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Shettar, Iranna and Hadagali, Gururaj S. Assistant Professor, "COLLABORATION TRENDS IN NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA (NITK), SURATHKAL, INDIA: AN ANALYSIS BASED ON NETWORK MAPPING" (2020). *Library Philosophy and Practice (e-journal)*. 4573. <https://digitalcommons.unl.edu/libphilprac/4573>

COLLABORATION TRENDS IN NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA (NITK), SURATHKAL, INDIA: AN ANALYSIS BASED ON NETWORK MAPPING

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ABSTRACT

The study analyzes the research productivity and collaboration trends of National Institute of Technology Karnataka, Surathkal (NITK Surathkal) during 2010-2019 as indexed in the Web of Science database. A total of 2,405 records were published over a period of ten years and have received 24,456 citations. The indicators used for the study are: the Degree of Collaboration; Collaborative Coefficient; Collaboration Index; Authorship & co-authorship pattern; various types of Collaboration patterns like: Institutional, National and International Collaboration; collaboration with other types of Institutions in India; most preferred collaborative Institutes and Countries etc. The findings of the study indicate that the NITK Surathkal has a tendency towards collaborated publications, but higher proclivity towards collaborations within the institutional authors. Publications with international collaboration have received the maximum average citations per paper compared with Institutional and national collaborations. The institute has the maximum number of collaborations with authors from colleges; MAHE Manipal was the most collaborative institute and Malaysia was the most preferred collaborating country during the period of study.

Keywords: Collaboration Trends, Research Productivity, Scientometric Analysis, Authorship Pattern, Impact of Collaboration, NITK Surathkal, Degree of Collaboration, India, Collaborative Coefficient.

INTRODUCTION

In recent decades scientometrics has become one of the vital techniques to analyze the performance of academic and research fraternity in higher educational institutions including research organizations. It includes a quantitative and qualitative assessment of the scientific productivity and collaboration in research. Collaboration and networking have become an integral part of research in every aspect. Due to the profound implications of increasing productivity and visibility, collaboration has received a significant attention in the research community. More specifically, collaboration brings tremendous potentiality to generate new knowledge to the society. Collaboration brings the new dimension to the research problem in terms of the cultural, social and scientific differences in various institutes, countries etc. Collaborated research publications increase the chances of higher visibility, which may lead to improved citations (Ale Ebrahim et al., 2013).

Katz and Martin (1997) defined research collaboration as working together of researchers to achieve the common goal of producing new scientific knowledge. As collaboration takes place between the individual researchers, at the same time, it may also act as collaboration between the institutions and countries. Collaboration patterns help to identify the Institute's research involvements and its reputation in the research community. The assessment of any higher educational research institutes usually conducted by the funding agencies to evaluate the research capabilities and potentialities. Therefore, Scientometric indicators have become an integral part of the university rating and ranking frameworks. Such studies using the Scientometric indicators will help institutes to undergo SWOC analysis to determine the strengths, weaknesses, opportunities and challenges.

ABOUT NITK SURATHKAL, INDIA

The National Institute of Technology Karnataka, Surathkal (NITK Surathkal) is a centrally funded technical institute, which works directly under the Ministry of Education, Government of India (earlier Ministry of Human Resource Development). It was established in 1960 as Karnataka Regional Engineering College (KREC) under 2nd five-year plan scheme to cater to the undergraduate level education in the field of Engineering in the state of Karnataka. KREC was upgraded to the National Institute of Technology Karnataka (NITK) with the status of deemed university in the year 2002 along with degree awarding status including research degrees. In the year 2007, the NITK was declared as the Institute of National Importance by the Government of India through NIT Act 2007. The NITK started its research programmes in the year 2002 and the status of Institute of National Importance helped them to get more grant for the research activities and infrastructure development. The Institute is currently providing higher educational degrees along with M. Tech. (Research) and Ph.D. degrees in the field of Engineering, Science, Technology and Management. The NITK has ranked 13th in Engineering category and 33rd

in overall categories in National Institutional Ranking Framework 2020 (NIRF), MHRD, Government of India along with 63rd rank in QS India ranking.

REVIEW OF RELATED LITERATURE

A very few studies are available in literature on scientometric studies in terms of the research productivity and other related indices on individual National Institute of Technology (NIT). However, a handful of studies have been appeared on individual Indian Institutes of Technology. The NITs are considered as the next line institutions after IITs, hence, the studies on IITs are also considered for review of literature in addition to the NITs.

