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Rabindra K. Maharana

National Institute of Science Education and Research (NISER), maharana.rabindra@gmail.com

Bipin Bihari sethi

Sambalpur University, bipin_bihari_sethi@hotmail.com

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**A bibliometric analysis of the research output of Sambalpur University's publication in ISI
Web of Science during 2007-11**

Rabindra K. Maharana

Technician (Library)

National Institute of Science Education & Research (NISER)

IOP Campus, Sachivalaya Marg, Sainik School,

Bhubaneswar-751005

E-mail: maharana.rabindra@gmail.com

Bipin Bihari Sethi

Professional Assistant

Prof. B. Behera Central Library,

Sambalpur University, Sambalpur-768019

E-mail: bbs21111967@gmail.com

Abstract: The present study is a bibliometric assessment of scientific research output of Sambalpur University during the 2007 to 2011. Which describes the growth, contribution and impact of research carried out by the faculty members, researchers or students of Sambalpur University. It also attempts to analyze the growth and development of research activity of the university as reflected in publications output covered by ISI Web of Science during the period under study. The study attempt to examines the content of papers published, including the annual average growth rate percent, authorship pattern, degree of collaboration, distribution of citations, organizational affiliation of papers. Subramanyam's formula is used to calculate degree of collaboration (C), Bradford's law used to determine scattering of literature in the publication pattern of the university.

Keywords: Bibliometrics, Sambalpur University, Web of Science, Bradford's Law, Degree of Collaboration.

Introduction

Bibliometric analysis is currently used for evaluating the qualitative and quantitative interest in a specific field through the analysis of publications. This method is currently used in the sciences of information to describe patterns of publications within a given field. Bibliometrics refers to research methodology employed in library and information sciences, which utilizes quantitative analysis and statistics methods to describe distribution patterns of articles with a given topic (Almind and Ingwersen, 1997), field (Campanario et. al., 2006), institute (Moed et. al., 1985) or country (Schubert et al., 1989). These methods have been used to investigate research trends of specific fields recently (Vergidis et. al., 2005; Falagas et. al., 2006; Kumari, 2006).

Literature review

Bibliometric methods have been used to measure scientific progress in many disciplines of science and engineering and are a common research instrument for systematic analysis (Van Raan, 2005). Since Narin et al. (1976) first proposed the concept of “evaluative bibliometrics”, many scientists have tried to evaluate the research trend in the publication outputs of countries, research institutes, journals and subject category (Garcia-Rio et al., 2001; Zhou et al., 2007), the citation analysis (Cole, 1989) and the peak year citation per publication (Chuang et al., 2007; Li and Ho, 2008).

Jeevan and Gupta have analyzed the contribution and impact of Indian Institute of Technology, Kharagpur by suggesting a methodology the quantitative profile of a research cum teaching institute, with a view to get idea about its performance an impact. Similarly Singh et. al. studied the research contribution and impact of Indian Institute of Technology, Roorkee from 1993 to 2001. Employing a variety of bibliometric methods, including publication and citation analyses, Bonnevie (2003) investigated a multifaceted portrait of the *Journal of Information Science*, focused on the last quarter of the 20th century. The areas of study included the visibility of the journal in databases, the pattern of authorship, the pattern of self-citation, internalization and scientific impact. The study revealed that 2,140 JIS publications in the SSCI and LISA, with 1,228 (57.4%) in SSCI and 912 (42.6%) in LISA, respectively.

Tsay (2008) explored the relationship between *Journal of the American Society for Information Science & Technology (JASIST)* and other disciplines by drawing citation data from references of articles of *JASIST* in 1980, 1985, 1990, 1995, 2000 and 2004. The results of this study revealed that the production rate of *JASIST* literature doubled and the average number of references cited per paper is also increased 2 to 3 times in a period of about 25 years. Singh (2013) in a bibliometric analysis of the *Chinese Librarianship: an International Electronic Journal (2009-2012)* found that in the year 2012 maximum number of papers published compared to other years, India is the most prolific country and among all the contributors most are related to non-teaching professionals.

