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Publications analysis of Second-generation IITs for the 2010-2019 period

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ABSTRACT

Aims - *To study second-generation IITs publications pattern for 2010-2019 as present in the Scopus database to understand the IITs research competence.*

Methods -*The study used Scopus database. The keyword, Indian Institute of Technology was searched under affiliation. Second generation IITs were selected one after the other and the search was restricted to the 2010-2019 period for the publications data to be analyzed.*

Result - *The results tell us the total number of publications of second-generation IITs for 2010-2019 is 20039 and an average citation per paper of 9.72. Total publications in open access journals by second-generation IITs were 2764; in other, they were 17275. For 2010-2019, the total citations of about 194821 were received, out of which 67659 were citations for open access publications and 127162 citations were from other publications. The significant research areas across second-generation IITs were Engineering, Physics and Astronomy, Computer Science, Material Science and Chemistry. The top two productive journals were Physical Review D and RSC Advance across eight IITs. Second-generation IITs published 25 top-cited papers for 2010-2019 in The Lancet, Physical Review Letters, Astrophysical Journal Letters, Autophagy, Journal of Environmental Management, Classical and Quantum Gravity, Progress in Polymer Science (Oxford), Physical Review X, Nature Photonics, Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics, Ultrasonics Sonochemistry and Journal of Applied Physics with an average citation per paper of 1290.68.*

KEYWORDS: IITs; Scholarly publications; Scopus Indexed; Second Generation IITs; Scientometric.

INTRODUCTION

The Indian Institutes of Technology (IITs) are technological institutes of national importance and are funded centrally by the Ministry of Education, Government of India. IITs are internationally recognized for engineering and technology education and research.

Historical background

Sir Ardeshir Dalal of the Viceroy's Executive Council was the first to think of the Indian Institute of Technology. Who anticipated that India's future welfare after the end of the second world war and before India's independence would rely on technology. Hence he thought of institutes that would prepare the human resources within the country. In 1945 Dr. Humayun Kabir, accompanied by Sir Jogendra Singh, Viceroy's Executive Council, Department of Education, Health and Agriculture, fixed up a 22-member committee with the chairman as Nalini Ranjan Sarkar to formulate a proposal for the establishment of the Higher Technical Institutes on par with the Massachusetts Institute of Technology, America. The NR Sarkar committee endorsed 4 Higher Technical Institutes in the country's Eastern, Western, Northern and Southern regions of the country.

First Generation IITs'

Pandit Jawaharlal Nehru believed that Science and Technology would make modern India by fulfilling the mounting population's needs, which led the way to the establishment of the Indian Institute of Technology. In 1950, the foremost Higher Technical Institute was established in Kharagpur, Hijli Detention Camp and the institute was named the Indian Institute of Technology. The official inaugural ceremony was on August 18, 1951. Later, IIT Bombay, IIT Madras, IIT Kanpur and IIT Delhi were established in 1958, 1959, 1959 and 1961 respectively. The Sixth and Seventh IITs were IIT Guwahati (1994) and IIT Roorkee (2001).

Second Generation IITs:

New IITs were established in 2008 at Bhubaneswar, Gandhinagar, Hyderabad, Patna, Rajasthan and Ropar. Along with two more IITs in the year 2009 at Indore and Mandi.

Third Generation IITs

Later in 2012, the Institute of Technology BHU was converted into the sixteenth IIT BHU. In 2015, IIT Palakkad and IIT Tirupati were established, and five more IITs, IIT (ISM) Dhanbad, IIT Bhilai, IIT Goa, IIT Jammu and IIT Dharwad were started in the year 2016. These IITs play a vital role in engineering and technology education in India and do high-quality research.

Objectives of the Study

The primary objective was to analyze Second-generation IITs publications for 2010-2019.

REVIEW OF LITERATURE

There are few Scientometric studies previously conducted on IITs, NITs, IISERs and Central Universities. Siddaiah D K et al., reported the work on the assessing publications between 2010-2014 of eight new IITs based on the Scopus database's data (2). Prathap G conducted a Scientometric study of the IITs' comparative research performance in engineering and technology and similarly placed institutions worldwide (3). Banshal S K reported the research performance of NITs based on the data from the Web of Science database. Solanki T et al., focused on the Research competitiveness of IISERs (4). Bala, A., & Kumari, S. worked on research performance in NITs during 2001-2010 (5). Prathap, G., & Gupta, B. M. presented the Indian engineering and technological institutes ranking based on the research performance during 1999-2008 (6).

