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Scientific Research Productivity of Visva-Bharati: A Bibliometric Study

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The present study attempts to analyse the research output of science departments (n=22) of Visva-Bharati university during the last 21years (2000-2020) as reflected in the Web of Science (WoS) database and identifies 4016 number of articles. The study examines the growth rate of publications, citation impact, collaboration trend at different levels, department wise publication, preferred source journals, identification of productive authors and tried to apply of the 80-20 ruleof publication. Fluctuating trend of publication has been observed in the overall publications productivity with a Compound Annual Growth Rate (CAGR) of 13.42 percent. Over 90 percent of articles have received citations,out of which the international collaborative publicationshave cited maximum. The *Journal of High Energy Physics*and *Journal of Instrumentation*have been found as the most preferred and most cited journal respectively.

Keywords: *Research Impact; Research Productivity; Web of Science (WoS); Research Progress;Visva-Bharati*

1 INTRODUCTION

The higher educational institution has a significant role in creating innovative knowledge for progress. The reputation and prestige of a higher educational institution are closely associated with its scholarly research output. The research output of a university mainly consists of research publications in peer-reviewed journals, Ph.D. theses, patents and reports, of which scholarly publication in peer-reviewed journals is being considered as one of the main criteria to evaluate the performance of the university scientists and faculties[1].Visva-Bharati, a Central University and "An Institution of National Importance" declared by an Act of Parliament in 1951 was founded on 23rd

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December 1921 by the great poet and first non-European Nobel Laureate Gurudev Rabindranath Tagore. The institute is considered as a pilgrimage for education and culture in India. Besides two Higher Secondary schools namely 'Patha-Bhavana' and 'Siksha-Satra' considered as bedrock of Visva-Bharati has nine Bhavanas or Institutes having 67 departments and 16 centres. As a unique education system Visva-Bharati offers education from pre primary toresearch level[2].

A good number of bibliometric studies had been conducted to analyze different aspects of research output such as year of publication, authorship pattern and collaboration trend, preferred journal etc on different universities[3-13]. From the available literature it is observed that no such study has been conducted on Visva-Bharati, a hundred year old university.

2 OBJECTIVES OF THE STUDY

- To identify growth of scientific publication and their impact;
- To assess trends of collaborated publication and their citation impact;
- To identify preferred source journal, most profile authors and area of publication; and
- To assess the applicability of 80-20 Rules on source journal and publication of articles.

3 RESEARCH METHOD

The present study is restricted to only research 'article' publications of the researchers and faculty membersof Science departments (n=22) of Visva-Bharati from 2000 to 2020. The data for this study has been collected from the database of WoS[14] up to August 2021. The impact factor (IF) of source journals has been scanned from the Thomson Reuters 'Journal Citation Report-2020'.

Out of 4084 records, only 'article' reveals 3876 number of articles of which 73 articles contributed as interdisciplinary by more than one department. Full credit in terms of the number of articles and their citation impact has been given to each contributory department in case of interdisciplinary publications. As a result 4016 number of articles considered during the period under study. For analysis of data bibliometrix package of R environment[15] has also been used.

Growth of scientific publication

Table 1 - Growth of publication

Year	No. of article	%	CAGR %	DCP	%	ICP	%
2000	30	0.75	---	7	23.33	1	3.33
2001	49	1.22	63.33	12	24.49	7	14.29
2002	48	1.20	-2.04	17	35.42	6	12.50
2003	49	1.22	2.08	16	32.65	8	16.33
2004	49	1.22	0.00	18	36.73	2	4.08
2005	72	1.79	46.94	34	47.22	8	11.11
2006	65	1.62	-9.72	28	43.08	13	20.00
2007	107	2.66	64.62	54	50.47	15	14.02
2008	102	2.54	-4.67	28	27.45	20	19.61
2009	143	3.56	40.20	48	33.57	33	23.08
2010	147	3.66	2.80	46	31.29	49	33.33
2011	214	5.33	45.58	70	32.71	96	44.86
2012	238	5.93	11.21	68	28.57	129	54.20
2013	264	6.57	10.92	94	35.61	120	45.45
2014	287	7.15	8.71	104	36.24	106	36.93
2015	293	7.30	2.09	113	38.57	119	40.61
2016	340	8.47	16.04	124	36.47	149	43.82
2017	340	8.47	0.00	98	28.82	167	49.12
2018	423	10.53	24.41	140	33.10	214	50.59
2019	384	9.56	-9.22	132	34.38	181	47.14
2020	372	9.26	-3.13	153	41.13	159	42.74
Total	4016	100.00	13.42	1404	34.96	1602	39.89

