

Research Performance of IIT Goa and IIT Dharwad: A Scientometric View

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ABSTRACT

This paper deals with the scientometric analysis of the research performance of two Indian Institute of Technology viz. IIT Goa and IIT Dharwad. The bibliographic data of both the IITs during 2017-2022 was extracted from the Scopus database and used for further analysis. Various scientometric indicators have been computed to get an in-depth insight of the research performance of these IITs. The results of research performance showed a promising trend at both the IITs. Moreover, both the IITs showed collaborative trends in publications. Subudhi S. and Prasanna S.R.M were the most productive authors at IIT Goa and IIT Dharwad respectively. Journal articles is the most favoured bibliographic form of the authors at both the IITs.

Keywords: Scientometric analysis, Publications, Research performance, Scopus, IIT Goa, IIT Dharwad

1. INTRODUCTION

The Indian Institutes of Technology are one of the most prestigious brand of engineering institutes in India. They are one of the most sought after institutes by every aspiring engineer. IITs came into existence by an Act of Parliament known as the Institutes of Technology Act, 1961 and hence all the IITs are governed by this Act. All IITs are under the Ministry of Education, Government of India, however, each IIT is an autonomous body i.e. they can develop their own curriculum and adapt to the rapidly changing educational

scenario free from any bureaucratic hurdles. Currently there are 23 IITs across India and all of them are listed as “Institutes of National Importance” in the IIT Act, 1961. Out of these 23 IITs, 7 are most recently established IITs during 2015 and 2016. The main objective of starting these new IITs was to provide a boost to the quality of technical education in India. IIT Palakkad and IIT Tirupati were established in 2015 while, IIT Bhilai, IIT Jammu, IIT (ISM) Dhanbad, IIT Goa & IIT Dharwad came into existence in 2016. (*About IITs / Council of Indian Institute of Technology, 2022*).

In the current study, IIT Goa and IIT Dharwad which are situated in the western part of India and in close proximity to each other have been selected. They are in their initial phase of development both in terms of physical and research infrastructure. Both these institutes are currently offering undergraduate, postgraduate and doctoral programmes in various disciplines. This study will be useful for all the stakeholders namely research scholars, funding agencies and prospective faculty members to take a note of the research output of both the institutes in terms of publications (quantity) and its research impact (quality) in terms of citations.

2. LITERATURE REVIEW

Review of the related literature forms an essential part of the research publications. It actually empowers the researcher to understand the past research interests, research trends and the importance of the research performance in a particular discipline. It also assists the investigator to identify the research gap and accordingly formulate the research problem. There are ample number of research papers on assessing the research performance of the premier institutes like IITs, NITs, IISERs, etc.

For instance, (Gangan Prathap, 2013) has analysed the research performance of the IITs and compared them with other world renowned engineering and technology institutes by using various bibliometric techniques. Similarly, (Banshal et al., 2019) has compared the research performance of private universities in India with other premier institutes like IITs, NITs, Central Universities during 2010-2016 to determine the quality of research, disciplinary variations, research trends, etc. This study also came out with significant conclusions that private universities may surpass the Central Universities in terms of research output in near future as well as they also seem to perform well on international collaboration front. (Banalata Pradhan & Ramesh, 2017) conducted a scientometric study wherein they have analysed the research performance of two renowned IITs viz. IIT Bombay and IIT Madras during 2006-2015. The study was concluded with very interesting results such

as the productivity of both the IITs grew consistently throughout the study period, while, the IITB authors were highly cited as compared to IITM. In another scientometric study conducted by (Shettar, Iranna M. & Angadi, 2018) showed the research performance and technological development of NITK, Surathkal, wherein, the annual growth of productivity, author collaboration pattern and individual performance of the researchers were showcased. (Bijayananda Pradhan, Kuri, et al., 2020) carried out a Scientometric analysis of NIT Rourkela to examine its research productivity. This study concluded with very rapid, strong and optimistic growth in research performance along with maintaining high quality of research at NIT Rourkela. In yet another study carried out by (Bijayananda Pradhan, Kumar, et al., 2020) explored the research performance of Sambalpur University during 1990-2019. This study evaluated the research output of two decades indexed in Scopus database. The major findings of this study was the annual growth rate of publications, authorship patterns, most prolific author, most preferred journal and collaborative countries. (Parida et al., 2020) also analysed the research performance of All India Institute of Medical Sciences (AIIMS) Bhubaneswar during 2012-2019. It was found in this study that 2019 witnessed the highest number of publications by AIIMS Bhubaneswar. Further, the study also identified the most prolific author, most preferred journal, most participating countries among international collaboration with the institute. (Kuri et al., 2020) has also attempted to identify the research trends at Indian School of Business (ISB), Hyderabad during 2002-2020. It was observed that 2015 and 2018 were the most productive years, while, 2002 was the least productive. Further, collaborative authorship pattern was mostly witnessed, United States followed by United Kingdom were the most participating countries among international collaboration and National Science Foundation was the top funding agency. (Patel et al., 2021) carried out the bibliometric analysis of the research articles published in the Webology Journal during 2006-2020. It was observed that there was a significant increase in the annual growth rate of publications, while, the highest productivity per author was witnessed in 2007.