METHODOLOGY

The Scopus data is used by ranking organizations Times Higher Education, QS World University Rankings, etc. and is the world's largest database. Hence, we used the Scopus database for the Publication analysis of Second-generation IITs for 2010-2019 in Sep 2020.

In quantitative and qualitative analysis, all document types (Article, Conference, Book Chapter, Review, Editorial, Book, Erratum, Letter and Note) of publications from Scopus for the period 2010-2019 are used for reliability. In the study, we considered all document types of publications from Scopus.

Results:

The data of publications for 2010-2019 is mentioned in Table 1. A total of 20039 publications were published, out of which 2764 were open access and 17275 were others. IIT Hyderabad contributed to 20% of the complete publications of second-generation IITs and was at the top with 4133 publications, including 515 in open access and 3618 in others. IITH is the best productive institution for the period 2010-2019. Total publications in open access journals by second-generation IITs were 2764 and the IIT Indore had the highest publications of about 568 in open access i.e., nearly about 20%. Complete publications in other access journals by second-generation IITs were 17275 and IIT Hyderabad was the best with 3618 (20%). The yearly average output of IITH was the best with, 516. The annual average output of IITI was 433, followed by IITP (322), IITBBS (322), IITRPR (259), IITGN (251), IITMandi (241) and IITJ (157).

Table 1: Publication summary table for the period 2010-2019 of second generation IITs

Name of the IIT	Abbreviation	Year of establishment	h-Index	Publications			Citations			Average Citations per Paper	Total number of faculty	Papers published per faculty
				TP	OP	OT	TC	COP	COT			
IIT Bhubaneswar	IITBBS	2008	68	2580	504	2076	26912	8414	18498	10.43	140	1.84
IIT Gandhinagar	IITGN	2008	66	2011	366	1645	32374	20086	12288	16.10	128	1.57
IIT Hyderabad	IITH	2008	71	4133	515	3618	35537	10437	25100	8.60	221	1.87

IIT Patna	IITP	2008	51	2582	246	2336	16211	1490	14721	6.28	123	2.09
IIT Jodhpur	IITJ	2008	41	1257	153	1104	6847	1378	5469	5.48	141	0.89
IIT Ropar	IITRPR	2008	68	2072	193	1879	29408	11635	17773	14.19	163	1.27
IIT Indore	IITI	2009	82	3471	568	2903	36019	12680	23339	10.38	145	2.39
IIT Mandi	IITMandi	2009	46	1933	219	1714	11513	1539	9974	5.96	123	1.57
			Total	20039	2764	17275	194821	67659	127162			

TP: Total publications, OP: Open publications, OT: Other publications, h: h Index, TC: Total Citations, COP: Citations of open access publications, COT: Citations of other publications.

For 2010-2019, the total citations across eight IITs were 194821, out of which 67659 were for open access publications and 127162 were for other publications. IIT Indore had contributed to 18% of the gross citations alone and was at the top with 36019 citations (12680 citations of open access publications and 23339 citations of other publications). Citations of other publications were about 127162, of which IIT Hyderabad had contributed 19% and was the top. The total citations of open access publications were 67659; IIT Gandhinagar had contributed significantly in open access citations to about 29% and was the best.

The high quality of research published in open access played a significant role in IIT Gandhinagar to top Average Citations per paper. IIT Indore is the best in documents published per faculty and the h index. The research publications have a prominent weightage in ranking systems.

Details of Publications Subject Area Wise for the period 2010-2019.

The Scopus database arranges Science and Technology knowledge in 27 main subject areas. **Physical sciences** include Physics and Astronomy, Chemistry, Mathematics, Earth and Planetary Sciences and Environmental Science. **Life sciences** include Agricultural and Biological Sciences, Biochemistry, Genetics and Molecular Biology, Pharmacology, Toxicology and Pharmaceutics, Immunology and Microbiology and Neuroscience. **Engineering Sciences** includes Engineering, Materials Science, Computer Science, Chemical Engineering and Energy. **Health Sciences** include Medicine, Nursing, Dentistry, Veterinary and Health Professions. Arts and Humanities, Business, Management and Accounting, Decision Sciences, Economics, Econometrics and Finance, Multidisciplinary, Psychology and Social Sciences are the others.

