RESEARCH PRODUCTIVITY OF INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH (IISER), MOHALI DURING 2011-2020: A SCIENTOMETRIC APPROACH

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ABSTRACT

IISER Mohali is a prominent MoE institute in India (Formerly MHRD). This study analyses IISER Mohali's research potential between 2011 and 2020 using Scientometrics tools. Scopus provided the research data. Co-occurrence phrases were visualised using VOS viewer 1.6.16. Scientometrics variables including RGR, DT, co-authorship index, Degree of Collaboration and Rate of Single Authorship, Time series analysis, and transformational Activity Index were utilised. The investigation found that the most papers, 350 (17.25%), were published in 2019 while the most were referenced in 2012. (4085, 13.70 percent). The analysis found that 2012 had the most citations per manuscript (46.95), whereas 2015 and 2019 had the most collaboration (0.95). In the study, growth averaged -0.19. India ranked first in transformational activity index for 2011-2015 and 2016-2020, with a -10.88 change. 2012 RQI was 3.64. This scientometric study will help IISER Mohali researchers.

Keyword: IISER, scientometric, bibliometric, citation, doubling time, transformative activity index.

Introduction:

Research is a systematic study conducted to increase the accumulation of knowledge, which include collecting, organizing, and analyzing information to better understand the topic or issue. A research project or a research paper may be a contraction on past work in the field. All the research products of an academic/research institution are important for the institutional ranking. It helps to collaborate with funding agencies, create an image of the institution and lay an impact on the research community and society. Different research metrics have been used to appraise the research fertility of an organization. Research metrics are the instruments used to quantify the influence or impact of scholarly work. Bibliometric**,** citation analysis**,** Scientometric, altimetric etc. are some examples of research metrics. These are used to compare scholarships for promotion and tenure purposes, and to attract or grant funding. Bibliometric focuses on the quantitative interpretations of erudite publication data & the process often mean the purpose of output & influence signs for

research evaluation determinations. Bibliometric, Scientometric are generally some similar tools used in research metric evaluation. Citation & content review are usually utilized in these methods. Scientometrics is one of the most critical areas for the appraisal of scientific productions (Singh, Nayak & Varma, 2017).

Concept & Definition:

Alan Pritchard coined this term 'bibliometric' in his paper titled 'Statistical Bibliography or Bibliometric' in 1969. It can be defined as "the application of mathematics and statistical methods to books and other media of communication"(Hood & Wilson, 2001). Scientometric is a part of bibliometric study; David J. Hess had defined "the quantitative study of science, communication in science, and science policy" in his book Science Study published in 1997 (Milojevic et. al, 2014). Scientometrics is commonly known as the "bibliometric" analysis of science. In the 1960s, the term 'Scientometrics' was coined by Vassily V. Nalimov (Hood & Wilson, 2001). Scientometrics is the study of measuring and analysing science, technology and innovation (Nayak, 2018).

Institutional Profile:

Indian Institutes of Science Education and Research (IISERs) were set up by the Ministry of Education (Formerly MHRD), Government of India, in light of the suggestion of the Scientific Advisory Council to the Prime Minister. Five IISERs were set up at Kolkata (2006), Pune (2006), Mohali (2007), Bhopal (2008) and Thiruvananthapuram (2008). Later two more IISERs were begun in Tirupati (2015) and Berhampur (2016). Each IISER is an independent foundation and it grants its own certificates. IISER's essential mission is to lead research in the wilderness areas of science to give quality science education.

IISER Mohali began in 2007 and situated in 125 sections of land of land in the Knowledge City at Sector 81, Mohali. In a mentally lively scholarly climate, IISER Mohali sustains the essential precepts of science schooling and exploration at undergrad and postgraduate levels. In this manner, the organization means to arise as a worldwide focal point of learning, scholarly greatness, and imaginative examination. According to the Annual Report 2019-20 of IISER Mohali, the Academic strength of IISER Mohali is 115 Faculty (97 Core Faculty, 2 Honorary Faculty, 3 Visiting Faculty, 3 Adjunct Faculty, 2 Inspire Faculty Fellow), 48 Postdoctoral Fellow, 1 BS Graduate, 160 BS-MS Graduates, 47 Ph.D. Graduates, 14 MS Graduates in 6 distinct Departments.

Review of Literature:

Bibliometric and Scientometric studies on different individual research/academic institutions/ organisations and universities have been done earlier by different authors. Among them a few studies on different IISERs i.e. Bhopal, Kolkata, Pune, Thiruvananthapuram, Mohali also have done this before.