3. OBJECTIVES OF THE STUDY

The objectives of the study are as under:

- 1) To examine the chronological growth rate of the publications and citations.
- 2) To identify the type of bibliographic form used for communicating research results.
- 3) To identify top ten most prolific authors and top ten highly cited publications.

- 4) To find out the most trending research areas for publications.
- 5) To investigate the authorship and collaboration pattern of the publications.
- 6) Keyword Co-occurrence Analysis for both the institutes.

4. METHODOLOGY

In the current study, the data was collected using the Scopus database for the period during 2017-2022. The records were retrieved using a search strategy as **AF-ID ("Indian Institute of Technology Goa" 60114558)** for IIT Goa and in the similar manner for IIT Dharwad. A total of 348 and 327 bibliographic records of IIT Goa and IIT Dharwad were retrieved respectively from Scopus database in CSV (Comma-Separated Values) format and further analysed using MS Excel. The required dataset was finally organized for further analysis in the form of tables and graphs for interpretation and deliberations to reach meaningful conclusions.

5. DATA ANALYSIS & INTERPRETATION

5.1 Chronological Growth rate of Publications and Citations:

Total number of publications published during 2017-2022 affiliated to IIT Goa were 348 that received 1122 citations, whereas, during the same period IIT Dharwad published 327 publications that received 1794 citations. The highest number of publications (125) affiliated to IIT Goa were in 2021 that received 141 citations, whereas, during the same year IIT Dharwad also had highest number of publications (108) that received 172 citations. On further analysing the data, the average number of publications per year (58) and the average number of citations per year (187) for IIT Goa was derived, whereas, the average number of publications per year (54.5) and the average number of citations per year (299) for IIT Dharwad was derived. Similarly, the data was further analysed to derive the average number of citations per publication for IIT Goa and IIT Dharwad that is (3.22) and (5.49) respectively. Figure 1 as shown below represents the year-wise growth rate of publications and citations of IIT Goa and IIT Dharwad. The highest growth rate of publications (2200%) and citations (3280%) for IIT Goa was observed in 2018, whereas, the highest growth rate of publications (950%) and citations (517.65%) for IIT Dharwad was also observed in 2018. As shown in the Table 1 below, the highest average citation per publication is (7.35) in 2018 for IIT Goa, whereas, (16.95) in 2019 for IIT Dharwad.

Table 1: Chronological Growth Rate (in %) of Publications and Citations

Year	IIT Goa							IIT Dharwad						
	TNP	% of TP	GRP	TNC	% of TC	Growth rate of citations	ACPP	TNP	% of TP	GRP	TNC	% of TC	Growth rate of citations	ACPP
2017	1	0.29	-	5	0.45	-	5	4	1.22	-	51	2.84	-	12.75
2018	23	6.61	2200%	169	15.06	3280%	7.35	42	12.84	950%	315	17.56	517.65%	7.5
2019	65	18.68	182.61%	380	33.87	124.85%	5.85	61	18.65	45.24%	1034	57.64	228.25%	16.95
2020	89	25.57	36.92%	419	37.34	10.26%	4.71	71	21.71	16.39%	214	11.93	-79.30%	3.01
2021	125	35.92	40.45%	141	12.57	-66.35%	1.128	108	33.03	52.11%	172	9.59	-19.63%	1.59
2022	45	12.93	-64%	8	0.71	-94.33%	0.18	41	12.54	-62.04%	8	0.44	-95.35%	0.20
Total	348	100		1122	100		3.22	327	100		1794	100		5.49

