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An Analytical Study of Research Performance of Private Universities of Uttar Pradesh, India: A Bibliometric Study

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Abstract: This paper investigates the research performance of all 29 private universities of Uttar Pradesh, India. The study was conducted by extracting data from 29 universities from the SCOPUS database. A total of 17 universities have indexed their research publications in SCOPUS. The Affiliation search technique was applied to extract the data of all the Private Universities one by one. Data were downloaded in the format as per the requirement of visualization software used for this study. The data were analyzed using bibliometric tools like *R*, VOSViewer, and MS Excel separately for each university and later data of all universities tabloid in different sheets as per the research questions. There are a total of 12 private universities in Uttar Pradesh India which have no publications indexed in SCOPUS. Among all the Private Universities, Jaypee University has maximum research output and a leading university in the state and received 1st rank. Similarly, Sharda University published 2nd highest publications among the universities of Uttar Pradesh. During the designing of methodology and analysis, there were implications that every university had no research or publications indexed in the SCOPUS database. Even though it was a bulk study and covering maximum private universities of Uttar Pradesh which assembled a huge amount of data for study, managing and arranging the data was difficult. The publications and research results of private universities are taken for the study and data analyzed without any manipulation of fake data. This study can be useful for further study to illustrate the constraints, challenges, and opportunities of the private universities of Uttar Pradesh and policy may be framed to enhance the research activities in the premises of the institutions. It may be helpful to the university authorities to make a policy by evaluating their planning of research and development.

Keywords: Private University, Bibliometrics, Uttar Pradesh, Research Performance, Analytical Study, India

1. Introduction

India is a vast country comprising 29 states and 7 Union Territories in which Uttar Pradesh is the biggest and most populous state of India situated in North where almost 23 crore population of the country resides. Fulfilling the needs of education, the state provides from primary to higher education through 5 central universities, 10 Deemed Universities, 15 Government Aided Minority Degree College, 16 state universities, and 29 private universities located in Uttar Pradesh which is engaged in research and development studies through various departments. Along with public universities, private universities and institutions played an essential role and contributed much to research and development. Lucknow, the capital city of Uttar Pradesh is measured as the hub of education in north India where educational activities in medical, engineering, arts, etc. are taking place through numerous academic institutions and students come from different states of India. Thousands of students are studying in these private universities and most of them are NAAC accredited and performing well in various subjects.

The purpose of this study is to find out research activities of universities which were established after the year of 2000

so that it could be concluded that private universities stand at which level and what can be done to improve the research environment by removing the constraints for enhancing the contribution in the research and development of the country. Such a study assists the organization to look into the matters of interest of its researcher and motivate for further efforts to make more achievements.

The data of private universities was extracted from the Directorate of Higher Education, Uttar Pradesh India, there are 29 private universities in Uttar Pradesh recognized by University Grant Commission and some universities are accredited by NAAC. Private Universities are started as a college and institutions that impart education to its students as academic institutions which are promoted to a university later on through an act of State Assembly, Uttar Pradesh. So, publications before their year of establishment have also been taken in the study.

Bibliometrics is a branch of knowledge in the field Library and Information Science research which analyzes and measures the quality, quantity as well as the impact of research outputs. The bibliometric study is conducted for the purpose of identifying the overall growth of knowledge in a specific field as well as leading authors, leading countries, distinguished contributing institutions and contributing countries etc.

A systematic literature was reviewed to comprehend the concepts and its role in research. Before kicking off the bibliometrics study, many literatures were studied and made a systematic review to know the prevalence of the research activities in the world. Bibliometric study has been considered as a complementary tool to a peer evaluation [2] and it became an emergent field of academic librarians with innovative services for both academic and administrative to partake in the international scientific discourse [5]. In a broad sense, Times Higher Education Ranking of Universities was analyzed. It is found that Harvard University scored top one in all of the three rankings in 2009 on peer review with high weighting in evaluation [7]. Researchers take interest to conduct study in public universities and organizations about quality and quantity of research output and current state-of-the-art of CSIR laboratories using publications output data as reflected in Web of Science and Scopus and shown growth rate between linear and exponential [12]. In the publishing world, it is found that scientist prefer to get publish their research in highly specialized journals and useful to study other qualitative indicators based on citations and impact factors, participation in international meetings, etc [8] and also shown through study in Khalifa University that publishing in top ranked journals would improve the chances of getting more citations [13].

By telling the importance of study of research performance, there is advocacy for developing national research policy to promote and support collaborations among researchers, organizations and countries [16]. The authority of the universities takes decisions of expenditure of research and development on the basis of their budget pointed out that expenditure of percentage of GDP on academic research in different nations are significantly correlated to historical contingencies depends upon number of researchers in population in that country [11]. It is recommended that mentoring, collaboration with foreign colleagues in research and publication can maximize the output [14] and opined about medical research as the supreme fantasy of humans that directly affect the longevity of life [15]. It is also indicated that research productivity of Banaras Hindu University is increasing at the average rate of 104.1 publications per year [4].