Singh (2015) in his study analyzed 13,208 publications of Indian Institute of Technology Bombay (IIT Bombay) extracted from Web of Science for the period from 1990 to 2014. The results reveal that 94.02% of the publications are nationally collaborated publications and 25.13% of the publications are internationally collaborated. The USA was the highly collaborated country and BARC, Mumbai was the most preferred collaborating Institute in India. **Singh (2015)** has assessed the research publications of Indian Institute of Technology Delhi (IITD). Out of 12,456 (94.82%) collaborated publications, 2,538 (19.32%) are internally collaborated publications. The USA was the most preferred collaborative country, and the National Physics Laboratory was the most collaborated Institute by the researchers from IITD. **Bid (2016)** evaluated the research output of the Indian Institute of Technology Kharagpur (IIT Kharagpur) based on its publications appeared in Scopus between 2000 and 2015. The trend is towards the collaborative publications with 0.95 Degree of Collaboration. Jadavpur University was the most preferred collaborative Institute, and the USA was the most preferred collaborative country. **Pradhan and Ramesh (2017)** evaluated 6,222 publications of IIT Guwahati indexed in Scopus for the period between 2006 and 2015. The study found that year-wise publications have recorded 13.24 growth rate and 58.21% of the articles published in journals with impact factor between one and three. The University of Cincinnati found the most collaborating Institute.

Patel (2017) analyzed the research publications of the National Institute of Technology, Kurukshetra (NIT, Kurukshetra). The authors used 352 publications reflected in WoS between 2012 and 2016. The study found a tendency towards two-authored publications with 59.09% of the overall publications and 0.97 Degree of Collaboration. NIT, Kurukshetra collaborated with eight countries among them, Malaysia was the most preferred country, and IIT Roorkee was the most collaborating institution. **Shettar and Angadi (2018)** studied the publication productivity of the National Institute of Technology Karnataka, Surathkal (NITK, Surathkal) during 2001-2017. The study analyzed 4,038 publications and found that 98.07 % of publications were multi-authored. The journal *Acta Crystallographica Section E: Structure Reports Online* was the most preferred journal among the authors affiliated to NITK Surathkal. **Patel and Malhan (2018)** in their study

evaluated the research productivity of the National Institute of Technology, Hamirpur (NIT, Hamirpur) using 859 bibliographic records as indexed in WoS during 2013-2017. The multi-author publications dominate with 98.14% publications with two or more authors. South Korea, the most preferred country to collaborate and IIT Roorkee was the most preferred collaborating Institute by NIT, Hamirpur.

Mohanty and Jena (2019) carried out a scientometric study on the research output of IIT Bombay in the field of engineering published between 2006 and 2016 indexed in Scopus database. The study found that the IIT Bombay preferred intra-institutional collaborative model with significantly less foreign collaborations. **Nidhisha and Sarangapani (2020)** assess the research performance of the National Institute of Technology Calicut (NIT, Calicut) using 875 records retrieved from the WoS during 2015-2019. A strong collaboration was observed with DC=0.993. The NIT Calicut collaborated with ten countries, USA being the most preferred country. CSIR Labs were the most collaborative institutes with NIT Calicut. **Kumar (2020)** conducted a study of the Indian Institute of Technology (ISM) Dhanbad for the period from 2000 to 2019. The study evaluated 6,962 research papers indexed in WoS database and found that nearly three-fourth (74.71%) research publications were research articles published in journals. The DC was 0.98 which reflects a strong collaboration. The DST was highly supported research in IIT Dhanbad through its funding, and CSIR labs were the most collaborative institutes. The USA was the most preferred collaborating country. **Shettar and Hadagali (2020)** evaluated the research performance of all 31 NITs based on the publications indexed in Web of Science during 2009-2018. The NIT Rourkela has the highest number of collaborated publications, and MANIT Bhopal has recorded the highest Impact of Collaboration. The NIT Trichy has recorded the highest number of internationally collaborated publications among the NITs and MANIT Bhopal has received the highest impact of International Collaboration.

The related literature revealed that there is a dearth of studies especially on individual IITs or NITs. In order to bridge the gap, it is considered to examine the publication productivity of National Institute of Technology Karnataka, Surathkal, a premier institution in the field of Engineering and Technology.