(CAGR=Compound Annual Growth Rate; DCP = Domestic collaborative publications; ICP=International collaborative publications)

The Compound Annual Growth Rate (CAGR) is calculated by the following formula [16].

$$\text{CAGR} = \left(\frac{\text{Ending value}}{\text{Begining value}}\right)\left(\frac{1}{\text{Numbers of years}}\right) - 1$$

Out of total published articles (n=4016) domestic collaborated articles occupies 34.96 % with an average of 67 articles per year. On the other hand internationally collaborated articles stands to 1602 numbers i.e. 39.89 %of total publications with an average 76 articles per year. A fluctuating trend of publication has been observedover the years with an overall 13.42 percent CAGR (Table1).

Impact of research publications

The impact of research output can be measured by number of citation received by an article.

Table 2 - Citation metrics

Year	No. of article	Cited articles	Non-cited articles	No. of citations received	Mean citations per article	Mean citations per year	Citable years
2000	30	29	1	443	14.77	0.70	21
2001	49	45	4	610	12.45	0.62	20
2002	48	44	4	1274	26.54	1.40	19
2003	49	45	4	783	15.98	0.89	18
2004	49	47	2	795	16.22	0.95	17
2005	72	70	2	1598	22.19	1.39	16
2006	65	61	4	1368	21.05	1.40	15
2007	107	97	10	1917	17.92	1.28	14
2008	102	98	4	1870	18.33	1.41	13
2009	143	128	15	2493	17.43	1.45	12
2010	147	139	8	3978	27.06	2.46	11
2011	214	208	6	8022	37.49	3.75	10
2012	238	231	7	16241	68.24	7.58	9
2013	264	255	9	9217	34.91	4.36	8
2014	287	275	12	9893	34.47	4.92	7
2015	293	277	16	9629	32.86	5.48	6
2016	340	327	13	5560	16.35	3.27	5
2017	340	322	18	6022	17.71	4.43	4
2018	423	389	34	4865	11.50	3.83	3
2019	384	331	53	2181	5.68	2.84	2
2020	372	201	171	583	1.57	1.57	1
Total	4016	3619	397	89342			

The year-wise citation metrics indicate that the maximum of 68.24 average citations per article received in the year 2012. Significantly it is also seen that out of the total publication over 90 percent of articles have received citations.

Collaboration trend its citation impact

Table 3–Non-collaborated and collaborated publications

Publication period	Total articles	Non-collaborative		Collaborated publications					
		No. of articles	%	No. of articles	%	Domestic	%	International	%
2000-06	362	185	51.10	177	48.90	132	36.46	45	12.44
2007-13	1215	345	28.40	870	71.60	408	33.58	462	38.02
2014-20	2439	480	19.68	1959	80.32	864	35.42	1095	44.90
Total	4016	1010	25.15	3006	74.85	1404	34.96	1602	39.89

Table 4 - Collaboration output and its citation			
Collaboration types	No. of articles	**Sum of times cited**	**Citations per article**
No collaboration	1010	14143	14.00
Domestic collaboration	1404	17673	12.59
International collaboration	1602	57526	35.91
Total	4016	89342	22.25

In it observed from the tables (3, 4) that number of collaborated publications increases with the passage of time and this kind of publications gets higher citations.