In view of the policy making which pointed out at the relevancy of Internal Quality Assurance Cell (IQAC) with organizations and focused on funds allocation for promoting, encouraging, and fostering research activities in particular subject areas [18] and investigated that research profile data usage in policy making may affect the quality of research [3].

The research output of the private universities is ignored to be noticed and could not get more exposure among universities and emphasized that advanced bibliometric methods become more strong instruments for both the evaluation of research performance as well as for monitoring scientific development [19]. The terms bibliometrics, scientometrics, and informetrics refer to component fields related to the study of the dynamics of disciplines as reflected in the production of their literature [6]. The reviews of the literature indicate that state universities of India and found that university research level is very low because after completion of Master Degree young generations are not much interested in research activities [9].

2. Research Questions

1. To find out major research areas of private universities in Uttar Pradesh,
2. To find out the research status of Universities,
3. To identify research output in private universities during two decades,
4. To investigate trends of authorship patterns of research publications,
5. To find out collaborations, cooperation and affiliations for research,
6. To find out citation trends of the research publications.

3. Research Methodology and Data

The bibliometric study investigates the publishing trends of research literature indexed in the SCOPUS database. It is recognized that SCOPUS is the most authentic and reliable indexing and abstracting database globally, whereas bibliometric analysis is a statistical method to analyze the publishing trends, patterns, and scope of the published scholarly work. Data was extracted from the SCOPUS database for all Private Universities one by one through basic search strategies. The data in CSV format were extracted on 15th October 2021 from SCOPUS for all 29 Private Universities separately.

A comprehensive search and selection strategy was framed to include publications to conduct bibliometric analysis. The

relevant query was designed, putting all the relevant keywords, to run into the SCOPUS database to retrieve the results. Boolean operators were used to combine the keywords to retrieve the maximum and relevant results. The basic search strategy was carried out by the researcher to extract the data in such a way that maximum accuracy could be maintained. The search criteria were - ALL FIELDS: (Name of the University) for 2000-2020 all publications (Publications of all document types in all languages); this search strategy was adopted for each university and data kept separately for further analysis.

Out of 17, 12 Private Universities had no publication indexed in SCOPUS database. Since the study is inclusively related to the research publications of private universities, therefore a basic search strategy is used.

The data were analyzed by using the bibliometric tool like Biblioshiny, VOS Viewer, and M.S. Excel for making a comparative statement to extract the results based on research questions in selected private universities.

The study has used Lawani's formula of Collaborative Index, Subramanyam's formula of Degree of Collaboration and Ajiferuke's formula of Collaborative Coefficient for measuring the strength of collaboration among authors [10, 17, 1].

Collaborative Index (CI) is a measure to calculate the mean number of authors per publication. This formula was devised by Lawani's formula as a measure of the mean number of authors per paper. As per Lawani the formula is:

$$CI = \frac{\sum_{j=1}^{k} jf_j}{N}$$

Where,

fj = the number of j-authored research papers published in a discipline during a certain period of time; N = the total number of research papers published in a discipline during certain period of time; j = the number of authors in a paper; and k = the greatest number of authors per paper in a discipline.

Subramanayam [17] mathematical formula is used to calculate the author's degree of collaboration in a discipline. The equation can be expressed mathematically as;

$$DC = \frac{Nm}{Nm+Ns}$$

Where,

DC= Degree of Collaboration, Nm= Number of Multi Authored Publications, Ns= Number of Single Authored Publications.

Overview of Private Universities of Uttar Pradesh India

It is found from the analysis of the Table 1 that out of 29 Private Universities, only 17 universities have research output indexed in SCOPUS in which Jaypee University has maximum publications and secured 1st position which was established in 2014; its publications have received maximum citations 19479. The 2nd highest publications 1659 are from Sharda University based in Greater Noida Uttar Pradesh and got 9106 citations. GLA University was established in 2010 and produced 1535 publications and got 5776 citations and Integral University has produced 1435 publications and received 10426 citations. Moreover, when research output is analyzed it is found that BBDU has scored the highest 12.82 average citations per publication however; its publications are very low. It indicates that BBDU produces the most cited publications.