Roy & Mandal (2021) presented in their paper on IISER Kolkata based on WoS and found 3495 scientific records during 2006-2020 among them highest 504 records in the year 2020 and lowest 2 records published in 2006. They also evaluate the highest publications in different subject areas, among which the Chemistry research area published 1207 scientific records followed by 988 in physics, 366 in materials science. Again Roy & Mandal (2021) had a study on IISER Pune during the year 2006-2020 and analysed the 3613 research publications and found the highest research output 546 in the year 2018. H. Sherin et al. (2021) had a scientometric study on Indian Institute of Science (IISc) Bangalore for last 2 decades from 2000 to 2019 and mentioned in their major findings that a number of 29580 research publications found during 20 years and the highest publications count in the year 2019 as 2200 which is 7.43% of the total research productivity. They also analyzed and identified most productive authors, most collaborating countries, highly preferred journals, funding agencies for project-based research and most cited documents. Singh et al. (2021) analyzed in their scientometric study on Forest Research Institute (FRI) Dehradun during 1990-2019 that the maximum number of papers 75(8.4%), was published in 2008 while the max. no. of papers was cited in 2007(480). The analysis also revealed that the mean citation per publication was maximum in 2015(88.00). The most focused research areas are Agricultural and Biological Sciences, Environmental Science, Biochemistry.

Kuri et al. (2020) mentioned in their paper that academic performance can be evaluated using the Scientometric approach to research productivity. The study also found that 561 publications were made during the study period. Between 2015 and 2018, research growth reached its apex (19.60 percent). During the study period, the average growth rate was 1376.32 percent. 295 scholarly publications were found to be devoted to business, management, and accounting topics in studies conducted by the authors themselves. Parida et al. (2020) visualised the research productivity of AIIMS Bhubaneswar during 2012-2019 and analysed 734 research outputs. They found a continued growth of research publications during the 8 years of their study and marked the highest publication in the year 2019. They also identified the top funding research institute and most productivity author. Kumar (2018) had a scientometric study on the writing usefulness of "Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital." He broke down WoS bibliographical information of 514 exploration papers during a long time from 2001-2015 and distinguished the researchers of ARIES those are dynamic; the regions wherein they are dynamic, the diaries in which they distribute their examination work, their efficiency as far as distribution, references and H-Index and so forth His paper uncovers the working together establishments, nations and examination financing organizations. Hadimant et al. (2016) interpreted the research papers of IISER Bhopal using WoS index during 2009-2013 with average growth per annum were 65.75%. Their research evaluates 187 publications of 451 contributors or authors which average 2.42 authors/ paper & 0.42 productivity/ author. Hadimani et al. (2015) likewise had concentrated on IISER Thiruvananthapuram, (TVM) of an aggregate of 157 examination papers in different disciplines of science and innovation from 2008 to 2013, in light of the Web of Science (WoS) data set. They played out an exhaustive synopsis of year-wise distributions with their references as 157 papers are refered to multiple times, with a mean reference for each paper is 13.58. Visakhi & Gupta (2013) had a study on IISER Mohali based on Scopus database, they analysed 186 number of research publications of 5 years and found an annual mean maturity rate of 44.98% on research publications and 65.43% on authors during 2008-2012.

Objectives:

- To find year-wise development of the exploration efficiency and Scholarly distributions of IISER Mohali up to the year 2020
- To find relative growth rate (RGR), doubling time and co-authorship index of the publications of IISER Mohali
- To determine the degree of collaboration and rate of single authorship.
- To analyze top five countries transformative activity index, year wise growth of relative quality index and time series analysis of the publications of IISER Mohali
- To analyze the network visualization of co-occurrence of keywords

Methodology:

Scopus, one of the most extensive databases carrying bibliographic data & citations, was used to conduct a scientometric descriptive survey of research papers published by researchers of Indian Institutes of Science Education & Research (IISER) scholarly publications, Mohali, from 2011 to 2020. The records were extracted from the database within the Scopus domain. The researchers carried out an affiliation search for the present study. The search term "Indian Institutes of Science Education & Research, Mohali" was used to search data from 2011-2011. The following search string was used in this study AF-ID("Indian Institute of Science Education and Research Mohali" 60103627) AND "(LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011)." The bibliographic data were retrieved on 06th November 2021, during the extraction of data, a total of 2029 articles were found.