Subject-wisepublications

Table 5 - Subject-wise distribution of publications during 2000-2020

Subject	2000-06	2007-13	2014-20	Total	%	Mean	SD	CV
Agricultural Econ	0	2	6	8	0.20	0.38	0.80	211.25
Agricultural Engg	0	0	6	6	0.15	0.29	0.72	251.00
Agricultural Extens	0	0	9	9	0.22	0.43	0.87	203.03
Animal Science	0	0	1	1	0.57	0.05	0.22	458.26
Agronomy	5	4	14	23	0.02	1.10	1.26	115.15
Biotechnology	3	7	71	81	2.02	3.86	5.17	134.04
Botany	28	35	74	137	3.41	6.52	3.83	58.69
Chemistry	113	291	630	1034	25.75	49.24	32.62	66.25
Computer Sc	1	6	30	37	0.92	1.76	2.98	169.23
Crop Physiology	0	1	2	3	0.07	0.14	0.36	251.00
Environment Sc	2	19	50	71	1.77	3.38	3.87	114.35
Genetics & Plant Breeding	1	2	18	21	0.52	1.00	1.92	192.35
Horticulture & HPHT	0	1	5	6	0.15	0.29	0.72	251.00
Integrated Sc	0	13	86	99	2.47	4.71	6.05	128.35
Mathematics	32	222	205	459	11.43	21.86	15.11	69.15
Physics	106	446	926	1478	36.80	70.38	56.30	79.99
Plant Pathology	0	1	3	4	0.10	0.19	0.40	211.25
Soil Sc & Agricultural Chem	4	6	13	23	0.57	1.10	1.37	125.54
Statistics	2	46	67	115	2.86	5.48	4.63	84.60
Zoology	65	113	223	401	9.99	19.10	10.82	56.64
Total	362	1215	2439	4016	100.00	199.00	136.29	68.49

The table clearly indicates highest, lowest contributed departments in terms of publications and also co-efficient of variance.

Department-wise publication

Table 6 -Top 10 productive departments

Departments	No. of articles	Sum of times cited	Citations per article
Physics	1478	52248	35.35
Chemistry	1034	14487	14.01
Mathematics	459	8029	17.49
Zoology	401	7014	17.49
Botany	137	2637	19.25
Statistics	115	907	7.89
Integrated Sc	99	1301	13.14
Biotechnology	81	701	8.65
Environmental Studies	71	1046	14.73
Computer Sc	37	213	5.76

Citation Source: WoS Database

Table 7 –Publications by disciplinary area

Publications	No. of articles	%	Sum of times cited	Citation per article
Interdisciplinary	3223	80.25	78,078	24.23
Interdisciplinary/ Multidisciplinary	793	19.75	11,264	14.20
Total	4016	100.00	89342	22.25

Citation Source: WoS Database

Department of Physics contributed maximum (n=1478) articles with 35.35 average citations per article (Table 6). The highest of 80.25 percent of the total research outputs is on interdisciplinary areas and has also got a maximum of 24.23 average citations per article (Table 7).

80-20 Rule on source journals and publication of articles

80-20 rulei.e. 20 percentmost productive journals contain 80 percent of articles and 80 percent journals contain 20 percent of articles[16] have been applied to analyze source journal and articles.

Table 8– 80-20 rules in sources journals and articles					
80-20 rule	No. of journals	No. of articles			
		Observed	%	Expected	%
20 % of journals	164	2877	71.64	3213	80
80 % of journals	649	1139	28.36	803	20

It is seen that the total research outputs (4016) of Visva-Bharati publish in 813 journals. Out of 813 journals, 164 (20 %) most productive journals have published 2877 articles (71.64 %) whereas the rest of the 80 percent journals i.e. 649 published 1139 articles (28.36 %). Here, the observed value varies from the expected value. Hence, the data set rejects the 80-20 rules.

Preferred journals and impact

Table 9 - Top 10 preferred journals								
Source Titles	**No. of articles**	**No. of citations**	**Citation per article**	**h-Index**	**g-Index**	**m-Index**	**AC_{50}**	**IF (JCR, 2020)**
Journal of High Energy Physics	331	10,570	31.93	54	89	4.58	58	5.88
Physics Letters B	224	16,581	74.02	54	125	2.45	64	4.38
European Physical Journal C	139	6,582	47.35	41	78	3.0	29	4.39
Physical Review D	125	3,672	29.38	32	58	1.45	22	4.83
Physical Review Letters	117	6,915	59.1	46	82	3.29	39	8.39
Physics of Plasmas	75	1,623	21.64	25	36	1.39	6	1.83
RSC Advances	53	839	15.83	18	25	2.0	2	3.12
Journal of Instrumentation	50	4,557	91.14	32	43	2.67	20	1.45
Journal of the Indian Chemical Society	41	92	2.24	41	5	0.23	0	0.23
Physical Review C	40	1,335	33.38	11	34	0.58	5	2.99

AC_{50}= Number of articles having at least 50 or more citations

Out of preferred journals top 6 are on Physics and its allied disciplines. There is only one Indian journal out of top 10 preferred journals contributed only 41 articles (0.98 %).The m-Index and g-Indexhavealso been calculated to measure the citation impact of source journals over a period of years andthe distribution of citations received by a researcher's articlesrespectively.To calculate the m-Index for a particular year, the h-Index for that particular year has been divided by number of citation years. The *Journal of High Energy Physics*hasreceived the highestm-Index of 4.58 whereasthejournal *Physics Letters B*has received the maximumg-Indexof 125.

