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A Bibliometric Analysis of Research Output from Indian Institutes of Management

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ABSTRACT

Indian Institutes of Management (IIMs) are among the most prestigious business schools in India, mainly offering postgraduate, doctoral and executive education programmes in the fields of Management and Business Education. They also contribute significantly to research in the area. This article attempts to analyse the bibliometric patterns in research output of IIMs. The data for research publications indexed in Scopus during 2010-19 is downloaded and analysed to identify important patterns and trends of research output, citations, international collaboration, open access, gender distribution and social media visibility. The results are also compared with three top internationally renowned business schools (Harvard Business School, MIT Sloan School of Management and NUS Business School). Results indicate that the older IIMs like Ahmedabad and Bangalore are placed at the top in terms of publication counts and citations. Newer IIMs like Rohtak and Raipur are found to be doing well in publications as compared to other IIMs of their generation. IIM Udaipur has more than 40 % of its research output internationally collaborated and also highest citations per paper value amongst all the IIMs. However, when the IIMs are compared with three well-known international schools (two of which have mentored the initial two IIMs), there appears a large gap in several indicators, such as h-index. The paper, thus, indicates that IIMs need to improve their research output and quality to be at par with the top business schools of the world. Research themes like 'sustainability', 'emerging markets' and 'supply chain management' are the most prominent thematic areas observed in the research output from IIMs, which indicates that IIMs are working on research topics of contemporary relevance.

Keywords: Indian Institute of Management; Management research; Research performance; Scientometrics

1. INTRODUCTION

Indian Institutes of Management (IIMs) are among the most prestigious business schools in India, mainly offering postgraduate, doctoral and executive education programmes in the fields of Management and Business Education. At present there are 20 IIMs located in different parts of India. The IIMs have been established during different periods, with the oldest being IIM Calcutta (in 1961) and the latest being IIM Jammu (in 2016). Pandit Jawaharlal Nehru, the first Prime Minister of India, initiated the establishment of IIMs on recommendation of the Planning Commission in 1959. The primary objective then was to produce "suitable managers for the massive public sector enterprises being established in pursuance of the Industrial policy"[1].

The first two IIMs established were - IIM Calcutta (1961) and IIM Ahmedabad (1961). While the former was set up in collaboration with the MIT Sloan School of Management, the later involved collaboration with Harvard Business School. IIM at Bangalore was established in 1973 followed by IIM at Lucknow in 1984. Two more IIMs, IIM Kozhikode and IIM Indore were established in 1996. An IIM at Shillong was established in 2007. Thirteen more IIMs were set up (at Raipur, Rohtak, Ranchi, Udaipur, Kashipur, Tiruchirappalli, Amritsar, Sambalpur, Nagpur, Bodh Gaya, Sirmaur, Visakhapatnam, and Jammu), during 2010 to 2016. In 2017, the Indian Government passed The Indian Institute of Management Act, declaring the IIMs as Institutes of National Importance.

IIMs are often classified into different generations (first, second and third) based on the chronology of their establishment. According to budget estimates for financial year 2022-23, the total allocation to IIMs is 653.92 crores[2]. Over the years, IIMs have established themselves as renowned institutes in the area of management and business education and research. Several first-generation IIMs find mention in different worldwide rankings. For example, in the QS World University rankings 2020, five of the IIMs (Bangalore, Ahmedabad, Calcutta, Lucknow and Kozhikode) feature in the Business and Management Subject Rankings. Three IIMs (Calcutta, Ahmedabad and Bangalore) feature in the ARWU (Academic Ranking of World Universities) – Social Science and Management Rankings. The 2nd and 3rd generation IIMs, being new, are yet to appear in such international rankings.

Motivated by the prestige associated with IIMs and the fact that they are at the forefront of business management education and research in the country, this paper attempts to analyse the bibliometric patterns in research output from the IIMs. The parameters of publications, citations, international collaboration, open access trends, social media availability and gender distribution in research output from IIMs are analysed.

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At the same time, a comparison is made between the research output and quality of the top performing IIMs with the three top ranking business schools of the world, namely Harvard Business School, MIT Sloan School of Management and NUS Business School. More specifically, the paper attempts to answer the following research questions:

RQ1: What are the trends of publication of the three generation of IIMs during the time period of 2010-2019?
RQ2: What are the citation trends of publications of the three generation of IIMs during the time period of 2010-2019?
RQ3: What proportion of research output from IIMs is internationally collaborated and with which countries?
RQ4: What percentage of research output from the IIMs is openly accessible?
RQ5: How much research output from IIMs attract social media attention and in which platforms?
RQ6: Which major thematic areas are IIMs researching on?
RQ7: How is the research output from IIMs distributed in terms of gender?
RQ8: How do research of IIMs compare with that of top Business Schools of the world, namely Harvard Business School, MIT Sloan School of Management and NUS Business School?

The research publication data for IIMs for the period 2010-19 is obtained from Scopus database and computationally analysed using standard bibliometric and computational methods to answer the research questions as above.

2. RELATED WORK

Several previous research studies tried to assess the research performance of Indian institutions, both individual institutions as well as institution systems. The research contribution of 10 selected research institutions/organisations was carried out through an impact-Citation-Energy (iCX) trajectory analysis[3]. It was found that the performance of research institutions/ organisations could be displayed as trajectories on a 2-D time map given the bibliometric sequences of the research institutions/organisations under study.

A work by Prathap analysed the contribution of Indian institutions to the country's academic research output[4]. He used the SCImago Institutions Rankings World Reports 2013 to evaluate the performance of 138 Indian Institutions based on eight bibliometric indicators for the time period of 2007-2011. It was concluded that the research output of the institutions drawn from the elite category (from the SCImago Report) displayed a high growth rate, however when seen from the quality angle, these high performing institutions remained at a relatively low growth level.

Another work by Prathap described how Indian universities and research oriented institutions performed globally by using web applications that visualise scientific excellence worldwide in various subject areas[5]. It was observed that India had a presence larger than its share of nominal GDP in 5 subject areas out of 22 subject areas considered for comparison across global institutions. In most of the other subjects, it had a marginal participation. Prathap has also studied a comparative performance of selected universities in India[6]. In this work, using the Leiden data of 2017, Prathap decomposed the research performance of of IISc, 7 IITs cluster, NUS and NTU into size and quality components. Henceforth, it was found that the NUS and NTU outperformed the IISc and the 7 IITs cluster. Moreover, when measured in terms of quality research, the NUS and NTU observed to have a steep growth rate in terms of research quality, while the Indian cluster showed a gradual decline.