*TNP: Total number of Publications

*TNC: Total number of Citations

*ACPP: Average Citation Per Publication

*GRP: Growth Rate of Publications

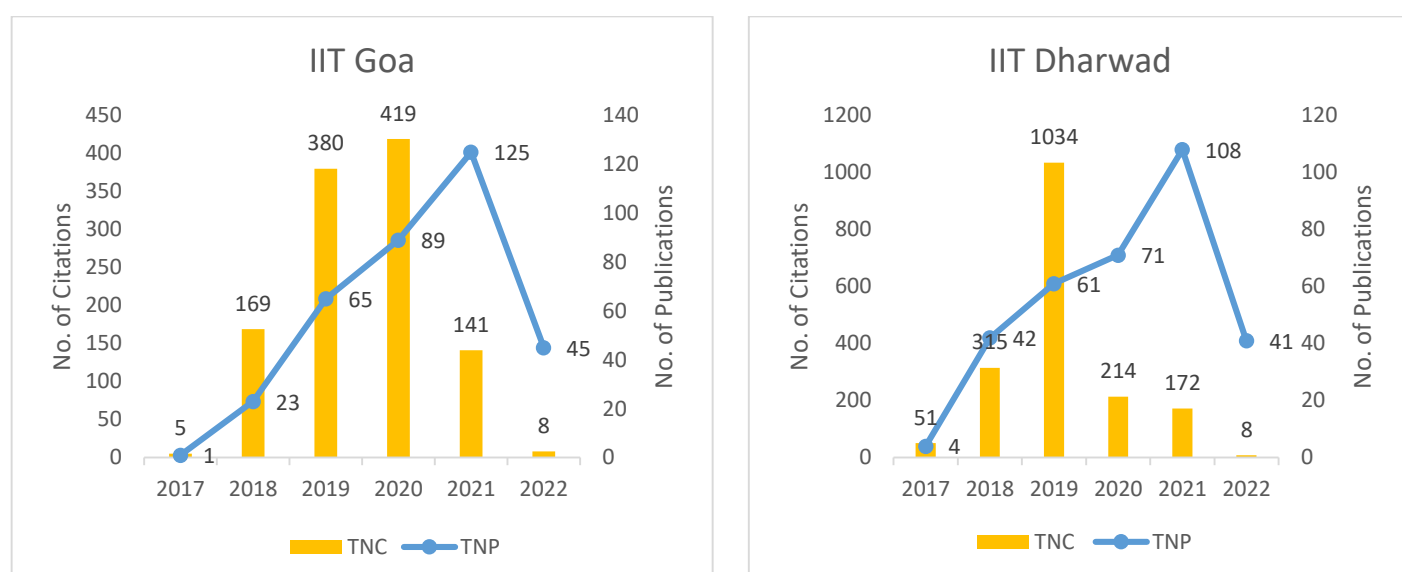


Figure 1: Chronological Growth rate of Publications and Citations of IIT Goa & IIT Dharwad

5.2 Distribution of the publications in various bibliographic forms:

Distribution of the publications in various bibliographic forms are shown in the Table 2 below. IIT Goa and IIT Dharwad publications are distributed in various bibliographic forms like Journal Articles, Book Chapters, Conference papers, Editorials, Letters, Reviews, etc. It is evident from the Figure 2 given below that majority of the publications of IIT Goa were published as Journal Articles and Conference papers that received 880 and 152 citations respectively, similarly, in the case of IIT Dharwad majority of the publications were also published as Journal Articles and Conference Papers that received 1384 and 262 citations respectively.

Table 2: Distribution of the publications in various bibliographic forms

Bibliographic forms	IIT Goa			IIT Dharwad		
	TNP	Percentage (%)	No. of Times Cited	TNP	Percentage (%)	No. of Times Cited
Article	210	60.34	880	179	54.74	1384
Book	0	0	0	1	0.31	0
Book Chapter	5	1.44	2	8	2.45	5
Conference Paper	123	35.34	152	123	37.61	262
Editorial	1	0.29	0	4	1.22	1
Erratum	1	0.29	0	2	0.61	0
Letter	1	0.29	34	0	0	0
Review	6	1.72	54	10	3.06	139
Short Survey	1	0.29	0	0	0	0
Total	348	100		327	100	

*TNP: Total number of Publications

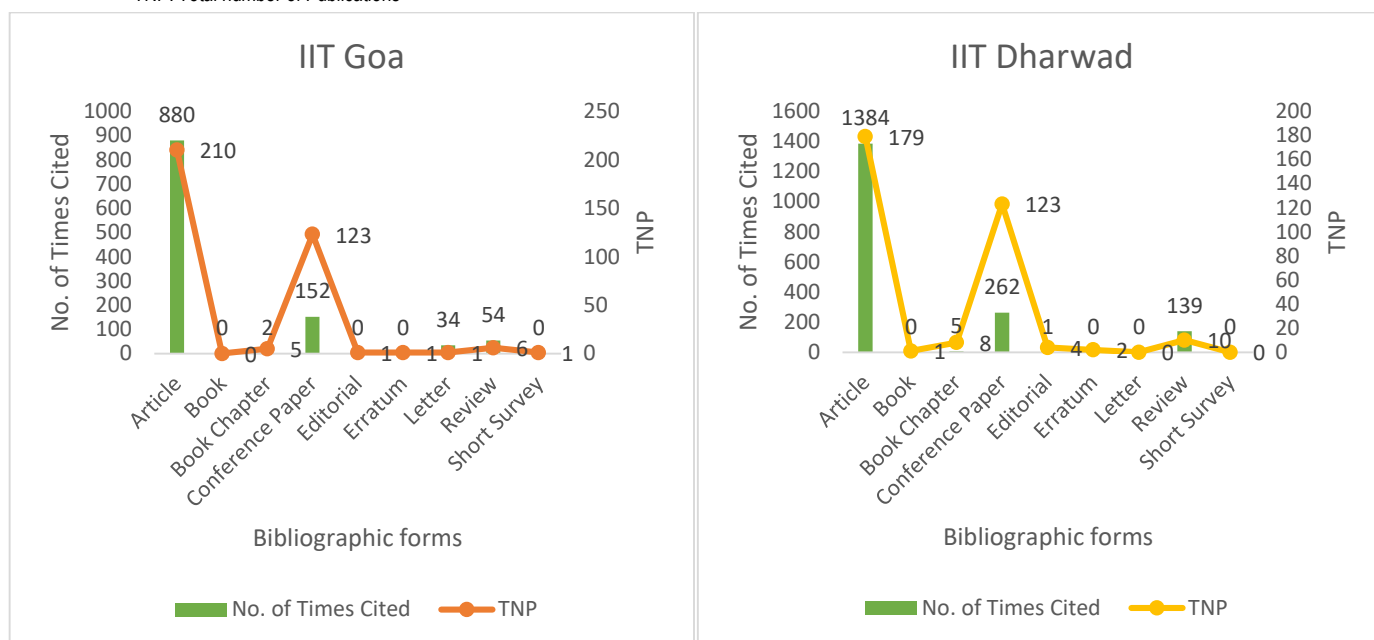


Figure 2: Distribution of the publications by bibliographic forms of IIT Goa & IIT Dharwad

