Visualizing the Research Performance of Jadavpur University during 2012-2021: A Scientometric Analysis

Ziaur Rahman[1] and Sk Sofik[2]

[1]Assistant Professor, Department of Library and Information Science, Rabindra Bharati University, 56A, BT Road, Kolkata,-700050 West Bengal, India, E-mail- ziaur.rahman@rbu.ac.in   ORCID ID – https://orcid.org/0000-0002-3393-8690 Mobile No: +91 9434890165

[2]Research Scholar, Department of Library and Information Science, Rabindra Bharati University, 56A, BT Road, Kolkata, -700050. West Bengal, India, E-mail- sofikrbu@gmail.com ORCID ID – https://orcid.org/0000-0003-0544-2038

Abstract:
The purpose of this study is to systematically analyze the development and trends in the scientific production and collaborative pattern of Jadavpur University (JU) faculties between 2012 and 2021. The study obtained data from the Web of Science Core Collection (WoSCC) and it employed Biblioshiny, Histcite, CiteSpace V, and ScientoPy tools to convert, process, visualize, mapping and evaluate the selected dataset. The review has been conducted applying Scientometric approach to recognize the research paper publication citations, prolific author's linkage and collaborations, preferred journals for research publishing, frequently used author keywords and co-occurrence network, subject distribution, citation bursts, as well as trend topics investigated. The collaborations amongst the leading research organizations and groups are also investigated with co-citation and keywords co-occurrence analysis. The results showed the production of JU research and pattern of scholarly communication has risen significantly over the past ten years and has made a significant contribution to the scientific community. Das S., Ghosh S., and Chakraborty S. were observed to be relevant authors in this University. National level collaboration with the USA, England, and Spain

was observed. 'RSC Advances,' 'Polyhedron,' and 'New Journal of Chemistry' were found the most influential. This research can assist in mapping the research output of universities and other educational institutions and make a paradigm for future studies of publication trends and academic performance.

Keywords: Scientometrics; Scientific literature; Collaborations; co-occurrence network; Citation bursts; Jadavpur University.

Introduction

Jadavpur University is a world-renowned university in India located in Kolkata. Led by intellectuals, government officials, and middle-class intellectuals, the aim was to advance global education and technology to create an independent industrial base in India. The Bengal Technical Institute was one of the educational institutions established by the NCE, Bengal. The Institute, later renamed the College of Engineering and Technology, was transformed into Jadavpur University in 1955 with a global vision and a commitment to building leaders who will build a humane and just world. The highest quality research has been conducted at the University of Jadavpur since its inception, and research in various fields is one of its pillars. Research in any field or discipline at a university is kept in mind with the latest developments worldwide. This is mainly due to the power of the university liaison, which includes its decade-long position as the Ryoichi Sasakawa Young Leaders Fellowship Fund (SYLFF), its Erasmus Mundus exchange program leading Indo-EU consortium to improve undergraduate education in India, among others. It was also the first University in India to be accredited by the Nippon Foundation, a Japanese charitable organization, in accepting research conducted in all its social sciences and humanities departments,

Jadavpur University occupies the 18th ranking among all Indian higher educational institutions in World University Rankings 2021/22 in the Centre for World University Ranking (CWUR); Jadavpur University secured the third position state universities in the country in the Times Higher Education Asia University Rankings 2021. The JU topped the list of all state universities in the eastern region in the same ranking which was published.

The JU was also among the top 22 Indian institutions in the London-based QS (Quacquerelli Symonds) Ranking 2022. The QS Ranking secured the second spot among all the state universities in India and the rest in the eastern region. The National Institutional Ranking Framework (NIRF) got ranked at 17 among engineering institutes in India in 2021, 14 overall, and 8th among universities. It is recognized as one of the top Universities for the UGC's prestigious program, 'University with Potential of Excellence (UPE).'

The research production of the JU researcher community is considered one of the key indicators of measuring the performance of university scholars, as research is an essential function of developing new ideas, events, and facts in any field of gaps and closure. Research production supports the upliftment and

level of any institution or organization. Therefore, the purpose of the following study is believed to include the functioning and participation of the JU research community from 2012 to 2021. In addition, the study aimed to draw a more reliable picture of JU's contribution to research. The prime aim is to identify the development and growth of the JU research product based on data collected from the Web Science core collection (WoS). The scientometric analysis is considered a broad way to investigate research productivity; therefore, it adopted this approach to identify the JU research product.

