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Unveiling the Hidden Impact: Measuring Alternative Research Impact of Private Higher Education Institutions of India Through Data Carpentry

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ABSTRACT

This research aims to measure the research impact of 27 private Higher Education Institutes (HEIs) in India through the lens of citations and social media. It applies data carpentry tools and techniques for gathering and formatting data from different databases. The primary bibliographic data was collected from Scopus, and the secondary data from four different databases (Dimensions.ai, Altmetric.com, Mendeley.com, and Unpaywall.org). The data is analysed in terms of coverage, associations between variables (citations vs. altmetrics), and open access advantages of altmetric. The result indicates that 18.51 % of publications from private HEIs are covered in altmetric, while 95.77 % of publications are in Mendeley. Twitter event has the most extensive coverage among altmetric data, and Dr D.Y. Patil Vidyapeeth registered with the broadest coverage in altmetric. The coverage level of altmetric data is higher for institutions focused on multidisciplinary research than medical, technical, and management institutions. The correlation results showed an almost positive between citations and altmetric mentions. Moreover, the coverage of open access publications in altmetric is considerably higher than those of non-OA articles. The Open Access Altmetric Advantages (OAAA) and Categorical Open Access Altmetric Advantages (COAAA) confirmed the open access advantages of selected institutions across altmetric events. The overall research result suggests that discipline- and institute-specific considerations are pivotal when evaluating institutions' productivity using altmetric.

Keywords: Altmetrics; Data carpentry; Data wrangling; NIRF ranking; OpenRefine; Social media visibility; Social media metrics

1. INTRODUCTION

Scholarly communications are considered the preferable way of disseminating human brainchild knowledge. Traditionally, the impact of scholarly artifacts has been measured by their citation counts. Nevertheless, nowadays, the unprecedented development of ICT- enabled tools, and internet technologies, especially the invention of the social web, has opened up new possibilities and completely changed the world's communication system for the last few decades. These technological transformations and innovations significantly impacted the scholarly communication process. People use social media platforms for real-time conversation or entertainment and for accessing, storing, and disseminating scholarly resources. In the meantime, scholarly products are increasingly being mentioned and discussed on different social media platforms. Sometimes researchers upload the pre-print or post-print version of the research product into social media for better visibility and access. These social media platforms have also become an alternative way of measuring scholarly publications' impact. As a result, the term "altmetrics" was introduced to measure scholarly activities over social media. Altmetrics or alternative metrics capture various aspects of research dissemination, such as mentions in social media, blogs, news outlets, policy documents, and other online platforms. It offers a more comprehensive and timely view of research impact, taking into account the increasingly diverse ways in which research is shared and consumed in today's digital world.

The most researched question in altmetric research is the presence of altmetric data across the scientific fields. Several studies have been observed to identify the presence at different levels and the research fields that are covered mostly[1-2]. The current study investigates the impact research of 27 private HEIs of India through the lens of scientific and public attention. More specifically, this research highlights the performance of the said institutions in terms of coverage, OA uptakes, associations between citations and altmetric events, and finally, open access (dis) advantages for altmetric data.

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2. LITERATURE REVIEW

This section tried to highlight only four important zones related to the study area, (i) Availability of altmetric for the Indian articles, (ii) Coverage of altmetric at the individual, and institutional level, (iii) Relationship between citations and altmetrics, (iv) Altmetric (dis) advantages of Open Access articles

2.1 Availability of Altmetric Data for Indian Article

Banshal[3], *et al.* conducted an exploratory study based on ResearchGate for 2016 and found that 61 % of WoS articles have mentioned been on ResearchGate. They also found some disciplinary variation for altmetric data in ResearchGate. Banshal[4], *et al.* analysed the coverage comparison of Indian and global publications in altmetric.com and found that 28.5 % of publications from India were covered in altmetric, which is 18 % lower than the world data. They found that Mendeley and ResearchGate were the most popular platforms among others, particularly for scholarly articles. Nath and Jana[5] found that altmetric presence was very meager; overall, 32.7 % of Indian EPS publications were covered in altmetric, while 35.75 % were for world data. Another study based on the coverage in Mendeley for Indian EPS articles was observed[6] and found that 98.57 % of publications have covered in Mendeley, and the presence level was varied by discipline. Banshal[7], *et al.* found that disciplines like Medical, Biological, and Multidisciplinary have above 60 % of publications with altmetric attention. Conversely, Mathematics, Material Sciences, and Engineering disciplines have less than 25% of altmetric attention Similarly, platform-wise variations also have been analysed. It is found that Twitter and Mendeley have more coverage than Facebook and News. Shrivastava & Mahajan[8] found that Twitter has the highest (22.68 %) coverage, followed by Facebook (3.62 %), and Blogs (2.18 %).

2.2 Coverage of Altmetric at the Institutional Level

Solanki[9], *et al.* analysed the social media coverage of the most productive Indian Institutions. They found that, on 28.5 % of publications were found in altmetric. However, the coverage percentage varies from 5-60 % for different institutions. They concluded that discipline-specific institutes, like Medical and Biological Science highly mentioned on social media platforms compared to others. Lamba[10], *et al.* studied 669 publications of Computer Science sub-disciplines from 35 central universities using Altmetric Explorer and Dimensions. They found that, as per attention score, Jawaharlal Nehru University (JNU) had ranked at the top, and the largest number of readers were from the University of Hyderabad. Also, Twitter received the most mentions in altmetrics, followed by Google+, patents, and finally, Facebook. Holmberg[11], *et al.* focused on the important reason which influences the number of altmetric events surrounding the scientific articles from that institution. The result showed that to capture altmetric attention, an international connection is essential, and the relationship between the researcher and the institution must be strong. Still, on the other side, the institutional research profile is not always reflected in the altmetric counts.