5.3 Most Prolific Authors of IIT Goa and IIT Dharwad:

The top 10 most prolific authors on the basis of number of publications of both the institutes are shown in Table 3 below. The authors who were most prolific at IIT Goa and IIT Dharwad were Subudhi, B. and Prasanna S.R.M with (72) publications; (209) citations and (51) publications; (126) citations respectively. This was followed by Sinha, S. with (26) publications; (67) citations at IIT Goa and Mahadeva Prasanna, S.R. with (21) publications; (64) citations at IIT Dharwad. Similarly, Das, S.K. with (24) publications and (195) citations at IIT Goa, whereas, Seshu, P. with (17) publications and (35) citations at IIT Dharwad. In the same way the list of authors (Top 10) of both the institutes are arranged in descending order of their number of publications in the Table 3 given below.

Table 3: Top 10 Most Prolific Authors on the basis of number of publications of IIT Goa & IIT Dharwad

IIT Goa				IIT Dharwad			
Author Name	No. of Authorships	No. of Times Cited	h-Index	Author Name	No. of Authorships	No. of Times Cited	h-Index
Subudhi B	72	209	8	Prasanna S.R.M.	51	126	5
Sinha S	26	67	5	Mahadeva Prasanna S.R.	21	64	4
Das S.K.	24	195	7	Seshu P	17	35	4
Deka K	19	88	5	Guha A	15	33	4
Kore S.D.	19	55	5	Sarmah P	14	31	4
Sharma S	16	76	5	Sen S	13	5	1
Nandy A	13	40	4	Bhat R.V.	12	28	3
Ray P.K.	13	18	2	Desai R	12	33	4
Zhang W	13	52	4	Basavarajappa S	11	34	3
Sashidhar S / Sampathirao S	12	12	2	Kalita S	11	46	3

5.4 Highly Cited Publications of IIT Goa & IIT Dharwad:

The highly cited publications of both the institutes during 2017-2022 are shown below in Table 4. The paper titled “Toward the determination of heavy-quark transport coefficients in quark-gluon plasma” that appeared in *Physical Review C* in 2019 received highest number of citations (59) at IIT Goa, whereas, at IIT Dharwad the paper titled “The Landscape of Circular RNA in Cancer” that appeared in *Cell* in 2019 received the highest number of citations (624). This was followed by the paper titled “Transmission of airborne virus through sneezed and coughed droplets” published in *Physics of Fluids* in 2020 with (48) citations at IIT Goa, similarly, at IIT Dharwad the paper titled “Analysis of the androgen receptor-regulated lncRNA landscape identifies a role for ARLNC1 in prostate cancer progression” published in *Nature Genetics* in 2018 with (121) citations. Similarly, the list of top 10 highly cited publications of IIT Goa and IIT Dharwad are arranged in the descending order of the citations received by them as shown in Table 4 below:

Table 4: Top 10 Highly Cited Publications of IIT Goa and IIT Dharwad

IIT Goa				IIT Dharwad			
Title	Source title	Year	Cited by	Title	Source title	Year	Cited by
Toward the determination of heavy-quark transport coefficients in quark-gluon plasma	Physical Review C	2019	59	The Landscape of Circular RNA in Cancer	Cell	2019	624
Transmission of airborne virus through sneezed and coughed droplets	Physics of Fluids	2020	48	Analysis of the androgen receptor-regulated lncRNA landscape identifies a role for ARLNC1 in prostate cancer progression	Nature Genetics	2018	121
A Comprehensive Review of Path Planning Algorithms for Autonomous Underwater Vehicles	International Journal of Automation and Computing	2020	47	Functional π -Conjugated Two-Dimensional Covalent Organic Frameworks	ACS Applied Materials and Interfaces	2019	72
Single-shot large field of view imaging with scattering media by spatial demultiplexing	Applied Optics	2018	35	Biosynthesis and Chemical Applications of Thioamides	ACS Chemical Biology	2019	55
Coulomb blockade in an atomically thin quantum dot coupled to a tunable Fermi reservoir	Nature Nanotechnology	2019	34	Direct observation of glucose fingerprint using in vivo Raman spectroscopy	Science Advances	2020	45
Joint Power-Domain and SCMA-Based NOMA System for Downlink in 5G and beyond	IEEE Communications Letters	2019	30	Air Pollution Monitoring Using Near Room Temperature Resistive Gas Sensors: A Review	IEEE Transactions on Electron Devices	2019	35
Position control of a flexible manipulator using a new nonlinear self-Tuning PID controller	IEEE/CAA Journal of Automatica Sinica	2020	23	Coupled Inductor-Based Zero Current Switching Hybrid DC Circuit Breaker Topologies	IEEE Transactions on Industry Applications	2019	26
Transfer of mass and momentum at rough and porous surfaces	Journal of Fluid Mechanics	2019	23	Immune associated lncRNAs identify novel prognostic subtypes of renal clear cell carcinoma	Molecular Carcinogenesis	2019	26
Determination of the two-dimensional distributions of gold nanorods by multiwavelength analytical ultracentrifugation	Nature Communications	2018	22	Epigenetic reprogramming with antisense oligonucleotides enhances the effectiveness of androgen receptor inhibition in castration-resistant prostate cancer	Cancer Research	2018	26
Evaluation of flocculation characteristics of kaolinite dispersion system using guar gum: A green flocculant	International Journal of Mining Science and Technology	2019	21	Dry sliding Wear Behavior of Hybrid aluminum Metal Matrix composite reinforced with Boron carbide and graphite particles	Materials Today: Proceedings	2017	25

