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Unveiling the Open Access Friendliness of NIRF Ranked Deemed Universities of India through Data Carpentry

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The present study emphasizes on the investigation of the openness to open access in the Indian deemed universities ranked in the National Institutional Ranking Framework 2021 under the "overall" top 100 categories. The research analysed the publication data from the Web of Science spanning ten years from the year 2011 to 2020. The scrutiny of the open access friendliness was focused on two main aspects: the sharing of OA publications and the use of licenses in OA publications. The conclusions reveal that, among the total publications, 29.15% were disseminated through four OA routes (Green OA, Gold OA, Hybrid OA, and Bronze OA). The highest percentage (43.85%) of the OA publications fall under "Gold OA." Out of a total of 13,066 (56.86%) articles, a legal license was applied for, with CC-BY being the preferred license. The study identifies JSS Academy of Higher Education and Research as the leader in open access friendliness, securing the first position with an OAF score of 68.46.

Keywords: *Open Access; Open Access Friendliness Indicator; OAF Ranking; OpenRefine; NIRF, Unpaywall*

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0 INTRODUCTION

During the past two decades, the concept of Open Access (OA) has flourished globally due to the Internet[1]. India also embraced the open-access philosophy in 2002, integrating it into scholarly publications through open access routes[2]. OA articles primarily utilize two strategic methods: self-archiving in repositories and publication in open access journals. The key requirements include free availability on the public Internet, enabling users to read, download, copy, distribute, print, search, or link to full-text articles. Additionally, it allows swarming for indexing and utilization of any lawful purpose without financial, legal, or technical barriers.

A large number of scholars have striven to measure open access indicators globally, regionally, and at the national level, examining the share of open access publications in diverse routes and repositories[3,4,5]. A novel approach involved testing open access uptake at the institutional level across the globe, combining Web of Science, Unpaywall, and the Leiden Ranking[6,7,8]. The discoveries highlighted variations in OA shares across countries, subjects, and universities. A recent scientometric study by Mukhopadhyay[9] explored the open access friendliness of top IITs, revealing the adoption of open access policies by newly established IITs. Roy & Mukhopadhyay also evaluated the open access friendliness of central universities, state universities, and the National Institutes of Technology (NITs)[9,10,11,12].

This study assesses the open access friendliness of Indian deemed universities structuring on the above-mentioned context. The open access friendliness framework, proposed by Mukhopadhyay, employs a weightage scale of 100 points and encompasses two primary areas: (a) share of OA publications, and (b) use of licenses in OA publications. These primary areas are further divided into five factors. The "share of OA publications" is segmented into three factors: (i) share of total OA publications, (ii) OA share in green and gold routes, and (iii) Green OA share in the repository. The "use of a license in OA publications" is divided into two components: (i) share of total license in OA publications, and (ii) share of license in Gold OA and Green OA. The research sample comprises 26 deemed universities of India (refer to Table-1) ranked in the National Institutional Ranking Framework (NIRF) 2021 in the overall ranking.

TABLE-1

01 Deemed Indian Universities in NIRF (2017-2021) in the Overall Category

SN	Name of the Institutions (Year of Establishment)	NIRF Rank List (2017-2021)				
		2017	2018	2019	2020	2021
1	Indian Institute of Science, 1909	1	1	2	2	2
2	Amrita Vishwa Vidyapeetham, 1994	16	15	15	13	12
3	Manipal Academy of Higher Education,1957	30	18	16	14	15
4	Vellore Institute of Technology,1984	22	24	32	28	21
5	Institute of Chemical Technology, 1933	41	30	27	34	27
6	Birla Institute of Technology & Science,1964	21	26	39	27	29
7	Homi Bhabha National Institute, 2005	35	41	30	30	36
8	Siksha `O` Anusandhan University, 1996	33	38	41	38	37
9	Kalinga Institute of Industrial Technology, 1992	79	65	50	44	39
10	Shanmugha Arts Science Technology & Research Academy, 1984	50	54	63	48	42
11	Thapar Institute of Engineering & Technology, 1956	75	50	45	51	45
12	Saveetha Institute of Medical and Technical Sciences, 2005	91	70	67	66	49
13	S. R. M. Institute of Science and Technology, 1985	55	63	52	58	53
14	JSS Academy of Higher Education and Research, 2008	NL	59	55	54	56
15	Sathyabama Institute of Science and Technology, 1987	72	68	64	61	61
16	Jamia Hamdard University,1989	42	37	31	37	64
17	Banasthali Vidyapith, 1935	89	91	87	79	66
18	Symbiosis International, 1971	97	67	82	73	68
19	Koneru Lakshmaiah Education Foundation University, 1980	NL	83	74	70	69
20	Tata Institute of Social Sciences, 1936	49	49	56	57	70
21	Kalasalingam Academy of Research and Higher Education, 1984	NL	NL	NL	NL	74
22	Bharath Institute of Higher Education & Research, 1984	35	35	57	87	75
23	Sri Ramachandra Institute of Higher Education and Research, 1985	61	62	54	51	79
24	Dr. D. Y. Patil Vidyapeeth, 1996	76	79	70	75	80
25	SVKM`s Narsee Monjee Institute of Management Studies, 1981	NL	82	83	92	94
26	Datta Meghe Institute of Medical Sciences, 2005	NL	NL	92	97	100