The second-generation IITs subject-wise total publications are indicated in Table 2. Major subjects contributing to the complete publications are Engineering, Physics and Astronomy, Computer Science, Material Science and Chemistry.

Table: 2 Subject-wise total publications of Second-generation IITs for the period 2010-2019

Subject	Code	No of publications
Engineering	ENG	7622
Physics and Astronomy	PHA	5627
Computer Science	COS	5253
Materials Science	MAS	4687
Chemistry	CHY	3224
Mathematics	MAT	2424
Chemical Engineering	CHE	1850
Energy	ENE	1516
Biochemistry, Genetics and Molecular Biology	BGM	934
Earth and Planetary Sciences	EPS	835
Environmental Science	ENS	773
Social Sciences	SOS	646
Medicine	MED	566
Decision Sciences	DES	361
Multidisciplinary	MUL	339
Agricultural and Biological Sciences	ABS	288
Pharmacology, Toxicology and Pharmaceutics	PTP	236
Business, Management and Accounting	BMA	234
Arts and Humanities	ARH	160
Economics, Econometrics and Finance	EEF	151
Neuroscience	NEU	120
Immunology and Microbiology	IMM	102
Psychology	PSY	91
Health Professions	HEP	65
Nursing	NUR	13
Dentistry	DEN	1
Veterinary	VET	1

The subject-wise publications of individual IITs are indicated in Table 3. In Engineering, IITH contributed the highest number of publications, followed by IITI, IITP, IITBBS, IITRPR, IITMANDI, IITGN and IITJ for the period 2010-2019. IITBBS had the best Average Citation per paper followed by IITI. IITRPR, IITH, IITP, IIT MANDI, IITGN and IITJ during 2010-2019.

Table: 3 Subject-wise publications of individual IITs for the period 2010-2019

Subject	**IITBBS**	**Citations**	**ACPP**	**IITGN**	**Citations**	**ACPP**	**IITH**	**Citations**	**ACPP**	**IITP**	**Citations**	**ACPP**	**IITJ**	**Citations**	**ACPP**	**IITRPR**	**Citations**	**ACPP**	**IITI**	**Citations**	**ACPP**	**IITMANDI**	**Citations**	**ACPP**
E	10	83	8.	6	29	4.	1	10	6.	1	62	5.	5	23	4.	75	55	7.	1	10	7.	654	3201	4.89

NG	24	50	15	03	48	89	722	649	18	062	10	85	21	33	48	6	65	36	280	059	86			
PHA	842	10167	12.07	598	24077	40.26	972	15108	15.54	540	5022	9.30	338	2080	6.15	641	6211	9.69	1136	17292	15.22	560	3269	5.84
COS	577	3724	6.45	450	1375	3.06	1098	4495	4.09	988	4024	4.07	397	1351	3.40	397	1906	4.80	876	5728	6.54	470	1425	3.03
MAS	517	4808	9.30	348	1943	5.58	925	7640	8.26	633	5868	9.27	287	1448	5.05	532	5216	9.80	881	6914	7.85	564	4367	7.74
CHY	247	3629	14.69	272	2095	7.70	698	7006	10.04	353	4685	13.27	124	736	5.94	481	6830	14.20	731	8584	11.74	318	2984	9.38
MAT	238	1379	5.79	233	659	2.83	470	1654	3.52	459	1808	3.94	175	650	3.71	244	1805	7.40	325	1676	5.16	280	1209	4.32
CHE	164	1711	10.43	224	1763	7.87	383	3562	9.30	210	1441	6.86	74	492	6.65	310	4043	13.04	333	3598	10.80	152	1457	9.59
ENE	231	2347	10.16	122	1046	8.57	285	2664	9.35	181	962	5.31	140	1066	7.61	179	1985	11.09	199	2147	10.79	179	1349	7.54
BGM	78	3244	41.59	100	742	7.42	194	1921	9.90	84	881	10.49	69	517	7.49	137	2178	15.90	196	1826	9.32	76	540	7.11
EPS	223	1645	7.38	216	5355	24.79	249	4723	18.97	34	131	3.85	8	24	3.00	20	142	7.10	56	172	3.07	29	83	2.86
ENS	143	2289	16.01	139	1511	10.87	164	1728	10.54	72	539	7.49	30	187	6.23	81	1009	12.46	84	712	8.48	60	655	10.92
SOS	76	356	4.68	77	389	5.05	138	405	2.93	96	344	3.58	29	60	2.07	55	123	2.24	90	168	1.87	85	287	3.38
MED	34	597	17.56	83	886	10.67	157	735	4.68	37	303	8.19	51	290	5.69	60	10816	180.27	73	1071	14.67	71	215	3.03
D	53	21	4.	2	13	6.	5	50	8.	8	43	5.	2	69	3.	39	88	2.	4	34	7.	43	151	3.51