The research performance of IIMs, however, have remained relatively less explored. There are only few studies to have analysed the research output of selected IIMs. An analysis of the institutional research index and the variation in the research index of 7 Top Indian Business Schools, which included the 6 IIMs belonging to the 1st generation group of IIMs, for the period 2012-2015 was done by Aithal[7]. The analysis was performed using an ABC model described as; A: Number of articles published in peer review journals, B: Number of books published and C: Number of case studies and/ or book chapters published during a given time of observation, and a parameter F: Number of full-time faculty members which remained constatnt during a given period of observation and the number of research scholars registered. It was concluded that the research performance of these high hailed Business schools in India was not so encouraging owing to the fact that most of them failed to publish even one article per faculty during the period of analysis. In another study by Aithal[8], a case study of few IIMs was done, including their curriculum etc. to bring out learning methods used by these institutions. The possibility of design of an industry-oriented curriculum in both business and information technology containing both industry and research experience components was discussed. This study, however, did not focus on analysis of research performance.

Another study[9] looked at Business schools in India and pointed out some historic reasons for unproductivity in research. It stressed upon the need of collaborative action across institutions and the need to inculcate specialised competence among faculty members to foster core academic activities.

Another work[10] discussed and debated over the lack of high quality and context specific management research in India. The authors suggested and made a case for confident indigenous scholarship, context relevant methodologies in research and modes of dissemination in order to suit the developmental and academic requirements of the country. The discussion further urged Indian researchers to strive for level of rigor in the western models of research excellence and not just blindly follow the western publication pattern.

An analysis[11] of the research productivity of management schools in India was performed that led to the development of a composite indicator (CI) using directional-benefit-of-doubt-model (BOD) for the time period 1968-2015. For this purpose, data for top 32 B-Schools in India (as appearing in Outlook, the Business World and Careers360 over the last years) was taken by searching individual B-School database, NUS/ABS/Scopus database and Google Scholar. The research output data for faculty members was also scraped for the time period of 1968-2015. Important conclusions were drawn such as the Business schools at IITs performed better than the IIMs; the faculties at

the IITs had better research productivity than those at the IIMs and faculty members that possessed doctoral degrees from foreign universities were more productive relative to those that are based in India.

A scientometric analysis[12] of the research productivity of 1st Generation of IIMs during the 2008-2018 was performed using data from Web of Science. It was observed that IIM Calcutta had the highest research output per capita (4.73) followed by IIM Ahmedabad (4.29). Moreover, in terms of average citations per paper, though IIM Bangalore performed better but IIM Ahmedabad accrued the maximum citations. A discussion on the development of management education in India was done, with specific reference to the role of the Institutes of Management[13]. Recently, a work by Tyagi[14] carried out a bibliometric analysis of the research performance of 4 premier IIMs of India namely, Ahmedabad, Bangalore, Calcutta and Lucknow during the years 2010-2021. This work focussed on the research productivity, authorship trends, collaboration patterns and prolific sources where research from these IIMs are published. Few conclusions of the study stated that the 4 IIMs showed a rising trend in research while the main subjects researched upon by these IIMs were Business, Management and Accounting followed by Economic, Econometrics and Finance. While IIM Ahmedabad produced maximum number of papers during the 12 year span, IIM Lucknow displayed high Annual (28.49 %) and Compounded Annual Growth (17.02 %) rates.

However, to the best of our knowledge none of the previous studies have systematically analysed all the relevant aspects of research output of all the three generations of IIMs in the recent period. This has motivated us to analyse the research output of all the IIMs and also compare it with the top business schools of the world, namely MIT Sloan School of Management (THE Ranking 2020: Rank 1 in Business and Economics), Harvard Business School (QS World University Rankings 2020: Rank 1 in Social Science and Management) and NUS Business School (ARWU Rankings 2020: Rank 1 in Management subject-area within the field of Social Science).

The present study attempts to bridge the research gap on bibliometric analysis of research output of all the IIMs on different parameters. A detailed analysis of research publication data from IIMs is done to understand patterns and trends of publications, citations, international collaboration, gender distribution, open access availability, social media visibility of the research output and the thematic structure of research publications from IIMs.

3. METHODOLOGY

The data for analysis comprised of research output for the IIMs downloaded from the Scopus database. Scopus database was chosen due to its wider coverage of publications/ journals in the domain of business and management. Scopus had data present for 17 out of 20 institutions. The publication records for IIM Bodh Gaya, IIM Sirmaur and IIM Vishakhapatnam were not found in Scopus. For each of the 17 IIMs, queries of the following form were formulated: (AF-ID("X" Y) AND (PUBYEAR > 2009 AND PUBYEAR < 2020), where X is the name of the IIM and Y is the Affiliation ID of that IIM in Scopus. This query was entered in the Advanced Search tab of Scopus and research publication data for each IIM was downloaded and processed. Data for a total of 5,186 publication records for the 17 IIMs was downloaded and processed. Some additional data like the year of establishment of each IIM, the latest Faculty data etc. have also been retrieved from the consortium of IIM libraries[15].

The research publication data obtained is computationally analysed to identify different patterns and trends. Total Paper (TP), Total Citations (TC), Citation Per Paper (CPP) and h-index etc. are computed and shown. The Compounded Annual Growth Rate (CAGR) of institutions is calculated as follows:

$$CAGR = \left(\left(\frac{\text{v final}}{\text{v begin}} \right)^{\frac{1}{t}} - 1 \right) * 100$$

where, Vfinal is the number of publication records in the year 2019, Vbegin is the number of publication records in the year where the first research output of the institution is seen, and t is the time period in years.

The international collaboration patterns of IIMs are identified by processing the affiliations metadata of publication records. Gender of each publication record is computed using the services of gender-api, a subscription-based platform which determines gender using the first name and the country of an author. The first author of each publication record is considered for the purpose. A file is created by extracting a publication's first author's name and country of affiliating organisation from the relevant metadata. The country of the affiliating organisation of the author is replaced with a unique country code and passed to the gender-api to obtain an output file[16]. The output file is then processed to obtain gender values determined by the gender-api with greater than 70 % accuracy while those gender values whose reliability or accuracy is less than 70 %, are discarded.

The social media presence of publications from the IIMs is also analysed by using the subscription-based access of Altmetric.com[17]. The Altmetric.com provides the mentions of a publication DOI on various social media platforms such as Twitter, Facebook, Wikipedia, Blogs etc. The DOIs of the publication data for each IIM is passed to the UI interface of Altmetric.com and the data obtained is processed to report the mentions of research output from the IIMs on few major social media platforms.