Literature Review

Review of related literature is essential for a new research topic; study of related literature impels locating, reading, and evaluating of research as well as a report of casual observation and opinion related to the individuals' planted research work (Das & Mondal, 2021) [1] analyzed referencing is a most important part of every research work. This work has been done to find out the referencing style of the doctoral dissertation under the Faculty of Arts of Jadavpur University. This study has shown how many researchers follow which reference guideline to display citation and which one is the most popular. (Bid & Mandal, 2021) [2] attempt to compare the contribution of two state universities of West Bengal, i.e., University of Burdwan (BU) and University of Kalyani (KU), under different parameters like publication size, authorship pattern, degree of collaboration, Subject, language, geographical distribution during the period 2000 to 2019 (20 years) by using Web of Science as a source database. The study revealed that both the universities have almost similar authorship patterns, citation distribution and prefer to publish articles in journals. (Mahala & Singh, 2021) [3] analyzed the science research output of top Indian universities from 2015 to 2019, as reflected in the Web of Science (WOS) database. The WOS core collection's Science Citation Index (SCI) selected top Indian universities in total publications in the last five years (2015–2019). The University of Delhi (DU), Banaras Hindu University (BHU), Anna University (AU), Jadavpur University (JU), and Punjab University (PU) have been selected. The study identified the most prolific authors, collaborating countries, collaborating institutions, and their output regarding citations per paper (CPP) and relative citation impact (RCI). (Magid et al., 2021) [4] explores the systematic analysis of the development and trends in scientific literature production and collaboration pattern of Imam Abdulrahman Bin Faisal University (IAU) between 2010 to 2020, as the research productivity is one of the evaluation parameters of universities' performance. The work tackled the production of the annual scientific research paper, prolific authors, collaborations, most relevant sources, frequently used keywords, topic distribution, research fronts, and research trends. The collaborations amongst the leading research organizations and groups were investigated with co-citation and keywords co-occurrence analysis. (Ahmad, Rahaman, Ansari, & Babel, 2020) [5] evaluate the research productivity of Banasthali University for a period of twenty-one years from

2000 to 2020. This study ventured to examine the overall performance of the faculties and researchers of Banasthali University in research productivity and publications. The study concerned with finding the year-wise distribution of the publications, author's keywords ID, period, average citations per document, top-ranked subjects, authors, most distinguished and productive author, author appearances, single-authored documents, multi-authored documents, top-ranked publications, co-authors per documents, co-authorship index, degree of collaboration based on the collected data and information gathered. (Kappi & Biradar, 2019) [6] discussed bibliometric assessment of scientific research output of the Kuvempu University, Shankaraghatta, Shivamogga, Karnataka (1990 – 2019). The data was collected from the Web of Science. The analysis includes the yearly output of research productivity. The study focuses on Author Productivity patterns, types of documents/records, individual author's research productivity, the geographical collaboration of authors (countries of contributing authors), and distribution of research output by language. (Kumar & Senthilkumar, 2019) [7] investigate the scientific research productivity of India's NIRF first ranked higher academic & research Institute, Indian Institute of Science (IISc), Bangalore for 05 years during 2014-2018. A total of 12,130 research papers were retrieved as SCIE publications from WoS bibliographical database and analyzed. The study is focused on finding out the year-wise institutional contribution in research, compound annual growth rate, areas of interest, collaborating institutions and countries, mode of publications, research funding agencies, prolific journals, prolific authors, authorship pattern, degree of collaborations, etc. (Mondal & Raychoudhury, 2017) [8] This study is to access the performance, trends and citation impact of research publications of faculty members of Jadavpur University. The study aims to trace out the research publications of faculty members and researchers of Jadavpur universities from 2006 to 2015, as reflected in the Web of Science (WOS) database. The Polyhedron journal has been found as the most preferred journal. Maximum articles have been published in Chemistry and Allied disciplines. The citations analysis has indicated that the research articles have received good citations, especially with international collaboration.(Teli & Dutta, 2016) [9] explores the growth of research output quantitatively in the Vidyasagar University this approach in terms of publication output as reflected in the web of science database over the years 1989 to 2014. The data was collected from the web of science database. The analysis highlights yearly output of research publications, publishing trend, authorship pattern, funding agencies, collaborating organizations, collaborating countries, most productive authors of the University, most preferred journals for publication, citation profile of the contributed papers, and the top-cited papers and authors of the University.