ES		7	09	2	5	14	7	9	93	0	3	41	3		00			26	4	3	80			
MUL	49	367	7.49	49	627	12.80	54	527	9.76	33	246	7.45	35	413	11.80	26	356	13.69	56	361	6.45	37	483	13.05
ABS	49	348	7.10	64	439	6.86	57	509	8.93	27	72	2.67	17	75	4.41	18	197	10.94	36	108	3.00	20	108	5.40
PTP	19	210	11.05	28	122	4.36	43	361	8.40	17	313	18.41	11	26	2.36	48	944	19.67	54	721	13.35	16	95	5.94
BMA	28	367	13.11	9	50	5.56	55	243	4.42	55	202	3.67	3	15	5.00	20	74	3.70	40	305	7.63	24	192	8.00
ARH	9	10	1.11	25	67	2.68	28	69	2.46	27	84	3.11	11	4	0.36	16	16	1.00	18	24	1.33	26	99	3.81
EEF	16	306	19.13	8	9	1.13	53	251	4.74	10	20	2.00	-	-	-	27	31	1.15	21	57	2.71	16	55	3.44
NEU	8	82	10.25	34	311	9.15	10	55	5.50	2	4	2.00	29	325	11.21	13	333	25.62	10	156	15.60	14	163	11.64
IMM	2	2	1.00	14	320	22.86	21	159	7.57	5	26	5.20	13	129	9.92	10	292	29.20	23	186	8.09	14	107	7.64
PSY	3	12	4.00	32	321	10.03	14	37	2.64	1	7	7.00	5	10	2.00	10	75	7.50	6	1	0.17	20	138	6.90
HEP	11	75	6.82	9	40	4.44	14	296	21.14	8	42	5.25	1	1	1.00	3	7	2.33	13	176	13.54	6	14	2.33
NUR	-	-	-	4	3	0.75	1	2	2.00	-	-	-	3	1	0.33	2	9	4.50	2	2	1.00	1	0	0.00
DEN	-	-	-	-	-	-	1	0	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VET	-	-	-	-	-	-	-	-	-	-	-	-	1	2	2.00	-	-	-	-	-	-	-	-	-

ACPP: Average Citations per Paper

IITI contributed the highest number of Physics and Astronomy publications, followed by IITH, IITBBS, IITRPR, IITGN, IITMANDI, IIT P and IITJ for the period 2010-2019. IITGN had the best Average Citation per paper followed by IITH, IITI, IITBBS, IITRPR, IITP, IITJ and IIT MANDI during 2010-2019.

In Computer Science IITH contributed the highest number of publications, followed by IITP, IITI, IITBBS, IITMANDI, IITGN, IITJ and IITRPR for the period 2010-2019. IITI had the best Average Citation per paper, followed by IITBBS, IITRPR, IITH, IITP, IITJ, IITGN and IIT MANDI during 2010-2019.

In Materials Science IITH contributed the highest number of publications, followed by IITI, IITP, IITMANDI, IITRPR, IITBBS, IITGN and IITJ for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITBBS, IITP, IITH, IITI, IITMANDI, IITGN and IITJ during 2010-2019.

IITI contributed the highest number of Chemistry publications, followed by IITH, IITRPR, IITP, IITMANDI, IITGN, IITBBS and IITJ for the period 2010-2019. IITBBS had the best Average Citation per paper, followed by IITRPR, IITP, IITI, IITH, IITMANDI, IITGN and IITJ during 2010-2019.

In Mathematics, IITH contributed the highest number of publications, followed by IITP, IITI, IITMANDI, IITRPR, IITBBS, IITGN and IITJ for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITBBS, IITI, IITMANDI, IITP, IITJ, IITH and IITGN during 2010-2019.