In order to identify the major thematic areas of research in IIMs, author keywords field is used. The author keywords is a field provided in the metadata of Scopus that contains the keywords provided by the author in the publication text. The publication data of the IIMs is processed to obtain the keywords from the Author keywords metadata. The keywords are then processed using an NLP module where a series of steps such as stop-word removal, punctuation removal etc. are performed. The word2vec model is used to replace few specific terms in keywords with more generic terms having similar semantic meaning. Thereafter, the most frequently occurring of the top 5 semantically similar terms for each keyword are used as the

Table 1. Research output of IIMs during 2010-2019

Institution Name	Year of establishment	Faculty strength (in 2019) *	TP (2010-2019)	PPC (for year 2019)	CAGR (%)
1st Generation IIMs					
IIM Calcutta	1961	88	869	8.78	4.96
IIM Ahmedabad	1961	109	1055	6.64	11.20
IIM Bangalore	1973	106	896	9.85	1.95
IIM Lucknow	1984	94	518	7.10	10.46
IIM Kozhikode	1996	88	446	7.19	14.51
IIM Indore	1996	104	532	4.79	27.21
2nd Generation IIMs					
IIM Shillong	2008	31	102	5.10	20.89
IIM Rohtak	2009	26	252	6.30	19.04
IIM Ranchi	2009	47	120	3.64	23.49
IIM Raipur	2010	29	268	3.94	42.28
IIM Tiruchirappalli	2011	32	107	3.57	25.89
IIM Kashipur	2011	27	127	3.74	42.28
IIM Udaipur	2011	52	183	4.95	28.56
3rd Generation IIMs					
IIM Nagpur	2015	27	24	2.40	--
IIM Amritsar	2015	12	43	1.72	--
IIM Bodh Gaya	2015	NA	NA	NA	--
IIM Sirmaur	2015	NA	NA	NA	--
IIM Visakhapatnam	2015	NA	NA	NA	--
IIM Sambalpur	2015	10	30	1.88	--
IIM Jammu	2016	15	14	1.56	--

Note: TP- Total Publications, PPC (2019) (Publications per capita as in 2019)- Total Publications in 2019/Faculty Strength in 2019, CAGR- Compounded Annual Growth Rate, CAGR calculated from the year in which 1st research output is found, CAGR not calculated for 3rd generation IIMs owing to their recent establishment.
*Faculty data taken from http://www.iimlibrariesconsortium.ac.in/faculty.html

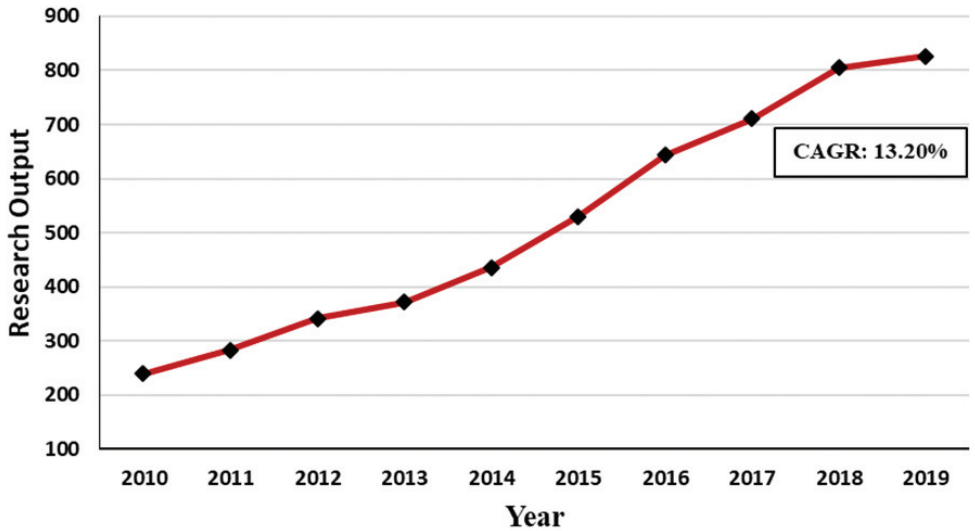

Figure 1. Research output of IIMs during 2010-2019.

generic terms for that keyword. These terms are taken as the thematic areas of research for the IIMs.

The various results obtained for IIMs are compared with the three benchmark institutions-Harvard Business School, MIT Sloan School of Management and NUS Business School. These three institutions have been chosen owing to their top rankings in world rankings. For example, MIT Sloan School of Management ranks 1st in Business and Economics according to THE Ranking 2020, Harvard Business School ranks 1st in Social Science and Management according to QS World University Rankings 2020 and NUS Business School ranks 1st in Management subject area within Social Science field

Table 2. Citation profile of IIMs during 2010-2019

Institution Name	TP (2010-2019)	TC (2010-2019)	CPP (2010-2019)	Cited (%) (2010-2019)	h-index (2010-2019)
1st Generation IIMs					
IIM Calcutta	869	6581	7.57	68.12	36
IIM Ahmedabad	1055	9782	9.27	76.59	40
IIM Bangalore	896	8398	9.37	72.66	42
IIM Lucknow	518	4350	8.40	80.69	32
IIM Kozhikode	446	3957	8.87	77.35	28
IIM Indore	533	3417	6.41	71.67	25
2nd Generation IIMs					
IIM Shillong	102	696	6.82	74.51	14
IIM Rohtak	252	2444	9.70	81.35	25
IIM Ranchi	120	653	5.44	80.00	12
IIM Raipur	268	2429	9.06	78.73	23
IIM Tiruchirappalli	107	972	9.08	74.77	14
IIM Kashipur	128	836	6.53	72.66	15
IIM Udaipur	183	1993	10.89	80.33	18
3rd Generation IIMs					
IIM Nagpur	24	63	2.63	70.83	5
IIM Amritsar	43	205	4.77	65.12	9
IIM Sambalpur	30	251	8.37	80.00	6
IIM Jammu	14	83	5.93	85.71	5

Note: TP- Total Publications, TC- Total Citations, CPP- Citation per paper, Cited%- Percentage of Research Output that is cited