2.3 Relationship Between Citations and Altmetrics

There have been lots of studies already published on the web that have measured the relationships or associations between citations and altmetrics in journal-specific[12-17]; discipline-specific[6,18-22], and region-specific[23-25]. Bornmann[26] provides an idea on the three most popular altmetrics, i.e., Twitter (microblogging), Mendeley and CiteULike (reference managers), and Blogs. The study specifically concentrated on the correlations between altmetric and citation counts. After calculation, the correlation with citations and microblogging was small (r= 0.003) and for Blogs (r= 0.12), CiteULike (r= 0.23), and Mendeley (r= 0.51). Costas[20], *et al.* explored that the density of altmetric counts was very low and not frequent for research outputs, where 15 % to 24 % of articles have altmetric attention. The correlation result was positive but relatively weak. Thelwall[27], *et al.* conducted an excellent comparative study taking 11 altmetric events and WoS citations, where 76 to 208,739 publications had at least one altmetric event in each case. A significant association was found among variables. Similarly, some studies have been conducted to determine the relationship between citations and altmetrics for Indian publications and found positive correlations[5,10,28].

2.4 Altmetric Coverage of Open Access Articles

Dehdarirad & Didegah[29] found the coverage of OA publications mentioned was higher than those of non-OA publications. The average Tweets, Facebook posts, News, and blogs increased by 92.7 %, 25.7 %, 83.9 %, and 48.4 %, respectively. Adie[30] found that OA articles of Nature communications got more social media attention on Mendeley and Twitter than non-OA articles. Schultz[31] found that Gold, Green, and Hybrid OA publications positively correlated with news mentions. After all, OA articles remained higher than those paywall-based articles. Holmberg[32], *et al.* explored that OA publications from Economic Geography, Psychology, Social and Veterinary Sciences received more attention in citations and social media. In contrast, the OA articles from Medicine and Health sciences get fewer.

The current body of literature focused on journal-, discipline-specific to determine the altmetric coverage of scholarly publications. However, no specific research incorporated altmetric analysis for private HEIs in respect of measuring the magnitude of associations as well as the advantage of the openness of articles of Indian origin. In this study, we tried to fill the research gap and measure the alternative impact of private HEIs in India through altmetric.

3. OBJECTIVES AND RESEARCH QUESTIONS

The research aims to measure the impact of selected private universities in India through the lens of public attention (social media engagement) and scientific attention (citations). Moreover, this research includes data carpentry tool (OpenRefine) and techniques to identify the presence level of altmetric and citation data, the degree of associations between them, and open access (dis)advantages of altmetric data. Based on these objectives, the following research questions have been formulated:

RQ1: What is the coverage level of Indian private HEIs on social media platforms? Do the institution types affect the coverage levels of social media? If yes, what are the possible reasons behind this variation?

RQ2: Do the altmetric counts and citation counts of Indian private HEIs related to each other? If related, which altmetric events are primarily associated with the citation counts?

RQ3: Does the openness of articles reflect on altmetric mentions? If yes, which path of OA impacted the most?

4 METHODOLOGY

The methodology used in this research is acknowledged and discussed in three sub-groups:

4.1 Selection of Institutions

India has had a large educational system in terms of variety and quantity since the past. There are 1,113 universities nationwide[33], including 657 publicly funded (235 Central Govt. and 422 State Govt.) and 456 privately funded (both aided and unaided). There are different ranking frameworks like QS University Ranking, NIRF ranking, World University Ranking, THE ("Times Higher Education World University Ranking"), and more. Here we consulted the NIRF Ranking for two reasons: (i) The framework is developed by the Ministry of Education, the Govt. of India, exclusively for Indian HEIs; (ii) It includes a variety of research institutions like universities (both public and private), research institutions, technical, management institutions, etc. The overall category of the NIRF Ranking 2022 includes 100 HEIs; among them, we found 27 privately funded institutions. We have selected those 27 top private institutions (12 multidisciplinary, 9 technical, 5 medical, and 1 management) for limiting our study (Table 1).

4.2 Data Acquisition

This research implies two types of datasets, primary data (mainly bibliographic metadata) and secondary data (citation data, altmetric data, open access data, and readership data).

4.2.1 Primary Dataset

The primary dataset for this study was collected from the Scopus database because of its coverage[34]. We searched the database through the affiliation ID search mechanism to retrieve relevant documents for each institution. The search results restricted two additional filters: (i) the publication year limited to a single year (i.e., 2020) to give considerable time for getting the optimum number of citations, usually 2-3 years after publication; and (ii) document types as Research Article (AR) and Review Article (RE) because of these two formats of the document are considered as first reported manifestation of brainchild knowledge. After meeting the selection criteria, the retrieved documents were downloaded in the 27 'CSV' files separately and merged those files into one 'CSV' through the OpenRefine data wrangling tool. Finally, we found 22,553 documents that 27 private universities in India published. Among those, 19,564 (86.75 %) publications have been found with active DOI (Table 1).

4.2.2 Secondary Dataset

The entire secondary data acquisition process is based on the DOI. Therefore, the articles with active DOI were incorporated individually to collect further data from diverse platforms through OpenRefine. We collected the secondary data from four ODbL (Open Data Commons Open Database License) -based databases (citation data from Dimensions.ai, altmetric data from Altmetric.com, open access data from Unpaywall.org, and readership data from Mendeley.com) through REST/API calls against each DOI. These databases produce JSON (JavaScript Object Notation) formatted text as a response against each API call and are stored in OpenRefine. Furthermore, each response has been observed, analysed, and parsed the desired data using GREL (General Refine Expression Language)[37]. The descriptive statistics of data coverage are presented (Table 2), and the data acquisition process was done in February 2023.