In Chemical Engineering IITH contributed the highest number of publications, followed by IITI, IITRPR, IITGN, IITP, IITBBS, IITMANDI and IITJ for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITI, IITBBS, IITMANDI, IITH, IITGN, IITP and IITJ during 2010-2019.

In Energy, IITH contributed the highest number of publications, followed by IITBBS, IITI, IITP, IITRPR, IITMANDI, IITJ and IITGN for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITI, IITBBS, IITH, IITGN, IITJ, IITMANDI and IITP during 2010-2019.

In Biochemistry, Genetics and Molecular biology IITI contributed the highest number of publications, followed by IITH, IITRPR, IITGN, IITP, IITBBS, IITMANDI and IITJ for the period 2010-2019. IITBBS had the best Average Citation per paper, followed by IITRPR, IITP, IITH, IITI, IITJ, IITGN and IITMANDI during 2010-2019.

In Earth and Planetary Science IITH contributed the highest number of publications, followed by IITBBS, IITGN, IITI, IITP, IITMANDI, IITRPR AND IITJ for the period 2010-2019. IITGN had the best Average Citation per paper, followed by IITH, IITBBS, IITRPR, IITP, IITI, IITJ and IITMANDI during 2010-2019.

In Environmental Science IITH contributed the highest number of publications, followed by IITBBS, IITGN, IITI, IITRPR, IITP, IITMANDI and IITJ for the period 2010-2019. IIT BBS had the best Average Citation per paper, followed by IITRPR, IITMANDI, IITGN, IITH, IITI, IITP and IITJ during 2010-2019.

In Social, Sciences IITH contributed the highest number of publications, followed by IITP, IITI, IITMANDI, IITGN, IITBBS, IITRPR and IITJ for the period 2010-2019. IITGN had the best Average Citation per paper, followed by IITBBS, IITP, IITMANDI, IITH, IITRPR, IITJ and IITI during 2010-2019.

In Medicine, IITH contributed the highest number of publications, followed by IITGN, IITI, IITMANDI, IITRPR, IITJ, IITP and IITBBS for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITBBS, IITI, IITGN, IITP, IITJ, IITH and IITMANDI during 2010-2019.

In Decision Sciences IITP contributed the highest number of publications, followed by IITH, IITBBS, IITI, IITMANDI, IITRPR, IITJ and IITGN for the period 2010-2019. IIT H had the best Average Citation per paper

followed by IITH had the best Average Citation per paper followed by IITI, IITGN, IITP, IITBBS, IITMANDI, IITJ and IITRPR during 2010-2019.

In Multidisciplinary IITI contributed the highest number of publications, followed by IITH, IITBBS, IITGN, IITMANDI, IITJ, IITP and IITRPR for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITMANDI, IITGN, IITJ, IITH, IITBBS, IITP and IITI during 2010-2019.

In Agricultural and Biological Sciences IITGN contributed the highest number of publications, followed by IITH, IITBBS, IITI, IITP, IITMANDI, IITRPR and IITJ for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITH, IITBBS, IITGN, IIT MANDI, IITJ, IITI and IITP during 2010-2019.

In Pharmacology, Toxicology and Pharmaceutics IITI contributed the highest number of publications, followed by IITRPR, IITH, IITGN, IITBBS, IITP, IITMANDI and IITJ for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITP, IITI, IITBBS, IITH, IITMANDI, IITGN and IITJ during 2010-2019.

In Business, Management and Accounting IITH contributed the highest number of publications, followed by IITP, IITI, IITBBS, IIT MANDI, IITRPR, IITGN and IITJ for the period 2010-2019. IITBBS had the best Average Citation per paper, followed by IITMANDI, IITI, IITGN, IITJ, IITH, IITRPR, IITP during 2010-2019.

In Arts and Humanities, IITH contributed the highest number of publications followed by IITP, IITMANDI, IITGN, IITI, IITRPR, IITJ and IITBBS (2010-2019). IITMANDI had the best Average Citation per paper, followed by IITP, IITGN, IITH, IITI, IITBBS, IITRPR and IITJ during 2010-2019.

In Economics, Econometrics and Finance, IITH contributed the highest number of publications, followed by IITRPR, IITI, IITBBS, IITMANDI, IITP, IITGN AND IITJ for the period 2010-2019. IITBBS had the best Average Citation per paper, followed by IITH, IITMANDI, IITI, IITP, IITRPR, IITGN and IITJ during 2010-2019.

