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Research Article

Trend Analysis of West Bengal Universities (India) Based on NIRF Ranking

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ABSTRACT

The present study analyses the scientific productivity of University of Calcutta and Jadavpur University for the study period from 2002 to 2021 using the Web of Science database. The retrieved data has been analyzed on the following parameters; year-wise distribution of publication, authorship pattern, degree of collaboration, most productive authors, collaborative institution, and preferred source for publication. A total of 10856 and 14669 records from both universities have been retrieved. The results show that productivity has a fluctuating trend in the publication growth pattern in both universities. The study found that the author S Ghosh has published 653 articles; 7582 total citations and 42 *h*-index values are the top research productivity of C.U. research output. The study also found that S Das is the most prolific author J.U. with 957 articles, 22006 citations, and 65 *h*-index values.

Keywords: West Bengal's University, Trend Analysis, Authorship Pattern, Prolific authors, VOSviewer, International Collaboration.

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INTRODUCTION

The main purposes of research are to inform action, to gather evidence for a theory, and to contribute to the development of knowledge in the field of study. Through the Universities' research, make important contributions to the growth and development of any discipline, thereby promoting national and global development. University is a hub of research and education.

The University of Calcutta is a state university situated at Kolkata, West Bengal in India. The C.U. was one of the first multidisciplinary and Western-style foundations in Asia. It was established in the year 1857. University of Calcutta is accredited with Grade 'A' by the "NAAC". According to NIRF 2021, C.U. ranked 1st and 11th category among universities in India, (MHRD, 2021). There are approximately 160 institutes that come under University of Calcutta.

Jadavpur University is a State level University located in Kolkata and established in 1906, West Bengal in India. The University has three affiliated Institutions. Jadavpur University offers more than 130 courses at U.G., P.G., and Doctor Levels. J.U. has been accredited by "NAAC" with Grade 'A'. According to NIRF in 2021, it ranked two in West Bengal and 14thranked among universities in India.

The Ministry of Education has introduced the sixth edition of India university rankings, based on the National Institutional Ranking Framework, for the year 2021, (Kumaren & Rajkumar, 2019). The sixth edition of India rankings consolidates, improves, and expands on the previous five annual exercises conducted between 2016 and 2020 in terms of additional categories and subject domains introduced to the ranking exercise, as well as the number of institutions examined for ranking, (Allam, 2016).

In a present paper, the authors focused on analyzing the two universities from West Bengal based on NIRF ranking in India, comparing the results obtained by these universities with major universities, (Balasubramani & Thangavel, 2019). This analysis was based on research output data indexed in Web of Science between 2002 and 2021.

OBJECTIVES OF THE STUDY

- To find out the year-wise distribution of research output of C.U. and J.U.
- To identify the Degree of Collaboration of the Researchers of C.U. and J.U.
- To study the Collaborative Index and Collaborative Co-efficient

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- To apply the Time Series Analysis to predict the trend of research output of C.U. and J.U.
- To determine the Authorship Pattern and the most prolific Author of C.U. and J.U.
- To identify the Annual Growth and Exponential Growth of Literature
- To know the research area-wise distribution of publications

METHODOLOGY

The present study focuses on the two Indian universities in terms of publications from 2002 to 2021. The bibliographic details of the publications of C.U. and J.U. were retrieved from the Web of Science database during the study period 2002-2021, and 10851 data were retrieved from University of Calcutta and 14665 data from Jadavpur University. The collected data were analyzed using Bib-excel, R-studio, according to objectives and some scientometric indicators. The downloaded data was placed into an excel sheet for analysis and tabulation following the study's objectives. The formula was used to calculate the Relative Growth Rate (RGR) and Doubling Time (Dt); Degree of Collaboration (DC); Collaborative Index (CI); and Collaborative Coefficient (CC).

REVIEW OF LITERATURE

We have found some related studies, carried out a study on scientometric analysis of publication output of Tumkur University faculty. A total of 646 records have been retrieved from the Scopus database during 2005-2019. The researcher found that the maximum number of publications (116) was published in the year 2015. Prof. S.C. Sharma, the former Vice-Chancellor, has the highest received citations, (Keshava *et al*., 2020). Conducted a scientometric study on authorship and collaboration pattern of research output published by researchers of Tripura University during 2010-2019. The data was collected from Web of Science databases and found that the total 503 papers published during this study period index in the web of science database, (Das & Verma, 2020). Revealed the growth of research literature produced by AIIMS from 2007 to 2016. A total of 14410 records were retrieved from the Scopus database. This researcher identified the top 20 most preferred journals by the faculties of AIIMS, (Nishavathi & Jeyshankar, 2018). Examined on oceanography research in Web of Science. The study focused on various aspects of Oceanography Research, such as the growth of publications, prolific authors, document types, and so on, (Rahaman *et al*., 2020). Studied the research output of SP Pune University which can be consulted mainly to get the information about getting research output for the period during 1990-2014, (Nagarkar & Kengar, 2017). Examines on scientometric analysis of the research Output of Biochemistry, Genetics and Molecular Biology of Gujarat University, total number of 400 documents from 1980-2018 and downloaded from Scopus indexed, (Jignesh & Yogesh, 2019). Examines on research productivity of AIIMS indexed in Scopus from 2007 to 2016. The researcher observed of this study exhibits that AIIMS plays a vital role in reducing the disease burden of India through quantitative and qualitative research publications, (Nishavathi & Jeyshankar, 2018).