Data Analysis:

Year-wise growth pattern

Table-1 clarifies the year-wise development of papers and mean references per paper. From 2011 to 2020, 2029 distributions and 29824 were gotten. The recurrence of distributions during the most recent ten years shows an expanding pattern till 2019 and somewhat diminished in 2020. The largest no. of distributions, i.e., 350 (17.25%), showed up in 2019, and the most minor 59 (2.91%) were in 2011. To know the distribution quality, the normal references per article is determined. The normal no. of references per article is most noteworthy in the year 2012 with 46.95 references followed by 2011 with 33.98 references.

Table 1 Year wise growth pattern

Sl. No.	*YEAR	*TP	%TP	*TC	%TC	*ACPP
1	2020	331	16.31	1325	4.44	4.00
2	2019	350	17.25	2837	9.51	8.11
3	2018	317	15.62	3964	13.29	12.50
4	2017	245	12.07	3820	12.81	15.59
5	2016	201	9.91	3548	11.90	17.65
6	2015	171	8.43	3078	10.32	18.00
7	2014	159	7.84	2593	8.69	16.31
8	2013	109	5.37	2569	8.61	23.57
9	2012	87	4.29	4085	13.70	46.95
10	2011	59	2.91	2005	6.72	33.98
Total		2029	100.00	29824	100.00	

*TP= total publications, TNC= total citations, ACPP= average citation per paper

Relative Growth Rate (RGR) and Doubling Time (DT)

Relative Growth Rate (RGR)

The relative growth rate (RGR) is calculated based on the formula cited by Rawat et al. (2021) in their study and mentioned as follows:

RGR=(1-2^r)=((w2) - (w1))/(T2-T1)

Where,

w1 = Total Number of Publications at Initial time.

w2 = Total Number of Publications at Final.

T2 –T1 = Difference between the initial year and the final year, the year can be taken here as the unit of time.

Table 2 depicts the outline of relative growth rate (RGR), doubling time (DT) of research papers published between 2011 and 2020. RGR defines the maturity in terms of a rate of inflation in size per unit of size (Kuri et al., 2020). Highest Relative growth rate with a value of 0.06 in 2019, whereas the lowest was -0.39 in 2011. The mean relative growth rate during the study was -0.19.

Doubling Time DT

Doubling Time of the published literature is a good measure to get an estimate of the time after which total literature gets double. It is equal to the natural logarithm of 2, divided by RGR (Rai, Singh & Varma, 2020).

$$\text{Doubling Time} = D(t) = \frac{0.693}{RGR}$$

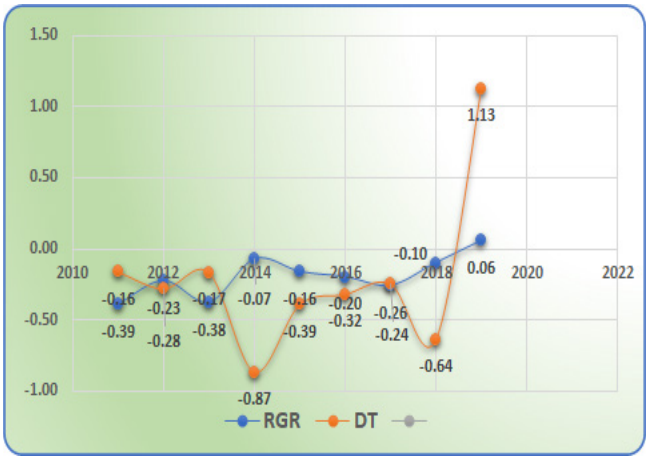
During the review time frame, it showed that the mean multiplying time was - 0.21. Most noteworthy and least multiplying time was seen in 2019 and 2014 individually.

Figure 1 addresses the correlation of relative development rate to the multiplying time with a particular time span.

Table 2 Relative Growth Rate RGR and Doubling Time DT

Sl. No.	*YEAR	*TP	*Cumulative	*LogW1	*LogW2	*RGR	*DT
1	2020	331	331		5.80		
2	2019	350	681	5.80	5.86	0.06	1.13
3	2018	317	998	5.86	5.76	-0.10	-0.64
4	2017	245	1243	5.76	5.50	-0.26	-0.24
5	2016	201	1444	5.50	5.30	-0.20	-0.32
6	2015	171	1615	5.30	5.14	-0.16	-0.39
7	2014	159	1774	5.14	5.07	-0.07	-0.87
8	2013	109	1883	5.07	4.69	-0.38	-0.17
9	2012	87	1970	4.69	4.47	-0.23	-0.28
10	2011	59	2029	4.47	4.08	-0.39	-0.16
Total		2029					
Mean				5.29	5.17	-0.19	-0.21

Figure 1 Relative Growth Rate (RGR) and Doubling Time (DT)