Table 1. *List of Private Universities of Uttar Pradesh India.*

Sl. No.	Name of Private Universities	Website	District	YoE	NP	TC	ACPP
1	Jaypee University	www.jaypeeu.ac.in	Bulandshahr, U.P.	2014	3334	19479	5.84
2	Sharda University	www.sharda.ac.in	Greater Noida, U.P.	2009	1659	9106	5.49
3	G.L.A. University	www.gla.ac.in	Mathura, U.P.	2010	1535	5776	3.76
4	Integral University	www.iul.ac.in	Lucknow, U.P.	2004	1435	10426	7.27
5	Shiv Nadar University	www.snu.edu.in	Greater Noida, U.P.	2011	1327	9616	7.25
6	Galgotia University	www.galgotiasuniversity.edu.in	Ghaziabad, U.P.	2011	1054	5381	5.11
7	Swami Vivekanand Subharti University	subharti.org	Meerut, U.P.	2008	803	4097	5.1
8	Teerthanker Mahaveer University	tmu.ac.in	Moradabad, U.P.	2008	494	1803	3.65
9	Bennett University	www.bennett.edu.in	Noida, U.P.	2016	381	1176	3.09
10	Shobhit University	www.shobhituniversity.ac.in	Saharanpur, U.P.	2014	292	1744	5.98
11	Shri Ramswaroop Memorial University	www.srmu.ac.in	Lucknow, U.P.	2012	251	973	3.88
12	Babu Banarasi Das University	www.bbdu.ac.in	Lucknow, U.P.	2010	181	2322	12.82
13	Mangalayatan University	www.mangalayatan.in	Aligarh, U.P.	2006	113	1025	9.07
14	Symbiosis Centre for Management Studies	https://www.scmsnoida.ac.in/#	Noida, U.P.	2016	40	75	1.88
15	IIMT University	www.iimtu.com	Meerut, Uttar Pradesh	2016	27	98	3.62
16	Maharishi University of Information Technology	www.maharishiuniversity.ac.in	Lucknow, U.P.	2001	19	15	0.79
17	Invertis University	www.invertisuniversity.ac.in	Bareilly, U.P.	2010	5	43	8.6
18	Jagadguru Rambhadracharya Handicapped University	www.jrhu.com	Chitrakoot, U.P.	2001	0	0	0
19	Amity University	https://www.amity.edu/	Lucknow, U.P.	2005	0	0	0
20	Monad University	www.monad.edu.in	Hapur, U.P.	2010	0	0	0
21	Noida International University	www.niu.edu.in	Noida, U.P.	2010	0	0	0
22	I.F.T.M. University	www.iftmuniversity.ac.in/iftmuniversity/index.php	Moradabad, U.P.	2010	0	0	0
23	Shri Venkateswara University	www.svu.edu.in	Noida, U.P.	2010	0	0	0
24	Mohammad Ali Jauhar University	www.jauharuniversity.edu.in	Rampur, U.P.	2012	0	0	0
25	Glocal University	www.glocaluniversity.edu.in	Saharanpur, U.P.	2012	0	0	0

Sl. No.	Name of Private Universities	Website	District	YoE	NP	TC	ACPP
26	Rama University	www.ramauniversity.ac.in	Kanpur, U.P.	2013	0	0	0
27	J. S. University	www.jsu.edu.in	Firozabad, U.P.	2015	0	0	0
28	Bareilly International University	www.biu.edu.in	Bareilly, U.P.	2016	0	0	0
29	Era University	www.erauniversity.in	Lucknow, U.P.	2016	0	0	0

JPU = Jaypee University, SU = Sharda University, GLAU = GLA University, IU = Integral University, SNU = Shiv Nadar University, GU = Galgotia University, SVSU = Swami Vivekanand Subharti University, TMU = Teerthanker Mahaveer University, BU = Bennett University, SBU = Shobhit University, SRMU = Shri Ramswaroop Memorial University, BBDU = Babu Banarsi Das University, MU = Mangalaytan University, SCMS = Symbiosis Centre for Management Studies, IIMTU = IIMT University, MUIT = Maharishi University of Information Technology, ITU = Invertis University, YoE = Year of Establishment, NP = Number of Publications, ACPP = AverageCitations Per paper, U.P. = Uttar Pradesh.

3.1. Authorship Pattern of Private Universities (Table A1)

Private Universities are productive and have an interesting authorship pattern. After analysis of authorship patterns, it is found that Joint authorship models are followed by the researcher and prefer to produce the publication in joint authorship of three authors. First, JPU has published 175 (5.25%) documents of single authorship, 1132 (33.95%) documents of double authorship and 1020 (30.59%) of three authorship patterns. Second, SU has published 116 (6.99%) documents of single authorship, 413 (24.89%) documents of double authorship and 462 (27.85%) of three authorship patterns. IU has been dominating in publications of six, seven, eight, nine, ten and more than ten authorship pattern as 159 (11.08%), 125 (8.71%), 72 (5.02%), 56 (3.90%), 23 (1.60%) and 49 (3.41%) respectively, however, JPU dominated in publications 279 (8.37%) of five authorships and 265 (18.47%) of four authorship pattern. (Table A1)

3.2. Years Wise Growth of Publication in Private Universities (Table A2)

It is found from Table A2 that research publications output has continuous growth from 2001 to 2019 and slightly decreased in 2020. In 2021, GLAU and IU have the same no. of publications of 20 documents. GLU has a maximum of 461 publications in the year of 2020 after that SU and JPU have publications 416 and 326 respectively. JPU has maximum publications of 520 in the year of 2019 and it also observed that it is a leading producer of the research output among all the private universities from 2006 to 2019. In terms of overall production of all universities, 2019 has been a most productive year among all with 2169 publications. (Table A2)