RESULTS AND DISCUSSION

Table 1 provides year-wise distribution of articles of the University of Calcutta and Jadavpur University. Total 10856 and 14669 articles were from the Web of Science database during the study period 2002-2021. It is seen from table 1 that 210 (1.93%) and 280 (1.91%) articles are published by C.U. and J.U., both the universities' publications increasing gradually. The maximum number of publications published by C.U. and J.U. are 947 (8.72%) and 1135 (7.74%) in 2020. The University of Calcutta average number of papers per year is 543 during the year 2002-2021, and 733 is the average number of documents during the study 2002-2021 of Jadavpur University.

Table 1: Year-wise distribution of University of Calcutta and Jadavpur University research output

Publication Year	No. of Publication		%	
	C.U.	J.U.	C.U.	J.U.
2002	210	280	1.93	1.91
2003	221	363	2.04	2.47
2004	246	407	2.27	2.77
2005	248	436	2.28	2.97
2006	285	504	2.63	3.44
2007	342	554	3.15	3.78
2008	370	620	3.41	4.23
2009	461	714	4.25	4.87
2010	455	670	4.19	4.57
2011	583	742	5.37	5.06
2012	630	779	5.80	5.31
2013	713	840	6.57	5.73
2014	771	911	7.10	6.21
2015	779	968	7.18	6.60
2016	785	988	7.23	6.74
2017	823	1000	7.58	6.82
2018	779	1093	7.18	7.45
2019	823	1130	7.58	7.70
2020	947	1135	8.72	7.74
2021	385	535	3.55	3.65
Grand Total	**10856**	**14669**	**100**	**100**

*CU= University of Calcutta, JU= Jadavpur University

Table 2: Most Productive Authors of University of Calcutta

Rank	Author name	No. of publication	%	Total citation	*h*-index
1	Ghosh S	653	6.02	7582	42
2	Ghosh A	422	3.89	8725	50
3	Das S	382	3.52	4611	33
4	Sarkar S	272	2.51	6648	28
5	Chattopadhyay S	271	2.50	4986	38
6	Das D	256	2.36	3614	30
7	Das A	248	2.29	2602	25
8	Mukherjee A	243	2.24	4085	34
9	Guchhait N	222	2.05	4032	33
10	Bhattacharyya A	220	2.03	2841	31

Table 3: Most Productive Authors of Jadavpur University

Rank	Author name	No. of publication	%	Total citation	*h*-index
1	Das S	957	6.53	22006	65
2	Ghosh S	560	3.82	10534	50
3	Chakraborty S	543	3.7	7767	40
4	Ghosh D	369	2.52	7875	31
5	Sarkar S	362	2.47	9260	40
6	Roy K	339	2.31	9253	43
7	Chattopadhyay KK	337	2.3	8004	41
8	Roy S	337	2.3	4797	33
9	Bhattacharya S	307	2.09	4768	36
10	Ghosh A	301	2.05	4795	34

Table 2 indicates the top ten authors written from 2002 to 2021 of University of Calcutta from the Web of Science database. While analyzing the data 62573 authors have produced 10851 articles. It shows that the author Ghosh S has published 653 (6.02%) articles. Out of 7582 total citations and 42 *h*-index values are topmost research productivity of C.U. research output, followed by the author Ghosh A. The second in rank has published 422 (3.89%) articles and 50 *h*-index values; followed by the author Das S, third in position, has published 382 (3.52%) articles and 33 *h*-index values.

Table 3 highlights the top ten authors written during 2002 to 2021 of Jadavpur University. While analyzing the data 65784 authors have produced 14665 articles. It is found that Das S is the most prolific author of J.U. with 957 (6.53%) articles, 22006 citations, and 65 *h*-index value. The author Ghosh S Second in Rank has published 560 (3.82%) articles with 50 *h*-index value, and Chakraborty S third in rank has published 543 (3.70%) articles with 40 *h*-index values.