Co Authorship Index

The co-authorship index is measured using the formula suggested by (Garg & Padhi, 2001). Thus, the co-authorship index (CAI) can be mathematically expressed as:

$$CAI = \left\{ \frac{\left(\frac{Nij}{Nio}\right)}{\left(\frac{Noj}{Noo}\right)} \right\} \times 100$$

Where,

Nij = The number of publications having j authors in block i

Nio = Total output of block i

Noj = The number of publications having j authors for all blocks

Noo= Total number of publications for all authors and all blocks

j = 1, 2, 3…

The proportional values of one, two, three, and more authored publications were used to calculate the co-authorship index during the study period (Singh et al. 2021). With a co-authorship index of 1.35 in 2013, single authorship papers had the highest co authorship index (CAI). In two authorships, the maximum co-authorship index of 1.32 was observed in 2015. While the maximum co-authorship index for three authorships, four authorships and five and above authorship was 1.32, 1.37 and 1.16 respectively in 2015, 2012 and 2020.

Table 3 Co Authorship Index

Sl. No.	Year	*One Author	*CAI	*Two Author	*CAI	*Three Author	*CAI	*Four Author	*CAI	> Four Author	*CAI	*Total
1	2020	24	1.07	60	0.80	74	1.03	31	0.80	142	1.16	331
2	2019	19	0.80	71	0.90	70	0.92	41	0.99	149	1.15	350
3	2018	23	1.07	58	0.81	75	1.09	37	0.99	124	1.06	317
4	2017	17	1.02	63	1.14	51	0.96	31	1.07	83	0.91	245
5	2016	15	1.10	49	1.08	45	1.03	25	1.06	67	0.90	201
6	2015	9	0.77	51	1.32	49	1.32	19	0.94	43	0.68	171
7	2014	12	1.11	42	1.17	30	0.87	21	1.12	54	0.92	159
8	2013	10	1.35	31	1.26	22	0.93	14	1.09	32	0.79	109
9	2012	5	0.84	17	0.86	17	0.90	14	1.37	34	1.05	87
10	2011	4	1.00	17	1.27	8	0.62	6	0.86	24	1.10	59
Total		138		459		441		239		752		2029

Degree of Collaboration and Rate of Single Authorship

Subramanyam (1983) formula was used to compute the degree of collaboration (DC). The degree of collaboration can be mathematically expressed as:

$$DC = \frac{Nm}{Nm+Ns} \quad \text{and} \quad RSA = \frac{Ns}{Nm+Ns}$$

Where,

"DC= Degree of Collaboration & RSA= Rate of single authorship" "*N*m= Number of multi-authored research papers in the discipline published during a year." "*N*s = Number of single-authored papers in the discipline published during the same year."

The Degree of Collaboration of authors by year wise and rate of single authorship is presented in Table 4. The DC ranges from 0.91 to 0.95. The year 2015 and 2019 has the maximum DC 0.95, lowest DC 0.91 in the year 2013. Rate of single authorship 0.09 is highest in 2013 & lowest 0.05 in 2015.

Table 4 Degree of Collaboration and Rate of Single Authorship

Sl. No.	YEAR	TP	Ns	Nm	DC	RSA
1	2020	331	24	307	0.93	0.07
2	2019	350	19	331	0.95	0.05
3	2018	317	23	294	0.93	0.07
4	2017	245	17	228	0.93	0.07
5	2016	201	15	186	0.93	0.07
6	2015	171	9	162	0.95	0.05
7	2014	159	12	147	0.92	0.08
8	2013	109	10	99	0.91	0.09
9	2012	87	5	82	0.94	0.06
10	2011	59	4	55	0.93	0.07
Total		2029	138	1891		

Time Series Analysis

Time series investigation is done essentially to make estimates for future and additionally, to assess past exhibitions.

yc=a+bx

a=No. of Authors

N=No. of years, a=2029/10=202.9

= No. of x2 tables

b= -2808.5/82.5 = -32.84

The time series analysis method is applicable for predicted value of upcoming years.

Table 5 Time Series Analysis

Sl. No.	*YEAR	*x	*y	*X	*Xy	*X2
1	2020	0	331	-4.5	-1489.5	20.25
2	2019	1	350	-3.5	-1225	12.25
3	2018	2	317	-2.5	-792.5	6.25
4	2017	3	245	-1.5	-367.5	2.25
5	2016	4	201	-0.5	-100.5	0.25
6	2015	5	171	0.5	85.5	0.25
7	2014	6	159	1.5	238.5	2.25
8	2013	7	109	2.5	272.5	6.25
9	2012	8	87	3.5	304.5	12.25
10	2011	9	59	4.5	265.5	20.25
Total		45	2029	0	-2808.5	82.5

Top five countries transformative Activity Index

In order to study the change in output in the last two blocks among the prolific countries, use of Transformative Activity Index (TAI) suggested by Guan and Ma."