3.3. Indicators of Publications and Authors of Private Universities

It is found from Table 2 that JPU received 19479 citations for 3334 publications in which 175 papers are single authored and 3159 are joint authored papers and these joint authored papers are produced by the 10188 joint authors, thus there are 10363 total numbers of authors. Its collaborative index is 3.23 and degree of collaboration is 0.95. Sharda University received 9106 citations for 1659 papers in which 116 papers are single authored and 1543 papers are joint authored papers by 5912 total joint authors, thus there are 6028 total authors. Its collaborative index is 3.83 and degree of collaboration is 0.93. It is observed from the study that Integral University published 1435 papers but received 10426 citations which are 2nd highest among all. The least collaborative index (CI) and degree of collaborations (DC) receivers are SCMS and ITU with 2.50 each for both and 0.90 and 0.80 respectively. The least Rate of Single authorship (RSA) goes to Shobhit University with 0.01 and Productivity Per author (PPA) belong to Integral University with 0.20.

Table 2. *Indicators of Publications and Authors of Private Universities.*

Sl. No.	Universities	TP	TC	NSAP (Ns)	NJAP (Nm)	TAJAP	TA	CI	DC	RSA	AAPP	PPA
1	JPU	3334	19479	175	3159	10188	10363	3.23	0.95	0.05	3.11	0.32
2	SU	1659	9106	116	1543	5912	6028	3.83	0.93	0.07	3.63	0.28
3	GLAU	1535	5776	104	1431	4815	4919	3.36	0.93	0.07	3.20	0.31
4	IU	1435	10426	26	1409	7127	7153	5.06	0.98	0.02	4.98	0.20
5	SNU	1327	9616	92	1235	5614	5706	4.55	0.93	0.07	4.30	0.23
6	GU	1054	5381	38	1016	3974	4012	3.91	0.96	0.04	3.81	0.26
7	SVSU	803	4097	21	782	3335	3356	4.26	0.97	0.03	4.18	0.24
8	TMU	494	1803	15	479	1961	1976	4.09	0.97	0.03	4.00	0.25
9	BU	381	1176	27	354	1282	1309	3.62	0.93	0.07	3.44	0.29
10	SBU	292	1744	2	290	1091	1093	3.76	0.99	0.01	3.74	0.27
11	SRMU	251	973	12	239	944	956	3.95	0.95	0.05	3.81	0.26
12	BBDU	181	2322	11	170	609	620	3.58	0.94	0.06	3.43	0.29
13	MU	113	1025	3	110	418	421	3.80	0.97	0.03	3.73	0.27
14	SCMS	40	75	4	36	90	94	2.50	0.90	0.10	2.35	0.43
15	IIMTU	27	98	2	25	107	109	4.28	0.93	0.07	4.04	0.25
16	MUIT	19	15	1	18	57	58	3.17	0.95	0.05	3.05	0.33
17	ITU	5	43	1	4	10	11	2.50	0.80	0.20	2.20	0.45

TP = Total Number of Publications, TC = Total Number of Citations, NSAP = Number of Single Authored Papers, NJAP = No. of Joint Authored Papers, TAJAP = Total Authored of Joint Authored Papers, TA = Total Authors, CI = Collaborative Index, DC = Degree of Collaboration, RSA = Rate of Single Authorship, AAPP = Average Author Per papers, PPA = Productivity Per Author.

3.4. Top 20 Author Impact of H Index

The h index is an index to quantify an individual's scientific research output which is most used author metrics based on number of publications and no. of citations whereas g index is measured based on the distribution of citations received by a given researcher's publications and gives more weight to highly cited articles along with this the m index is defined as h-index/n, where n is number of years since the first published paper of the scientist. Table 3 reveals that JPU's Kumar, M has secured 1st rank with 23 h-index by publishing 94 publications with 1560 citations among all authors of the covered private universities and secured 1st rank whose g-index is 36 and m-index is 1.643. GU's author Chakraborty, C has secured 2nd rank in h-index whereas received most top g-index and m-index with 1584 citations of 70 publications similarly, JPU's author Pathak, A. has same 2nd rank by receiving 22 h-index as of GU's author, but it is interesting that this author has produced 109 publications more than both earlier mentioned. IU's author Ahmad, S has produced 125 papers more than any other authors of all private universities but secured 3rd rank and got 21 h-index, 29 g-index and 1.75 m-index. It clearly states that more citations improve the h-index and age of research output also matters.