4.3 Data Analysis

The dataset was analysed to measure the alternative impact of research publications by privately-funded HEIs in India. The descriptive statistics of research and altmetric profile were performed using Excel. We only consulted six altmetric events (Twitter, Facebook, Wikipedia, News, Blogs, and Readers) because these were mostly covered events for Indian publications, as reported by previous studies[4,6]. To measure the degree of association between variables (Citations vs. Altmetric events), we performed the Spearman Correlations (rho) instead of Pearson due to the skewing problem of the dataset. Results were interpreted using the scale given by Akoglu[35]. The rho values were calculated for altmetric and citation data with the 95 % confidence level for total datasets and for individual institutions. Further, we investigated the open access altmetric advantages (OAAA) and categorical open access altmetric advantages (COAAA) based on the entire dataset. The OA Altmetric Advantages ($OAAA_i$) can be measured for all types of altmetric events in two ways, i.e., article-based and altmetric-based. OAM represents either the mean of

Table 1. Brief overview of selected institutions

Rank in NIRF 2022	Name of the institutes	Abbreviation	Location	Year of establishment	Total publications	Publications with DOI
16	Amrita VishwaVidyapeetham	AVV-C	Coimbatore, Tamil Nadu	1994	943	857
17	Manipal Academy of Higher Education	MAHE	Manipal, Karnataka	1953	1979	1810
18	Vellore Institute of Technology	VIT-T	Vellore, Tamil Nadu	1984	2298	2117
30	Siksha `O` Anusandhan	SOA-B	Bhubaneswar, Odisha	1996	955	884
32	Birla Institute of Technology & Science	BITS	Pilani, Rajasthan	1964	1106	1071
34	Kalinga Institute of Industrial Technology	KIIT	Bhubaneswar, Odisha	1992	669	611
36	S.R.M. Institute of Science and Technology	SIST	Chennai, Tamil Nadu	2002	1629	1356
42	Amity University	AMI-U	Gautam Budh Nagar, Uttar Pradesh	2005	1478	1277
44	Saveetha Institute of Medical and Technical Sciences	SIMT	Chennai, Tamil Nadu	2005	2238	1641
48	Chandigarh University	CHU-M	Mohali, Punjab	2012	544	298
49	Shanmugha Arts Science Technology & Research Academy	SATR	Thanjavur, Tamil Nadu	1984	709	686
50	Kalasalingam Academy of Research and Education	KARE	Srivilliputtur, Tamil Nadu	1984	356	312
54	K L College of Engineering	KLCE	Vaddeswaram, Andhra Pradesh	1980	1153	848
57	Thapar Institute of Engineering and Technology	TIET	Patiala, Punjab	1956	950	913
58	Lovely Professional University	LPU-P	Phagwara, Punjab	2005	976	801
60	JSS Academy of Higher Education and Research	JAHR	Mysuru, Karnataka	2008	427	395
62	Symbiosis International	SYM-P	Pune, Maharashtra	1971	456	379
67	Sathyabama Institute of Science and Technology	SIST	Chennai, Tamil Nadu	1987	634	530
76	Dr. D. Y. Patil Vidyapeeth	DYPV	Pune, Maharashtra	1956	142	135
83	Sri Ramachandra Institute of Higher Education and Research	SRHR	Chennai, Tamil Nadu	1985	339	318
87	Banasthali Vidyapith	BNV-B	Banasthali, Rajasthan	1935	277	247
89	SVKM`s Narsee Monjee Institute of Management Studies	NMMS	Mumbai, Maharashtra	1981	256	234
92	Datta Meghe Institute of Medical Sciences	DMMS	Wardha, Maharashtra	1990	766	749
94	Shiv Nadar University	SNU-U	Dadri, Uttar Pradesh	2011	221	212
95	Bharath Institute of Higher Education & Research	BIHR	Chennai, Tamil Nadu	1984	394	294
96	Sri Sivasubramaniya Nadar College of Engineering	SNCE	Kancheepuram, Tamil Nadu	1996	335	306
97	University of Petroleum and Energy Studies	UPES	Dehradun, Uttarakhand	2003	323	283
			Total		22553	19564

OA articles that are mentioned in the altmetric event (article-based) or the mean of the altmetric event for all OA articles in the altmetric event i. Similarly, NOAM refers to the same value for non-OA articles. The OAAA of altmetric event can be measured as:

$$OAAA_i = \frac{OAM_i - NOAM_i}{NOAM_i} \times 100$$

We proposed the Categorical Open Access Altmetric Advantages (COAAA) to access the OA advantages based on the OA channels. It is calculated by specific OA publications (e.g., Gold OA) with respect to other OA publications (e.g., Green, Bronze, and Hybrid). Here, SOAM refers to the mean of specific OA (Gold) articles that are mentioned in altmetric event (article-based) or the mean of the altmetric event for all specific OA articles in the altmetric event i, and OOAM refers to the same value for other OA (Green/ Bronze/Hybrid) articles. Similarly, other OA categories have been calculated. The COAAA can be measured across altmetric events as follows:

$$COAAA_i = \frac{SOAM_i - OOAM_i}{OOAM_i} \times 100$$

The value of $OAAA_i = 50$ means that OA publications are mentioned 50 % more than non- OA publications (OA advantage) on a specific altmetric event, Twitter. On the other hand, a negative value of $OAAA_i$ indicates OA articles are mentioned less than non- OA articles (OA disadvantage). The data analysis and visualisation were performed in R programming using 'dplyr', 'ggplot2', and 'ggcorrplot' packages.