1 INDICATOR FOR OPEN ACCESS FRIENDLINESS (OAF)

The current section profiles the Open Access Friendliness Indicators (OAFI). Open-access friendliness is dependent on the accessibility, reusability,

and findability of open access publications. Mukhopadhyay introduced the OAFI in his study. This research determined open access friendliness through two key areas: (1) the share of open access publications, and (2) the utilization of a license in OA publications. Both of these aspects are entirely dependent on the strategy of an institution's publication and awareness of OA licenses. The two primary areas are further characterized into five factors (as detailed in Table-2), utilizing a 100-point scale. The OAFI calculations have been computed as proposed by Mukhopadhyay in his study.

TABLE-2

11 Areas, Groups and Factors for Calculating OAFI

Areas	**Groups within the area (with distributed weightage)**		
OA Publications (Area weightage: 60)	**OA share (Group weightage: 30)**	**Green and Gold OA share (Group weightage: 15)**	**Repository share (Group weightage: 15)**
OA Licensing (Area weightage: 40)	OA License Share (Group weightage: 30)	Gold and Green License Share (Group weightage: 10)	

2 SCOPE

The scope of the study is confined to NIRF-ranked deemed universities in India. A total of 26 deemed universities are included in the NIRF (2021) overall ranking. The NIRF overall ranking amalgamates seven subject domains: Engineering, Management, Pharmacy, Law, Medical, Architecture, and Dental. Additionally, it is considered into three bands: rank band I (1-100), rank band II (101-150), and rank band III (151-200). The present study specifically focuses on the 26 deemed universities belonging to rank band I (1–100).

3 OBJECTIVES

The primary purpose of the present study is to divulge the status of open access friendliness among NIRF-ranked deemed universities in India. The specific objectives for this purpose are as follows:

- To scrutinize the growth of open access publications of deemed universities during 2011–2020.
- To identify the use of licenses in OA publications.
- To determine the preferred open access journals and publishers.
- To assess the open access friendliness of deemed universities in India.

4 METHODOLOGY : SELECTION OF INSTITUTIONS

A deemed university is a higher education institution declared by the

Government of India under Section 3 of the UGC Act, 1956, specializing in specific areas of study. There is a total of 124 deemed universities in India. Out of these, 26 deemed universities have been ranked in NIRF's (2021) overall ranking (top 1-100) with ranks ranging from 2 to 100 (refer to Table-1).