Swain (2011) in his scientometric analysis of *Library Philosophy and Practice* from 2004 to 2009 found that the degree of collaboration in LPP ranged from 0.222 to 0.52 and the highest numbers of contributors hailed from Nigeria, followed by USA, India, and Iran. Hussain and Fatima (2011) in their study a bibliometric analysis of the *Chinese Librarianship: an International Electronic Journal (2006-2010)* found that USA is the most prolific country; highest paper cite the journal *Interlending and Document Supply*; the majority of papers were contributed by single authors.

Objectives

- To measure the research output of the university;
- To identify the most prolific authors during the period;

- To identify the authorship pattern the papers published;
- To identify the journals which were most preferred by the researchers of the university;
- Measure the most cited journals during the period under study;

Methodology

One common method of bibliometric research is to trace publications using the SCI of the Institute for Scientific Information (ISI), Philadelphia (Fu et al., 2010). The present study covers research publications of various departments of Sambalpur University during 2007 to 2011. It access the university's contribution and impact of research in different field of science and technology. The publication data of the university has been drawn from Web of Science database. Web of Science is published by Thomson Reuters, USA, it is an online version of Science Citation Index (SCI), a citation Index published by *Institute for Scientific Information (ISI)*, Philadelphia. For information retrieval "Sambalpur University" and "India" were the keywords used as address and 2007-01-01 to 2011-12-31 selected as the time span of study. Further, the result was refined only to article. Finally 170 research papers in different disciplines of science and technology retrieved matched with Sambalpur University as author's affiliation/ address. Aspects referring to type of document, subject category, journal, country, departments, keywords and h-index were analyzed with MS-Excel.

The screenshot displays the Web of Knowledge interface. The browser address bar shows the URL: `apps.webofknowledge.com/summary.do?SID=W19goCfcPJo23cGldf9&product=WOS&qid=58&search_mode=Refine`. The page header includes the "WEB OF KNOWLEDGE" logo and the Thomson Reuters logo. Navigation links include "Sign In", "Marked List (0)", "My EndNote Web", "My ResearcherID", "My Citation Alerts", "My Saved Searches", "Log Out", and "Help".

The main content area shows the search results for the query: `Address=(Sambalpur University) AND Address=(india)`. The results are refined by "Document Types-(ARTICLE)", "Timespan=2007-01-01 - 2011-12-31", "Databases=SCI-EXPANDED", and "Lemmatization=On". There are buttons for "Create Alert" and "RSS".

The results section indicates 170 results. The first result is:

- Title: **A note on magnetization of high temperature superconductors (YBCO, BSCCO) in mixed state**
- Author(s): Kalita, B.; Pattanaik, A.; Nayak, P.; et al.
- Source: PHYSICA C-SUPERCONDUCTIVITY AND ITS APPLICATIONS Volume: 471 Issue: 23-24 Pages: 1664-1668 DOI: 10.1016/j.physc.2011.09.002 Published: DEC 2011

A "Refine Results" sidebar is visible on the left, showing "Web of Science Categories" with options for "CHEMISTRY MULTIDISCIPLINARY (20)" and "ASTRONOMY ASTROPHYSICS (18)".

Analysis & discussion

Details of publication

Sambalpur University published a total of 170 research papers in different disciplines of science and technology during 2007 to 2011, as seen from the Web of Science database. During these period its publications output rose continuously, growing by more than two times from 2007 to 2011. Its annual growth rate is average 30.53%. Table-1 gives a detailed overview of publications with their citations details as 170 papers are totally 541 times cited, 445 times cited without self-citations with an average of 3.018 citations per paper and h-index of 11.

Table-1 Details of publication

Total results	170
Sum of times cited	541
Sum of times cited without self-citations	445
Citing articles	422
Citing articles without self-citations	370
Average citations per item	3.018
h-index	11

Annual distribution of publication

Table-2 gives the annual distribution of papers, out of 170 papers published maximum number of 49 (28.82%) papers are published in 2011 followed by 2009 (22.94%); 2008 (19.41%); 2010 (16.47%) and 2007 (12.35%) respectively. The range of papers published per year during the period under study is in between 21- 49.