3. Objectives of the Study

The main objective of this study is to analyze the research performance of JU as reflected in the publication and citation output during 2012-2021. In particular, the study focuses on the following aspects

- To study the year-wise growth of publications and citations.
- To know the most prolific authors with more linkages and collaboration.
- To find out the level of collaboration at the national and international level with JU.
- To identify the preferred journals for research publishing.
- To identify Subject-wise distribution.
- To identify the highly influential research papers concerning citation and average citation per year by JU researchers.
- To recognize the most frequently used Authors keywords and Co-Occurrence network.
- To know the Keywords Citation Bursts in the research of JU.

4. Design/Methodology/Approach

The data has been collected from the web server of Clarivate Analytics, popularly known as Web of Science (WoS), a platform used by a wide range of scientific studies in bibliometrics. Wang, Pan, Ke, Wang, & Wei [10] and Gorraiz and Schloegl [11] .The most comprehensive scientific research website (the ISI System of Science Website) mostly covered all the necessary data regarding the bibliometric analysis. We mainly used the Web of Science core collection database to cover more than 20,300 journals, books, and conferences with over 71 million records [12].

The research publications data of Jadavpur University (IAU) was downloaded from the Web of Science Core Collection (WoSCC) as a CSV file (Plain text and Tab-delimited (Win, UTF-8) containing complete bibliographic records and citation information on 14th July 2021. The query for searching was: "ADDRESS: (Jadavpur University) OR ADDRESS: (University of Jadavpur) Timespan: 2012 -2021. Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI, CCREXPANDED, IC". Then restricted the search to JU documents indexed in Web of Science Core Collection (WoSCC), which resulted in 8,426 documents.

The study employed the Biblioshiny app specially designed for the Bibliometrix R package, Histcite, CiteSpace V, and a robust Java-based application ScientoPy, to convert, process, visualize, mapping and evaluate the selected dataset. Moreover, we utilized another java based apps VOSViewer, to provide some more complete visualization**.**

5. Result and Discussion

Based on the results of the collection of research articles of JU from 2012 to 2021, there are 8426 documents published by 1786 sources (journals, books, etc.), written by 6026 authors, 90 single-authored documents, and 5936 multi-authored documents affiliated with 2407 institutions and 47 countries. These

documents received 97271 total citations. Out of 8426 research output, 8160 of the publication were published in the form of the Article, Article; Proceeding Paper 130, Article; Early Access 78, Editorial Material 54, Article; Book Chapter 2, Article; Retracted Publication 1 and Editorial Material; Book Chapter 1.

5.1 Year-Wise Research Growth Trend

The number of published academic papers is an important indicator to measure the development trend of specific scientific research. Figure 1 shows the year-wise frequency of publications and citations published from 2012 to 2021. JU published a total of 8426 publications during 2012-2021, and these publications received 97271 citations. Figure 1 clearly outlines the gradual increase in the research productivity of JU. The highest number of articles (1049) was published in 2018. The data indicates that the JU research productivity and scholarly communication pattern have risen considerably in the last ten years and contributed much to the scientific community. The trend shows that the number of publications gradually increased, but the number of citations was decreased. However, fewer papers (69) in 2020 are because of the data collected on 14th July 2021. The maximum numbers of citations (15,751) were recorded for 2014, followed by 15,398 citations in 2012.
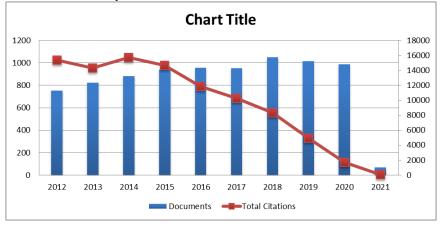

Figure 1: Publications and citations trends

Author Impact

In general, more than 6000 authors participated in research by JU from 2012 to 2021. Table 1 and Figure 2 highlights the top ten (10) most prolific authors of JU presented with total publications, total citations, Average citation per paper(ACPP), H Index, G Index, and Publication year start. The results show

that majority of the authors starting their publication in the year 2012. The list of most prolific authors shows that Das S. is the most productive author with 726 publications, 14502 citations, 19.98 ACPP, 55 H Index, and 96 G Index. The Author Ghosh S. listed 2nd rank with 343 publications, 4709 citations, 13.73 ACPP, 33 H Index and 49 G Index, followed by Chakraborty S. with 284 publications, 3290 citations, 11.58 ACPP, and 29 H and 44 G Index. Saha S. on the bottom of the list with 180 publications, 1552 citations, 8.62 ACPP, 20 H Index, 27 G Index.