IITGN contributed the highest number of publications in Neuroscience, followed by IITJ, IITMANDI, IITRPR, IITH, IITI, IITBBS and IITP for the period 2010-2019. IITRPR had the best Average Citation per paper followed by IITI, IITMANDI, IITJ, IITBBS, IITGN, IITH and IITP during 2010-2019.

In Immunology and Microbiology, IITI contributed the highest number of publications, followed by IITH, IITGN, IITMANDI, IITJ, IITRPR, IITP and IITBBS for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITGN, IITJ, IITI, IITMANDI, IITH, IITP and IITBBS during 2010-2019.

IITGN contributed the highest number of publications in Psychology, followed by IIT MANDI, IITH, IITRPR, IITI, IITJ, IITBBS and IITP for the period 2010-2019. IITGN had the best Average Citation per paper followed by IITRPR, IITP, IITMANDI, IITBBS, IITH, IITJ and IITI during 2010-2019.

In Health Professions IITH contributed the highest number of publications, followed by IITI, IITBBS, IITGN, IITP, IITMANDI, IITRPR and IITJ for the period 2010-2019. IITH had the best Average Citation per paper, followed by IITI, IITBBS, IITP, IITGN, IITRPR, IITMANDI and IITJ during 2010-2019.

In Nursing, IITGN contributed the highest number of publications, followed by IITJ, IITRPR, IITI, IITH, IITMANDI, IITBBS and IITP for the period 2010-2019. IITRPR had the best Average Citation per paper, followed by IITH, IITI, IITGN, IITJ, IITBBS, IITP AND IITMANDI during 2010-2019.

In Veterinary IIIJ alone contributed the publication.

The best productive journals and publications of individual IITs for the period are indicated in Table 4. There are 55 most productive journals of eight new IITs, which have contributed 3546 articles. These 3546 articles make up 27.05 % of the articles published in journals (2010-2019). The IITs published largely in Physical Review D (276), RSC Advances (270), Journal of High Energy Physics (193), Scientific Reports (141), Physical Review Letters

(136), Physics Letters Section B Nuclear Elementary Particle and High Energy Physics (136), Dalton Transactions (110), Chemistry select (109), Journal of Applied Physics (109), etc. The distribution pattern of articles in these 55 journals is tabulated as in Table 4.

Table 4: Best productive journals and publications of individual IITs for the period 2010-2019

Journal	TP	Impact Factor	IIT BBS	IITGN	IITH	IITP	IITJ	IITRPR	IITI	IIT Mandi
Physical Review D	276	4.833	80	95	74	0	7	9	11	0
RSC Advances	270	3.119	22	17	53	38	8	39	66	27
Journal Of High Energy Physics	193	5.875	125	7	9	0	3	0	49	0
Scientific Reports	141	3.998	15	18	21	8	19	8	31	21
Physical Review Letters	136	8.385	54	23	25	0	0	3	31	0
Physics Letters Section B Nuclear Elementary Particle And High Energy Physics	136	4.110	37	8	5	0	2	0	84	0
Dalton Transactions	110	4.174	14	5	18	6	0	12	44	11
Chemistryselect	109	1.811	9	6	22	11	4	9	30	18
Journal Of Applied Physics	109	2.286	15	6	23	8	7	9	29	12
Journal Of Physical Chemistry C	95	4.189	3	13	15	8	2	6	33	15
New Journal Of Chemistry	94	3.288	0	10	15	8	6	21	23	11
Materials Research Express	87	1.929	12	0	12	11	6	0	20	26
Journal Of Alloys And Compounds	85	4.65	8	0	30	17	2	0	17	11
Physical Chemistry Chemical Physics	76	3.43	0	5	15	9	4	5	34	4
European Physical Journal C	74	4.839	5	9	6	0	7	6	41	0
ACS Applied Materials And Interfaces	72	8.758	5	0	17	7	8	11	14	10
Sensors And Actuators B Chemical	72	7.1	10	0	10	3	2	28	8	11
Tetrahedron Letters	70	2.275	6	0	17	5	0	21	16	5
Applied Physics Letters	61	3.597	12	2	13	0	5	0	16	13
International Journal Of Heat And Mass Transfer	54	4.947	8	0	4	11	0	16	13	2