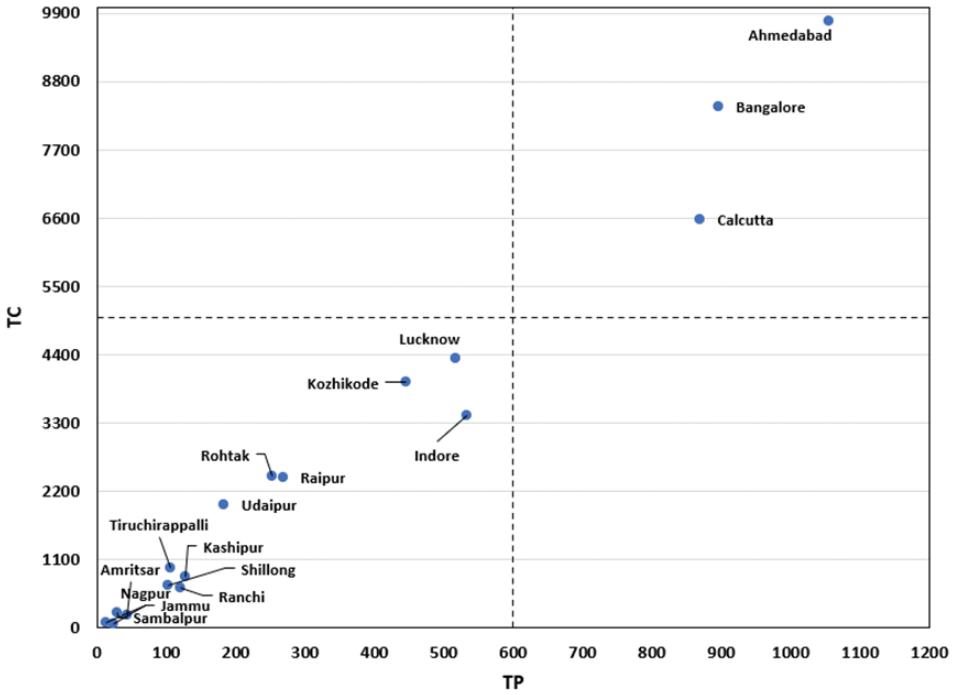

Figure 2. Total papers (TP) vs. total citations (TC) for the IIMs (2010-2019).

according to the ARWU Rankings 2020. It may be noted that two of these institutions (MIT Sloan School of Management and Harvard Business School) mentored establishment of the initial two IIMs.

4. RESULTS

4.1 Research Output

The year of establishment, faculty strength, research output, publication per capita (PPC) and the CAGR (Compounded

Annual Growth Rate) values of the IIMs is shown in Table 1. Research publication data for IIMs at Bodh Gaya, Sirmaur and Visakhapatnam are not available. Out of the total output from IIMs, 83.2 % publications are from the 1st generation IIMs, 22.3 % of the publications belong to the 2nd generation IIMs, and third generation IIMs contribute 2.1 % of the publications. IIM Ahmedabad has highest publication records of 1,055 followed by IIM Bangalore (896 papers). In terms of PPC values, IIM Bangalore has highest PPC value of 9.85 followed by 8.78 for IIM Calcutta. Research output from IIM Indore is reported to have fastest growth with CAGR value of 27.21 % in the first-generation IIMs. All the IIMs combined have a CAGR value of 13.20 %, as seen in Fig. 1, which is higher than India's average CAGR of 9.27 %. Thus, these values help answer RQ1.

4.2 Citations

The citation profile of the IIMs is shown in Table 2. It can be observed that IIM Ahmedabad and IIM Bangalore get highest citations. IIM Ahmedabad has CPP value of 9.27 and cited percentage of 76.59 %. IIM Bangalore has CPP value of 9.37 and cited percentage of 72.66 %. IIM Lucknow has cited percentage value of 80.69 %. Among the 2nd generation IIMs, IIM Rohtak has highest cited percentage of 81.35 % with CPP value of 9.70 and IIM Udaipur has cited percentage of 80.33 % and CPP value of 10.89. Almost all the IIMs have a cited percentage value of more than 60 %, indicating that at least 60 % of the papers from them are cited. Figure 2 presents a scatter plot of TC vs. TP for the IIMs. It can be observed that the three 1st generation IIMs- namely at Ahmedabad, Bangalore and Calcutta- are in the top quadrant with higher TC and TP values. IIMs at Lucknow, Kozhikode and Indore are placed next with moderate TC and TP values while the IIMs at Rohtak, Raipur and Udaipur follow these institutions. This analysis thus helps in answering RQ2.

4.3 International Collaboration

Internationally collaborated papers (ICP) usually lead to higher impact on research productivity of an institution, as compared to the non-ICP ones[18-19]. Table 3 presents the overall internationally collaborated output and percentage of internationally collaborated output for the 17 IIMs during 2010-2019. IIM Ahmedabad has the highest number of internationally collaborated papers (379 papers), followed closely by IIM Bangalore (369 papers). However, IIM Bangalore reports a higher percentage of ICP (41.18 %) than IIM Ahmedabad (35.92 %). In the 2nd generation IIMs, IIM Udaipur has the highest ICP value of 83, alongside having the overall highest ICP value of 45.36 %, indicating that a good part of its published output is internationally collaborated. This may possibly be a reason for the cited percentage value of 80.33 % for IIM Udaipur, and the highest CPP value of 10.89 among all the IIMs. The 3rd generation IIMs have between 25 % to 35.71 % of research papers being internationally collaborated. These results successfully answer the RQ3.

Table 3. International collaboration of IIMs during 2010-2019

Institution name	TP (2010-2019)	Internationally collaborated output (2010-2019)	ICP (%) (2010-2019)
1st Generation IIMs			
IIM Calcutta	869	206	23.71
IIM Ahmedabad	1055	379	35.92
IIM Bangalore	896	369	41.18
IIM Lucknow	518	89	17.18
IIM Kozhikode	446	118	26.46
IIM Indore	533	82	15.38
2nd Generation IIMs			
IIM Shillong	102	10	9.8
IIM Rohtak	252	25	9.92
IIM Ranchi	120	17	14.17
IIM Raipur	268	67	25
IIM Tiruchirappalli	107	31	28.97
IIM Kashipur	128	15	11.72
IIM Udaipur	183	83	45.36
3rd Generation IIMs			
IIM Nagpur	24	6	25
IIM Amritsar	43	10	23.26
IIM Sambalpur	30	9	30
IIM Jammu	14	5	35.71

Note: TP- Total Publications, ICP- Internationally collaborated papers

4.4 Open Access

Countries and institutions across the world are now taking and participating in different kinds of open access initiatives for making the knowledge generated available to a wider section. The open access model brings significant benefits to authors, readers, funders, institutions etc., and more so for developing and under-developed countries, where enough resources are not readily available with academicians to pay the article access charges. Previous studies on open access in India have shown that less than 1/3rd research output from India is available in open access[20]. The open access avilability of research output from IIMs is presented in Table 4. It is observed that among

Table 4. Open access profile of IIMs during 2010-2019

Institution name	TP (2010-2019)	Open access publications (2010-2019)	Percentage of open access articles (2010-2019)
1st Generation IIMs			
IIM Calcutta	869	91	10.47
IIM Ahmedabad	1055	224	21.23
IIM Bangalore	896	248	27.68
IIM Lucknow	518	57	11.00
IIM Kozhikode	446	71	15.92
IIM Indore	533	78	14.66
2nd Generation IIMs			
IIM Shillong	102	7	6.86
IIM Rohtak	252	22	8.73
IIM Ranchi	120	14	11.67
IIM Raipur	268	39	14.55
IIM Tiruchirappalli	107	16	14.95
IIM Kashipur	128	12	9.45
IIM Udaipur	183	28	15.30
3rd Generation IIMs			
IIM Nagpur	24	1	4.17
IIM Amritsar	43	6	13.95
IIM Sambalpur	30	5	16.67
IIM Jammu	14	4	28.57