Table 2. Acquiring secondary datasets

Sources	Methods used	Data sources	Number of articles	%
Altmetric data	REST/API calls through OpenRefine	Altmetric.com	3622	18.51
Readership data		Mendeley.com	18736	95.77
Citations data		Dimensions.ai	14315	73.17
Open access data		Unpaywall.org	18709	95.63

5. RESULTS

The entire result section has been divided into three parts, i.e., research and altmetric profile of private HEIs of India, testing associations between variables at different levels, and finally, OA (dis)advantages in altmetric.

5.1 Research Profile

Before going into an in-depth analysis, let us introduce the quantitative research profile of selected private HEIs through the eye of scientific impact. A total of 27 private HEIs have produced 22,553 research publications collaboratively. Among those, 19,564 publications have active DOI, produced by 34,446 faculty members (Item/Faculty is 0.57), and received 261,225 citations (citations/item is 13.35).

The descriptive statistics of publications, citations, h-index, and faculty strength were presented in Table 3. In terms of research outputs, VIT-T ranked at the top with 2,117 publications and an h-index of 68, followed by MAHE (1,810 publications and h-index of 53, SIMT (1,641 publications and h-index of 32), and SRIST (1,356 publications and h-index of 47). When we consulted the CPI value, DYPV holds the first position with a CPI of 60.52, followed by KIIT (27.53), BITS (26.16), TIET (18.88), and LPU-P (17.77). When we consider the item/ faculty, SIMT ranked at the top with a value of 1.97, followed by TIET (1.61), DMMS (1.38), BITS (1.28), and SNCE (1.28).

5.2 Altmetric Profile

The altmetric and readership data for 27 private HEIs have been fetched from the Altmetric and Mendeley database, respectively. The altmetric events have been analysed in two formats, i.e., overall and institutional presence. There are 3,622 publications (18.51 %) that have been mentioned with at least one altmetric event, and 18,736 publications (95.77 %) mentioned in Mendeley amongst the total. The SNU-U has become the top as 40.57 % of publications have mentioned in altmetric, followed by MAHE having 38.34 % of coverage and DYPV having 35.56 %.

Conversely, SIMT has the lowest rank in terms of altmetric attention; only 3.11 % of publications are covered, followed by KLCE having 4.95 % and DMMS having 4.94 %.

According to the altmetric event, Twitter holds the first position for getting 16.73 % of publications coverage, followed by News having 2.07 %. Wikipedia has the lowest coverage having 0.67 % of publications. However, the individual coverage percentage also varies across institutions. For instance, the SNU-U ranked at the top, having 39.62 % of publications covered by Twitter, followed by MAHE with 35.80 % of coverage. The DYPV ranked the top among the observed institutions regarding coverage in all social media platforms, except for Twitter and Mendeley (Figure 1). In Mendeley, the highest coverage comes from CHU-M, with 99.66 % of publications, followed by BNV-B (99.60 %), SNU-U (99.06 %), and SYM-P (98.94 %).

5.3 Testing Associations Between Variables

A total of 3,622 publications from 27 private HEIs have been found with at least one altmetric event and incorporated to measure the degree of association among the variables, i.e., citations and six altmetric events. The Spearman correlation study was applied with a 95 % confidence level for measuring the associations at three levels (overall, institution-wise and OA vs. non-OA).

The overall associations between variables have been observed using the correlation matrix (Figure 2). Here, the blue-color indicates the positive rho values, whereas brown-color for negative rho value, the intensity of the color and size of the square indicates how strong the rho value is, whether positive or negative. We observed very strong correlations between DC vs. MR and a strong correlation for BM vs. NM, with rho values of 0.67 and 0.33, respectively. On the other hand, the rest of the variables are relatively low as they are negligible

Table 3. Research profile of Indian private institutions

Rank	Name of the institutes	Total publication	H-index	Faculty strength	Item/faculty	Sums of citations	Citations/item (CPI)
16	AVV-C	857	34	1830	0.47	6955	8.12
17	MAHE	1810	53	2617	0.69	29835	16.48
18	VIT-T	2117	68	2633	0.80	28627	13.52
30	SOA-B	884	42	1161	0.76	7926	8.97
32	BITS	1071	50	835	1.28	28020	26.16
34	KIIT	611	40	1898	0.32	16821	27.53
36	SRIST	1356	47	3624	0.37	14019	10.34
42	AMI-U	1277	55	1871	0.68	22441	17.57
44	SIMT	1641	32	831	1.97	3827	2.33
48	CHU-M	298	28	2217	0.13	2949	9.90
49	SATR	686	40	722	0.95	8564	12.48
50	KARE	312	31	546	0.57	4599	14.74
54	KLCE	848	29	1024	0.83	4631	5.46
57	TIET	913	61	566	1.61	17237	18.88
58	LPU-P	801	55	2371	0.34	14235	17.77
60	JAHR	395	28	874	0.45	3320	8.41
62	SYM-P	379	25	1258	0.30	3012	7.95
67	SIST	530	40	1260	0.42	6203	11.70
76	DYPV	135	18	583	0.23	8170	60.52
83	SRHR	318	17	750	0.42	1708	5.37
87	BNV-B	247	23	621	0.40	2248	9.10
89	NMMS	234	24	554	0.42	2367	10.12
92	DMMS	749	17	543	1.38	10462	13.97
94	SNU-U	212	26	246	0.86	3281	15.48
95	BIHR	294	23	1896	0.16	2136	7.27
96	SNCE	306	29	268	1.14	3693	12.07
97	UPES	283	30	847	0.33	3939	13.92

[#]collected from the NIRF ranking website

to weakly correlate with each other. Only TM has, on average, a moderate range of positive correlation with others except with WPM (zero rho value).