5.5 Discipline-wise distribution of Research Output of IIT Goa & IIT Dharwad:

The total research output of both the institutes was classified into 13 sub-disciplines. Table 5 given below depicts the total number of publications (TNP), percentage, total number of citations (TNC) received

by each discipline along with the values of citation per paper (CPP). The average value of CPP for entire research output of IIT Goa is 3.36, whereas for IIT Dharwad is 4.00. This specifies that the publications by IIT Dharwad had a higher impact value than IIT Goa in terms of CPP. The highest value of CPP (5.71) was for *Chemical Engineering* at IIT Goa, while, (44.24) was for *Biochemistry, Genetics & Molecular Biology* at IIT Dharwad. As shown below in Table 6 the lowest value of CPP (1.50) was for *Decision Sciences* at IIT Goa, whereas, at IIT Dharwad it was (1.14) for the same discipline. From the Figure 3 below it is clearly evident that the highest number of publications at IIT Goa were published in Engineering discipline, whereas, Computer Science discipline was at the top at IIT Dharwad.

Table 5: Most Trending Research Areas for Publications

Disciplines	IIT Goa				IIT Dharwad			
	TNP	Percentage (%)	TNC	CPP	TNP	Percentage (%)	TNC	CPP
Engineering	198	28.29	658	3.32	134	20.43	393	2.93
Computer Science	131	18.71	320	2.44	153	23.32	338	2.21
Physics & Astronomy	82	11.71	457	5.57	62	9.45	108	1.74
Mathematics	81	11.57	157	1.94	104	15.85	199	1.91
Materials Science	55	7.86	209	3.80	36	5.49	218	6.06
Arts & Humanities	-	-	-	-	36	5.49	115	3.19
Energy	32	4.57	106	3.31	-	-	-	-
Chemical Engineering	28	4.00	160	5.71	23	3.51	40	1.74
Chemistry	17	2.43	87	5.12	-	-	-	-
Decision Sciences	16	2.29	24	1.50	21	3.20	24	1.14
Biochemistry, Genetics & Molecular Biology	14	2.00	65	4.64	21	3.20	929	44.24
Medicine	-	-	-	-	15	2.29	50	3.33
Others	46	6.57	112	2.43	51	7.77	212	4.16
Total	700	100.00	2355	3.36	656	100.00	2626	4.00