OBJECTIVES OF THE STUDY

The main objective of this study is to analyze the research publications and collaboration trends in National Institute of Technology Karnataka, Surathkal for a period of ten years from 2010 to 2019. The specific objectives of the study are to:

1. know the citations pattern and its impact in National Institute of Technology Karnataka, Surathkal;
2. examine the authorship pattern;
3. find out the level of collaboration with national and international institutions;

4. examine the national collaboration among different types of institutes;
5. ascertain the country-wise collaboration;
6. analyse the most preferred journals and most prolific authors of NITK; and
7. analyse various collaboration trends using bibliographic coupling

METHODS AND MATERIALS

For this study, the data was retrieved for the National Institute of Technology Karnataka, Surathkal using the Web of Science database developed by the Thomson Reuters and managed by Clarivate Analytics for a period of ten years from 2010 to 2019. The advanced search option was used with the search string “*OG= (National Institute of Technology Karnataka) AND PY= (2010-2019)*”. The Research publication data was retrieved in the plain text and BibTex formats. The extracted data was then analyzed using HistCite and Ms-Excel applications. The study further used VOSviewer (**Van Eck and Waltman, 2010**), and visualization software to develop network mapping using bibliographic data extracted.

ANALYSIS AND INTERPRETATION OF DATA

Publications’ productivity of top ten NITs

The table 1 presents the data on the top ten National Institutes of Technology based on the number of publications during 2010-2019. The data reveals that the NIT Rourkela published 4,283 publications (62,657 citations), followed by the NIT Tiruchirapalli (3,653 publications, 52,453 citations) and the NITK Surathkal (2,405 publications, 24,456 citations) ranked second to third respectively. The other details are presented in table 1.

Table 1: Top ten NITs based on number of publications

Name of the NIT	Publications	Citations	ACPP	h-index
NIT Rourkela	4,283	62,657	14.63	76
NIT Tiruchirapalli	3,653	52,453	14.36	78
NITK Surathkal	2,405	24,456	10.17	54
NIT Durgapur	2,114	24,026	11.37	61
SVNIT Surat	1,902	25,960	13.65	60
NIT Warangal	1,790	17,802	9.95	48
MNIT Jaipur	1,732	18,526	10.70	50
VNIT Nagpur	1,825	18,930	10.37	50
MNNIT Allahabad	1,685	23,171	13.75	61
NIT Kurukshetra	1,501	16,203	10.79	50

Year wise distribution of publications and citations of NITK, Surathkal

The table 2 presents the year wise distribution of publications, citations and h-index. The number of publications amplified from 126 in 2010 to 2405 in 2019. The highest number of publications were found in the year 2019 (547 publications) and the lowest was observed during 2012 (112 publications). A total of 24,456 citations were received for 2405 publications with 10.17 average citations per paper. The year 2017 has received the highest citations (3322) and the lowest was observed during 2012 (1456).

The Annual Growth Rate (AGR) was calculated using the formula proposed by Gracio et al. (2013). The highest AGR was recorded for the year 2017 (41.23) and the lowest during 2012 (-32.12). During 2012 only 112 publications were published which is the lowest in ten years and also received the lowest citations. Because of this, the value of AGR was negative. According to **Choi et al., (2011)** the Compound Annual Growth Rate (CAGR) is a standard for measuring the growth for the overall period of study. The average CAGR calculated for the NITK publications between 2010 and 2019 was 15.81%.

Table 2: Year-wise distribution of publications, citations and h-index of NITK, Surathkal

Year	TP	TC	ACPP	h-index	AGR	CAGR
2010	126	2189	17.37	25		15.81%
2011	165	2290	13.88	27	30.95	
2012	112	1456	13.00	20	-32.12	
2013	148	2661	17.98	28	32.14	
2014	160	2416	15.10	26	8.11	
2015	180	3051	16.95	30	12.50	
2016	228	3032	13.30	27	26.67	
2017	322	3322	10.32	27	41.23	
2018	417	2532	6.07	20	29.50	
2019	547	1507	2.76	13	31.18	
Total	2405	24,456	10.17			

(TP= Total Publications; TC= Total Citations; ACPP= Average Citations per paper; AGR= Annual Growth Rate; CAGR= Compound Annual Growth Rate)

Authorship and Co-authorship pattern

According to the table 3, the authorship pattern clearly shows the multi-authored publications (98.46%) dominate over the single authored publications (1.54%). Among the multi-authored publications, two authored publications dominate (30.64%), followed by three authored publications (29.36%) and publications with five or more authors (22.91%).