Table-2 Annual distribution of publication

Year	No. of publication	Percentage (%)	Annual average growth rate percent (%)
2007	21	12.35	--
2008	33	19.41	57.14286
2009	39	22.94	18.18182
2010	28	16.47	-28.2051
2011	49	28.82	75
Grand Total	170	100	Ave 30.53

Period-wise authorship pattern of publication

Table-3 gives a detailed overview of authorship pattern of papers published during 2007 to 2011. It is observed that out of 170 contributions, a total of 50 (29.41%) contributions have

been contributed by four authors followed, by three authors (28.82%), two authors (17.06%), seven and more than seven authors (11.18%) respectively.

Table-3 Authorship pattern of papers published during 2007-2011

Year	One	Two	Three	Four	Five	Six	≥Seven	Total
2007	--	3	8	4	4	0	2	21 (12.35)
2008	--	9	10	9	1	1	3	33 (19.42)
2009	1	3	9	17	3	1	5	39 (22.94)
2010	--	6	5	11	0	4	2	28 (16.47)
2011	--	8	17	9	5	3	7	49 (28.82)
Grand Total	1 (0.59)	29 (17.06)	49 (28.82)	50 (29.41)	13 (7.65)	9 (5.29)	19 (11.18)	170 (100)

Note: Figures in parentheses represented percentage.

Author productivity

A total of 707 authors produced 170 papers with an average of 4.16 authors per paper and 0.24 paper per author (Table-4). Out 707 total authors 317 authors are affiliated to Sambalpur University, with an average of 1.87 authors per paper and 0.54 paper per author. Further, it shows that in 2009 maximum number of authors (84) are affiliated to the university.

Table-4 Author productivity

Year	Total no. of papers	Total no. of authors	Total AAPP	Total PPA	Authors only affiliated to SU	AAPP (SU)	PPA (SU)
2007	21	81	3.86	0.26	39	1.86	0.54
2008	33	125	3.79	0.26	66	2	0.5
2009	39	177	4.54	0.22	84	2.52	0.47
2010	28	113	4.04	0.25	51	1.83	0.55
2011	49	211	4.31	0.23	77	1.58	0.64
Total	170	707	4.16	0.24	317	1.87	0.54

Note: Average Authors Per Paper (AAPP) = Number of authors/ Number of papers.

Productivity per author (PPA)= Number of papers/ Number of authors.

Subject-wise rank distribution of publication

The subject-wise rank distribution of publication is listed in Table-5, which shows Chemistry is the most favoured area of research among the research community of Sambalpur University with 27.65%, followed by Physics (24.12%), Astronomy & Astrophysics and Plant Science with 10.59% each. Engineering and Materials Science stood at the fourth position with 7.65% each.

Table-5 Major research areas

Rank	Top 10 Research Areas	No. of publication (N=170)	Percentage (%)
1	Chemistry	47	27.65
2	Physics	41	24.12
3	Astronomy & Astrophysics	18	10.59
3	Plant Science	18	10.59
4	Engineering	13	7.65
4	Materials Science	13	7.65
5	Biochemistry Molecular Biology	11	6.47
6	Environmental Sciences Ecology	6	3.53
6	Optics	6	3.53
7	mathematics	5	2.94
7	Pharmacology Pharmacy	5	2.94
8	Biotechnology Applied microbiology	4	2.35
8	Energy Fuels	4	2.35
8	Science Technology & Others	4	2.35
9	Crystallography	3	1.77
9	Metallurgy & Metallurgical Engineering	3	1.77
9	Telecommunications	3	1.77
10	Agriculture	2	1.18
10	Computer Science	2	1.18

Degree of collaboration

Degree of collaboration is an examination of the prominent area of inquiry in bibliometric studies indicating the trend in patterns of single and joint authorship in the publication of Samblapur University during the period under study, as shown in Table-6. The degree of collaboration “C” is 0.99 (nearly equals to 1) that means there is few/ negligible contributions by single authors.