Note: TP- Total Publication

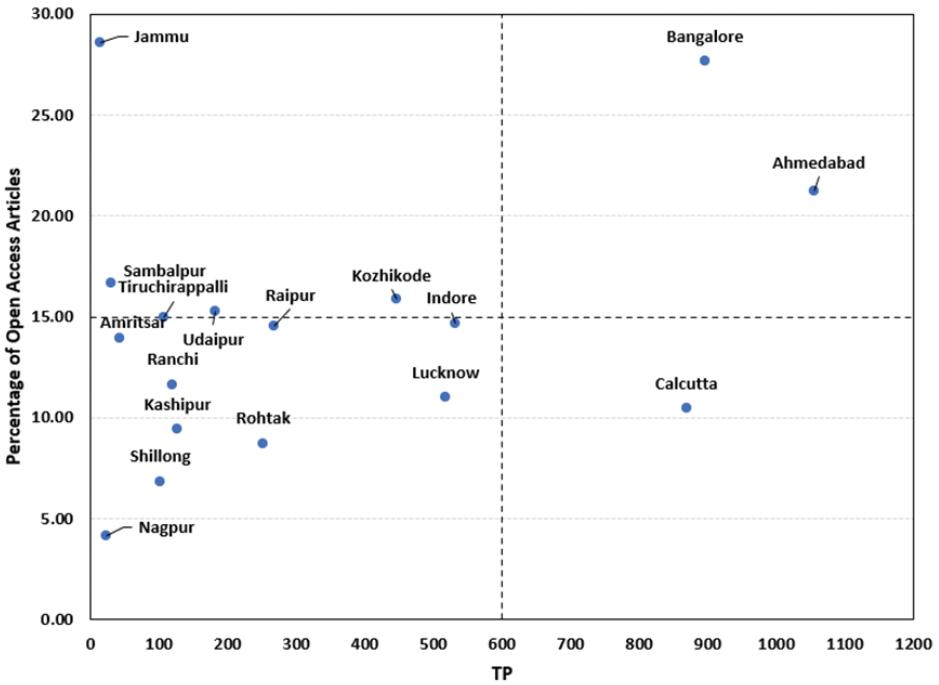

Figure 3. Total papers (TP) vs. percentage of open access articles of the IIMs.

Table 5. Social media Attention gathered by publications from IIMs during 2010-2019

Institution name	TP (2010-2019)	Altmetric instances	Coverage percentage	Blog mentions (per paper)	Facebook mentions (per paper)	News mentions per paper	Patent mentions (per paper)	Twitter mentions (per paper)	Wikipedia mention (per paper)	No. of Mendeley readers (per paper)
1st Generation IIMs										
IIM Calcutta	869	229	26.35	1.2	1.59	2.2	1.5	4.76	1.33	46.7
IIM Ahmedabad	1055	393	37.25	2.48	2.53	8.88	3.33	9.2	1.38	57.24
IIM Bangalore	896	336	37.50	2.23	2.53	3.31	1	11.65	1.33	63.75
IIM Lucknow	518	96	18.53	2	2	3.5	No mentions	2.12	No mentions	59.52
IIM Kozhikode	446	155	34.75	1.33	2.5	1	No mentions	2.57	1	67.72
IIM Indore	533	121	22.74	1.17	1.5	1.5	No mentions	3.89	1	33.86
2nd Generation IIMs										
IIM Shillong	102	17	16.67	1	1.71	No mentions	1	5.33	No mentions	24.88
IIM Rohtak	252	48	19.05	1	1.17	3	No mentions	1.89	1	52.33
IIM Ranchi	120	24	20.00	No mentions	2	1	No mentions	3.92	1	97.33
IIM Raipur	268	56	20.90	No mentions	5.5	1	No mentions	3.1	1	62.07
IIM Tiruchirappalli	107	24	22.43	No mentions	1	No mentions	No mentions	10.25	1	80.58
IIM Kashipur	128	16	12.60	2	1.33	20	No mentions	4	No mentions	70.06
IIM Udaipur	183	70	38.25	1	1.33	3.6	No mentions	7.38	2	48.5
3rd Generation IIMs										
IIM Nagpur	24	5	20.83	No mentions	No mentions	No mentions	No mentions	1.5	No mentions	19
IIM Amritsar	43	9	20.93	No mentions	No mentions	No mentions	No mentions	2.25	No mentions	25.67
IIM Sambalpur	30	3	10.00	No mentions	No mentions	No mentions	No mentions	4.67	No mentions	272.33
IIM Jammu	14	1	7.14	No mentions	1	No mentions	No mentions	2	No mentions	17

Note: TP- Total Publications

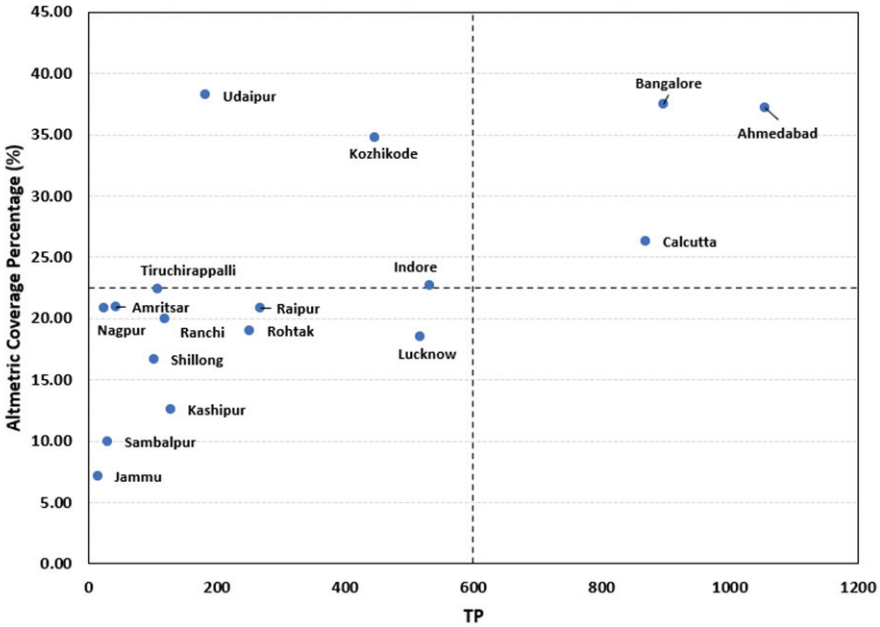

Figure 4. Total papers (TP) vs. Altmetric coverage percentage of the IIMs (2010-2019).

the 1st generation IIMs, IIM Bangalore and IIM Ahmedabad have 27.68 % and 21.23 % of their publications available as Open Access. Figure 3 shows a scatter plot of open access percentage vs. TP, and it can be observed that most of the 2nd generation IIMs cluster around the 15 % mark, i.e., less than 20 % of their articles are available as Open Access. Thus, IIMs show a similar pattern of open access availability as that of India's average. These results answer the RQ4.