A total of 8363 authors contributed 2405 publications during 2010-2019. The Degree of Collaboration (DC) was calculated using the formula proposed by **Subramanyam (1983)**. The value of the Degree of Collaboration (DC) ranges from 0.989 to 0.998. The lowest DC was recorded in the year 2010 and the highest was observed for 2015 and 2016. The mean value of the Degree of Collaboration for the whole period was 0.996. As the number of single-authored papers in each year is less, hence the collaborative effort among the researchers of NITK is high.

The data pertaining to year wise Collaborative Index (CI) is also calculated using the formula proposed by **Lawani (1980)**. The CI varied from the lowest i.e. 3.19 in the year 2014 and the highest i.e. 3.85 in the year 2012. The Collaborative Index (CI) for the whole period of study was 3.48 average authors per publication, which is considered to be slightly higher than the international standard of 3 authors per publication as reported by ISI Global Research Report by Clarivate Analytics (2019). The Collaboration Coefficient (CC) is calculated using the mathematical formula proposed by **Ajiferuke et al. (1988)**. CC value always lies between 0 and 1, if the CC is higher than 0.5 then the collaboration rate among the authors is treated as better collaboration and if CC value is near to 0 means that the authors have a weak collaboration. The mean of Collaboration Coefficient (CC) calculated for publications of NITK published between 2010 and 2019 was 0.649. Hence the collaboration rate for the whole period of the study was found better.

Table 3: Authorship pattern with Degree of Collaboration (DC), Collaborative Coefficient (CC) and Collaboration Index (CI)

Year	Single Author	Two	Three	Four	Five & Above	Multi-Author Papers	Total Authors of Multi Authored Papers	Total Authors of Multi Authored Papers	DC	CI	CC
2010	5	29	41	10	41	121	442	447	0.989	3.55	0.652
2011	2	29	45	22	67	163	633	635	0.997	3.85	0.695
2012	2	26	45	15	24	110	382	384	0.995	3.43	0.656
2013	3	41	44	25	35	145	509	512	0.994	3.46	0.653
2014	3	58	51	23	25	157	507	510	0.994	3.19	0.627
2015	1	64	48	32	35	179	613	614	0.998	3.41	0.644
2016	2	68	61	28	69	226	861	863	0.998	3.79	0.662
2017	6	106	88	53	69	316	1134	1140	0.995	3.54	0.642
2018	5	140	120	76	76	412	1382	1387	0.996	3.33	0.642
2019	8	176	163	90	110	539	1863	1871	0.996	3.42	0.644
Total	37	737	706	374	551	2368	8326	8363	0.996	3.48	0.649

Institutional, National and International Collaboration in NITK Surathkal

The Institutional, National and International collaboration in NITK Surathkal is presented in the table 4. The results showed that among the collaborated publications, Institutional collaborated publications dominated with the highest share of 42.99% publications, followed by National collaborations (33.89%) and International collaborations (21.58%). The Institutional collaborated publications attracted the highest share i.e. 37.93% citations, followed by national collaborations (33.30%) and International collaborations (27.83%). However, the International collaborated publications received more per cent of the citations' share than the publications' share.

The International collaborations received the highest i.e. 13.11 ACPP, followed by the domestic collaboration (9.99 ACPP) and Institutional collaboration (8.97 ACPP). The international collaborations have gained greater attention and impact among the research community with a reasonable citation rate. But at the same time, Compounded Annual Growth Rate (CAGR) during the period of the study was significantly lower compared to the CAGR of institutional and domestic collaboration.

Table 4: Institutional, National and International Collaboration in NITK Surathkal

Year	Institutional Collaboration			National Collaboration			International Collaboration		
	TP	TC	ACPP	TP	TC	ACPP	TP	TC	ACPP
2010	39	503	12.90	49	1269	25.90	33	379	11.48
2011	46	793	17.24	60	1016	16.93	57	463	8.12
2012	47	483	10.28	38	565	14.87	25	401	16.04
2013	64	747	11.67	45	796	17.69	36	1067	29.64
2014	71	1058	14.90	54	673	12.46	32	620	19.38
2015	80	1131	14.14	55	803	14.60	44	1115	25.34
2016	92	1223	13.29	75	778	10.37	59	1024	17.36
2017	140	1595	11.39	110	947	8.61	66	754	11.42
2018	191	1106	5.79	142	734	5.17	79	680	8.61
2019	264	636	2.41	187	564	3.02	88	302	3.43
Total	1034	9275	8.97	815	8145	9.99	519	6805	13.11
%	42.99	37.93	-	33.89	33.30	-	21.58	27.83	-
CAGR	21.07	-	-	14.33	-	-	10.30	-	-