TABLE-3

41 Primary Dataset

SN	Name of Deemed Universities	Total Publications (2011-2020)	Publications with DOI	NIRF Rank 2021
1	Indian Institute of Science	19107	18276	2
2	Vellore Institute of Technology	8372	7830	21
3	Homi Bhabha National Institute	7420	7331	36
4	Manipal Academy of Higher Education	7577	6676	15
5	Thapar Institute of Engineering & Technology	5201	4919	45
6	Birla Institute of Technology & Science	4790	4607	29
7	S. R. M. Institute of Science and Technology	4834	4595	53
8	Institute of Chemical Technology	3817	3705	27
9	Shanmugha Arts Science Technology & Research Academy	3470	3275	42
10	Jamia Hamdard	3176	2877	64
11	Siksha `O` Anusandhan	2055	1930	37
12	Kalinga Institute of Industrial Technology	1903	1798	39
13	Sathyabama Institute of Science and Technology	1568	1340	61
14	Banasthali Vidyapith	1317	1214	66
15	Kalasalingam Academy of Research and Higher Education	1281	1206	74
16	JSS Academy of Higher Education and Research	1448	1137	56
17	Koneru Lakshmaiah Education Foundation University	1145	1086	69
18	Sri Ramachandra Institute of Higher Education and Research	1237	997	79
19	Amrita Vishwa Vidyapeetham	1004	962	12
20	Dr. D. Y. Patil Vidyapeeth	857	764	80
21	SVKM`s Narsee Monjee Institute of Management Studies	747	711	94
22	Saveetha Institute of Medical and Technical Sciences	670	595	49
23	Bharath Institute of Higher Education & Research	547	512	75
24	Symbiosis International	506	473	68
25	Tata Institute of Social Sciences	483	427	70
26	Datta Meghe Institute of Medical Sciences	314	250	100
Total Publications		**84,846**	**79,493**	

5 DATASETS

DEVELOPMENT OF PRIMARY DATASETS

Throughout the decade from 2011 to 2020, publications from 26 deemed universities were congregated from the Web of Science (WoS) core collections in "CSV" format. There was a limitation of the Web of Science where users were permitted to download only 1000 publications at a given time and the data was collected year-wise (e.g., 2011). Subsequently, the publication data from all 26 institutions were consolidated into a single "CSV" file using a data carpentry tool. The table displaying the publications of these 26 deemed universities is presented in Table-3.

DEVELOPMENT OF SECONDARY DATASET

The foremost dataset was compiled by consolidating publications for ten years spanning through the years 2011 to 2020) across 26 deemed universities. The subsequent step involves in determining the Open Access (OA) status of these publications by uploading the merged CSV file into OpenRefine. The open-source data carpentry tool retrieved the OA status of the publications from Unpaywall through an Application Programming Interface (API). Table-4 displays the OA status of publications as provided by Unpaywall. Out of 79,493 DOI publications, Unpaywall presented the status for 78,825 publications, accounting for 99.16%.

TABLE-4

51 Unpaywall - API Calls and Results

API call structures for Unpaywall	**No. of queries sent**	**Responses received**
"https://api.unpaywall.org/v2/" +value +"?email=<your-mail-id-here" Value is DOI	79,493 Publications with DOI	78,825 99.16% of publications with DOI

DATA EXTRACTION

In the final step, the Open Access (OA) status of all publications responded by Unpaywall were extracted. Unpaywall furnishes comprehensive details for each DOI publication, including information such as title, genre, OA status, authors, publisher name, journal name, in JavaScript Object Notation (JSON) format. OpenRefine automatically extracts pertinent information from JSON data using the General Refine Expression Language (GREL). A set of examples is provided in Table-5.

TABLE-5

5.2 GREL: An Example to Extract Data from Unpaywall Datasets

Response from Unpaywall in JSON	GREL for data extraction	Extracted data
"genre":"journal-article "published_date": "2011-12-01", "year": 2011, "journal_name": "Plant Methods", "journal_issns": "1746-4811", "journal_issn_l": "1746-4811", "journal_is_oa": true, "journal_is_in_doaj": true, "publisher": "Springer Science and Business Media LLC", "is_oa": true, "oa_status": "gold", "has_repository_copy": true, "license": "cc-by", "version": "publishedVersion", "host_type": "publisher",	value.parseJson().has_repository_copy	True
	value.parseJson().journal_is_in_doaj	True
	value.parseJson().publisher	Publisher
	value.parseJson().journal_is_oa	True
	value.parseJson().is_oa	True
	value.parseJson().oa_locations[0].license	CC-BY

6 DISCUSSIONS AND FINDINGS

This section of the present study has examined the Open Access (OA) contributions of the 26 deemed universities listed in the NIRF 2021 ranking under the overall top hundred categories.

GROWTH OF OA PUBLICATIONS

An analysis of the merged datasets spanning ten years from the year 2011 to 2020 from the 26 deemed universities revealed that 70.85% of documents (n=55,846) were published in closed access, while 29.15% of documents (n=22,979) were published in open access. These open access publications were distributed across four open access routes: Gold OA (n=10,076, 43.85% of total OA publications), Green OA (n=6331, 27.55% of total OA publications), Bronze OA (n=4214, 18.34% of total OA publications), and Hybrid OA (n=2358, 10.26% of total OA publications). The Figure-1 illustrates that the highest number of OA publications from the 26 deemed universities was distributed in Gold OA.