Table 3. *Top 20 Author Impact of H Index.*

Rank	Universities	Author	h_index	g_index	m_index	TC	NP	PY_start
1	JPU	Kumar, M	23	36	1.643	1560	94	2007
2	GU	Chakraborty, C	22	38	2.75	1584	70	2013
2	JPU	Pathak, A	22	30	1.222	1421	109	2003
3	IU	Ahmad, S	21	29	1.75	1264	110	2009
3	SNU	Kaskaoutis, DG	21	26	2.625	1034	26	2013
4	SU	Singh Pk	19	30	1.727	1298	125	2010
5	GLAU	Tiwari Ak	18	34	2.571	1359	34	2014
5	IU	Khan Ms	18	27	1.8	960	84	2011
5	SU	Bhattacharya, B	18	27	1.5	942	83	2009
6	JPU	Gupta S	17	32	1.308	1131	93	2008
6	SU	Kaskaoutis, DG	17	21	1.7	891	21	2011
7	IU	Lohani, M	16	28	1.333	861	62	2009
7	JPU	Chhoker, S	16	29	1.778	866	36	2012
7	SU	Singh, NB	16	26	1.455	835	84	2010
8	IU	Kamal, MA	15	28	1.875	852	47	2013
8	JPU	Sajal, V	15	23	1.154	661	66	2008
8	JPU	Rani, V	15	33	1.071	1106	55	2007
8	SU	Singh, S	15	28	1.5	831	71	2011
8	SU	Rhee, HW	15	19	1.364	519	19	2010
8	SBU	Singh, R	15	21	1.25	637	82	2009

3.5. Top 15 Most Global Cited Documents of Universities

In the Table 4, 15 most global cited documents have been selected for the study and found that BBDU's document received 482 citations with 48.20 total citations per year and secured 1st rank. SNU's three documents have secured 2nd, 3rdand 11th rank which received 433, 353 and 179 global citations with 86.60 and 50.43 total citations per year respectively. IU's three documents have secured 7th, 8th and 14th rank which received 239, 236 and 171 global citations with 26.56, 39.33 and 21.38 total citations per year respectively. JPU's 3 documents have placed in the top 15 most global cited documents and secured 5th and 13th ranks.

Table 4. *Top 20 Most Global Cited Documents of Universities.*

Ranks	Uni.	Paper	Total Cit.	TC per Year
1	BBDU	Singh, R., Gautam, N., Mishra, A., & Gupta, R. (2011). Heavy metals and living systems: An overview. Indian journal of pharmacology, 43 (3), 246.	482	48.20
2	SNU	Wang, Z., Bauch, C. T., Bhattacharyya, S., d'Onofrio, A., Manfredi, P., Perc, M., & Zhao, D. (2016). Statistical physics of vaccination. Physics Reports, 664, 1-113.	433	86.60
3	SNU	Upadhyay, R. K., Soin, N., & Roy, S. S. (2014). Role of graphene/metal oxide composites as photocatalysts, adsorbents and disinfectants in water treatment: a review. RSC Adv 4: 3823–3851.	353	50.43
4	SU	Dakal, T. C., Kumar, A., Majumdar, R. S., & Yadav, V. (2016). Mechanistic basis of antimicrobial actions of silver nanoparticles. Frontiers in microbiology, 7, 1831.	334	66.80
5	JPU	Rani, V., Deep, G., Singh, R. K., Palle, K., & Yadav, U. C. (2016). Oxidative stress and metabolic disorders: Pathogenesis and therapeutic strategies. Life sciences, 148, 183-193.	328	65.60
6	GU	Chakraborty, C., Sharma, A. R., Sharma, G., Doss, C. G. P., & Lee, S. S. (2017). Therapeutic miRNA and siRNA: moving from bench to clinic as next generation medicine. Molecular Therapy-Nucleic Acids, 8, 132-143.	313	78.25
7	IU	Hussain, M. S., Fareed, S., Saba Ansari, M., Rahman, A., Ahmad, I. Z., & Saeed, M. (2012). Current approaches toward production of secondary plant metabolites. Journal of pharmacy &bioallied sciences, 4 (1), 10.	239	26.56