The extent of collaboration in research can be measured with the help of the formula:

$$C = \frac{N_M}{N_M + N_S}$$

Where, C= Degree of Collaboration

N_M = Number of multiple authors

N_S = Number of single authors

Table-6 Degree of collaboration

Year	Single authored paper (N _S)	Multiple authored paper (N _M)	N _M +N _S	Degree of Collaboration (C)
2007	--	21	21	1

2008	--	33	33	1
2009	1	38	39	0.97
2010	--	28	28	1
2011	--	49	49	1
Total	1	169	170	0.99

Bradford's law and distribution of core journals

Bradford stated that "if scientific journals are arranged in order of decreasing productivity of articles on a given subjects, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus and succeeding zones will be as 1:n:n²...".

The journal distribution of Table-7 shows that there was a tremendous scattering of literature in the publication pattern of the university. Further, it shows that the first zone or nucleus contains four journals which covered about one-third of the total papers, followed by second zone with nine accounted for another one-third and the third zone with 88 journals covered the remaining third zone.

Table-7 Ranking of contributing journals published two or more papers

Rank	Most favored journal for publication	No. of paper	Percentage (%)	Cumulative	
				No. of papers	Percentage (%)
1	Astrophysics and Space Science	17	10	17	10
2	Journal of The Indian Chemical Society	8	4.71	25	14.71
3	Indian Journal of Chemistry Section A Inorganic Bio Inorganic Physical Theoretical Analytical Chemistry	6	3.53	31	18.24
3	Optics Communications	6	3.53	37	21.76
3	Plant Science	6	3.53	43	25.29
4	Journal of Colloid and Interface Science	5	2.94	48	28.24
4	Physical Review C	5	2.94	53	31.18
5	International Journal of Theoretical Physics	4	2.35	57	33.53
6	Energy Fuels	3	1.76	60	35.29
6	Plant Growth Regulation	3	1.76	63	37.06
7	Acta Crystallographica Section E Structure Reports Online	2	1.18	65	38.24
7	European Physical Journal A	2	1.18	67	39.41
7	Industrial Engineering Chemistry Research	2	1.18	69	40.59
7	International Journal of Modern Physics B	2	1.18	71	41.76
7	International Journal of Modern Physics E Nuclear Physics	2	1.18	73	42.94
7	Journal of Alloys and Compounds	2	1.18	75	44.12

7	Journal of Heterocyclic Chemistry	2	1.18	77	45.29
7	Journal of Physics G Nuclear and Particle Physics	2	1.18	79	46.47
7	Letters in Drug Design Discovery	2	1.18	81	47.65
7	Materials Letters	2	1.18	83	48.82
7	Nuclear Physics A	2	1.18	85	50
7	Phosphorus Sulfur and Silicon and the Related Elements	2	1.18	87	51.18
7	Photosynthetic A	2	1.18	89	52.35
7	Physic A B Condensed Matter	2	1.18	91	53.53
7	Plant Physiology and Biochemistry	2	1.18	93	54.71
7	Synthetic Communications	2	1.18	95	55.88
8	Journal with single paper	75	44.1	170	100
Grand Total		170	100	--	--

Figure 2 shows Bradford's distribution of core journals on the publication pattern of Sambalpur University during 2007 to 2011. Altogether there were 101 journals represented by 170 papers. Out of these, one journal alone published 17 papers, 6 journals published 5 to 8 papers, 19 journals published 2 to 4 papers and remaining 75 papers are scattered among 75 journals (Table-7). In Bradford's distribution, core journals are those that lay on the initial curved part of the "S" shaped plot until it tangentially becomes a straight line. Here, in figure-2, the slope of the curve also decreases slightly after the 4th journal, so these journals may be regarded as the core journals on the research publication of Sambalpur University during 2007 to 2011.