The tabulated data discloses that the proportion of OA publications remained consistently above 25% over the ten-year period (2011-2020). The maximum percentage (30.97%) of OA share from deemed universities was observed in 2019, while the lowest percentage (25.33%) occurred in 2014. Additionally, the tabulated data shows a significant increase in "total publications" by 337%, with closed access experiencing a growth of 314%, and open access exhibiting a growth of 399%, considering the respective categories based on the lowest and the highest value range. Among OA categories, Hybrid OA demonstrated

the highest growth at 872%, followed by Gold OA (518%), Green OA (318%), and Bronze OA (194%).

Among the 26 deemed universities, the top five with the highest numbers of OA distributed publications are - Indian Institute of Science (n=6845, 29.79% OA publications), Homi Bhabha National Institute (n=2887, 12.56% OA publications), Manipal Academy of Higher Education (n=2833, 12.33% OA publications), Vellore Institute of Technology (n=1549, 6.74% OA publications), and Birla Institute of Technology & Science (n=1067, 4.64% OA publications).

TABLE-6

61 Growth of OA in Deemed Universities

(For Publications with Open/Close Status from Unpaywall)

Year	Total Pub.	Closed Access Pub.	Open Access Pub.	Open Access Categories				% of OA in Total Pub.
				Green	Gold	Bronze	Hybrid	
2011	3,457	2,524	933	283	368	227	55	26.99%
2012	3,957	2,886	1,071	352	384	267	68	27.07%
2013	4,660	3,460	1,200	384	450	286	80	25.75%
2014	5,594	4,177	1,417	355	561	368	133	25.33%
2015	6,147	4,531	1,616	449	628	364	175	26.29%
2016	7,100	5,058	2,042	535	822	504	181	28.76%
2017	8,843	6,182	2,661	736	1,191	477	257	30.09%
2018	10,784	7,479	3,305	876	1,532	496	401	30.65%
2019	13,166	9,089	4,077	1,183	1,864	557	473	30.97%
2020	15,117	10,460	4,657	1,178	2,276	668	535	30.81%
Total	**78,825**	**55,846**	**22,979**	**6,331**	**10,076**	**4,214**	**2,358**	**29.15%**

LICENSES OF OA PUBLICATIONS

The study investigated the use of licenses in Open Access (OA) publications, as depicted in Table-7. A total of 13,066 OA publications (58.68% of deemed universities' OA publications) were distributed with a legal license. The percentage of licenses employed in OA publications witnessed an alarming increase, rising from 47.59% in 2011 to 61.48% in 2020. A prominent aspect is that 7,976 OA publications (61.04% of total licensed publications) from deemed universities were published under the most liberal licenses, including CC0 (31), CC-BY (7,895), Public Domain (42), and CC-BY-SA (8). Among these, CC-BY emerged as the most utilized OA license. At the institutional level, the JSS Academy of Higher Education and Research had OA licenses for 75.1% of its publications, while the Indian Institute of Science had OA licenses for 44.38% of its publications.

TABLE-7

62 Growth of License in Deemed Universities

(For Publications with OA Status from Unpaywall)

Year	Total OA Pub.	OA Pub. without a License	OA Pub. with License	License Categories		% of License in OA Pub.
				Most Liberal License	Less Liberal License	
2011	933	489	444	257	187	47.59%
2012	1,071	600	471	281	190	43.98%
2013	1,200	608	592	325	267	49.33%
2014	1,417	632	785	435	350	55.40%
2015	1,616	706	910	481	429	56.31%
2016	2,042	879	1,163	609	554	56.95%
2017	2,661	1,138	1,523	846	677	57.23%
2018	3,305	1,337	1,968	1,314	654	59.55%
2019	4,077	1,730	2,347	1,497	850	57.57%
2020	4,657	1,794	2,863	1,931	932	61.48%
Total	**22,979**	**9,913**	**13,066**	**7,976**	**5,090**	**56.86%**