Table 4 shows the top 10 journals preferred by the researchers of the University of Calcutta. The journal of "Journal of the Indian Chemical Society" has published 227(2.09%) articles, total citation 348 with 0.12 RCI and 8 *h*-index value dominate 1st rank of research output of C.U. The journal of "RSC Advances" has 194 (1.79%) articles, total citations 2771 with 1.08 RCI and 28 *h*-index and occupies 2nd rank of the publications. The journal of "Polyhedron" has 124 (1.14%) papers, 2802 total citations, and 31 *h*-index, and it stood in 3rd rank of the publications. "Physical Review D" had the highest impact factor among all journals given in the table.

Table 5 shows which journals are preferred mainly by the researchers of Jadavpur University. According to Table 5, "Polyhedron" is the highly preferred research journal at Jadavpur University. Jadavpur University produced 14665 publications during the study period; the journal "Polyhedron" has published 284 (1.94%) articles, 5648(2.25%) total citations with 1.16 RCI and 36 *h*-index values. "RSC Advances" and "Inorganic Chemica ACTA" are in the 2nd and 3rd rank of the preferred publication

Table 4: Journals Preferred by the Authors of University of Calcutta

Journal Name	Records	Total Citation	CPP	RCI	*h*-index	If
Journal of the Indian Chemical Society	227(2.09)	348(0.24)	1.53	0.12	8	0.284
RSC Advances	194(1.79)	2771(1.93)	14.28	1.08	28	3.361
Polyhedron	124(1.14	2802(1.95)	22.60	1.71	31	2.108
Current Science	121(1.11)	406(0.28)	3.36	0.25	10	1.102
Physical Review D	90(0.83)	1429(0.99)	15.88	1.20	24	5.296
Inorganic Chemica ACTA	87(0.80)	1750(1.22)	20.11	1.52	24	2.046
Journal of Applied Polymer Science	85(0.78)	1184(0.82)	13.93	1.05	18	3.125
Dalton Transactions	76(0.70)	1938(1.35)	25.50	1.92	27	4.052
Journal of Applied Physics	73(0.67)	855(0.59)	11.71	0.88	17	2.546
New Journal of Chemistry	73(0.67)	660(0.46)	9.04	0.68	15	3.591
Sub-Total	1150(10.59	14143(9.83)	12.30	0.93	-	-
Others	9706(89.41)	129728(90.17)	13.37	1.01	-	-
Total	10856	143871	13.25	1.00	-	-

*CPP= Citation per paper, RCI= Relative citation impact, If= Impact factor

Table 5: Journals Preferred by the Authors of Jadavpur University

Journal Name	Records	T C	CPP	RCI	*h*-index	If
Polyhedron	284(1.94)	5648(2.25)	19.89	1.16	36	2.108
RSC Advances	222(1.51)	3787(1.51)	17.06	1.00	29	3.361
Inorganic Chemica ACTA	172(1.17)	2788(1.11)	16.21	0.95	30	2.046
Journal of the Indian Chemical Society	165(1.12)	279(0.11)	1.69	0.10	6	0.284
Dalton Transactions	154(1.05)	3685(1.47)	23.93	1.40	35	4.052
New Journal of Chemistry	148(1.01)	1678(0.67)	11.34	0.66	20	3.591
Journal of Molecular Structure	101(0.69)	912(0.36)	9.03	0.53	16	2.011
International Journal of Advanced Manufacturing Technology	99(0.67)	2774(1.11)	28.02	1.64	30	3.226
Inorganic Chemistry	96(0.65)	4085(1.63)	42.55	2.49	40	5.165
Indian Journal of Physics	85(058)	240(0.10)	2.82	0.17	8	1.407
Sub-Total	1526(10.40)	25876(10.32)	16.96	0.99		
Others	13143(89.40)	224854(89.68)	17.11	1.00		
Total	14669	250730	17.09	1.00		

*CPP= Citation per paper, RCI= Relative citation impact, If= Impact factor

with 222 (1.51%) and 172 (1.17%) articles, respectively. These journals are also high-quality, where "RSC Advances" received 3787 total citations with 29 *h*-index, while "Inorganic Chemica ACTA" received 2788 total citations with 30 *h*-index values. Among all the journals given in the table "Dalton Transactions" had the highest impact factor.

Table 6 shows the Exponential Growth Rate of the publications published by the University of Calcutta and Jadavpur University research scientists. During the study of 20 years (2002-21), the highest growth rate of the University of Calcutta was found 0.25 with 583 publications during the year 2011, and the lowest growth rate -0.51 was found in the year 2021. In the case of Jadavpur University, the maximum growth rate was 0.26 in 2003 with 363 publications, and the minimum growth rate was found -0.39 in the year 2021 with 700 publications.

Table 7 shows the Degree of Collaboration of the University of Calcutta and Jadavpur University. The Degree of Collaboration during the 20 years (2002-21) of the University of Calcutta and Jadavpur University is 0.95 and 0.97. The University of Calcutta published 512 single-authored papers, and multi-authored papers were 10339 during the study period. The highest value of D.C. of the University of Calcutta is 0.84 among three authored articles. The lowest value of D.C. is 0.31 among nine-authored papers.