At the institutional level, the correlational analysis was performed between Dimensions Citations (DC) and altmetric events. Figure 3 represents institution-wise rho values of six altmetric events, where two colors indicate different meanings. The black square-dots indicate the rho values for institutions, and the blue line indicates the mean rho value for each altmetric event. Two institutes, DYPV and DMMS, showed moderate to strong correlations across all altmetric events. Among the events, a powerful correlation has been identified for Mendeley readers with citations for every observed institution. Where the mean rho value for Rs is 0.72, strong to very strong correlations have been found for all institutions with citations, highest for SNCE (0.93), followed by KARE (0.86), DMMS (0.85), TIET (0.84), DYPV (0.80), and SRHR (0.78).

For Facebook, the average rho value is 0.10, ranging from -0.28 (KLCE) to 0.84 (DMMS). In the context of Blogs, the average rho value is 0.13, where the DYPV became the top with the rho value of 0.70, followed by DYPV(0.54) and also four institutions (SOA-B, SATR, SBU-U, and KARE) with negative rho values. For Wikipedia, the average rho value is 0.10, and nineteen institutions have registered weak to moderate positive correlations. While five institutions with negligible to weak negative correlations. The mean rho value 0.16 and 0.18 have registered for News and Twitter, respectively. Fifteen institutions have more than the mean value in News, whereas eleven institutions for Twitter. Along with positive rho values, we observed some institutions have registered with zero rho values across altmetric events, such as SIMT, KARE, and BIHR for Wikipedia, CHU-M, KARE, and TIET for Facebook, BNV-B, CHU-M, SNCE, and UPES for Blogs.

5.3.1 OA vs. Non-OA

We found 3,598 publications with OA status (1806 OA and 1792 non-OA) and incorporated them in the analysis. Figure 4 reveals the correlation plot of OA and non-OA

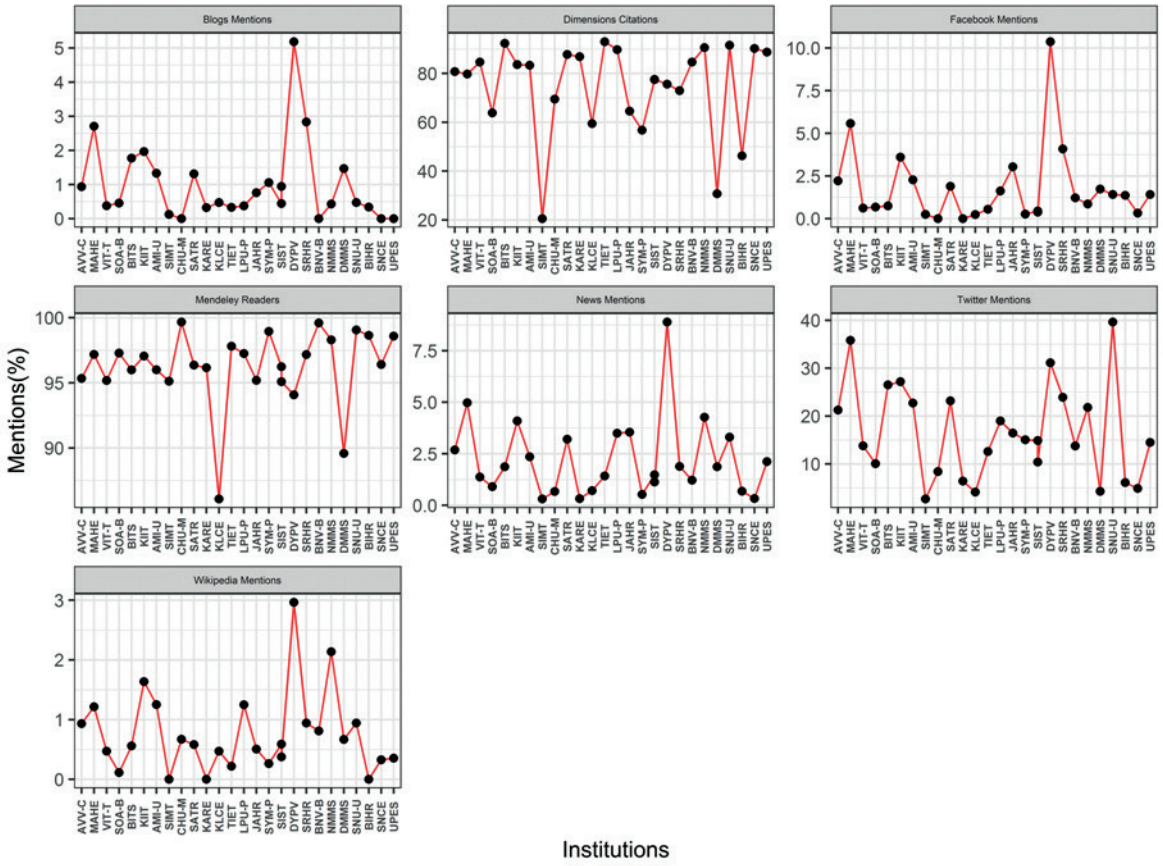

Figure 1. Institute-wise coverage of altmetric and citation data for private HEIs.