Ranks	Uni.	Paper	Total Cit.	TC per Year
8	IU	Shaikh, S., Fatima, J., Shakil, S., Rizvi, S. M. D., & Kamal, M. A. (2015). Antibiotic resistance and extended spectrum beta-lactamases: Types, epidemiology and treatment. Saudi journal of biological sciences, 22 (1), 90-101.	236	39.33
9	GU	Jaiswal, M., Dudhe, R., & Sharma, P. K. (2015). Nanoemulsion: an advanced mode of drug delivery system. 3 Biotech, 5 (2), 123-127.	233	38.83
10	SU	Sherwani, A. F., & Usmani, J. A. (2010). Life cycle assessment of solar PV based electricity generation systems: A review. Renewable and Sustainable Energy Reviews, 14 (1), 540-544.	227	20.64
11	SNU	Kandasamy, G., & Maity, D. (2015). Recent advances in superparamagnetic iron oxide nanoparticles (SPIONs) for in vitro and in vivo cancer nanotheranostics. International journal of pharmaceutics, 496 (2), 191-218.	179	29.83
12	GLAU	Sharma, A. K., Tiwari, A. K., & Dixit, A. R. (2016). Rheological behaviour of nanofluids: a review. Renewable and Sustainable Energy Reviews, 53, 779-791.	174	34.80
13	JPU	Iqbal, M. A., Md, S., Sahni, J. K., Baboota, S., Dang, S., & Ali, J. (2012). Nanostructured lipid carrier's system: recent advances in drug delivery. Journal of drug targeting, 20 (10), 813-830.	173	19.22
13	JPU	Sheikholeslami, M., Gorji-Bandpy, M., Ganji, D. D., Rana, P., & Soleimani, S. (2014). Magnetohydrodynamic free convection of Al_2O_3–water nanofluid considering Thermophoresis and Brownian motion effects. Computers & Fluids, 94, 147-160.	173	24.71
14	IU	Rahman, Q. I., Ahmad, M., Misra, S. K., & Lohani, M. (2013). Effective photocatalytic degradation of rhodamine B dye by ZnO nanoparticles. Materials Letters, 91, 170-174.	171	21.38

3.6. Most Cited Countries by the Universities

It found from Table 5 that Private Universities are citing the research work globally published. The study reveals that most of the universities are citing India in which JPU has secured 1st rank with total citations of 10550 and average article citations 8.87 whereas IU has secured 2nd rank with total citations of 5822 but its average article citations are 11.20 more than JPU. SU has obtained 3rd rank with total citations of 3605 and 8.1 average article citations. It is also observed from the study that GU has cited India as well as Korea, Saudi Arabia; SNU has cited India 2853 times and also cited USA, Singapore, and United Kingdom 426, 396, and 145 times respectively. JPU also cited Iran and China; and IU has cited Saudi Arabia and Korea along with India.

Table 5. *Top 25 Most Cited Countries by the Universities.*

Rank	Universities	Country	Total Citations	Average Article Citations
1	JPU	India	10550	8.87
2	IU	India	5822	11.20
3	SU	India	3605	8.1
4	SVSU	India	3017	6.45
5	SNU	India	2853	9.416
6	BBDU	India	2181	17
7	GLAU	India	1808	6.72
8	SBU	India	1381	7.94
9	GU	India	1128	6.67
10	TMU	India	1066	5.49
11	GU	Korea	703	39.06
12	MU	India	692	12.8
13	SU	Korea	608	11.1
14	SRMU	India	494	5.88
15	IU	Saudi Arabia	491	10.02
16	SNU	USA	426	19.364
17	SNU	Singapore	396	30.462
18	SU	USA	390	26
19	SU	South Africa	314	78.5
20	GU	Saudi Arabia	288	18.00
21	IU	Korea	271	13.55
22	JPU	Iran	173	173.00
23	SNU	United Kingdom	145	12.083
24	JPU	China	144	48.00
25	BU	India	134	3.72

3.7. Top Highest Relevant Countries by Corresponding Authors

Table 6 shows about top highest relevant countries by corresponding authors and it is observed that JPU's most relevant country is India produced 1190 articles which 35.69% of total publications with the frequency 0.97; out of 1190, 1094 publications are SCP and 96 are MCP, the MCP ratio is 0.08. IU's highest relevant countries are India with 520 (36.24%), Saudi Arabia with 49 (3.41%) and Korea with 20 (1.39%) publications and secured 2nd, 14th and 16th ranks respectively. The 2nd rank of IU's

corresponding authors produced 427 SCP and 93 MCP. SVSU secured 3rd rank where corresponding authors found India as a highest relevant country with 468 (58.28%) articles in which 457 SCP and 11 MCP. SU's highest relevant countries are India with 445 (26.82%) publications at 5th rank, Korea with 55 (3.32%) publications at 12th and USA with 15 (0.90%) publications at 19th rank.

Table 6. *Top Highest Relevant Countries by Corresponding Authors.*

Rank	Universities	Country	Articles	% of Articles	Freq	SCP	MCP	MCP_Ratio
1	JPU	INDIA	1190	35.69	0.97	1094	96	0.08
2	IU	INDIA	520	36.24	0.84	427	93	0.18
3	SVSU	INDIA	468	58.28	0.96	457	11	0.02
4	SU	INDIA	445	26.82	0.80	387	58	0.13
5	GLAU	INDIA	269	17.52	0.97	257	12	0.04
6	TMU	INDIA	194	39.27	0.99	187	7	0.04
7	SBU	INDIA	174	59.59	0.95	167	7	0.04
8	GU	INDIA	169	16.03	0.72	149	20	0.12
9	BBDU	INDIA	128	70.72	0.99	126	2	0.02
10	SNU	INDIA	84	6.33	0.97	55	29	0.35
11	SRMU	INDIA	84	33.47	0.97	55	29	0.35
12	SU	KOREA	55	3.32	0.10	0	55	1.00
13	MU	INDIA	54	47.79	0.92	52	2	0.04
14	IU	SAUDI ARABIA	49	3.41	0.08	0	49	1.00
15	BU	INDIA	36	9.45	0.84	32	4	0.11
16	IU	KOREA	20	1.39	0.03	0	20	1.00
17	GU	KOREA	18	1.71	0.08	0	18	1.00
18	GU	SAUDI ARABIA	16	1.52	0.07	0	16	1.00
19	SU	USA	15	0.90	0.03	0	15	1.00
20	SCMS	INDIA	14	35.00	1.00	14	0	0.00