Mathematically, TAI = [(Ci /Co)/(Wi /Wo)] x100

"Where Ci is the number of publications of the specific country in the ith block."

"Co is the total number of publications of the specific country during the period of study."

"Wi is the number of publications of all countries in the ith block."

"Wo is the number of publications of all the countries during the period of the study."

Table 6 depicts the top five countries' transformative Activity index. India topped the rank with transformative activity index 107.98 and 97.10, for the year 2011-2015 and 2016-2020 respectively whereas the change in transformative activity index is -10.88. United States in the second position with 109.20 and 96.65 for the year 2011-2015 and 2016-2020, whereas the change in transformative activity index is -12.55.

Table 6 Top five countries transformative Activity Index

S. N.	Country	2011-2015	TAI	2016-2020	TAI	2011-2020	Change in TAI
1	India	584	107.98	1444	97.10	2028	-10.88
2	United States	83	109.20	202	96.65	285	-12.55
3	Germany	61	106.39	154	97.68	215	-8.71
4	China	7	23.44	105	127.84	112	104.41
4	Spain	17	56.91	95	115.67	112	58.75
5	Australia	11	37.84	98	122.61	109	84.77
Total		763		2098		2861	

Year wise Growth of Relative Quality Index

The indicator is actually the ratio of the proportion of top-quality papers to the proportion of the publications, in which RQI= (Number of high-quality papers for a discipline or an institution / Total number of high-quality papers) x 100. The measure relates to the incidence of high-quality documents of an area or perhaps by an institution. A value of RQI >1 indicates higher than average.

Table 7 depicts the year wise growth of relative quality index of Indian institute of science Education Research (IISER), Mohali for the period 2011-2020. Highest relative quality index 3.64 in 2012 succeeded by 3.03 in 2011. In 2020 lowest relative quality index is found 0.28.

Table 7 Year wise Growth of Relative Quality Index RQI

S. N.	YEAR	TP	TC	Cited by	RQI
1	2020	331	1325	14538	0.28
2	2019	350	2837	17561	0.50
3	2018	317	3964	15259	0.80
4	2017	245	3820	11804	0.99
5	2016	201	3548	9051	1.20
6	2015	171	3078	7879	1.20
7	2014	159	2593	5718	1.39
8	2013	109	2569	4245	1.86
9	2012	87	4085	3443	3.64
10	2011	59	2005	2032	3.03
	Total	2029	29824	91530	

Co-occurrence of Keywords

The figure 2 shows that there are minimum occurrences of 10 terms of 6093 terms and 38 terms meet the threshold. For each of the 38 terms & 60% of the most relevant terms.The terms "Drosophila" has occurrence is 10 and relevance is 2.37 same as the relevance of "structural characterization". There are 4 clusters with 22 items, Cluster 1 has 8 items, cluster 2 has 5, cluster 3 has 5 and cluster 4 has 4 items and total link strength is 143.

Figure 2 Co-occurrence with Keywords

Finding & Conclusion:

The current review analyzed the exploration usefulness of IISER, Mohali as reflected in the SCOPUS information base during the period 2011-2020 utilizing Scientometric implies. The exploration uncovers that 2029 distributions were distributed by the creators subsidiary with IISER Mohali. The example of authorships demonstrated that the discipline of exploration usefulness in IISER MOHALI is overwhelmed by four creators' distributions. The time series examination additionally shows the positive development patterns in future. The Relative Growth rate (RGR) determined for both distribution and references. The multiplying time (DT) against every extended time of the not set in stone. The worth of RGR and DT of distributions are introduced in Table-2. It tends to be inspected from Table-2 the Relative Growth Rate (RGR) of papers decreases ceaselessly from 0.06 to - 0.39. The benefit of Doubling Time is 1.13 for the year 2011-2019. The Transformative Activity Index (TAI) India and USA nations showed an extending tendency in their distribution action by the Value of TAI. In this review saw that the Relative Quality Index (RQI) 2029 distributions were refered to and gotten 29824 references. The RQI is above from the year 2012 onwards shows the greater number of value research yield is being created during the new years. The results of this scientometric study will be helpful to IISER Mohali researchers who are leading examination in various regions.

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