Table 1: Most Relevant Author

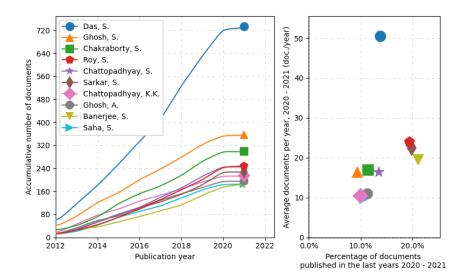| Author	NP	TC	ACPP	H Index	G Index	Publication Year Start
Das S	726	14502	19.98	55	96	2012
Ghosh S	343	4709	13.73	33	49	2012
Chakraborty S	284	3290	11.58	29	44	2013
Roy S	245	3160	12.90	27	44	2012
Chattopadhyay S	241	3152	13.08	29	35	2012
Sarkar S	215	2452	11.40	28	38	2012
Chattopadhyay KK	213	3340	15.68	30	45	2012
Ghosh A	190	2725	14.34	27	45	2014
Banerjee S	182	2111	11.60	22	36	2012
Saha S	180	1552	8.62	20	27	2013
NP- Number of Publication, TC- Total Citations, ACPP- Average Citation per Paper						

Figure 2: Author Impact

Author Collaboration

The network visualization of authorship in the research article of JU is shown in Figure 3. Each circle (or node) represents an author, and the size of the circle indicates the number of papers published. The link connecting two circles stands for the cooperative relationship between two authors, and the thickness of the link represents the intensity of cooperation. Of the 6,026 authors producing top articles by JU researchers, 1906 authors met the thresholds but connected only 33 authors. Circles denoting authors in the same cluster suggested that the authors studied in a similar field and had close cooperation. Among 33 clusters, the largest cluster in Figure 3 consisted of 53 authors (marked in red). The second cluster (green) consisted of 47 authors. The third cluster (blue) consisted of 36 authors.
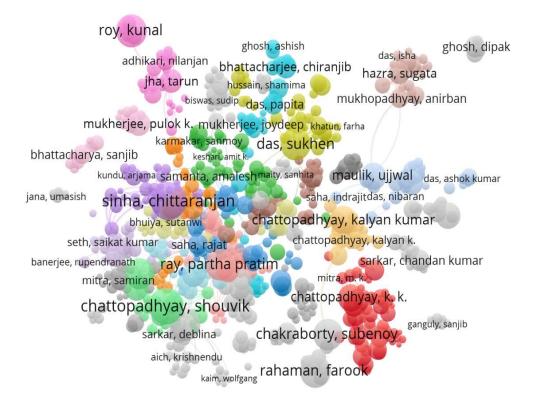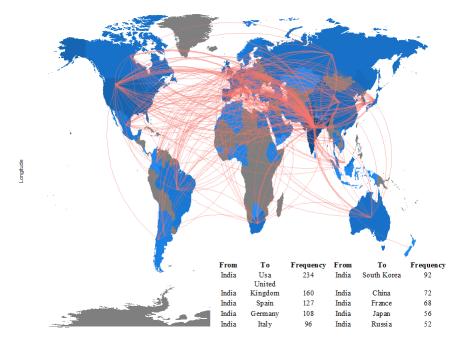
Figure 3: Author Collaboration

Country Collaboration

Table 2 and Figure 4 demonstrate the research collaborations of JU research scientists. The results show that the researcher's preference for collaborative work has extended to the national and international levels. National level collaboration (India) recorded highest for paper production 7037 papers, followed by the USA, the second highly collaborated country (234 papers), whereas collaboration with England (160 papers) is at 3rd place. The national collaboration recorded 76461 citations, followed by England (2456 citations), the USA (2214 citations), Spain (1922 citations), and Italy (1534 citations).