(TP= Total Publications; TC= Total Citations; ACPP= Average Citations per paper)

NITK's collaboration with other types of Institutions in India

The NITK has a total of 815 publications through the national collaborations. It means that collaborating only with institutions and organizations located in India, where, at least one author is from another Indian Institute. It is observed from the table 5 that the

NITK has the maximum national collaborations with Colleges (37.18%), followed by Universities (25.77%) and IIT's (18.04%). Among the nationally collaborated institutions, colleges have received the highest i.e. 2885 citations, followed by Universities (2820) and Research Institutes / Centres (878). Collaborations with Industry sector have received the highest average citations per paper with 25.58 ACPP, followed by Universities (13.43) and Indian Institute of Science, Bengaluru (10.66). It is also observed that 382 authors affiliated to various colleges in India have contributed 303 nationally collaborated publications with NITK with 1.26 authors per publication, followed by 265 authors affiliated to various Indian universities have collaborated 210 research publications at the rate of 1.26 authors per publication. A total of 1204 authors from various Indian institutions and organizations collaborated with NITK and published 815 publications at the rate of 1.48 authors per publication. Although collaborations with colleges yielded the utmost number of citations, it was the Industry collaborations which have received the maximum average citations per publications.

Table 5: NITK's collaboration with other types of Institutions in India

Category of Institutes / Organizations	TP	TC	ACPP	No. of Authors	Authors / Paper	h-index
Colleges	303	2885	9.52	382	1.26	29
Universities	210	2820	13.43	265	1.26	30
Indian Institutes of Technology	147	845	5.75	164	1.12	14
Research Institutes / Centres	96	878	9.15	118	1.23	16
Council of Scientific and Industrial Research (CSIR)	80	807	10.09	97	1.21	15
Other NIT's	56	556	9.93	56	1	12
Indian Institute of Science, Bengaluru	44	469	10.66	54	1.23	15
Industries	33	844	25.58	36	1.09	12
Defense Research and Development Organization (DRDO)	13	131	10.08	13	1	5
Government Organizations	10	46	4.6	10	1	4
Other Centrally Funded Technical Institutes (CFTIs)	9	43	4.78	9	1	2
Total	1001	10324	35.82	1204	1.48	39

(TP= Total Publications; TC= Total Citations; ACPP= Average Citations per paper)

Most preferred collaborating Institutions

The table 6 lists out the most preferred collaborative institutions with NITK across the globe. The Manipal Academy of Higher Education (MAHE), Manipal has emerged as the most preferred collaborative Institute with 143 publications, followed by the University of Science, Malaysia (85) and Indian Institute of Science, Bengaluru (55). The publications collaborated with MAHE, Manipal have received the highest number citations (1900), followed by the University of Technology, Malaysia (1311) and Indian Institute of Science, Bengaluru (615). Among the top ten most preferred collaborated institutions the University of Technology, Malaysia has received the highest i.e. 27.89 ACPP, followed by MAHE, Manipal (13.29) and the National Aerospace Laboratories, Bengaluru (13.15). The figure 1 depicts the graphical visualization on the bibliographic coupling of collaborating institutions with NITK Surathkal.

Table 6: Most preferred collaborating Institutions

Institute	TP	TC	ACPP	h-index
Manipal Academy of Higher Education, Manipal	143	1900	13.29	23
University of Science, Malaysia	85	441	5.19	10
Indian Institute of Science, Bengaluru	55	615	11.18	16
University of Technology, Malaysia	47	1311	27.89	21
Indian Institute of Technology Kharagpur	43	292	6.79	11
NMAM Institute of Technology, Nitte	42	315	7.50	10
Cameron University, Lawton	33	67	2.03	5
Raman Research Institute, Bengaluru	32	244	7.63	10
Vellore Institute of Technology, Vellore	29	231	7.97	9
National Aerospace Laboratories, Bengaluru	27	355	13.15	10

(TP= Total Publications; TC= Total Citations; ACPP= Average Citations per paper)