4.5 Social Media Visibility of Research Output

Social media presence of research output helps to keep a track of mentions of research publications on various platforms. It has been shown earlier that only 28.5 % of Indian research output is covered on social media platforms, which is about 18 % less than the world average of 46.7 %. The social media visibility of research output from IIMs is analysed and coverage percentage and mentions per paper values are shown in Table 5. It is observed that, among 1st generation IIMs, IIM Bangalore has the best coverage percentage value of 37.50 % followed by 37.25 % from IIM Ahmedabad. Among the 2nd generation IIMs, IIM Udaipur has social media coverage percentage value of 38.25 %, indicating higher coverage. Thus, some IIMs have social media coverage levels higher than India's average value. Figure 4 presents a scatter plot of altmetric coverage percentage vs. TP. IIM Ahmedabad, Bangalore and Calcutta are in the top quadrant. IIM at Udaipur and Kozhikode are other IIMs with higher coverage. It is also observed that the no. of Mendeley readers is the highest across different platforms, followed by Twitter mentions. The mentions on other platforms are relatively low. IIM Ahmedabad has highest News mentions per paper and IIM Bangalore has highest Tweets per paper. These analytical results thus help answer the RQ5.

4.6 Thematic Areas of Research

The major thematic areas of research, within the IIMs, is identified using the author keywords obtained from the publication records of the 17 IIMs during 2010-2019. We have extracted all author keywords, taken a set of 500 most frequent keywords, and provided a keyword co-occurrence network of the same, as shown in Fig. 5. The top five keywords obtained are – 'supply-chain management', 'innovation', 'emerging markets', 'social media' and 'corporate governance'. Although these keywords look independent, they give us a fair idea of what topics or subtopics of the field of management have been researched by the IIMs during the given time-period 2010-2019. Some frequent keywords like "green" and "sustainable" can be an example of how sustainable or environmental-friendly research topics have been explored by the IIMs. Other keywords like 'e-commerce' and 'online-reviews' show how the IIMs are exploring the recent trends in the Indian consumer market. From the Fig. 5, we can observe 6 major clusters related to topics including (but not limited to) 'emerging markets', 'marketing', 'human resource management', 'optimisation', 'data envelopment analysis' and 'social media' (These are based on the largest bubble i.e., most frequent keywords, for each coloured cluster). This may correspond to the different areas of research being performed in the IIMs.

From the figure, one can see high intra-cluster linking between keywords like innovation and emerging markets, and also between social media, clustering and sentiment analysis. This shows the research trends on a micro-thematic level, with emphasis on in-depth analysis of such fields. On the other hand, inter-cluster links between clusters represented by innovation and supply chain management, or culture, social media and marketing shows how a macro-level analysis on current trends and their closely related areas, is happening within the IIMs. (RQ6)

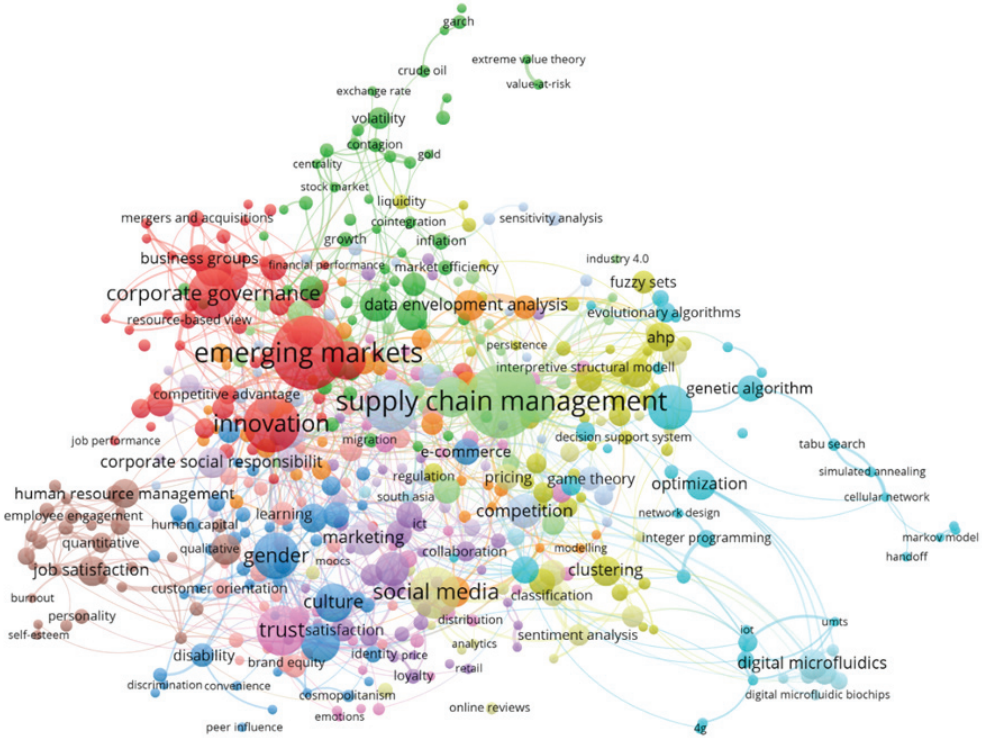

Figure 5. Co-occurrence network of author keywords (top 500 with freq. count>=5).

4.7 Gender Distribution

The gender distribution of first author for research publication for the six 1st generation IIMs is shown in Fig. 6. The year-wise proportion of female and male 1st authored papers during 2010-2019 and for the 1st generation of IIMs is presented. In all the 6 IIMs, the percentage of male first authored publications quite exceed the female first authored publications. However, in later years a rise in female first authored publications is seen. IIM Bangalore has the highest percentage of female first authored publications (31.29 %) while IIM Ahmedabad and IIM Indore also show a clear rising pattern of female first authored papers with time. In this context, it would be relevant to note that Indian research output in general has only 28 % research papers authored by a female researcher as first author[21]. In the case of IIMs, some are found to have better female representation (such as IIM Bangalore). However, majority of the other IIMs have lesser female representation in publications. This may be an indirect indication of a smaller number of female faculty/female research students in the IIMs or perhaps a lower productivity of female researchers. A qualitative analysis can be carried out to understand the probable reasons for the observed patterns, however few relevant points are discussed in the discussion section (RQ7).