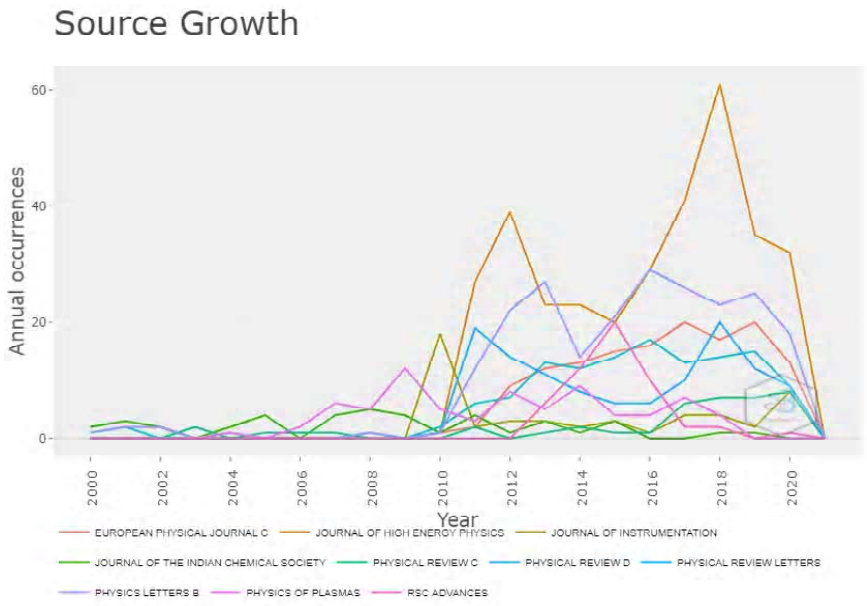

Figure1 - Top tendynamic sources

Figure 1 reflects that the *Journal of High Energy Physics* isthe most preferred choice of the authors up to 2018.

Productive authors

Table 10 - Top 10 prolific authors

Authors	Department	No. of articles	Sum of times cited	Citations / article	h-index
Maity, Manas	Physics	991	50,203	50.66	100
Sarkar, Tanmay	Physics	358	11,457	32.00	48
Bhowmik, Sandeep	Physics	184	10,361	56.31	50
Ghosh, Manas	Chemistry	139	1,550	11.15	19
Sarkar, Pranab	Chemistry	135	1,720	12.74	23
Hajra, Alakananda	Chemistry	132	3,931	29.78	34
Chatterjee, Prasanta	Mathematics	125	2,182	17.46	26
Majee, Adinath	Chemistry	108	2193	20.31	27
Brahmachari, Goutam	Chemistry	94	1,604	17.06	23
Misra, Amar Prasad	Mathematics	70	1,154	16.49	21

ManasMaity of the Physics Department has published a maximum of 991 articles but, the articles of *Sandeep Bhowmik*have received the maximum citations with 56.31 citations per article.

Leading collaborative institutions

Table 11 - Top 10 collaborating institutions					
Collaborating institutions	**Country**	**Articles**	**Sum of times cited**	**Citations/ article**	**h-index**
Russian Academy of Sciences	**Russia**	**1,039**	**50,564**	**48.67**	**100**
Bhaba Atomic Research Centre (BARC)	India	1,020	50,315	49.33	100
Centre National de la Research Scientific (CNRS)	**France**	**1,019**	**50,365**	**49.43**	**100**
University of Delhi	India	1,013	50,204	49.56	100
Tata Institute of Fundamental Research (TIFR)	India	1,002	50,116	50.02	100
Saha Institute of Nuclear Physics	India	1,001	46,518	46.47	97
State University System of Florida	**USA**	**1,000**	**50,433**	**50.43**	**100**
Punjab University	India	**999**	50,105	50.16	100
University of California System	**USA**	**996**	**50,381**	**50.58**	**100**
Istituto Nazionale di FisicaNucleare (INFN)	**Italy**	**993**	**50,150**	**50.5**	**100**