SCP = Single Country Publication, MCP = Multiple Country Publication

3.8. Top Most Author Keywords of Private Universities

Table 7 depicts the top most Author Keywords which are trending in research activities and most preferred by the researchers. JPU secured the 1st rank in the top most authors' keyword for "Machine Learning", occurring 0.87% (80) of its total author keywords and it is a very popular topic of research. GU secured 2nd rank for "Cloud Computing" with 1.12% (40) of its total author keywords reveals that "Cloud Computing" of Computer Science is very famous among the authors of GU. It is also found from the analysis that the authors of IU are engaged in the "apoptosis" in DNA research which is very famous and producing topic of research and secured 3rd rank among the private universities as hot topic of research with 37 occurrences of author keywords as 0.81% of total author keywords. Author Keywords "Spherical geometries" occurred only once but the share is 4.17% of the total author keywords.

Table 7. *Top 10 Most Author Keywords of Private Universities.*

Rank	Universities	keyword	occurrences	% of Author Keywords
1	JPU	machine learning	80	0.87
2	GU	cloud computing	40	1.12
3	IU	apoptosis	37	0.81
4	SU	X-Ray diffraction	31	0.57
5	GLAU	mechanical properties	23	0.46
6	BU	machine learning	21	1.57
7	SNU	malaria	16	0.44
8	SVSU	tuberculosis	11	0.45
9	SBU	Very large Scale Integration	10	0.92
10	TMU	antimicrobial activity	7	0.41
10	BBDU	High-performance thin-layer chromatography	7	1.10
11	MU	molecular docking	6	1.49
12	SRMU	antimicrobial activity	4	0.42
12	SCMS	internet of things	4	2.12
13	IIMTU	dye sensitized solar cell	2	1.75
13	MITU	bucephalopsis	2	2.35
14	ITU	spherical geometries	1	4.17

4. Conclusion

It is concluded from the study that some universities are performing well and satisfactory, where maximum universities have poor performance in which JPU is highest producer of research publication and received highest citations. SU, GLAU, and IU are also performing well and

contribute to research activities of India as IU received 2nd highest citations among all universities. Jagadguru Rambhadracharya Handicapped University was established in 2001 earliest among all were not a single research publications took place whereas, Maharishi University of Information Technology established in same year that published 19 papers only and received 15 citations; it shows that their research activities are very poor and no effort done so far. Joint authorship pattern is very preferable and article document type is more opted among the researchers. Kumar, M of JPU achieved highest 23 h-index whereas Chakraborty, C of GU and Pathak, A of JPU secured same rank of 22 h-index; Ahmad, S of IU and Kaskaoutis, DG of SNU secured 3rd rank and received 21 h-index. Most globally cited document of BBDU received the highest citation of 482 among all and the most cited country among most of the universities is India whereas Korea, Saudi Arabia, and USA have a respectable place in terms of cited countries. JPU became top corresponding authors country as India for 1190 papers in which 1094 papers are single country publication whereas 96 papers are multi country publications highest among all universities. Integral University secured 2nd place with 520 articles in 427 articles are single country and 93 articles are multi country publications, however, 2nd top most single country publications are 457 of SVSU. For Author keywords analysis, it is found that Machine Learning, Cloud Computing and Apoptosis are trending research field among the JPU, GU and IU respectively. Finally, it is concluded that Private Universities need to improve the infrastructure and environment for research activities so that more and more research publications could be produced and make contributions in the research and development of the country.