Table 2: Country Collaboration

Country	Documents	Citations	ACPP	Total Link Strength
India	7037	76461	10.87	8994
USA	234	2214	9.46	1432
England	160	2456	15.35	2122
Spain	127	1922	15.13	3230
Germany	108	1485	13.75	2058
Italy	96	1534	15.98	1131
South Korea	92	1072	11.65	546
China	72	858	11.92	308
France	68	639	9.40	519
Japan	56	585	10.45	421
ACPP- Average Citation per Paper				

From	To	Frequency	From	To	Frequency
India	Usa	234	India	South Korea	92
India	United Kingdom	160	India	China	72
India	Spain	127	India	France	68
India	Germany	108	India	Japan	56
India	Italy	96	India	Russia	52

Figure 4: Country Collaboration Map

Relevant Institutions

Table 3 presents the affiliation-wise productivity for the author at JU with selected some other international, regional, and national higher education institutions. More than 2407 institutions have contributed publications with JU. Table 3 shows the top 10 productive institutions and their relevant indicators. It is noticed that most of the organizations belong from India, and only one institution belongs to Spain. Results showed that the 'Jadavpur University (India) is at the top of the list with 6172 publications, 60213 citations, 9.76 ACPP, and total link strength of 7112. 'The University of Calcutta' (India) is at 2nd rank with 280 publications, 2709 citations, 9.68 ACPP, and Total link strength of 1282. 'Indian Institute Technology, Kharagpur' (India) on 3rd position with 191 publications, 3705 citations, 19.40 ACPP, and total link strength 798. 'Indian Institute of Chemical Biology (India) is at the bottom of the list with 57 publications, 1446 citations, 25.37 ACPP, and total link strength 606; and receiving the highest ACPP.

Table 3: Productive Research Institutions

Organization	Country	Documents	Citations	ACPP	Total Link Strength
Jadavpur University	India	6172	60213	9.76	7112
University of Calcutta	India	280	2709	9.68	1282
Indian Institute Technology, Kharagpur	India	191	3705	19.40	798
Indian Statistical Institute	India	139	3201	23.03	523
Indian Association for the Cultivation of Science	India	117	2189	18.70	877
Indian Institute of Engineering Science & Technology	India	106	1741	16.42	778
Council of Scientific and Industrial Research	India	96	1653	17.22	577
Aliah University	India	82	1343	16.38	1194
University of the Balearic Islands	Spain	68	1440	21.18	2219
Indian Institute of Chemical Biology	India	57	1446	25.37	606
ACPP- Average Citation per Paper					

Journal Wise Contribution to Publications

Journals have a prominent role as the main disseminators of knowledge. A total of 1786 journals published relevant researches from 2012 to 2021. The journal's impact regarding the number of publications, citations, ACPP, H Index, G Index, and starting publication year is highlighted in Table 4. It shows the journal "RSC Advances" is a highly influential journal producing a maximum of 213 publications, 3505 citations, 16.46 ACPP, 29 H Index, and 43 G Index. The "Polyhedron" is on 2nd rank with 165 publications, 2122 citations, 12.86 ACPP, 25 H Index, and 31 G Index; followed by "New Journal of Chemistry" with 127 publications, 1124 citations, 8.85 ACPP, 17 H Index, and 22 G Index. The "International Journal of Biological Macromolecules" is at the bottom of the list and has produced 48 publications, 608 citations, 12.66 ACPP, 14 H Index, and 22 G Index. The results show that majority of the Journals starting their publication in the year 2012. It was observed that the "Applied Soft Computing" has the highest ACPP (22.38) than the total listed journals.

Table 4: Source impact

Source	NP	TC	ACPP	H Index	G Index	PY Start
RSC Advances	213	3505	16.46	29	43	2012
Polyhedron	165	2122	12.86	25	31	2012
New Journal of Chemistry	127	1124	8.85	17	22	2013
Dalton Transactions	111	2210	19.91	28	38	2012
Journal of the Indian Chemical Society	89	93	1.04	4	5	2012
Inorganica Chimica Acta	86	904	10.51	16	23	2012
Chemistryselect	70	359	5.13	10	14	2016
Journal of Molecular Structure	69	491	7.12	12	16	2012
Crystengcomm	52	1070	20.58	18	31	2012
Applied Soft Computing	50	1119	22.38	21	32	2012
European Physical Journal C	50	935	18.70	17	28	2012
International Journal of Biological Macromolecules	48	608	12.66	14	22	2012
NP- Number of Publication, TC- Total Citations, ACPP- Average Citation per Paper						

