from 24.71% to 70.04%, indicating the influence of each parameter on its score. Among the parameters, PR and RPP have the lowest effectiveness percentages, making the least contribution to the overall NIRF score.

The tables (VI, VII, and VIII) show the effectiveness percentages of parameters used in NIRF rankings for engineering institutes in 2021, 2022, and 2023, with PR and RPP showing the lowest effectiveness percentages, indicating their limited contribution to overall NIRF scores. In light of these observations, it is recommended that institutes focus on enhancing PR and RPP scores. Implementing measurable actions, such as refining research policies, fostering collaborative interdisciplinary projects, and strengthening industry partnerships, can contribute to improvements. Additionally, introducing academic incentives, such as credits for student publications in indexed journals, is advised. These strategic initiatives address specific areas highlighted in the respective sections, aiming to elevate overall rankings in the NIRF engineering assessments.

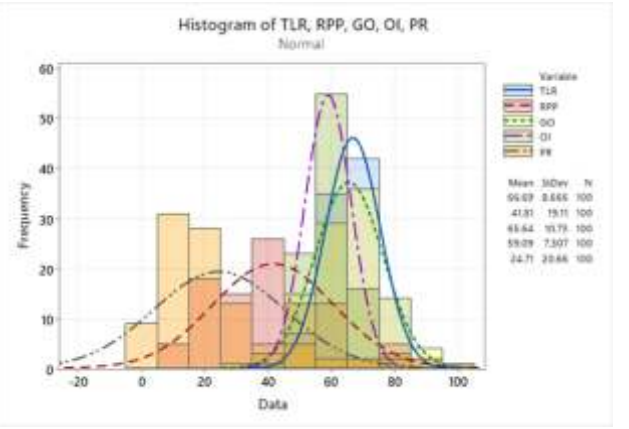

Fig.8 : Shows overlaid histogram of NIRF 2023 Engineering Parameters.

Fig. 8 displays a histogram analyzing NIRF 2023 engineering parameters. It shows that 75% of ranked institutions have scores below 60% for PR and RPP, indicating inadequate performance in perception and research aspects. On the other hand, the histogram shows similar distribution patterns for TLR, GO, and OI parameters, with minor variations in mean scores, suggesting consistent performance across ranked institutions.

The above analysis of NIRF 2021, 2022 and 2023 engineering parameters shows consistent trends across different years, with a majority of ranked institutions scoring below 60% for PR and RPP, indicating suboptimal performance in perception and research domains. However, TLR, GO, and OI parameters show consistent performance across institutions. The histograms highlight the need for improvements in perception and research aspects. Institutions aiming for better NIRF engineering scores can focus on enhancing stakeholder perception, research activities, and creating a conducive environment for high-quality research and professional practice, leading to improved PR and RPP parameters and enhanced rankings.

4. Conclusions:

The findings of the present study on the top 100 Engineering Institutes of NIRF 2023 rankings yield the following conclusions:

1. NIRF Rankings' complexity, encompassing diverse parameters and sub-parameters, makes it impossible for a single measure to fully encompass the entire spectrum.

2. The NIRF Rankings consist of five parameters and seventeen sub-parameters.

3. The seventeen sub-parameters are categorized into five distinct groups based on their intrinsic characteristics, namely teaching, learning, and resources; research and professional practice; graduation outcomes; outreach and inclusivity; and perception.

4. The NIRF 2021, 2022 and 2023 top 100 engineering institution rankings show parameter 2 - Research & Professional Practice and parameter 5 – Perception are the least effective. Strengthening a conducive research ecosystem requires identifying research-oriented faculty, implementing training programs, enhancing infrastructure, and fostering interdisciplinary collaborations and robust industry–institute partnerships.

5. Evaluation of seventeen sub-parameters effectiveness in major categories.

    - The sub-parameter "Financial Resources & their Utilization (FRU - 44.18%)" in Category 1 - TLR needs improvement, focusing on increasing annual capital and operational expenditure per student.

    - The least effective sub-parameter, "Footprint of Projects and Professional Practice (FPPP - 19.70%)" from RPP, should be addressed to improve faculty research funding earnings and consultancy amounts.

    - The sub-parameter "Number of Ph.D. Students Graduated (GPHD - 30.65%)" in Category 3 - GO is the least effective. To address this, strategic actions like hiring strong research faculty, increasing stipends, and fellowships, improving research infrastructure, establishing research support services, and fostering partnerships with industries and research institutions are recommended.

    - The least effective sub-parameter in Category 4 - OI is ESCS (38.25%). To improve inclusivity, the institution should offer financial aid and scholarships to economically disadvantaged students. This can be achieved through funding, philanthropic efforts, alumni contributions, and industry CSR initiatives.

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