*TNP: Total number of Publications

*TNC: Total number of Citations

*CPP: Citation Per Paper

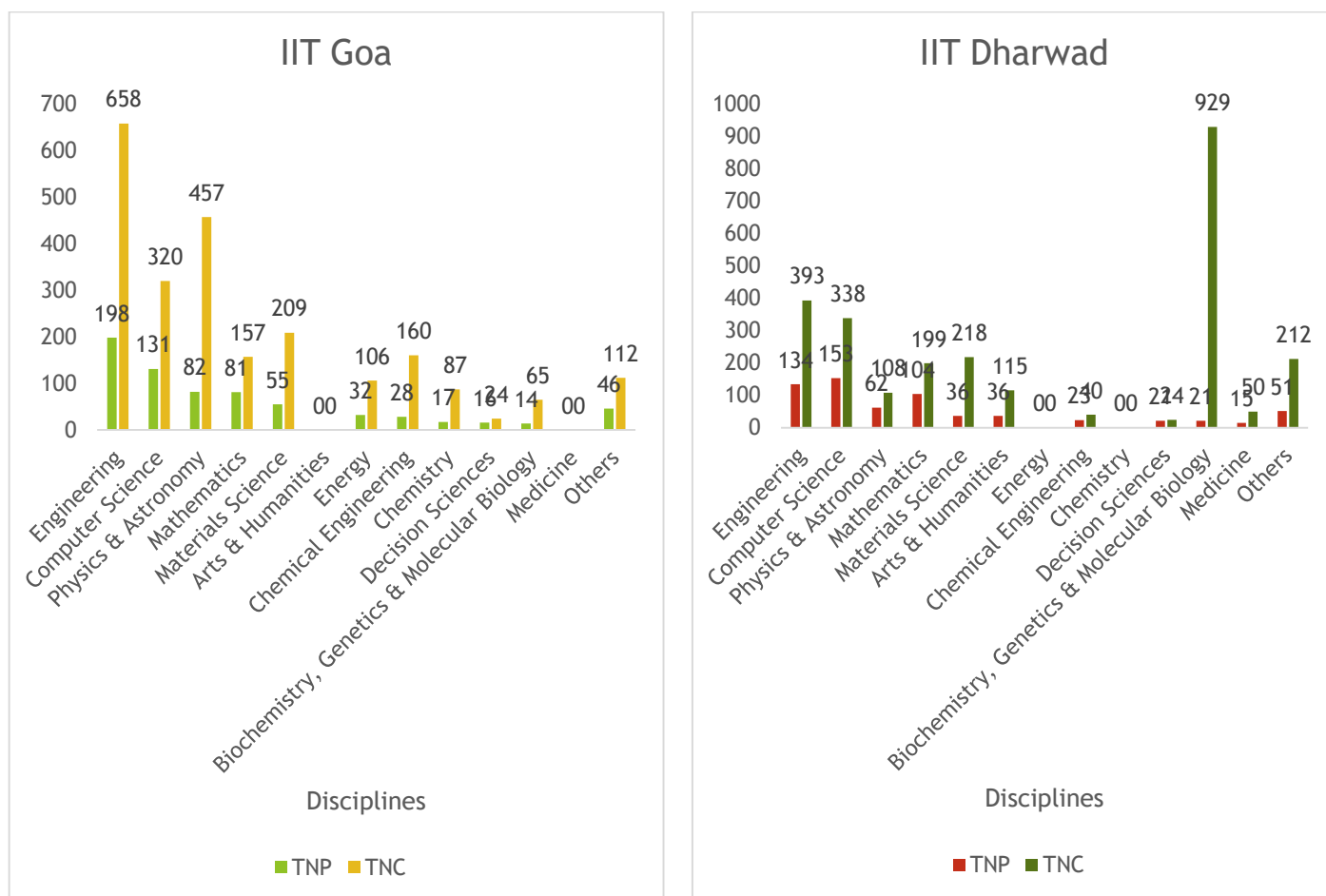


Figure 3: Discipline-wise distribution of Research Output of IIT Goa & IIT Dharwad

5.6 Year-wise Authorship and Collaboration Pattern of Publications of IIT Goa & IIT Dharwad:

Table 6 and Figure 4 given below shows the year-wise authorship (single author & multi-authored) and collaboration pattern of publications at both the institutes. From the Table 6 given below it is evident that 95.40% of publications at IIT Goa and 96.02% of publications at IIT Dharwad were multi-authored. This indicates that the authorship trend at both the institutes is towards collaborative publications. The highest number of multi-authored publications at IIT Goa & IIT Dharwad were found in 2021 viz. 123 and 104 publications respectively. The Collaboration Co-efficient as per (Ajiferuke et al., 1988) will always vary between 0 and 1, where 0 signifies single author publications and value closer to 1 depicts publications in collaboration. In the current study, the Collaboration Co-efficient (CC) ranges between 0 and 1, while overall CC of the current study is 0.95 and 0.96 for IIT Goa and IIT Dharwad respectively. The highest CC for both the institutes were found in the year 2017.

Table 6: Year-wise Authorship and Collaboration Pattern of Publications

Year	IIT Goa				IIT Dharwad			
	Single Authored Papers	Multi-Authored Papers	Total	Collaboration Co-efficient	Single Authored Papers	Multi-Authored Papers	Total	Collaboration Co-efficient
2017	-	1	1	1	-	4	4	1
2018	3	20	23	0.87	2	40	42	0.95
2019	5	60	65	0.92	3	58	61	0.95
2020	3	86	89	0.97	3	68	71	0.96
2021	2	123	125	0.98	4	104	108	0.96
2022	3	42	45	0.93	1	40	41	0.98
Total	16	332	348	0.95	13	314	327	0.96