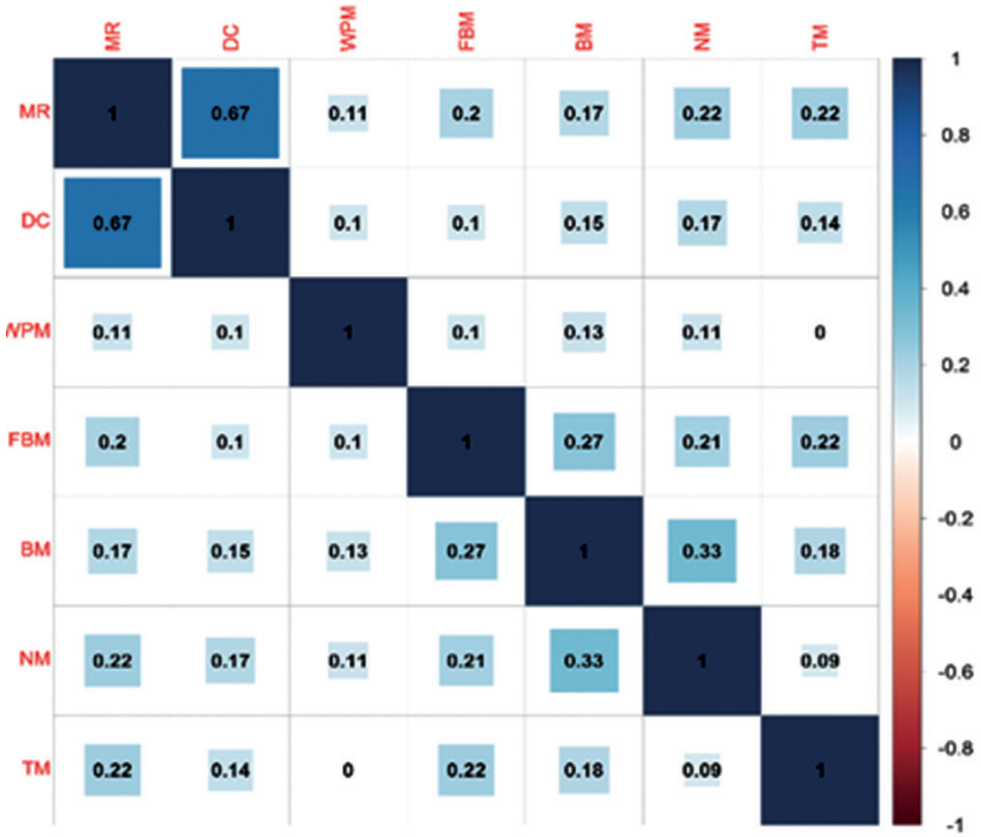

Figure 2. Correlation matrix (n= 3,622) for observed data (MR= Mendeley Readership, DC=Dimensions Citations, WPM= Wikipedia Mentions, FBM= Facebook Mentions, BM= Blog Mentions, NM= News Mentions, TM= Twitter Mentions).

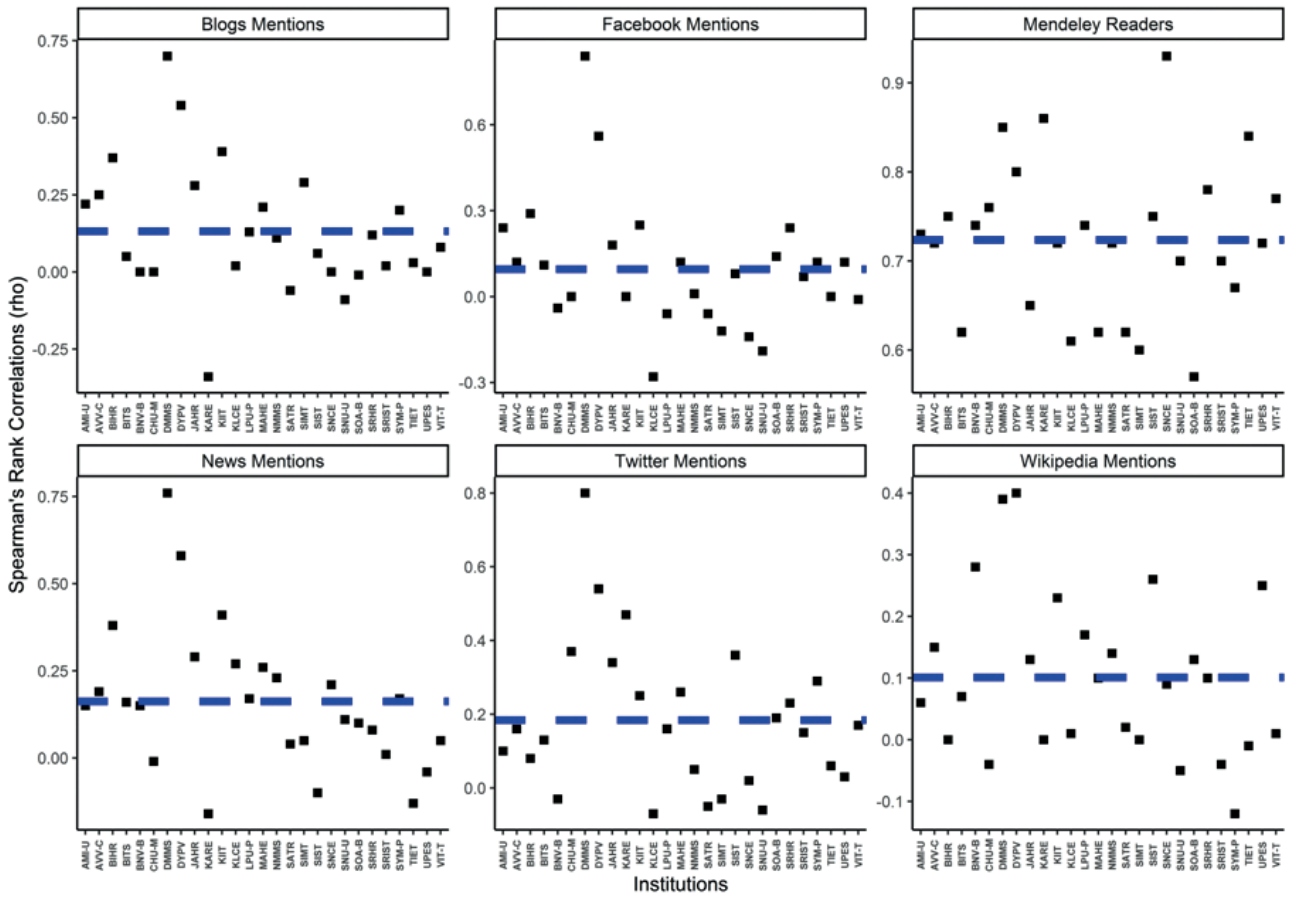

Figure 3. The rho values for six altmetric events and citations across the institutions.