Table 6: Exponential Growth Rates of University of Calcutta and Jadavpur University

Year	No. of Records		Exponential Growth Rate	
	C.U.	J.U.	C.U.	J.U.
2002	210	280	-	-
2003	221	363	0.05	0.26
2004	246	407	0.11	0.11
2005	248	436	0.01	0.07
2006	285	504	0.14	0.14
2007	342	554	0.18	0.09
2008	370	620	0.08	0.11
2009	459	713	0.22	0.14
2010	455	670	-0.01	-0.06
2011	583	742	0.25	0.10
2012	630	779	0.08	0.05
2013	712	840	0.12	0.08
2014	771	911	0.08	0.08
2015	778	968	0.01	0.06
2016	784	988	0.01	0.02
2017	823	1000	0.05	0.01
2018	777	1092	-0.06	0.09
2019	762	1064	-0.02	-0.03
2020	873	1034	0.14	-0.03
2021	522	700	-0.51	-0.39

Cu= University of Calcutta, JU= Jadavpur University

Table 7: Degree of Collaboration of University of Calcutta and Jadavpur University

Pattern	C.U.		J.U.	
	Records	D.C.	Records	D.C.
Single-Authored	512		461	
Two-Authored	2316	**0.82**	2445	**0.84**
Three-Authored	2597	**0.84**	3870	**0.89**
Four-Authored	1825	**0.78**	2981	**0.87**
Five-Authored	1184	**0.70**	2041	**0.82**
Six-Authored	811	**0.61**	1242	**0.73**
Seven-Authored	595	**0.54**	688	**0.60**
Eight-Authored	337	**0.40**	427	**0.48**
Nine-Authored	230	**0.31**	215	**0.32**
Above Ten-Authored	444	**0.46**	295	**0.39**
Total	10851	**NIL**	14665	**NIL**
N.M	10339	**NIL**	14204	**NIL**
D.C Mean	0.95	**NIL**	0.97	**NIL**

Cu= University of Calcutta, JU= Jadavpur University

The same thing shows for the D.C. of Jadavpur University. The maximum value of D.C. found among three-authored papers was 0.89, followed by four-authored papers 0.87, and the minimum value of D.C. is 0.32 among nine authored documents.

Table 8 analyses the year-wise authorship pattern of the University of Calcutta and Jadavpur University during the study period for the year 2002-21. It has observed from Table 8 that University of Calcutta research scientists produces the maximum number of research paper published by more than five authors 3601 (33.19%) and followed by three authors 2597 (23.93%), and the minimum number of research paper published by Single author paper 512 (4.72%). In the case of Jadavpur University, research papers were published by more than five authors 4908 (33.47%), followed by three authors 3870 (26.39%) and the lowest number of research papers published by a single author 461 (3.14%). It finds from the study that both the universities published the majority of research work produced by multi- authors.

Table 9 analyses the Annual Growth Rate (AGR) of publication of the University of Calcutta and Jadavpur University during the study period 2002-2021. The University of Calcutta's highest 28.13 AGR was recorded in 2011, followed by 20.00 AGR in 2007, and the lowest AGR of the University of Calcutta is -40.21 in 2021. In the case of Jadavpur University, the maximum AGR 29.64 was found in the year 2003. It is inferred from this study, 15.00 AGR in the year 2009 and the minimum AGR -32.30 are recorded in the year 2021.

The Annual Growth Rate (AGR) calculates by the given formula –AGR=

$$\text{AGR} = \frac{\text{END VALUE} - \text{FIRST VALUE}}{\text{FIRST VALUE}} \times 100$$

Table 10 gives information about the value of the Collaborative index and Collaborative co-efficient of the University of Calcutta and Jadavpur University. The highest C.I. value of C.U. was 3.80 in the year 2019, followed by 3.77 C. I. value in 2020, in the year 2005, 2009, and 2011; the C.I. value is the same (3.37). The year 2002 was the lowest value of C.I. i.e., 3.00 University of Calcutta maximum C.C value was 0.69 in 2019, followed by 0.68 C.C values in 2018 and 2020. The C.C (0.67) values are also the same in 2015, 2016, 2017, and 2021. The minimum C.C value was 0.59 in 2002. In the case of Jadavpur University, the maximum value of C.I. 3.83 was found in 2019, 2020, and 3.79 C. I. value in the year 2020. The lowest C.I. value was 3.22 in the year 2003. The C.C. 0.70(highest) value of J.U. was found in 2017, 2018, 2019, 2020, and 2021, and the lowest C.C 0.62 value was found from the table in 2003.