Citation Source: WoS Database

Leading collaborative countries

Table 12 -Top 10 countries of collaboration				
Country	**Articles**	**Sum of times cited**	**Citations/ article**	**h-index**
USA	1,126	52,602	46.72	102
Germany	1,069	51,627	48.29	101
Russia	1,056	50,834	48.14	100
France	1,040	1,040	48.77	100
Peoples R China	1,037	50,718	48.91	100
England	1,019	50,846	49.90	100
Italy	1,017	50,689	49.84	100
Poland	1,016	50,382	49.59	100
Spain	1,010	50,894	50.39	101
Greece	**1,007**	50,154	49.81	100

Citation Source: WoS Database

The authors of Visva-Bharati have collaborated with the authors of 86 countries. Out of these, the *United States of America (USA)* takes the lead with 1,126 articles followed by the countries *Germany* with 1,069 articles. Significantly, the 1,010 collaborated articles with *Spain*have received the highest of 50.39 average citations per article (Table 12).*Mapping of the top 10 collaborating countries with Visva-Bharati* has been sketched in Figure 2 using VOSviewer software

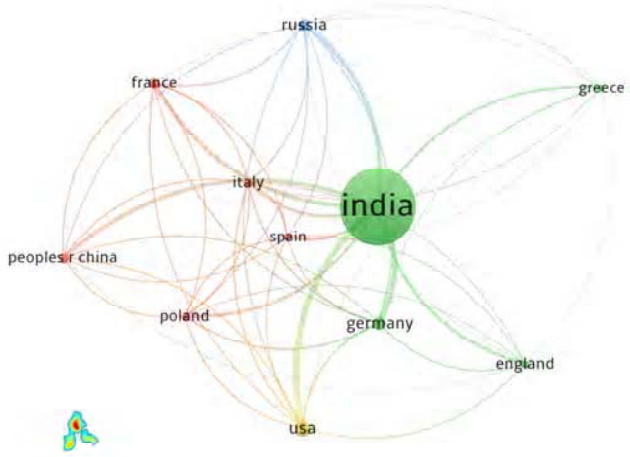

Figure2 - Mapping of top 10 collaborating countries with Visva-Bharati

Multiple correspondence analysis

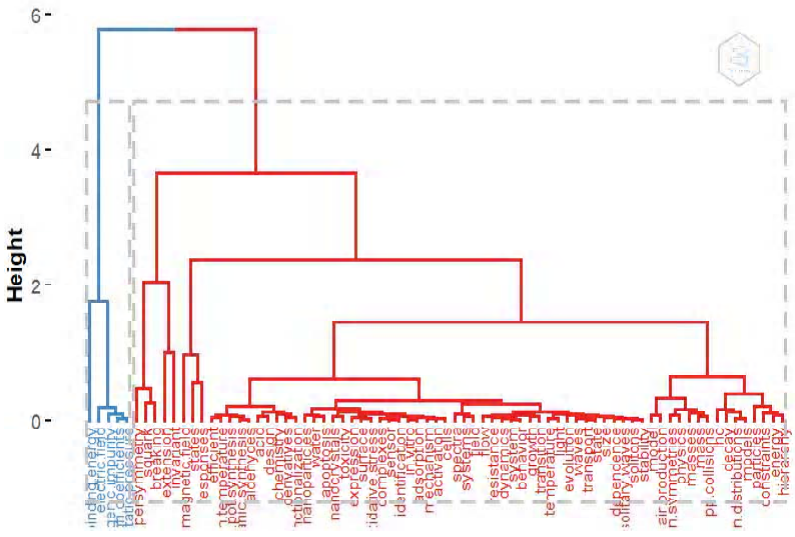

Figure3–Topic dendrogram of keywords

CONCLUSION

An insight into the scientific research progress of Visva-Bharati can be observed from this study. Relatively publications of science departments of agriculture are low because the departments have been established in recent years.The findings might encourage the scholars towards more contribution in research productivity. The study also focuses the need of more international collaboration for high impact factor as well as for international reorganization. The present study might draw the attention ofappropriate fund agencies towards focused and emerging areas of research.It mayact as a blueprint and helpful reference for the authority, researchers and other academics towards decision making for scientific research.

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