Journal Of Materials Science Materials In Electronics	54	2.22	3	0	14	10	2	0	20	5
Ceramics International	53	3.83	7	3	8	16	2	0	13	4
IEEE Transactions On Electron Devices	53	2.62	0	10	0	5	6	0	26	6
IEEE Sensors Journal	51	3.076	10	2	6	0	6	4	20	3
Journal Of Organic Chemistry	51	4.335	10	0	18	6	2	6	9	0
Physical Review D Particles Fields Gravitation And Cosmology	49	4.833	6	22	11	0	3	0	7	0
Applied Surface Science	45	6.182	11	2	4	4	3	8	9	4
Electrochimica Acta	45	6.215	0	0	25	3	0	6	8	3
Inorganic Chemistry	44	4.825	0	0	9	4	0	7	22	2
Journal Of Magnetism And Magnetic Materials	43	2.717	4	0	14	6	0	3	5	11
Expert Systems With Applications	42	5.452	10	2	0	10	2	0	18	0
ACS Omega	40	2.87	0	4	9	4	1	5	9	8
Journal Of Physics D Applied Physics	40	3.169	6	0	9	3	2	0	14	6
Journal Of Molecular Structure	37	2.463	9	4	9	7	0	0	4	4
International Journal Of Hydrogen Energy	35	4.939	0	2	6	0	4	8	10	5
Materials Letters	35	3.204	3	0	14	0	0	7	5	6
Wireless Personal Communications	35	1.061	3	0	9	12	2	0	9	0
ACS Sustainable Chemistry And Engineering	34	7.632	0	2	0	0	2	16	10	4
IEEE Communications Letters	33	3.457	4	0	7	6	2	0	14	0
Journal Of Physical Chemistry B	32	2.857	0	6	7	7	4	4	4	0
Nanotechnology	32	3.551	7	0	8	0	7	3	7	0
International Journal Of Electrical Power And	30	3.588	16	0	0	5	3	0	4	2

Energy Systems										
Langmuir	29	3.557	0	3	5	3	0	5	13	0
Materials Science And Engineering A	29	4.652	12	4	0	3	3	7	0	0
Chemical Communications	28	5.996	4	0	0	3	0	3	12	6
Applied Thermal Engineering	27	4.725	3	0	5	0	1	6	9	3
Applied Optics	27	1.961	2	4	0	10	2	0	9	0
Applied Physics A Materials Science And Processing	27	1.81	5	2	0	0	8	0	9	3
ACS Applied Nano Materials	26	NA	0	3	0	0	2	6	8	7
Industrial And Engineering Chemistry Research	25	3.573	0	5	7	5	0	4	4	0
Applied Soft Computing Journal	22	5.472	3	0	0	8	3	0	4	4
Physics Letters Section A General Atomic And Solid State Physics	21	2.278	0	4	0	5	3	3	0	6
Journal Of Environmental Chemical Engineering	18	4.3	4	3	6	3	0	0	0	2
Applied Mathematical Modelling	17	3.633	5	0	4	3	2	3	0	0
Journal Of Manufacturing Processes	17	4.086	3	0	5	3	3	3	0	0

The best 25 cited papers from second generation IITs for the period 2010-2019 are tabulated in Table 5. There is a greater need for international collaboration, which can shape the research abilities, as is evident from the best-cited 25 papers (citation range 410-4978); 23 articles had first authors from abroad institutions. The IITGN, IITRPR, IITH, IITBBS, IITP and IITI contributed to these best-cited papers. Elite journals published the best-cited articles that are The Lancet- 08, Physical Review Letters- 06, Astrophysical Journal Letters- 02, Autophagy- 01, Journal of Environmental Management- 01, Classical and Quantum Gravity- 01, Progress in Polymer Science (Oxford)- 01, Physical Review X- 01, Nature Photonics- 01, Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics- 01, Ultrasonics Sonochemistry- 01 and Journal of Applied Physics- 01.