PROLIFIC OPEN ACCESS JOURNALS AND PUBLISHERS IN VARIOUS OA CATEGORIES

Gold OA publications (n=10,076, 43.85% of total OA publications) have been published in a total of 1,066 OA journals, encompassing three document formats: journal article (n=10,072, 99.96%), proceedings article (n=3, 0.03%), and as a component (n=1). Of these, 889 journals (90.64% of total OA journals) are listed in the Directory of Open Access Journals (DOAJ). The top five OA journals are Scientific Reports (n=622, 6.17%), Journal of High Energy Physics (n=586, 5.82%), PLoS ONE (n=536, 5.32%), IEEE Access (n=245), and Physics Letters B (n=245). The Gold OA publications from deemed universities were published by 272 publication agencies, with the top five publishers being Springer Science and Business Media LLC (n=2,277, 22.60%), Elsevier BV (n=1,359, 13.49%), MDPI AG (n=781), Medknow (n=718), and the Public Library of Science (n=643). In the licensing scenario of Gold OA publications, 93.43% of Gold OA has been published with legal licensing. The most popular OA license used in Gold OA publications is CC-BY (n=6,355, 67.51% of total Gold OA publications). Out of the 26 deemed universities, the top five Gold OA contributors have been the Indian Institute of Science (n=2,023, 20.08% of total Gold OA publications), Manipal Academy of Higher Education (n=1,408), Homi Bhabha National Institute (n=1,007), Vellore Institute of Technology (n=1,002), and Jamia Hamdard (n=503).

The Green OA publications (n=6,331, 27.55% of total OA publications) have been distributed to 1,551 closed-access journals. The top five closed-access journals are Physical Review B (n=315, 4.98%), Physical Review D

(n=173, 2.73%), Physical Review E (n=122), Physical Review A (n=117), and Indian Journal of Pharmacology (n=107). In the Green OA licensing scenario, 612 publications (9.67% of total Green OA publications) have been published with 9 types of licenses: CC-BY-NC-SA (n=201, 32.84% of licensing publications), CC-BY-NC-ND (n=137, 22.39%), CC-BY (n=128, 20.92%), Implied-OA (n=99, 16.18%), CC-BY-NC (n=25), Public Domain (n=10), CC0 (n=6), CC-BY-ND (n=3), and CC-BY-SA (n=3). The Green OA publications of 26 deemed universities have been published by 151 publication agencies, with the top five publishers being Springer Science and Business Media LLC (n=1166, 18.42% of total Green OA), Elsevier BV (n=1156, 18.26%), American Physical Society (n=924, 14.59%), IOP Publishing (n=381, 6.02%), and Wiley (n=354, 5.59%). Out of the total Green OA publications, 52.63% (n=3332) are "submitted versions", 1557 articles are "published versions", and 1439 articles are "accepted versions". There are 3 articles with unidentified versions. Unpaywall provides the name of the "repository institution" under "best-on-location", and 85.58% (n=5418) of the total Green OA publications have been deposited in 301 institutional repositories worldwide.

According to the study of the data, the top five institutional repositories are arXiv of Cornell University (n=2883 Green OA), Europe PMC of PubMed Central (n=1051 Green OA), ePrints@IISc of Indian Institute of Science (n=263 Green OA), CiteSeerX (n=50 Green OA), and ePrints@Bangalore University of Bangalore University (n=48 Green OA). A notable facet of the institutional repositories is that two of the top five repositories belong to India. Out of the 26 deemed universities, a total of 6.13% (n=332) of Green OAs are available in six Indian institutional repositories. The top five Indian institutional repositories are the Indian Institute of Science-ePrints@IISc (n=263), Bangalore University-ePrints@Bangalore University (n=48), CSIR-The National Physical Laboratory (NPL)-IR@NPL (n=12), Indian Institute of Technology Hyderabad-Research Archive of Indian Institute of Technology Hyderabad (n=4), and Mysore University Library-MyPrints@UOM (n=4). The highest Green OA contributing institution among the 26 deemed universities is the Indian Institute of Science (n=2724, 43.03% of total Green OA publications).