Subject Categories Distribution

Figure 5 denotes the top 10 research areas comprised of JU researchers. It found that a large number of published papers by JU were profoundly distributed within the area of Chemistry (2460), Engineering (1830), Physics (1452), Materials Science (1130), Computer Science (655). On the right side, the figure represents each Subject's growth for the 2020–2021 period, and we see that the trending Subject with the highest absolute growth in Chemistry and Engineering. It's observed that the subject Computer Science growth has been an increase in the 2020–2021 period.
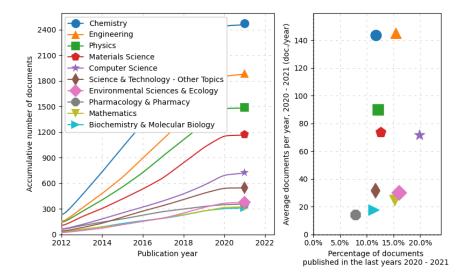

Figure 5: Subject Categories Distribution

Highly-Cited Literature Analysis of JU

Citation analysis has been regarded as an essential indicator to measure the quality of articles in bibliometric research, and it represents the influence and attention of researchers in academic circles. Table 5 lists the ten most frequently cited articles from 2012–2021 in the research articles of JU with relevant information, including title, authors, journal, total citations, and total citations per year. The paper entitled "An Adaptive Differential Evolution Algorithm with Novel Mutation and Crossover Strategies for Global Numerical Optimization." by Islam, Sk Minhajul, published in 2012 in "IEEE Xplore" is on the top of the list with 369 citations and 36.90 total citations per year. The

article entitled "Be aware of error measures. Further studies on validation of predictive QSAR models" by Roy Kunal published in 2016 in "Chemometrics and Intelligent Laboratory Systems" is on 2nd rank with 324 citations and 54.00 total citations per year. The article entitled "Comparative Studies on Some Metrics for External Validation of QSPR Models" by Roy Kunal, published in 2012 in "Journal of Chemical Information and Modeling," is on 3rd rank with 309 citations and 30.90 total citations per year. It is noted that "Wettability patterning for high-rate, pumpless fluid transport on the open, non-planar microfluidic platform" is the bottom of this list, written by Ghosh, Aritra published in 2014 in "Lab on a Chip" with 183 citations and 22.87 total citations per year.

Table 5: Highly Cited Documents

Paper	First Author	Source	Total Citations	TC per Year
An Adaptive Differential Evolution Algorithm with Novel Mutation and Crossover Strategies for Global Numerical Optimization. (2012)	Islam, Sk Minhajul	IEEE Xplore	369	36.90
Be aware of error measures. Further studies on validation of predictive QSAR models (2016)	Roy, Kunal	Chemometrics and Intelligent Laboratory Systems	324	54.00
Comparative Studies on Some Metrics for External Validation of QSPR Models (2012)	Roy, Kunal	Journal of Chemical Information and Modeling	309	30.90
On a simple approach for determining the		Chemometrics	296	42.29

applicability domain of QSAR models (2015)	Roy, Kunal	and Intelligent Laboratory Systems		
Three Dimensional Ag2O/TiO2 Type-II (p–n) Nanoheterojunctions for Superior Photocatalytic Activity (2013)	Sarkar, Debabrata	ACS Applied Materials & Interfaces	287	31.89
Some case studies on the application of "rm2" metrics for judging the quality of quantitative structure-activity relationship predictions: Emphasis on the scaling of response data (2013)	Roy, Kunal	Computational Chemistry	243	27.00
A Survey of Multiobjective Evolutionary Algorithms Based on Decomposition (2017)	Trivedi, Anupam	IEEE Xplore	218	43.60
TOPSIS method for multi-attribute group decision-making under single-valued neutrosophic environment (2016)	Biswas, Pranab	Neural Computing and Applications	217	36.16
Understanding the pathway of antibacterial activity of copper oxide nanoparticles (2015)	Meghana, Surapaneni	RSC Advances	189	27.00
Wettability patterning for high-rate, pumpless fluid transport on the open, non-planar microfluidic platform (2014)	Ghosh, Aritra	Lab on a Chip	183	22.87
TC- Total Citations				