Table 8: Year-wise Authorship Pattern of University of Calcutta and Jadavpur University

Year	1		2		3		4		> 5		Total		%	
	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.
2002	15	14	79	63	42	81	38	65	36	57	210	280	1.94	1.91
2003	17	29	72	87	61	101	31	68	40	78	221	363	2.04	2.48
2004	18	21	61	90	67	123	40	66	60	107	246	407	2.27	2.78
2005	19	22	54	92	55	120	56	91	64	111	248	436	2.29	2.97
2006	14	16	77	102	69	143	35	98	90	145	285	504	2.63	3.44
2007	18	17	97	84	71	151	63	117	93	185	342	554	3.15	3.78
2008	21	22	101	118	85	186	54	119	109	175	370	620	3.41	4.23
2009	26	38	111	138	123	192	66	143	133	202	459	713	4.23	4.86
2010	30	21	99	137	121	147	78	163	127	202	455	670	4.19	4.57
2011	38	30	138	114	141	196	101	184	165	218	583	742	5.37	5.06
2012	25	27	140	140	170	198	116	175	179	239	630	779	5.81	5.31
2013	27	24	186	150	175	233	112	168	212	265	712	840	6.56	5.73
2014	38	27	169	151	179	240	135	198	250	295	771	911	7.11	6.21
2015	27	28	160	145	196	263	138	183	257	349	778	968	7.17	6.6
2016	41	24	142	144	180	268	123	207	298	345	784	988	7.23	6.74
2017	31	18	159	141	178	254	140	221	315	366	823	1000	7.58	6.82
2018	26	20	136	157	166	258	150	213	299	444	777	1092	7.16	7.45
2019	24	29	111	134	181	266	122	193	324	442	762	1064	7.02	7.26
2020	36	23	128	149	194	257	154	193	361	412	873	1034	8.05	7.05
2021	21	11	96	109	143	193	74	116	189	271	522	700	4.81	4.77
Total	**512**	**461**	**2316**	**2445**	**2597**	**3870**	**1825**	**2981**	**3601**	**4908**	**10851**	**14665**	**100**	**100**
%	4.72	3.14	21.34	16.67	23.93	26.39	16.82	20.33	33.19	33.47	NIL	NIL	NIL	NIL

Table 9: Annual Growth Rate of University of Calcutta and Jadavpur University

Year	No. of Records		Annual Growth Rate	
	C.U.	J.U.	C.U.	J.U.
2002	210	280	-	-
2003	221	363	5.24	29.64
2004	246	407	11.31	12.12
2005	248	436	0.81	7.13
2006	285	504	14.92	15.60
2007	342	554	20.00	9.92
2008	370	620	8.19	11.91
2009	459	713	24.05	15.00
2010	455	670	-0.87	-6.03
2011	583	742	28.13	10.75
2012	630	779	8.06	4.99
2013	712	840	13.02	7.83
2014	771	911	8.29	8.45
2015	778	968	0.91	6.26
2016	784	988	0.77	2.07
2017	823	1000	4.97	1.21
2018	777	1092	-5.59	9.20
2019	762	1064	-1.93	-2.56
2020	873	1034	14.57	-2.82
2021	522	700	-40.21	-32.30

Time Series

Time Series analysis is done for making a future prediction with the help of observed facts. For future projection, the straight line equation is applied under Time Series Analysis.

Straight line equation

$$Yc = a+bX$$

$$a= \sum y/N = 543$$

$$b= \sum XY/\sum X\ 2 = 33$$

Estimated literature in 2025 is when X = 2025-2011= 14 = 1004

Estimated literature in 2030 is when X = 2030-2011= 19 = 1169

On the applications of the formula of time series analysis, and subsequently from the research obtained separately for 2025 and 2030. The predicted value of the University of Calcutta literature output for 2025 is 1004, and the 1169 predicted literature value for 2030. There is a positive growth in research output in the University of Calcutta publications.

Table 10: Year wise Collaborative Indices of University of Calcutta and Jadavpur University