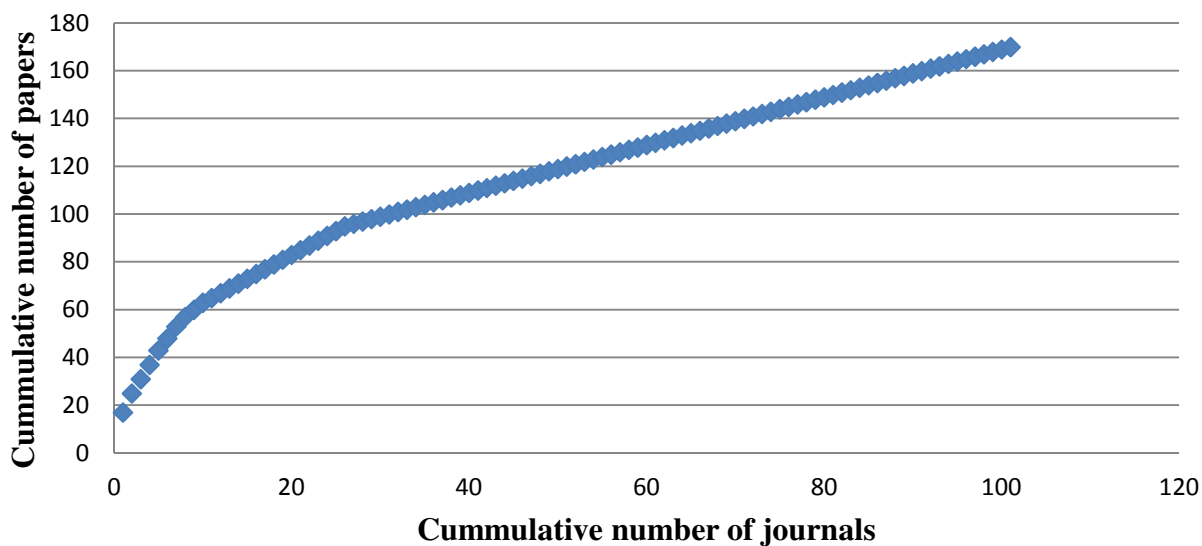


Fig. 2- Bradford's distribution

Length of paper published

The length of papers of researchers of Sambalpur University which have been published in different journals of scientific repute during 2007 to 2011 is listed in Table-8, which shows more than half of the papers are in between 6-10 pages in length i.e. 86 (50.59%), followed by 47 (27.65%) papers in between 1-5 pages, 22 (12.94%) papers in between 11-15 page range respectively.

Table-8 Length of paper published during 2007-2011

Page range	2011	2010	2009	2008	2007	Total
1-5	13	8	8	11	7	47 (27.65)
6-10	26	12	18	20	10	86 (50.59)
11-15	7	5	6	2	2	22 (12.94)
16-20	2	2	2	0	1	7 (4.12)
21-25	1	0	3	0	1	5 (2.94)
≥ 26	0	1	2	0	0	3 (1.76)
Grand Total	49 (28.82)	28 (16.47)	39 (22.94)	33 (19.42)	21 (12.35)	170 (100)

Most prolific institution/ organizations

Table-9 shows the most prolific contributor during the period under study. With 170 (100%) publication authors affiliated with Indian Institute of Technology contribute 20 (11.76%) followed by National Institute Technology (8.23%)

Table-9 Most prolific institution/ organization

Rank	Most prolific Institution/ Organizations	No. of publication (N=170)	Percentage (%)
1	Sambalpur University	170	100
2	Indian Institute of Technology	20	11.76
3	National Institute of Technology	14	8.235
4	Birla College of Engineering	10	5.882
5	Sundargarh Engineering College	9	5.294
6	Hiroshima University	8	4.706
7	Institute of Physics	7	4.118
8	Hope College	6	3.529
8	Panjab University	6	3.529
9	Bhabha Atomic Research CTR	5	2.941
9	CAIRO University	5	2.941
10	Anchal College	4	2.353
10	Berhampur University	4	2.353
10	CSIR	4	2.353

Prolific author during 2007-2011

Table-10 lists the prolific authors of Sambalpur University identified in the study who produced 7 or more papers in the field. On the whole, a total of 707 authors contributed 170 papers during the period under study out of which only 295 contributors affiliated to various departments of the university.