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Appendix

Table A1. *Authorship Pattern of Private Universities.*

Sl. No.	Universities	One No. (%)	Two No. (%)	Three No. (%)	Four No. (%)	Five No. (%)	Six No. (%)	Seven No. (%)	Eight No. (%)	Nine No. (%)	Ten No. (%)	>Ten No. (%)	Total Papers
1	JPU	175 (5.25%)	1132 (33.95%)	1020 (30.59%)	527 (15.81%)	279 (8.37%)	117 (3.51%)	43 (1.29%)	20 (0.60%)	15 (0.45%)	4 (0.12%)	2 (0.06%)	3334
2	SU	116 (6.99%)	413 (24.89%)	462 (27.85%)	271 (16.34%)	148 (8.92%)	120 (7.23%)	55 (3.32%)	34 (2.05%)	18 (1.08%)	7 (0.42%)	15 (0.90%)	1659
3	GLAU	104 (6.78%)	476 (31.01%)	517 (33.68%)	228 (14.85%)	99 (6.45%)	47 (3.06%)	25 (1.63%)	13 (0.85%)	10 (0.65%)	4 (0.26%)	12 (0.78%)	1535
4	IU	26 (1.81%)	161 (11.22%)	296 (20.63%)	265 (18.47%)	203 (14.15%)	159 (11.08%)	125 (8.71%)	72 (5.02%)	56 (3.90%)	23 (1.60%)	49 (3.41%)	1435
5	SNU	92 (6.93%)	233 (17.56%)	328 (24.72%)	199 (15%)	157 (11.83%)	99 (7.46%)	56 (4.22%)	49 (3.69%)	41 (3.09%)	26 (1.96%)	47 (.354%)	1327
6	GU	38 (3.61%)	244 (23.15%)	335 (31.78%)	207 (19.64%)	106 (10.06%)	66 (6.26%)	32 (3.04%)	13 (1.23%)	7 (0.66%)	3 (0.28%)	3 (0.28%)	1054
7	SVSU	21 (2.62%)	93 (11.58%)	167 (20.80%)	231 (28.77%)	142 (17.68%)	89 (11.08%)	35 (4.36%)	15 (1.87%)	4 (0.50%)	1 (0.12%)	5 (0.62%)	803
8	TMU	15 (3.04%)	79 (15.99%)	133 (26.92%)	113 (22.87%)	59 (11.94%)	55 (11.13%)	17 (3.44%)	14 (2.83%)	1 (0.20%)	5 (1.01%)	3 (0.61%)	494
9	BU	27 (7.09%)	70 (18.37)	141 (37.01%)	83 (21.78%)	39 (10.24%)	10 (2.62%)	4 (1.05%)		2 (0.52%)	1 (0.26%)	4 (1.05%)	381
10	SBU	2 (0.68%)	60 (20.55%)	90 (30.82%)	62 (21.23%)	41 (14.04%)	19 (6.51%)	12 (4.11%)	5 (1.71%)		1 (0.34%)		292
11	SRMU	12 (4.78%)	52 (20.72%)	91 (36.25%)	42 (16.73%)	17 (6.77%)	13 (5.18%)	9 (3.59%)	4 (1.59%)	2 (0.80%)		9 (3.59%)	251
12	BBDU	11 (6.08%)	27 (14.92%)	65 (35.91%)	46 (25.41%)	22 (12.15%)	7 (3.87%)	1 (0.55%)	1 (0.55%)	1 (0.55%)			181
13	MU	3 (2.65%)	23 (20.35%)	37 (32.74%)	21 (18.58%)	10 (8.85%)	9 (7.96%)	7 (6.19%)	3 (2.65%)				113
14	SCMS	4 (10%)	20 (50%)	14 (35%)	2 (5%)								40
15	IIMTU	2 (7.41%)	1 (3.70%)	7 (25.93%)	7 (25.93%)	7 (25.93%)	1 (3.70%)	1 (3.70%)	1 (3.70%)				27
16	MUIT	1 (5.26%)	6 (31.58%)	7 (36.84%)	2 (10.53%)	2 (10.53%)	1 (5.26%)						19
17	ITU	1 (20%)	2 (40%)	2 (40%)									5

Table A2. *Year-wise Publication Growth of Private Universities.*

Sl. No.	Universities	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	TP
1	JPU		1	3	1	3	13	40	44	55	94	101	139	231	271	310	328	349	493	520	326	12	3334
2	SU								1	4	19	95	94	105	121	104	135	120	197	246	416	2	1659
3	GLAU									8	9	28	39	43	51	74	110	142	170	380	461	20	1535
4	IU				2		2	5	21	36	43	79	81	90	106	111	144	155	203	207	147	3	1435
5	SNU											3	31	65	99	134	147	177	196	239	232	4	1327
6	GU										1	6	16	47	96	108	85	144	139	197	195	20	1054
7	SVSU	1	3	0	3	3	5	10	15	25	32	63	80	86	91	93	74	47	68	57	43	4	803
8	TMU									3	16	28	36	43	45	48	54	55	51	70	45		494
9	BU																8	42	125	107	95	4	381
10	SBU							1	1	7	29	67	44	14	21	21	19	20	14	19	15		292
11	SRMU													7	18	9	15	21	44	66	70	1	251
12	BBDU		1	1		3	5	5	2	7	22	31	30	11	11	7	13	11	6	10	5		181
13	MU								2	2	9	17	16	12	7	6	6	9	8	12	7		113
14	SCMS																2	4	4	22	8		40
15	IIMTU										1	2	2	1	2	6	1	1	3	4	4		27
16	MUIT																		5	13	1		19
17	ITU							1		1	2							1					5
Total		1	5	4	6	9	25	62	86	148	277	520	608	755	939	1031	1141	1298	1726	2169	2070	70	12950

TP = Total Publications

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