High-frequency Author Keywords Analysis and Visualization of Co-occurrence Network
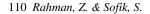
Keywords reflect the core content of the article in a concise form, which can be regarded as the soul of the article. By analyzing the high-frequency keywords, the research hotspots and overall development trends in the field are accurately revealed [13]. The evolution of the top 20 author keywords and frequency in different periods was also listed in Table 6. Observing the changes in the ranking of the most frequently used keywords in different periods can directly understand the chances of hotspots in related research. The keyword 'Crystal Structure' has the highest frequency of 156 in 2012-2021. Other keywords with a high frequency include 'Schiff Base' (120), 'DFT' (91), and 'Optimization' (82). It's observed that the ranking of keywords is changing in different periods. The keyword 'Crystal Structure' has ranked 1st between 2012 and 2021 and 2012-2016, but 2nd ranked in 2017-2021. The keyword 'Schiff Base' has ranked 2nd from 2012 to 2021, 3rd in 2012-2016, and 4th in 2017-2021. The keywords 'DFT' and 'Optimization' are ranked changed in different periods.

The VOSviewer software constructed the author keyword co-occurrence network of JU. The minimum number of 5 keywords occurrence is selected, and hence only 976 keywords meet the threshold out of a total of 23559 keywords. The size of the nodes and words in Figure 6 represents the weights of the nodes. The bigger the node and words are, the larger the weight is. The distance between two nodes reflects the strength of the relation between two nodes. A shorter length generally reveals a more important link. The line between two keywords represents that they have appeared together. The thicker the line is, the more co-occurrence they have [14]. The nodes with the same color belong to a cluster. VOSviewer divided the keywords of JU publications into 21 clusters. The top three clusters were "Photoluminescence" (Marked in red color and consist of 122 keywords), "Crystal Structure" (Marked in green color and comprised of 113 keywords), and "Optimization" (Marked in blue color and consist of 87 keywords). In the 1st cluster, "Photoluminescence," the most used keywords were "Microstructure" (24), "Nanoparticles" (13), and "PVDF" (11). In the 2nd cluster, "Crystal Structure," the most used keywords were "Schiff Base" (120), "DFT" (91), and "DFT Calculation" (28). In the 3rd cluster, "Optimization," the most used keywords were "Genetic algorithm" (16), "Feature Selection" (14), and "Differential Evolution" (11).

Table 6: Top 20 author keywords and frequency in different periods

Rank	2012-2021		2012-2016		2017-2021	
	Keywords	**Freq**	**Keywords**	**Freq**	**Keywords**	**Freq**
1	Crystal Structure	156	Crystal Structure	73	Optimization	64

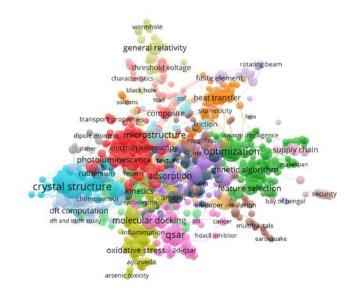| 2	Schiff Base	120	Optimization	60	Crystal Structure	61
3	DFT	91	Schiff Base	58	DFT	52
4	Optimization	82	QATAR	47	Schiff Base	51
5	X-Ray Structure	44	X-Ray Structure	40	Microstructure	45
6	Copper(II)	41	Fluorescence	38	Molecular Docking	44
7	Electrochemistry	38	DFT	37	QATAR	42
8	Fluorescence	37	Adsorption	36	Adsorption	41
9	Structure	31	Copper(II)	35	India	35
10	DFT Calculation	28	Microstructure	29	Analysis	33
11	Photochromism	25	Photoluminescence	25	Stability	28
12	Photoluminescence	25	Photochromism	23	Kinetics	28
13	Microstructure	24	DFT Calculation	22	Fluorescence	27
14	Molecular Docking	24	Antioxidant	21	Response Surface Methodology	23
15	DFT Calculations	23	General Relativity	20	Photoluminescence	23
16	General Relativity	23	Neural Network	12	Feature Selection	21
17	Crystal Structures	20	Nanofluid	12	Deep Learning	20
18	Coordination Polymer	16	Permeate Flux	10	Insulation	19
19	DFT Computation	16	Friction	9	Validation	18
20	Adsorption	16	Power	9	Feature Extraction	16
Freq - Frequency						

Figure 6: Co-Occurrence Network of Author Keywords

Burst Detection Analysis

Burst keywords refer to words whose appearance frequency suddenly increased in some period. In general, the stronger the burst strength of keywords, the more likely the topic will become emerging research frontiers [15]. This study used CiteSpace V to identify the burst keywords, and the top 50 keywords with the strongest bursts are shown in Table 7, where the length of the entire line (green and red) in the last column represents the research period from 2003 to 2020. The red line represents the burst period. The high-frequency keywords with low burst strength were classical terms that have been stably cited during the whole research period. The low-frequency keywords with high burst strength have attracted more attention in a specific research period, representing an emerging research direction.