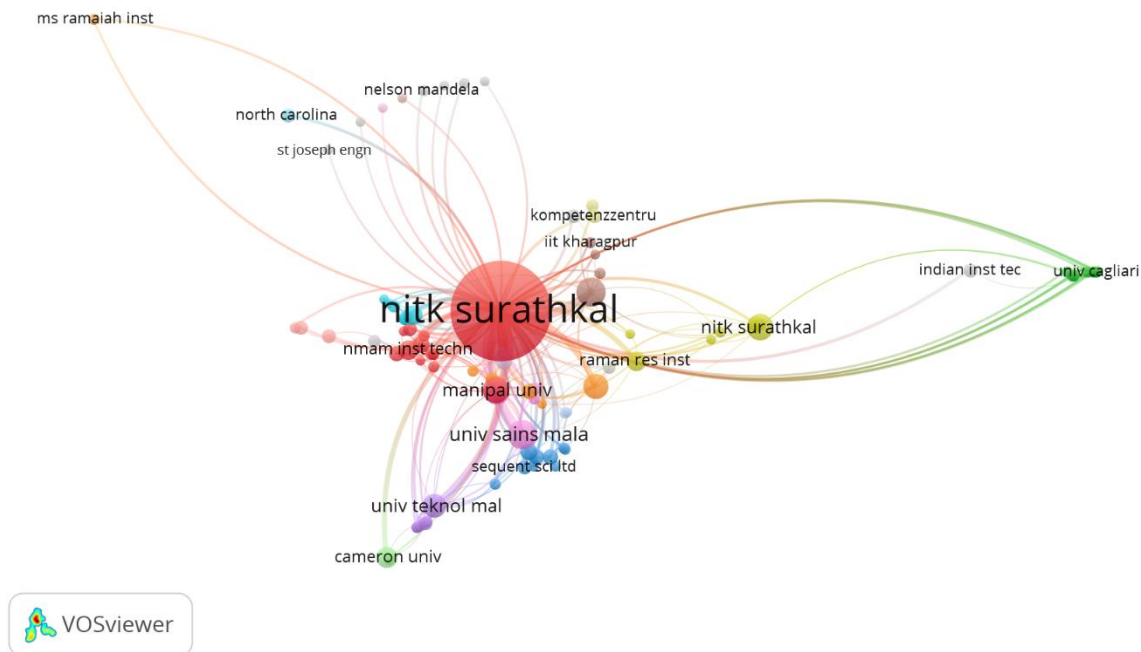


Fig 1: Bibliographic coupling of collaborating Institutions

Most preferred Collaborative Countries

The table 7 presents the international collaboration with NITK Surathkal. Overall, 55 countries collaborated with NITK and contributed 519 publications with 699 authors from countries other than India. Malaysia has topped the list with the most preferred collaborated country with NITK with 155 publications, followed by the USA (132) and South Korea (51). The publications collaborated with Malaysia has received 2,487 citations, followed by the USA (1302) and Saudi Arabia (1116). According to the average citations per paper, Saudi Arabia lead the table with 39.53 ACPP, followed by Italy (26.25) and Israel (20.89). The authors generated the co-author network of countries contributing along with NITK during the period of the study. The figure 2 indicates that the strongest link strength was found with Malaysia and USA.

Table 7: Most preferred Collaborative Countries

Country	TP	TC	ACPP	h-index
Malaysia	155	2487	16.05	27
USA	132	1302	9.86	22
South Korea	51	382	7.49	12
Saudi Arabia	42	1116	26.57	18

Israel	19	397	20.89	6
Germany	18	177	9.83	8
Peoples R China	18	163	9.06	8
England	16	226	14.13	8
Canada	15	250	16.67	8
Austria	15	107	7.13	7
Japan	14	98	7.00	7
Italy	12	315	26.25	7
Australia	12	139	11.58	8
France	12	137	11.42	9
South Africa	12	59	4.92	5
Sweden	11	164	14.91	6
Thailand	11	138	12.55	5
Netherlands	11	85	7.73	4
2 Countries (8 articles each)	16	258	16.13	N.A.
1 Country with 7 articles	7	35	5.00	N.A.
2 Countries (6 articles each)	12	196	16.33	N.A.
7 Countries (5 articles each)	35	574	16.40	N.A.
3 Countries (4 articles each)	12	178	14.83	N.A.
7 Countries (3 articles each)	21	238	11.33	N.A.
5 Countries (2 articles each)	10	93	9.30	N.A.
10 Countries (1 article each)	10	113	11.30	N.A.