Table-10 Most prolific authors

Rank	Name of author	No. of publication (n=170)	Percentage (%)
1	B.K. Mishra	28	16.47
2	P.K. Mohapatra	19	11.18
3	B. Behera	17	10
4	P. Nayak	16	9.412
4	S. Patel	16	9.412
5	T.R. Routray	14	8.235
6	R.N.P. Choudhury	13	7.647
7	S.K. Tripathy	12	7.059
8	G. Mohanty	11	6.471
9	S.P. Pati	10	5.882
10	P.K. Mishra	9	5.294
11	S. Dash	8	4.706
11	D.C. Dash	8	4.706
11	S. Ghosh	8	4.706
11	S. Panigrahi	8	4.706
11	S. Sahu	8	4.706
12	B. Biswal	7	4.118

Most prolific department

Out of 170 research output of the university (table-11), Department of Chemistry contributed maximum number of papers with 35.29% during the period under study, followed by Department of Physics with 57 papers; Department of Life Science with 30 papers; Department of Mathematics with 18 papers. Department of Earth Science, Environmental Science, Home Science, Library & Information Science and Statistics each have single contributions.

Table- 11 Most prolific department

Rank	Name of the department	No. of contributions	Percentage (%)
1	Chemistry	60	35.29
2	Physics	57	33.53
3	Life Science	30	17.64

4	Math	18	10.59
5	Earth Science	1	0.59
5	Environmental Science	1	0.59
6	Home Science	1	0.59
6	Library & Information Science	1	0.59
6	Statistics	1	0.59
Grand Total		170	100

Geographical distribution of publication during 2007-2011

Distribution of research output by geographical regions illustrates the collaboration of other countries with the researchers/ scholars of Sambalpur University. On the whole 170 contributors belonging to India (sambalpur university), the collaborative contributors are from USA with 5.29%, Japan (4.71%), Egypt (2.94%), Austria (1.77%), Canada and South Korea with 0.59% each respectively.

Rank	Country	No. of publication (N=170)	Percentage (%)
1	India	170	100
2	USA	9	5.29
3	Japan	8	4.71
4	Egypt	5	2.94
5	Austria	3	1.77
6	Canada	1	0.59
6	South Korea	1	0.59

Findings/ Conclusion

The followings are the key findings of the present study:

1. The publication range of the university ranges between 21 papers to 49 papers during the period with an annual average growth rate percent of 30.53.
2. Maximum number of four authored papers (29.41%) published which is followed by three authors (28.82%), two authors (17.06%), seven or more than seven authored papers (11.18%) etc.
3. A total of 707 authors contributed 170 number of papers out of which 317 authors are affiliated to Sambalpur University and only one paper has single authored which resulted high degree of collaboration (0.99).
4. Chemistry is the most favoured research area followed by Physics (24.12%), Astronomy and Astrophysics (10.59%), Plant Science (10.59%), Engineering (7.65%), Materials Science (7.65%) etc.

5. Astrophysics and Space Science is the most favoured journals for publication among the researchers of the university with 17 (10%) papers, followed by Journal of The Indian Chemical Society with 8 (4.71%) papers and Indian Journal of Chemistry Section A Inorganic Bio Inorganic Physical Theoretical Analytical Chemistry with 6 (3.53%) papers, further it has been observed that these three journals alone consists one third of papers published during the period.
6. Indian Institute of Technologies were the most prolific institution next to Sambalpur University, which is followed by National Institute of Technology, Birla College of Engineering etc.
7. Prof. B.K. Mishra from Department of Chemistry with 28 (16.47%) contributions stood at the 1st position followed by, Prof. P.K. Mohapatra with 19 (11.18%) papers, Prof. B. Behera with 17 (10%) papers.
8. P.G. Department of Chemistry is the most prolific department and all the 707 contributors are scattered among India with 6 foreign countries.

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