Year	1		2		3		4		> 5		Total		C.I		C.C	
	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.	C.U.	J.U.
2002	15	14	79	63	42	81	38	65	36	57	**210**	**280**	**3.00**	**3.31**	**0.59**	**0.64**
2003	17	29	72	87	61	101	31	68	40	78	**221**	**363**	**3.02**	**3.22**	**0.60**	**0.62**
2004	18	21	61	90	67	123	40	66	60	107	**246**	**407**	**3.26**	**3.36**	**0.62**	**0.64**
2005	19	22	54	92	55	120	56	91	64	111	**248**	**436**	**3.37**	**3.41**	**0.63**	**0.65**
2006	14	16	77	102	69	143	35	98	90	145	**285**	**504**	**3.39**	**3.50**	**0.64**	**0.67**
2007	18	17	97	84	71	151	63	117	93	185	**342**	**554**	**3.34**	**3.67**	**0.64**	**0.68**
2008	21	22	101	118	85	186	54	119	109	175	**370**	**620**	**3.35**	**3.50**	**0.63**	**0.66**
2009	26	38	111	138	123	192	66	143	133	202	**459**	**713**	**3.37**	**3.47**	**0.64**	**0.65**
2010	30	21	99	137	121	147	78	163	127	202	**455**	**670**	**3.38**	**3.58**	**0.64**	**0.67**
2011	38	30	138	114	141	196	101	184	165	218	**583**	**742**	**3.37**	**3.60**	**0.64**	**0.67**
2012	25	27	140	140	170	198	116	175	179	239	**630**	**779**	**3.45**	**3.59**	**0.66**	**0.67**
2013	27	24	186	150	175	233	112	168	212	265	**712**	**840**	**3.42**	**3.60**	**0.65**	**0.68**
2014	38	27	169	151	179	240	135	198	250	295	**771**	**911**	**3.51**	**3.64**	**0.66**	**0.68**
2015	27	28	160	145	196	263	138	183	257	349	**778**	**968**	**3.56**	**3.70**	**0.67**	**0.69**
2016	41	24	142	144	180	268	123	207	298	345	**784**	**988**	**3.63**	**3.71**	**0.67**	**0.69**
2017	31	18	159	141	178	254	140	221	315	366	**823**	**1000**	**3.67**	**3.78**	**0.67**	**0.70**
2018	26	20	136	157	166	258	150	213	299	444	**777**	**1092**	**3.72**	**3.83**	**0.68**	**0.70**
2019	24	29	111	134	181	266	122	193	324	442	**762**	**1064**	**3.80**	**3.83**	**0.69**	**0.70**
2020	36	23	128	149	194	257	154	193	361	412	**873**	**1034**	**3.77**	**3.79**	**0.68**	**0.70**
2021	21	11	96	109	143	193	74	116	188	271	**522**	**700**	**3.60**	**3.75**	**0.67**	**0.70**
Total	**512**	**461**	**2316**	2445	2597	3870	1825	2981	1183	4908	10851	14665	3.45	3.59	0.65	0.67

Table 11: Time Series Analysis of University of Calcutta

Year	Articles (Y)	X	X2	X*Y	Trend Value
2002	210	-10	100	-2100	213
2003	221	-9	81	-1989	246
2004	246	-8	64	-1968	279
2005	248	-7	49	-1736	312
2006	285	-6	36	-1710	345
2007	342	-5	25	-1710	378
2008	370	-4	16	-1480	411
2009	459	-3	9	-1377	444
2010	455	-2	4	-910	477
2011	583	-1	1	-583	510
2012	630	1	1	630	576
2013	712	2	4	1424	608
2014	771	3	9	2313	641
2015	778	4	16	3112	674
2016	784	5	25	3920	707
2017	823	6	36	4938	740
2018	777	7	49	5439	773
2019	762	8	64	6096	806
2020	873	9	81	7857	839
2021	522	10	100	5220	872
2025	-	14	-	-	1004
2030	-	19	-	-	1169
	10851	0	770	25386	

Table 12: Time Series Analysis of Jadavpur University

Year	Articles (Y)	X	X2	X*Y	Trend Value
2002	280	-10	100	-2800	375
2003	363	-9	81	-3267	411
2004	407	-8	64	-3256	447
2005	436	-7	49	-3052	482
2006	504	-6	36	-3024	518
2007	554	-5	25	-2770	554
2008	620	-4	16	-2480	590
2009	713	-3	9	-2139	626
2010	670	-2	4	-1340	662
2011	742	-1	1	-742	697
2012	779	1	1	779	769
2013	840	2	4	1680	805
2014	911	3	9	2733	841
2015	968	4	16	3872	877
2016	988	5	25	4940	912
2017	1000	6	36	6000	948
2018	1092	7	49	7644	984
2019	1064	8	64	8512	1020
2020	1034	9	81	9306	1056
2021	700	10	100	7000	1092
2025	-	14	-	-	1235
2030	-	19	-	-	1414
	14665	0	770	27596	-

Table 13: Research Area-wise Distribution of University of Calcutta and Jadavpur University

Research Area (CU)	Records	% of 10851	Research Area (JU)	Records	% of 14665
Chemistry	2693	24.82	Chemistry	4155	28.33
Physics	1972	18.17	Engineering	3051	20.80
Engineering	1199	11.05	Physics	2794	19.05
Materials Science	811	7.47	Materials Science	1815	12.38
Biochemistry & Molecular Biology	721	6.64	Computer Science	1100	7.50
Science & Technology - Other Topics	712	6.56	Pharmacology & Pharmacy	874	5.96
Environmental Sciences & Ecology	619	5.70	Science & Technology - Other Topics	817	5.57
Mathematics	478	4.41	Environmental Sciences & Ecology	563	3.84
Optics	428	3.94	Crystallography	548	3.74
Plant Sciences	366	3.37	Mathematics	528	3.60

Straight line equation

$$Yc = a+bX$$

$$a= \sum y/N = 733$$

$$b= \sum XY/\sum X\ 2 = 36$$

Estimated literature in 2025 is when X = 2025-2011= 14 = 1235

Estimated literature in 2030 is when X = 2030-2011= 19 = 1414

It is found that the future growth in publication productivity of Jadavpur University has increased over the years. The research output in the year 2025 is 1235 and 2030 is 1414. The presumption is that there is a positive trend in the growth of research productivity of Jadavpur University.