Figure 4. Correlation matrix for mentions and citations of OA (upper triangle; n= 1,806) and Non-OA articles (lower triangle; n=1,792). MR= Mendeley Readers, DC= Dimensions Citations, WPM= Wikipedia Mentions, FBM= Facebook Mentions, BM= Blog Mentions, NM= News Mentions, TM= Twitter Mentions.

publications across the institutions. The upper triangle (right) plots the correlation values of OA publications, whereas non-OA publications are in the lower triangle (left). It is observed that the intensity of the blue color box is more in the upper triangle than in the lower one. As the intensity grows, the rho values increase, and the correlation becomes strongly positive. Moreover, All the OA publications correlate more significantly with citations than non-OA articles, except for Dimensions citations. Except for Mendeley, all variables registered with negligible to weak correlations for non-OA publications. Some negligible negative correlations (DC vs. FBM, FBM vs. WPM, WPM vs. TM, and TM vs. BM) were also found for non-OA publications. Similarly, for OA publications, the rho value shows positive values for all pairs, strong correlations between DC and MR, and other altmetric events showed weak to moderate correlations. The result indicates that OA publications are more frequently mentioned in altmetric than non-OA publications.

5.3.2 OA (dis)Advantages

The OAAA for all altmetric events has been observed and presented in Figure 5. According to the altmetric- based OAAA, the highest value was observed for NM (1093.50 %), followed by TM (938.71 %), BM (888.00 %), and the lowest value observed for MR (78.65 %) and WPM (180.51 %). FBM has the lowest to moderate value of 380.12 %. On the other hand, BM has the highest value of article-based OAAA of 404.97 %, and the lowest value is 0.64 % for MR, followed by TM (50.84 %).

According to altmetric-based COAAA (Figure 6), Hybrid OA occupies an advantageous position across all altmetric events. The News mentions registered with the highest advantages (1054.58 %), followed by Blogs (1039.25 %), Twitter (928.81 %), Facebook (423.13 %), Mendeley (232.58 %), and Wikipedia (165.17 %). Interestingly, Gold OA (the most popular path of OA) holds the disadvantageous position for all events, while Green and Bronze OA have advantages for three (Blogs, News, and Mendeley) and four (Facebook, Twitter, Wikipedia, and Mendeley) events, respectively. When we looked at the article-based COAAA, the Green OA holds the highest advantageous position compared to other OA paths for all altmetric events. In contrast, Gold OA is disadvantageous for all events.

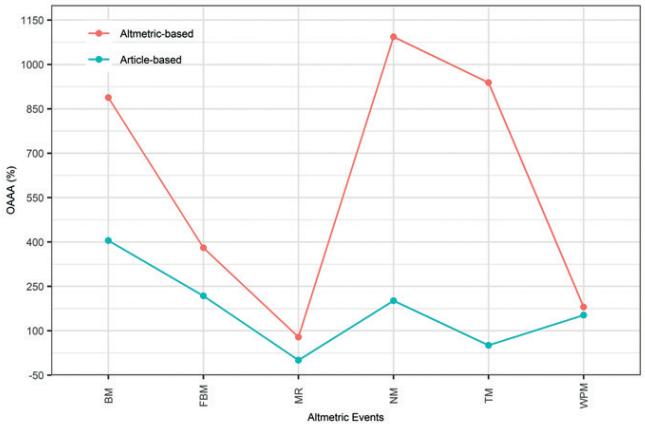

Figure 5. OA altmetric advantages of articles across 14 6 altmetric events.

6. DISCUSSION

This study measured the altmetric performance of India's top 27 private HEIs according to NIRF ranking 2022 (overall category).These private HEIs produced 22,553 research publications for 2020 and 19,564 publications with active DOI. The research portfolio indicates:

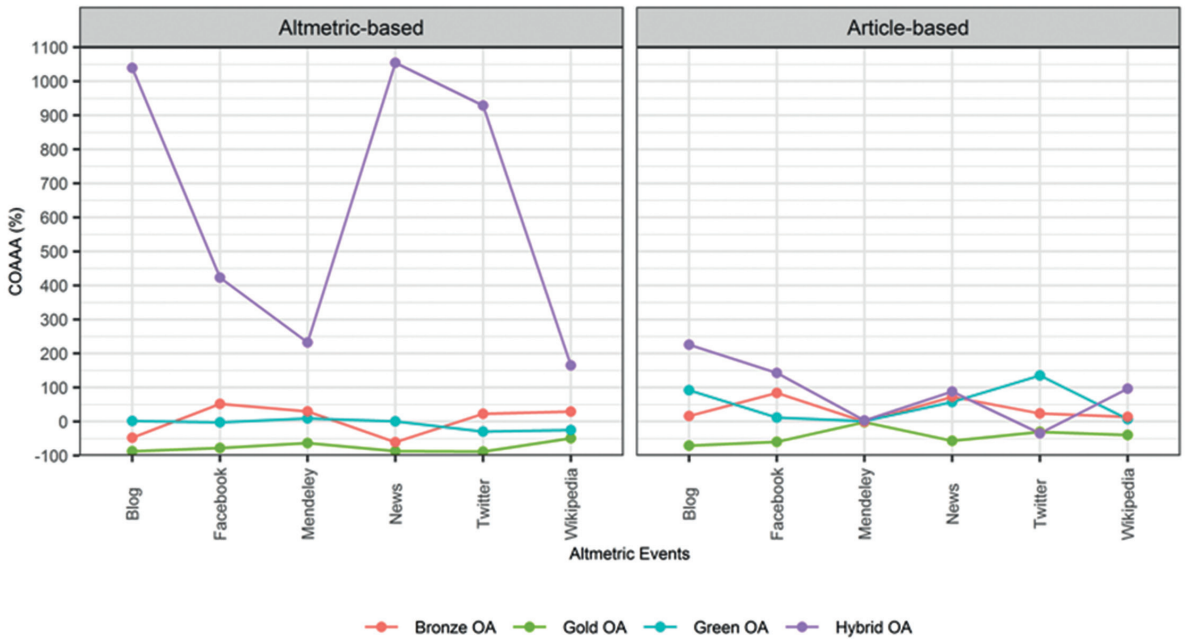

Figure 6. Categorical OA advantages of articles across altmetric events.

(i) the top producing institutions (VIT-T, MAHE, SIMT, and SIST) are mainly from the southern part (Tamil Nadu, Karnataka) of India. Among the selected HEIs, 13 institutions were located in the southern states of India, six from the western states, four from the northern states, and two from central and eastern states of India. It indicates an enthusiastic environment of higher education in the southern parts of India; (ii) the institutes with large research outputs do not necessarily receive the highest CPI values compared to those with small research outputs. In contrast, VIT-T, MAHE, SIMT, SIST, and AMI-U are the top five research-producing institutions with CPI values of 13.52, 16.48, 2.33, 10.34, and 17.57, respectively. Whereas DYPV has made only 135 research publications and received the highest CPI of 60.52, due to skewing distribution of citations, two articles got 4150 and 2230 citations, respectively; (iii) the institutes with large research outputs do not necessarily mean the faculty strength is higher or vice-versa. For instance, SIMT's total research output and items per faculty are 1,641 and 1.97, respectively. In contrast, VIT-T has a total research output, and items per faculty are 2,117 and 0.80, respectively, which is relatively low items per faculty compared to SIMT. Similarly, with only 306 total research output, SNCE has good items per faculty of 1.14; (iv) we also noticed a strong collaboration network between five institutes (MAHE, KIIT, DYPV, AMI-U, and DMMS). These institutions have published several highly cited articles collaboratively.

The altmetric portfolio of 27 private HEIs was also analysed and presented. Based on the total publications, we found that 18.51 % of publications are covered in altmetric, whereas 95.77 % of publications are covered in Mendeley. The coverage of altmetric data is still inadequate, increasing over the years as found by previous studies for Indian publications[4-6,9]. Some previous studies also observed altmetric data coverage issues at a global scale[1,2,20]. According to presence level, Mendeley has the largest, followed by Twitter, News, Facebook, Blogs, and Wikipedia. The coverage level of altmetric data is higher for institutions focused on multidisciplinary research than medical, technical, and management institutions.

To answer the RQ2, we performed a correlational study between variables at different levels. The results confirmed strong correlations between DC vs. MR and a strong correlation for BM vs. NM; the rest of the pairs are moderate to weak correlations. Several previous studies also confirmed the strong rho values for Mendeley readership and Scopus/WoS/Dimensions citations[6,10,21,24].

We found zero correlations for the overall category between TM and WPM because only a few publications have been mentioned in WPM. The institution-wise correlation between readership and citations showed surprising results (an almost perfect correlation is found for SNCE). We found higher rho values for all investigated institutions compared to previous studies[21,24]. To identify the open access benefits of altmetric data, we calculated OAAA and COAAA. Our findings are similar to previous studies[29-30,32], and the OAAA values also confirmed that open access articles are significantly mentioned in altmetric compared to non-OA articles. It is noticed that the value of altmetric-based OAAA is more than the value of article-based OAAA across the altmetric events because of the mentioned density (the number of post counts is higher) of publications.

Besides the findings described above, however, this research also has some methodological limitations. Firstly, several databases are available in the bibliographic domain in both ODbL-based (OpenAlex, Semantic Scholar, Crossref, MAG, Dimensions.ai, and more) and subscription-based (WoS) that provides metadata against the search query. Here, we collected the bibliographic metadata from Scopus, leading to bias. Secondly, we collected citation data from the Dimensions database, which may lead to bias because citation counts mostly depend on the coverage of the database. Thirdly, we applied Spearman's correlations method to test the associations. However, it does not provide any causal relationship between variables, but it is the easiest way to see how variables are related[15,27,36]. Lastly, we only selected the institutions listed in the overall category of NIRF 2022; a mass number of institutions are avoided for this reason. Therefore, results may vary when other institutions are included.

7. CONCLUSION

This research aims to measure the impact of research publications made by 27 private HEIs of India through the lens of scientific and public attention. A total of 19,564 publications have found been with active DOI; only 18.51 % of publications are covered in altmetric and 95.77 % of publications in Mendeley. VIT-T has ranked the top as per publications, while DYPV holds the first position as per the altmetric coverage. The openness of publications plays a momentous role to be mentioned in altmetric. Based on the data sources and methodology used in this research can be extended for measuring the alternative impact of individual entities (like journals, institutions, authors, and countries) and also comparing with others.

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