The Bronze OA publications (n=4,214, 18.34% of total OA publications) are accessible through 1,141 closed-access journals by 173 publication agencies. The top five publication agencies are Springer Science and Business Media LLC (n=906, 21.50% of total Bronze OA), Elsevier BV (n=824, 19.55%), Wiley (n=410, 9.73%), Informa UK Limited (n=294, 6.98%), and Oxford University Press (n=267, 6.98%). The top five journals are Value in Health (n=181, 4.30% of total Bronze OA), Sadhana (n=143, 3.39%), Journal of Chemical Sciences (n=140, 3.32%), Bulletin of Materials Science (n=135, 3.20%), and Acta Crystallographica Section - A Foundations and Advances (n=72). The Bronze OA publications are distributed in two document formats:

journal articles (n=4,201, 99.69%) and proceedings-article (n=13). In Bronze OA publications, a total of 96.04% (n=4,047) of documents are "published version," while 3.96% (n=167) are "accepted version." In the licensing scenario, Bronze OA publications are published without any licensing. The institution with the highest number of Bronze OA publications is the Indian Institute of Science (n=1,374, 32.61% of total Bronze OA), and the least productive institute is Datta Meghe Institute of Medical Sciences (n=17).

A total of 2,358 Hybrid OA publications have been distributed across 584 closed-access journals by 98 publication agencies. The top five Hybrid OA publication agencies are Elsevier BV (n=683, 28.97% of total Hybrid OA), American Physical Society (n=519, 22.01%), Springer Science and Business Media LLC (n=304, 12.89%), Royal Society of Chemistry (n=95), and Wiley (n=80). The top five Hybrid OA journals are Physical Review D (n=248, 10.52%), Ultrasonics Sonochemistry (n=176, 7.46%), Physical Review Letters (n=137, 5.81%), Journal of Biological Chemistry (n=133, 5.64%), and The Lancet (n=81). In Hybrid OA publications, 94.81% of Hybrid OA articles have been published with a license. The licenses used in Hybrid OA are CC-BY (n=1,412), CC-BY-NC-ND (n=515), Publisher-specific license (n=169), CC-BY-NC (n=113), Implied OA (n=62), ACS specific (n=21), CC-BY-NC-SA (n=20), Public Domain (n=17), and CC-BY-SA (n=1). In Hybrid OA publications, 98.83% (n=2,189) of Hybrid OA articles are "published versions," while 169 of them are "accepted versions." The highest number of Hybrid OA publications comes from the Indian Institute of Science (n=724, 30.74% of total Hybrid OA publications).

STATUS OF OPEN ACCESS FRIENDLINESS

The OAFI score is the sum of five factors (OA share, Green and Gold OA share, Repository share, OA license share, and Gold and Green license share), which totally depend on an institution's level of OA publication policies. Out of the 26 deemed universities, the highest OAF score (68.46 out of 100) has been obtained by the newly established deemed university, the JSS Academy of Higher Education and Research, while the lowest OAF score (50.37 out of 100) has been obtained by the Institute of Chemical Technology. A positive finding shown in Table-8 is that the OAF scores of all 26 deemed universities are above 50. The highest OAF score in Area I (OA share, Green and Gold OA share, and Repository share) is 42.65 (out of 60), obtained by the Datta Meghe Institute of Medical Sciences. The highest score in Area II (OA license share, Gold and Green license share) is 30.61 (out of 40), obtained by the JSS Academy of Higher Education and Research.

Upon observing Table-8, it is evident that various deemed universities have obtained the highest OAF score in different factors (OA share, Green

and Gold OA share, Repository share, OA license share, Gold and Green license share). The highest OAF score for Factor 1 (OA share) is obtained by the Datta Meghe Institute of Medical Sciences (15.98 out of 30), the highest score for Factor 2 (Green and Gold OA share) is obtained by Banasthali Vidyapith (11.88 out of 15), Datta Meghe Institute of Medical Sciences (15 out of 15) for Factor 3 (Repository share), the JSS Academy of Higher Education and Research (22.53 out of 30) for Factor 4 (OA license share), and Koneru Lakshmaiah Education Foundation University (8.88 out of 10) for Factor 5 (Gold and Green license share). The OAFI score represents the openness of research publications by an individual institution. A higher OAFI score tends to indicate more openness in terms of OA.