4.8 Comparison with Benchmark Institutions

The research output of IIMs can be compared with research output of the three selected benchmark institutions taken, namely the Harvard Business School, MIT Sloan School of Management, and NUS Business School. Table 6 shows that Harvard Business School has research output of 2,411 papers and MIT Sloan School of Management has research output of 2,078 papers. These values are almost twice of the IIM producing the highest research output in the corresponding period. It may be noted that these two international institutions mentored the establishment of the first two IIMs. The NUS Business school, which is relatively a contemporary to the 1st generation IIMs, produces 591 research papers, which is less than the three IIMs at Calcutta, Ahmedabad and Bangalore. Since a reliable data for the faculty strength of these institutions are not available, therefore, PPC values could not be compared.

When comparing the citation related values of IIMs with the three international institutions, it is observed that Harvard Business School has cited percentage of 82.7 % and CPP value of 34.35; MIT Sloan School of Management has cited percentage of 86.81 % and CPP value of 31.19; and NUS Business School has cited percentage of 89.51 % and CPP value of 23.87. These values are slightly higher than that of IIMs. In terms of h-index values, IIM Bangalore has highest h-index of 42 followed by IIM Ahmedabad with h-index of 40. The three international institutions have h-index values of 132, 113 and 60, all of which are significantly higher than the best performing IIMs.

A comparison of international collaboration patterns shows that IIM Ahmedabad and IIM Bangalore have better or comparable ICP percentage as compared to Harvard Business School and MIT Sloan School of Management. NUS Business school, however, has a very high ICP percentage of 69.2 %. Among the major collaborating countries with all IIMs taken together, it was found that US accounts for the highest ICP count of 695, followed by UK with ICP count of 213, Canada

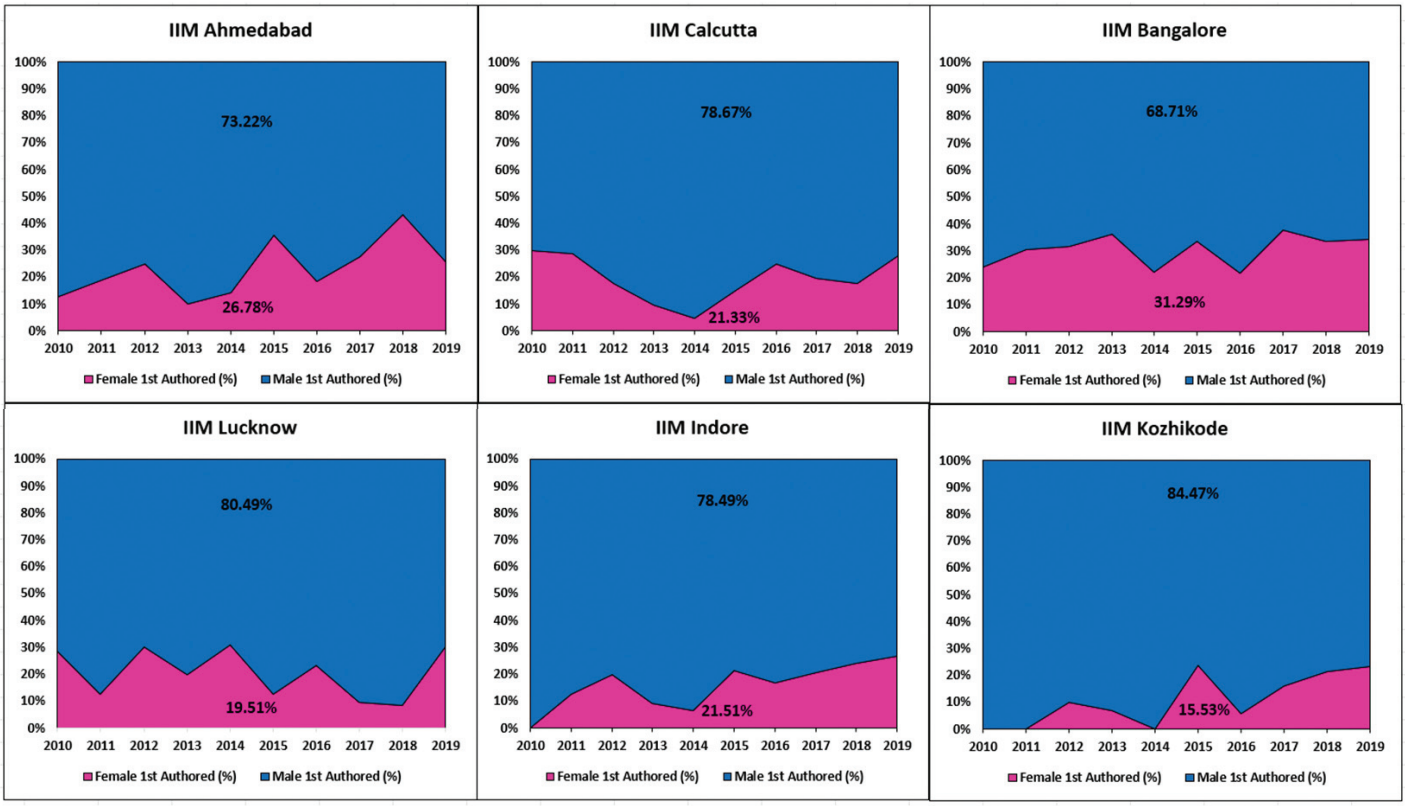

Figure 6. Gender distribution of 1st generation IIMs.

Table 6. Research profile of top 3 business schools of the world

Institution	Year of Establishment	TP (%) (2010-2019)	TC (%) (2010-2019)	CPP (%) (2010-2019)	Cited (%) (2010-2019)	ICP (%) (2010-2019)	Open Access (%) (2010-2019)	Altmetric Coverage (%) (2010-2019)	h-index
Harvard Business School	1908	2411	82829	34.35	82.7	28.91	36.33	86.75	132
MIT Sloan School of Management	1914	2078	64814	31.19	86.81	36.33	51.15	57.22	113
NUS Business School	1965	591	14105	23.87	89.51	69.2	28.60	56.01	60

Note: TP- Total Publications, TC- Total Citations, CPP- Citation per paper, ICP- Internationally collaborated papers, Cited%- Percentage of Research Output that is cited

with ICP count of 115 and China with ICP count of 102. Other major countries having internationally collaborated output with IIMs include Germany (96 papers), Australia (87 papers), Netherlands (74 papers) and France (57 papers).