Based on the results of burst keywords detection, two development stages in research of JU in the past ten years were identified. In the first stage before 2017, 'X-Ray Structure,' 'External Validation,' 'Copper(II),' 'Metrics,' 'Nickel(II),' 'Field Emission,' 'Field Emission,' 'Molecular Structure,' 'Electron Transfer' and 'Drinking Water' had higher burst strength (> 8), while 'Nickel(II),' 'Field Emission' and 'Nickel(II) Complex' showed more extended burst period, indicating that they were the frontier keywords in this period. The burst keywords in the second stage from 2017 to 2021 include only two keywords: ' Supercapacitor' and 'Living Cell' had higher burst strength (> 8), while 'Supercapacitor' showed a longer burst period. These emerging burst keywords

can inspire researchers to propose new research topics and perspectives for future research.

Table 7: Top 20 Keywords with the Strongest Citation Bursts

Keywords	Strength	Begin	End	2012 - 2021
X-Ray Structure	11.46	2012	2014	
External Validation	8.95	2012	2014	
Copper(II)	8.23	2012	2014	
Metrics	8.1	2012	2014	
QPR	7.67	2012	2014	
X-Ray Structure	7.59	2012	2014	
Photochromism	7.56	2012	2013	
Redox Property	7.35	2012	2013	
Particle Swarm Optimization	7.28	2012	2014	
Ruthenium	7.24	2012	2014	
Nickel(II)	9	2013	2016	
Field Emission	8.45	2013	2016	
Molecular Structure	8.18	2014	2015	
Nickel(II) Complex	7.57	2014	2017	
Electron Transfer	8.58	2015	2017	
Drinking-Water	8.96	2016	2018	
Wear	7.4	2017	2019	
Supercapacitor	9.98	2018	2021	
Living Cell	8.13	2018	2019	
Tool	7.63	2019	2021	

Conclusions

This paper aimed to map the research performance of JU through a Scientometric analysis. The methodology was structured in three steps: data collection, data processing, and results extraction. Based on 8426 articles retrieved from the WoS, this bibliometric study provided an overview of the research of JU and identified some significant points in the research throughout the investigation period (2012-2021). The trends indicate that the JU research productivity and scholarly communication pattern have risen considerably in the

last ten years and contributed much to the scientific community. The trend indicates that the number of publications gradually increased, but the number of citations was decreased. About 2800 authors contributed by the JU researchers according to the data collected. Das S., Ghosh S., and Chakraborty S. were observed to be relevant authors in this University. JU researcher's preference for collaborative work has extended to the national and international levels. National level collaboration with the USA, England, and Spain was observed. 'RSC Advances,' 'Polyhedron,' and 'New Journal of Chemistry' were the most influential journals where JU researchers prefer to publish their work. Maximum numbers of published papers by JU researchers were profoundly distributed within the area of Chemistry, Engineering, Physics, and Materials Science. The affiliation-wise productivity for the author at JU with selected some other international, regional, and national higher education institutions were the University of Calcutta, Indian Institute Technology; Kharagpur, and Indian Institute of Technology. The paper "An Adaptive Differential Evolution Algorithm with Novel Mutation and Crossover Strategies for Global Numerical Optimization." by Islam, Sk Minhajul, published in "IEEE Xplore," was the most important paper. Key areas or research hotspots were identified, 'Crystal Structure', 'Schiff Base', 'DFT', 'Optimization'. The keywords 'Optimization', 'Crystal Structure', 'Schiff Base', 'DFT', 'Microstructure', 'Molecular Docking', 'QSAR', 'Adsorption', 'Kinetics' and 'Fluorescence'   has become an emerging research frontier.

Our study revealed that there is an increasing growth trend in publications and research production within the Jadavpur University, Kolkata, India, especially in recent years. The research findings indicated that researchers published their papers in differently highly cited international and national journals. Attentions went to share, and characteristics of selected favorably cited papers, top productive authors, strong and weak areas of university research, their growth rate, and impact in terms of average citations received. Equally, the study showed the increasing trend of collaborative research at both national and international levels, and leading publication mainstreaming at core journals. In recent years, there have been fewer frontier topics, and relevant scholars should expand new research directions.

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