(TP= Total Publications; TC= Total Citations; ACPP= Average Citations per paper)

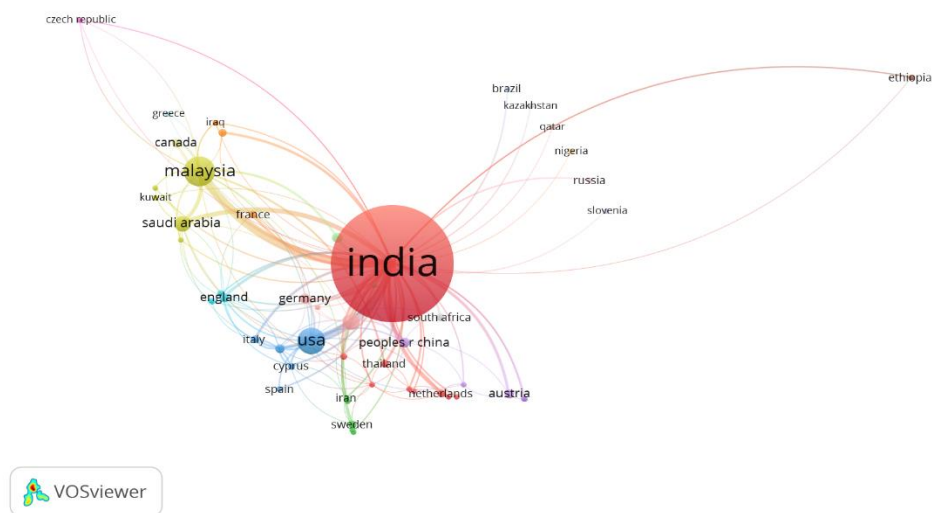


Fig 2. Co-authorship network of countries

Most prolific authors of NITK

The table 8 shows the top ten highly prolific authors affiliated to NITK Surathkal. Arun M. Isloor of the department of Chemistry lead the table with the highest i.e. 177 papers to his credit, followed by Badekai Ramachandra Bhat (77) and Airody Vasudeva Adhikari (75). All the top three authors belong to the department of Chemistry. Arun M. Isloor has received the highest number of citations i.e. 3384 and h-index (33), followed by A. V. Adhikari (1369 citations and h-index 20) and B. R. Bhat (1008 citations and h-index 19). However, A. V. Adhikari has the highest number of national collaborated publications (41) among the top ten most prolific authors of NITK, followed by D. Krishna Bhat and A. Nityananda Shetty with 22 nationally collaborated publications. Arun M. Isloor has the highest internationally collaborated publications (155), followed by Santhosh George (35) and A. V. Adhikari (24).

Out of the top ten authors, six authors belong to the department of Chemistry, whereas, two authors belong to the Metallurgical and Materials Engineering and one each from Mathematics and Physics. The figure 3 presents the bibliographic coupling of contributing authors and also shows 7 clusters of the networks between the authors based on their number of collaborations and associations between the individual authors.

Table 8: Most prolific authors of NITK

Name of an Author	Department	TP	TC	h-index	NCP	TC	ICP	TC
Arun M. Isloor	Chemistry	177	3384	33	17	509	155	2732

Badekai Ramachandra Bhat	Chemistry	77	1008	19	10	124	19	253
Airody Vasudeva Adhikari	Chemistry	75	1369	20	41	920	24	370
D. Krishna Bhat	Chemistry	57	941	17	22	425	4	116
K. Narayan Prabhu	Metallurgical Engg.	58	352	10	5	8	3	20
S. Anandhan	Metallurgical Engg.	52	540	14	14	151	21	179
Santhosh George	Maths	51	113	6	4	5	35	81
A. Chitharanjan Hegde	Chemistry	52	819	16	3	9	7	264
H.S. Nagaraja	Physics	49	752	15	13	314	14	204
A. Nityananda Shetty	Chemistry	48	590	14	22	261	2	113

(TP= Total Publications; TC= Total Citations; NCP= National Collaborated paper;
ICP= International Collaborated paper)