Among the three international institutions, open access availability varies from 51.15 % of MIT Sloan School of Management to 28.60 % of NUS Business School. IIMs on the other hand have much less proportion of their research output available as open access as compared to these three institutions. Similarly, on the parameter of social media coverage, it is observed that MIT Sloan has 57.22 % coverage, Harvard Business School has 58.65 % coverage and NUS has 56.07 % coverage of its publications on social media platforms. These values are noted to be significantly higher as compared to IIMs. (RQ8)

5. DISCUSSION

This study has made an attempt to analyse the research output of the premier management institutes in India, the IIMs. Some previous studies have explored the research growth from the IIMs but they have been focussed only on the 1st generation IIMs and there are hardly any studies to have analysed research output of 2nd and 3rd generation IIMs. Further, most of the existing analysis focused on publication and citations and/ or curriculum etc. and did not analyse the important parameters of open access trends, social media visibility of research, and gender distribution in research output from the IIMs. The present study addressed these unexplored parameters and presented a comprehensive analysis of research output and relevant parameters of all the IIMs together. The analysis performed could successfully answer all the research questions proposed.

While it may be intuitive to note that most of the 1st generation IIMs have higher research output as compared to IIMs established later, it is equally interesting to note that several IIMs established in 2nd generation (such as IIM at Rohtak and Raipur) record a very impressive growth rate of research publications. The previous studies[12,14] which analysed research output of 1st generation of IIMs, have shown similar patterns of output, citations and citation per paper for those IIMs, as observed in the current study. This study adds supplements to the existing studies by including analysis of 2nd and 3rd generation of IIMs. Some IIMs (such as IIM at Udaipur) have a very high proportion of internationally collaborated research papers. One may expect that in the time to come when the newer IIMs have established themselves well, all the IIMs taken together will produce significant amount of research output in the area of management. However, the pace at which newer IIMs are coming up academically and in research needs to be improved further.

When seen in the light of openly accessible research, less than 25 % of the research output from the IIMs are openly accessible. This is a bit problematic taken into account the fact that India suffers from serious problems of access to journals and databases. The results indicate towards lack of appropriate institutional policies for open access and about lack of awareness in the researchers towards the national mandates of open access. It may be noted that India has a policy in force that all public funded research should be openly accessible[20]. The IIMs, therefore, need to take proactive action to increase open access availability of their research output so that knowledge produced by them is accessible to wider audience without any barriers. Creation of institutional open access policies with increased emphasis on open access could be one possible solution to this. Strategies like deposit in institutional repositories and various archives can be used for the purpose. Incentive mechanisms for deposit in various open access archives can be explored. Increased open access is likely to benefit these institutions in many ways.

The social media dissemination of research from IIMs is also not very impressive. Since, a good amount of research work done in the IIMs may be of applied nature and has an important connect to organisations and industries, it becomes increasingly important for the IIMs to make more of their research disseminated widely in various sources, including the newer channels of social media platforms. One possible reason for this may be that most of the IIMs do not have a well-defined social media policy. The relevant structures to promote social media dissemination are either not in place, or if they exist, they do not have the knowledge and awareness about the effectiveness of the newer social media platforms. Therefore, IIMs need to work towards this so that the research that they do can reach to a wider audience and can be used more effectively.

Incentive structures for researchers may also be proposed by IIMs to reward the champions who are able to effectively use the new tools for wider dissemination of research output produced.

In terms of the gender distribution in research output from the 1st generation of IIMs, though a rise in female first authored research output is noticed for later years during the 2010-2019 period, the proportion of female first authored papers remain low. There could be several reasons for this. The lesser proportion may be either due to a smaller number of female researchers or their lower productivity levels. The lack of support towards work-family interface in Indian institutions may also be a reason for lower productivity of female researchers[22]. Indian institutions have been lately affirming female representation in their faculty; however, the gender equity policies are yet to make a concrete effect. The barriers in the rise of women in senior leadership in Indian institutions still continue[23]. Nevertheless, the growth in proportion of female first authored research output over the years is a welcome development. The rise is slow but steady which stresses upon the need to have more effective gender equity policies for achieving a better representation of females in faculty and student population in Indian institutions, including IIMs. The growth in female participation in research in IIMs may not only help in gender balance but also in terms exploring newer dimensions and themes of management research, as it is often believed that the research preferences of male and female researchers vary a bit with females focusing more on people-oriented topics whereas male researchers focusing more on things-oriented topics.

On comparison of research output quantity (publications) and quality (citations and h-index) of the IIMs with the top 3 Business schools of the world, it appears that IIMs have to improve considerably in terms of research so as to be able to match the values with the three benchmark institutions considered. This is more relevant taking into account the fact that two of these premier institutions have played the mentoring role in establishment of the initial IIMs. In terms of other parameters of international collaboration, open access, social media visibility etc. too, the IIMs lag behind the three benchmark institutions. Therefore, a systematic effort is needed to further improve the research output from the IIMs and its visibility on various parameters. The comparison with the three benchmark institutions, however, does not take into account the difference in funding and full-time researcher counts and hence more research considering both inputs and outputs is needed for a better comparison. Nevertheless, in order to become the world leaders in management research and knowledge production, IIMs have a long way to go. Higher level support from government, industry etc. can help in further improving the knowledge production from IIMs.

6. CONCLUSION

The study performed a bibliometric analysis of research output of the IIMs for the most recent 10 years period. The study is unique in the sense that it is first such study to have analysed research performance of all the three generations of IIMs on a wide range of parameters. The open access profile of research, the social media visibility of research, thematic areas of research and gender distribution of research from the IIMs are the new features explored and discussed, which were not covered in previous studies. Moreover, the research performance of the IIMs is also compared with the top three business schools of the world namely, Harvard Business School, MIT Sloan School of Management and NUS Business School, which is also a novel contribution of the study. The analysis presents interesting outcomes that can be used to design targeted schemes to further improve the research output from IIMs on various parameters.

The study presents several relevant implications (discussed in more detail in the Discussion section). It implies that IIMs not only need to focus more on their research output and their visibility and dissemination but also need to address the problems of lower level of open access and female authored research papers. Systematic efforts are needed to improve the research output and at the same time institution of appropriate policies and incentive structures are required to increase open access and visibility of the research output produced. The comparison of IIMs with the three benchmark world institutions selected, points to the need for higher level of input and support that need to be provided to IIMs.

Like any other study, this study has also some limitations. One of them is that it only focuses on research publications and does not take into account patents or other scholarly outputs (such as books and case studies). Further, it focuses mainly on the output side evaluation and does not take into consideration the input factors (such as funding, faculty etc.). Therefore, more analysis can be carried out to explore other types of outputs produced from IIMs and also to include input-side normalisations in the analysis. Further, the study mainly focuses on quantitative analysis to uncover the relevant bibliometric patterns which need to be used as input by a systematic qualitative analysis to better understand the probable reasons behind the observed patterns.

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