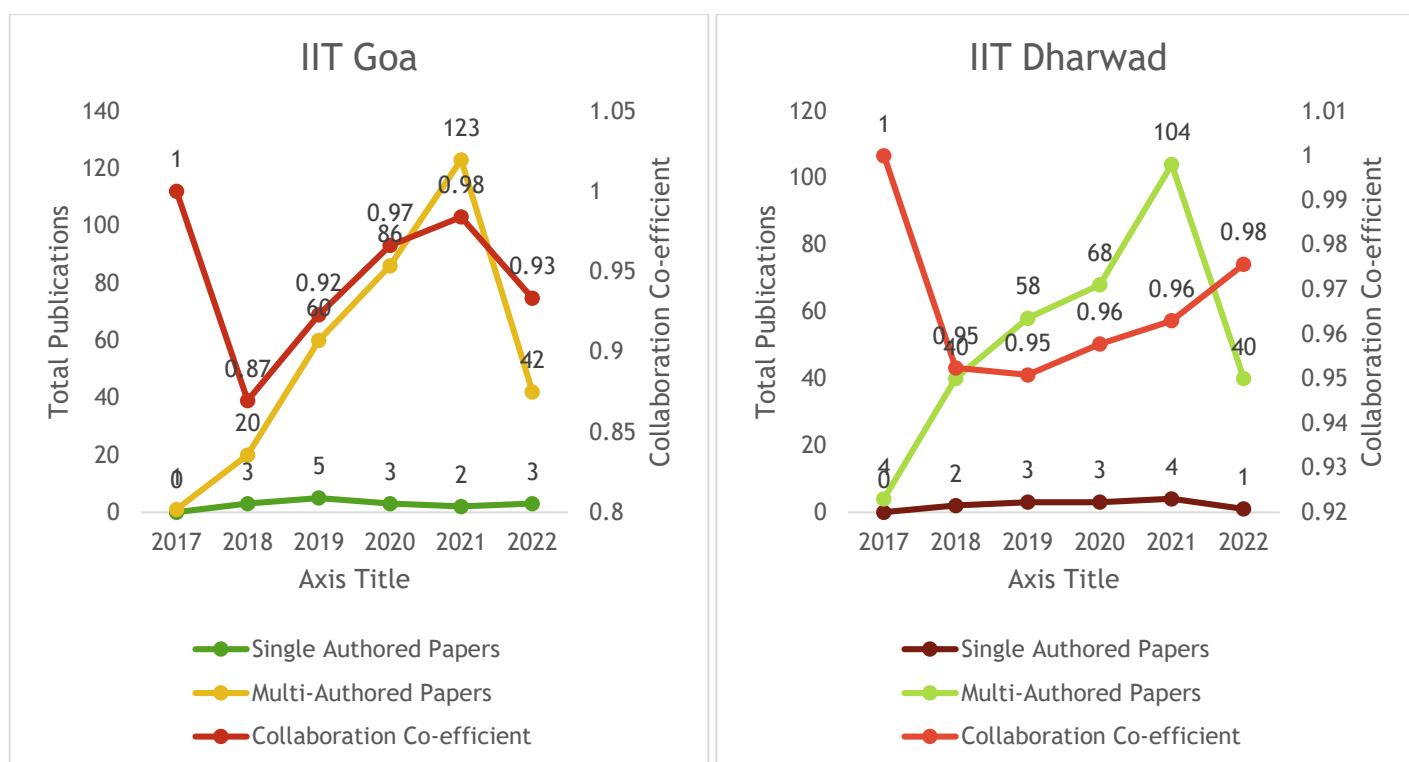


Figure 4: Growth Pattern of Authorship & Collaboration Pattern of Publications of IIT Goa & IIT Dharwad

5.7 Keyword Co-occurrence Analysis:

The keyword co-occurrence mapping (Figure 5 & 6) was done using VOSviewer visualization software by uploading the bibliographic details of both the institutes extracted from Scopus database. This visualization network was chosen to identify the important keywords used and mapping of those keywords to provide a clear understanding of the content of the articles selected. The below map clearly reveals the relationship of research themes of the publications under current study through the keywords. In the visualization map given below the size of the nodes represents the frequency of the keywords. If the frequency of the keyword is higher, the size of the node will be larger. It may also be observed in the map given below that the thickness of line represents

the closeness of relationship between the two keywords. Thicker the line between two keywords, closer is the relationship.

As shown in the Figure 5, the *Controllers* node has the biggest size which represents that the *Controllers* has the highest frequency of keywords. This is closely followed by keywords such as *Modulation* and *Field Programmable Gate Arrays*. Conversely, it is very easy to find out from the map below that some of the keywords such as *External Disturbances* and *Chemistry* has lower frequency as their nodes are smaller in size. The thicker lines between the keywords such as *Modulation*, *Spatial Modulations* and *Compressive Sensing* represents closer relationship between these keywords.