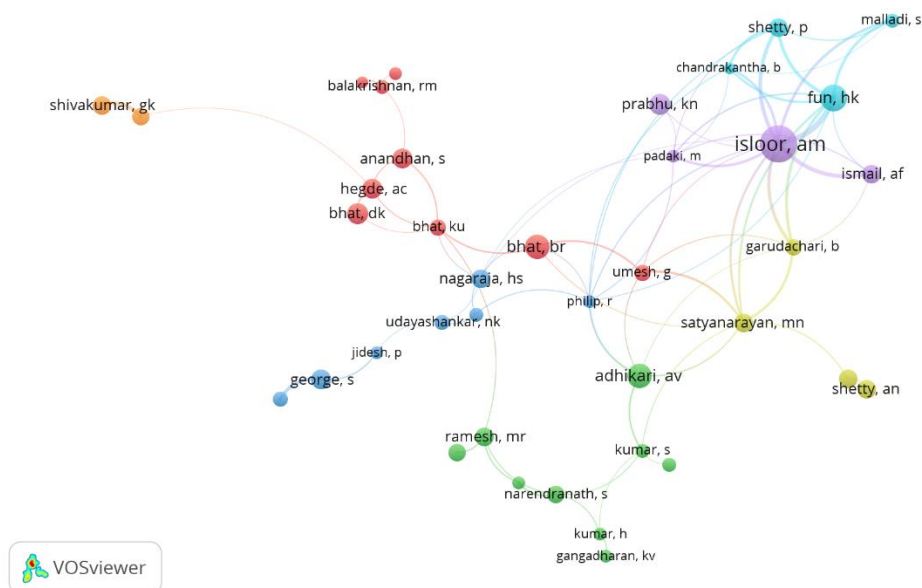


Fig 3: Bibliographic coupling of contributing authors

Top five highly cited papers of NITK Surathkal

The table 9 provides the list of top five highly cited papers published by the authors of NITK. However, the top ten publications together received 1,664 citations, which is 6.80% of the overall publications. The paper entitled, 'Enhanced hydrophilicity and salt rejection study of graphene oxide-polysulfone mixed matrix membrane' authored by

Ganesh, BM; Isloor, AM; Ismail, AF published in *Desalination*, (Vol. 313, 2013) has received the highest citations, i.e. 322 (4.9%), which is internationally collaborated research publications with two authors from NITK and one author from the University of Technology, Malaysia. All the top five highly cited papers are the outcome of the international collaboration.

Table 9: Top five highly cited papers by authors of NITK

Authors	Article Title	Source Title	Year of Publication	Citations received
Ganesh, BM; Isloor, AM; Ismail, AF	Enhanced hydrophilicity and salt rejection study of graphene oxide-polysulfone mixed matrix membrane	<i>Desalination</i>	2013	322
Shenvi, SS; Isloor, AM; Ismail, AF	A review on RO membrane technology: Developments and challenges	<i>Desalination</i>	2015	193
Raghavendra, NS; Deka, PC	Support vector machine applications in the field of hydrology: A review	<i>Applied Soft Computing</i>	2014	193
Swaminathan, K; Naveenkumar, DT; Zenkour, AM; Carrera, E	Stress, vibration and buckling analyses of FGM plates-A state-of-the-art review	<i>Composite Structures</i>	2015	191
Vijesh, AM; Isloor, AM; Shetty, P; Sundershan, S; Fun, HK	New pyrazole derivatives containing 1,2,4-triazoles and benzoxazoles as potent antimicrobial and analgesic agents	<i>European Journal of Medicinal Chemistry</i>	2013	163

FINDINGS AND CONCLUSION

The main aim of this study is to analyse the research performance of the National Institute of Technology Karnataka, Surathkal in terms of publications and collaboration trends between 2010 and 2019 as per the data extracted from the Web of Science. The results indicate that the NITK's publications have grown from 126 in 2010 to 547 during 2019 with an average Compound Annual Growth Rate of 15.81%. The mean Degree of Collaboration i.e. 0.996 implies that the researchers of NITK have a tendency towards collaborated publications with a very minimal number of single-authored publications. The data shows the higher proclivity towards institutional collaborations rather than the national and international collaboration. However, international collaborations have earned more visibility through higher citations per paper than other types of collaboration.

Among the national collaborations, colleges have most collaborated research partner with NITK. The Manipal Academy of Higher Education, Manipal was the most preferred collaborating Institute. This may be due to the short physical distance between the institutions. Among the 519 international collaborated publications, Malaysia was the country with the most collaboration among the 55 collaborating countries. The author A.M. Isloor topped the list in terms of publications and citations for NITK and also has an extensive number of international collaborations. NITK faculties and researchers' publications have appeared more in the international journals than in Indian journals. The authors observed an intra-institutional collaboration among the NITK authors is pragmatic. Hence, the need of the hour is to improve the international collaboration rather than the institutional or domestic collaboration. Several Scientometric studies show that the international collaboration yields them a good number of citations. International Collaboration also helps the authors to attract the international funding agencies. The situation is ripe for the NITK to improve its ranking in national and international ranking systems like NIRF, QS and Times rankings etc.

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