Table 5: Twenty-five most cited papers from IITs research output data (2010–2019)

Publication year	**Title**	**Authors Affiliation from IITs**	**IITs Affiliation**	**Citations**	**JOURNAL**

2016	Observation of gravitational waves from a binary black hole merger (7)	Sengupta A S and Gaur G	IITGN	4978	Physical Review Letters
2017	GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral (8)	Sengupta A S and Somala Surendra Nadh	IITGN, IITH	2822	Physical Review Letters
2016	Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015 (9)	Sharma Rajesh S	IITRPR	2450	The Lancet
2016	Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015 (10)	Sharma Rajesh S	IITRPR	2450	The Lancet
2016	GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence (11)	Sengupta A S and Gaur G	IITGN	1939	Physical Review Letters
2017	Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016 (12)	Sharma Jayendra	IITRPR	1797	The Lancet
2016	Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015 (13)	Sharma Rajesh S	IITRPR	1579	The Lancet
2017	Global, regional, and national age-sex specifc mortality for 264 causes of death, 1980-2016: A systematic analysis for the Global burden of Disease Study 2016 (14)	Sharma Rajesh S	IITRPR	1502	The Lancet
2017	GW170104: Observation of a 50-Solar-Mass Binary Black Hole Coalescence at Redshift 0.2 (15)	Sengupta A S and Gaur G	IITGN	1361	Physical Review Letters
2017	GW170814: A Three-Detector Observation of Gravitational Waves from a	Sengupta A S, Gaur G and	IITGN, IITH	1045	Physical Review

	Binary Black Hole Coalescence (16)	Somala Surendra Nadh			Letters
2017	Gravitational Waves and Gamma-Rays from a Binary Neutron Star Merger: GW170817 and GRB 170817A (17)	Sengupta A S, Gaur G and Somala Surendra Nadh	IITGN, IITH	999	Astrophysical Journal Letters
2017	Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016 (18)	Sharma Jayendra	IITRPR	921	The Lancet
2016	Global, regional, and national disability-adjusted life-years (DALYs) for 315 diseases and injuries and healthy life expectancy (HALE), 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015 (19)	Sharma Rajesh S	IITRPR	916	The Lancet
2012	A review on chemical coagulation/flocculation technologies for removal of colour from textile wastewaters (20)	Verma Ak, Dash R R and Bhunia P	IITBBS	908	Journal of Environmental Management
2015	Advanced LIGO (21)	Sengupta A S and Gaur G	IITGN	850	Classical and Quantum Gravity
2011	A review on the mechanical and electrical properties of graphite and modified graphite reinforced polymer composites (22)	Bhowmick A K	IITP	800	Progress in Polymer Science
2016	Binary Black Hole Mergers in the First Advanced LIGO Observing Run (23)	Sengupta A S and Gaur G	IITGN	753	Physical Review X
2017	Global, regional, and national disability-adjusted life-years (DALYs) for 333 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016 (24)	Sharma Rajesh S	IITRPR	736	The Lancet

2016	Tests of General Relativity with GW150914 (25)	Sengupta A S and Gaur G	IITGN	627	Physical Review Letters
2017	GW170608: Observation of a 19 Solar-mass Binary Black Hole Coalescence (26)	Sengupta A S, Gaur G and Somala Surendra Nadh	IITGN, IITH	561	Astrophysical Journal Letters
2013	Enhanced sensitivity of the LIGO gravitational wave detector by using squeezed states of light (27)	Sengupta A S	IITGN	488	Nature Photonics
2013	Long-range angular correlations on the near and away side in p-Pb collisions at √sNN=5.02 TeV (28)	Sahoo R and Nath Mishra A	IITI	472	Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics
2011	Ultrasonic pretreatment of sludge: A review (29)	Bhunia P	IITBBS	466	Ultrasonics Sonochemistry
2013	Small particles, big impacts: A review of the diverse applications of nanofluids (30)	Tyagi H	IITRPR	437	Journal of Applied Physics
2016	Properties of the Binary Black Hole Merger GW150914 (31)	Sengupta A S and Gaur G	IITGN	410	Physical Review Letters

CONCLUSIONS

This work portrays the publication productivity of second-generation IITs for 2010-2019. The publications of second generation IITs for 2010-2019 vary widely from 1257-4133. IITH is the best with 4133 and next is IITI with 3471, followed by IITP (2582), IITBBS (2580), IITRPR (2072), IITGN (2011), IITMandi (1933) and IITJ (1257). The most productive areas of second generation IITs were engineering, Physics and astronomy, Computer Science, Material Science and Chemistry. The study recognized 25 highly cited papers (citation range 410-4978). The IITGN, IITRPR, IITH, IITBBS, IITP and IITI contributed to these best-cited papers.

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