Table 13 shows the top ten research areas of both universities. Chemistry is the most productive department with 2693 (24.82%) publications of University of Calcutta, followed by Physics with 1972 (1.17%), Engineering -1199 (11.05%), Materials Science – 811 (7.47%), Biochemistry & Molecular Biology – 721 (6.64%). In the case of Jadavpur University, the leading subject is Chemistry with 4155 (28.33%) publications, Engineering – 3051 (20.80%), with Physics – 2794 (19.05%), Materials Science – 1815 (12.38%), Computer Science – 1100 (7.50%), etc.

Organization of University of Calcutta and Jadavpur University

Figure 1 depicts the visualization of the distribution of institutes. It should be noted that the frequency analysis was based on a total of 5812 institutes. A network consisting of items 15, cluster 2, links 105, and total link strength 2051 on behalf of the collaborating countries between 2002 and 2021 from University of Calcutta. Whereas Jadavpur University collaborated with 4940 organizations, A network consisting of items 15, cluster 4, links

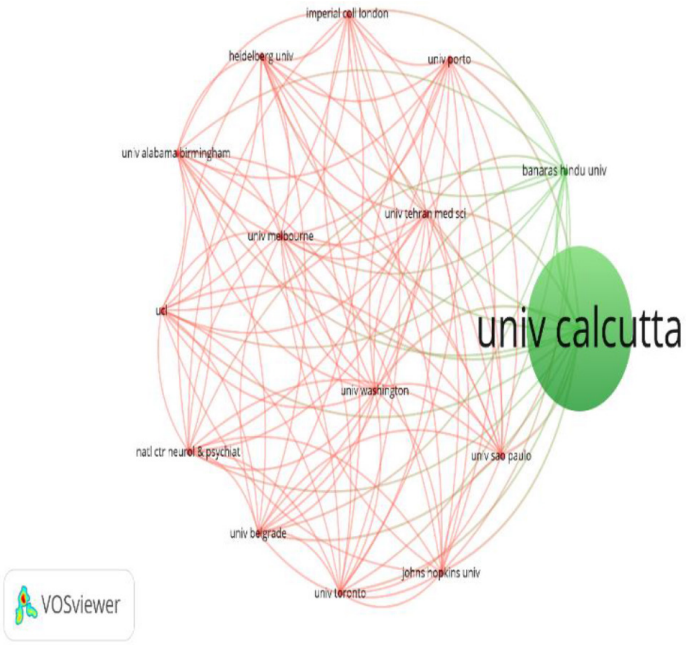

Figure 1: Co-authorship organization of University of Calcutta

105, and total link strength 1920 (see Figure 2) on behalf of the collaborating countries between 2002 and 2021.

Country Collaboration of University of Calcutta and Jadavpur University

A network consisting of 133 countries collaborated, items 15, cluster 2, links 105, and total link strength 5374 on behalf of the collaborating countries between 2002 and 2021 from University of Calcutta was shown in Figure 3. The significant contribution of the total output mainly came from 15 countries out of 133 countries. The frequency distribution of papers indicates that India is the most significant contributor to publishing 10834 papers. Jadavpur University has collaborated on a network consisting of 133 countries, items 15, cluster 7, links 105, and