TABLE-8

63 Ranked List of Deemed Universities based on OAFI Score

Name of Deemed Universities	Area I (60)			Area II (40)		OAF (100)	Rank
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5		
JSS Academy of Higher Education and Research	13.87	10.94	13.04	22.53	8.08	68.46	1
Datta Meghe Institute of Medical Sciences	15.98	11.68	15.00	16.95	5.98	65.58	2
Sri Ramachandra Institute of Higher Education and Research	12.98	10.00	13.94	18.44	6.84	62.20	3
Manipal Academy of Higher Education	12.91	10.05	12.80	19.22	7.00	61.99	4
Saveetha Institute of Medical and Technical Sciences	8.83	11.14	13.45	20.18	7.72	61.31	5
Dr. D. Y. Patil Vidyapeeth	15.46	9.79	12.50	16.50	6.93	61.18	6
Jamia Hamdard	8.46	11.22	11.67	21.20	8.49	61.03	7
Bharath Institute of Higher Education & Research	7.26	11.59	12.35	20.73	8.53	60.46	8
Shanmugha Arts Science Technology & Research Academy	7.07	10.96	12.95	21.05	8.01	60.04	9
Vellore Institute of Technology	5.99	11.59	12.77	21.36	8.24	59.95	10
Kalinga Institute of Industrial Technology	9.09	10.34	12.36	19.57	7.84	59.22	11
Koneru Lakshmaiah Education Foundation University	7.14	10.52	11.47	21.16	8.88	59.16	12
Banasthali Vidyapith	5.61	11.88	12.91	20.97	7.71	59.08	13
Tata Institute of Social Sciences	9.88	10.93	12.19	18.43	7.16	58.58	14
Siksha `O` Anusandhan	6.86	11.48	13.26	19.54	7.20	58.34	15
Homi Bhabha National Institute	11.84	11.45	14.47	15.71	4.64	58.12	16
Sathyabama Institute of Science and Technology	6.15	11.14	11.67	19.96	8.22	57.14	17
S. R. M. Institute of Science and Technology	5.88	11.30	12.22	19.33	7.35	56.09	18
SVKM`s Narsee Monjee Institute of Management Studies	6.41	11.00	13.21	17.60	7.09	55.32	19
Amrita Vishwa Vidyapeetham	3.87	10.89	14.35	18.39	7.22	54.71	20
Symbiosis International	9.49	10.74	8.57	18.65	6.79	54.24	21
Kalasalingam Academy of Research and Higher Education	4.54	10.81	10.63	19.88	7.98	53.84	22
Birla Institute of Technology & Science	6.98	11.30	13.74	14.54	5.29	51.85	23
Thapar Institute of Engineering & Technology	4.00	10.61	13.80	16.45	6.69	51.55	24
Indian Institute of Science	11.27	10.40	12.02	13.31	4.37	51.38	25
Institute of Chemical Technology	3.88	7.37	14.17	19.08	5.87	50.37	26

7 CONCLUSION

The study has surveyed the Open Access Friendliness (OAF) of deemed universities in India ranked in the NIRF Ranking 2021 under the overall category. The OAFI has been designed based on five main factors – OA share, Gold and Green OA share, Green OA in Institutional Repositories, Use of license in OA

publications, and OA license used in Gold and Green OA publications. The study analyzed a total of 78,825 publications (with OA status) and found that 29.15% of publications are published in four altered OA routes (Green, Gold, Hybrid, and Bronze). The highest OA publications were found under Gold OA (43.85% of total OA publications), followed by Green OA (27.55%), Bronze OA (18.34%), and Hybrid OA (10.26%). Among the deemed universities, the JSS Academy of Higher Education and Research was found to be the most open access-friendly university, while the Institute of Chemical Technology was identified as the least open access-friendly university.

In the licensing scenario, the use of licenses has grown from 47.59% to 61.04%, and 56.86% of OA publications have been published with a license. The study observed that the most liberal licenses (Public Domain, CC0, CC-BY, and CC-BY-SA) have been expended in more than 61% of total licensed publications. Reputed publishers, such as, Springer Science and Business Media LLC and Elsevier BV have emerged as the top OA-supporting publishers. Well-reputed journals like *Scientific Reports*, *Journal of High Energy Physics*, *PLoS ONE*, *Physical Review B*, *IEEE Access*, and *Physics Letters B* are the top journals where OA publications of deemed universities reside. The repository "arXiv" of Cornell University is identified as the most suitable place for Green OA publications, while "ePrints@IISc" of the Indian Institute of Science stands out in the Indian scenario.

The conclusions of the study are limited to 10 years of data collected from Web of Science, and thus, the results may have some limitations in a wider perspective. A study conducted using other databases may provide a broader perspective on the domain. The findings of the study can be valuable for prospective researchers undertaking similar studies in the future and can assist in designing OAF strategies by institutions and individual researchers.

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