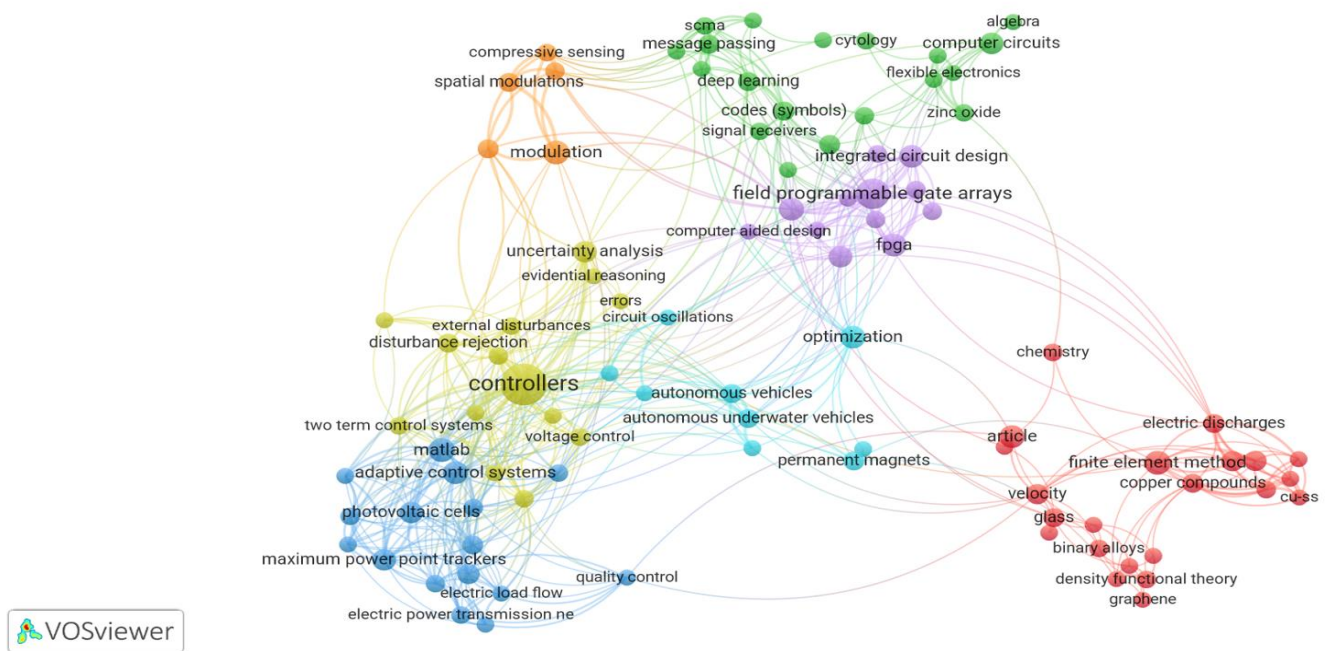


Figure 5: Mapping of Keyword Co-occurrence of IIT Goa

As shown in the Figure 6, the *Speech Recognition* node has the biggest size which represents that the *Speech Recognition* has the highest frequency of keywords. This is closely followed by keywords such as *Human* and *Article*. Conversely, it is very easy to find out from the map below that some of the keywords such as *Animal* and *Machine Learning* has lower frequency as their nodes are smaller in size. The thicker lines between the keywords such as *Speech Recognition*, *Speech* and *Linguistics* represents closer relationship between these keywords.

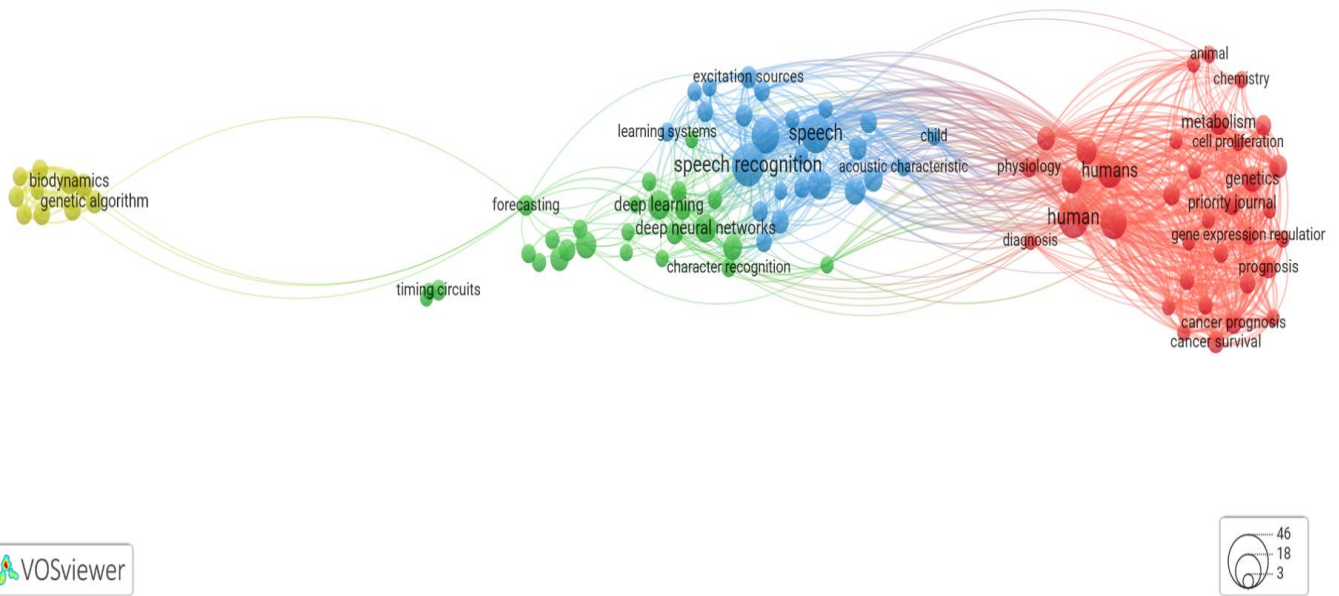


Figure 6: Mapping of Keyword Co-occurrence of IIT Dharwad

6. FINDINGS & CONCLUSION

After analysing and evaluating the research output of both the IITs as shown above, it has now been concluded that IIT Goa has published more publications (quantity) than IIT Dharwad during 2017-2022, however, IIT Dharwad is leading in terms of citations (quality) received on these publications during the same period. From the analysis it is clearly evident that the research output of both the IITs looks promising considering that these are new IITs, which are still in their infancy stage. On further evaluating the research output, it can be seen that the authors of both the IITs are publishing in various bibliographic forms such as journal articles, book chapters, conference papers, editorials, letters, reviews, etc. However, the leading bibliographic form where authors at both the IITs like to publish is Journal Articles. It is also evident from the analysis that most trending research areas of IIT Goa and IIT Dharwad are *Engineering* and *Computer Science* respectively. On analysing the authorship and collaboration pattern, it can be seen that the authorship trend at both the IITs is towards multi-authored publications.

Therefore, conducting a scientometric analysis of the research output of any academic/ research institution will help all the stakeholders to know the scientific and technological developments and progress made by that institute and make informed choices. The competent authorities of the institute would be able to determine the direction of the research activities of the institute and take corrective measures accordingly.

Moreover, it also reflects the contribution of the individual scientist engaged in research on a particular subject. Thus, the present study would facilitate the authorities at both the institutes to strive and develop a culture of research and innovation from the beginning that will eventually help the researchers of these institutes to enhance the research output.

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