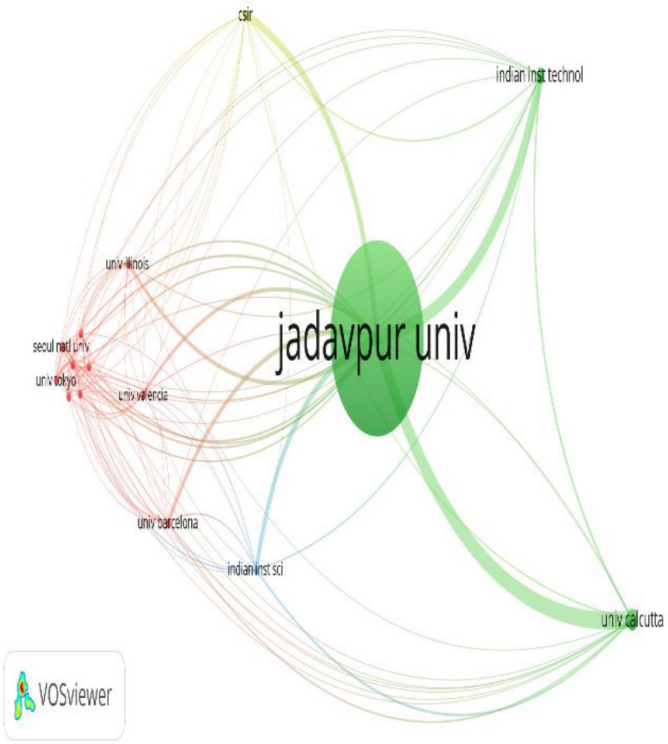

Figure 2: Co-authorship organization of Jadavpur University

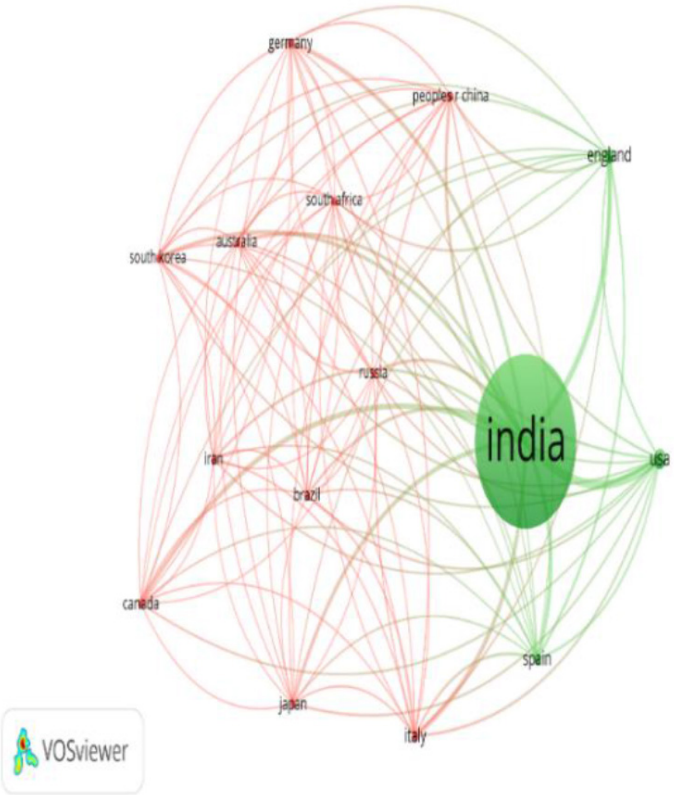

Figure 3: Co-authorship country of University of Calcutta

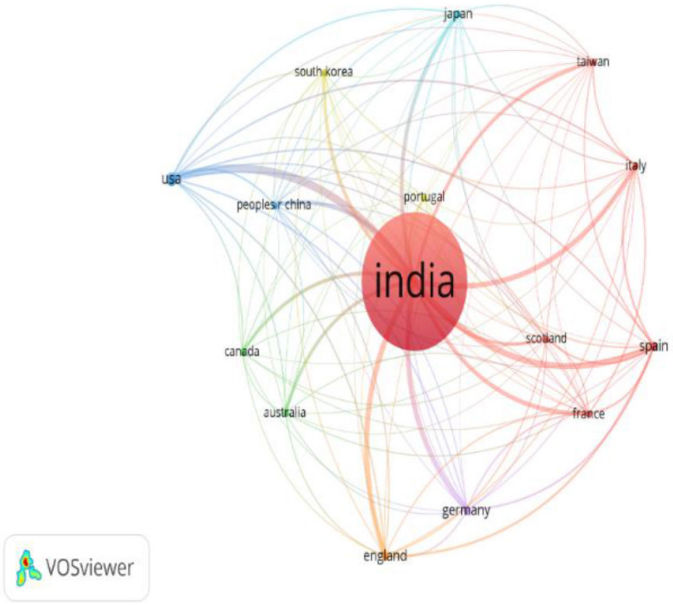

Figure 4: Co-authorship country Jadavpur University

total link strength 4160 on behalf of the collaborating countries between 2002 and 2021, Figure 4.

CONCLUSION

The present study presents a scientometric analysis of 2002–2021 from the selected two Indian universities. Most of the publications had come in an article form with an increasing number of publications as time proceeded. The study found the citation pattern also follows the general trends, e.g., the number of citations increases as the number of authors increases or multi-authored papers get more citations. The researcher also found that most of the highly cited papers came from the science field. The country of India is at the top collaborating for both the universities and journal articles, proceeding papers and review are the most favourite mode of communication. The most favourite subjects for both the universities are chemistry, physics, engineering, mathematics, and arts & humanities.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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