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A Scientometric Assessment of the Research Output of the Sambalpur University during 1990-2019

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Abstract

The significance of scientometric assessment in measuring the research performance and decision making process is well known to the academic community. This paper illustrates the result of a scientometric assessment of the research publications of the Sambalpur University, Odisha, India over the period 1990 to 2019. The SCOPUS database of Elsevier is used to pile-up the data. Various scientometric parameters are used for assessing the growth and measuring its implications. The analysis and visualization has been performed based on the total publication output, its growth rate, quality of papers published, global ranking, national and international levels of collaborative papers share, citation impacts etc. A total of 1527 publications with 15,440 citations (ACPP 9.88%) appeared during the period of assessment. A fluctuation trend in research productivity has been primarily observed. Over the study three author papers contributions have appeared more in number and found the DC as 0.95 and the CC as 0.62 and it shows the existence of collaborative research work. The United States and Japan are the two countries that made significant research collaborations with Sambalpur University. The weak collaboration link between highly cited authors also indicates that collaborative research team work in this field does not exist much. It is apparent from the study that the two decades of research activities in Sambalpur University is not quite up to par when compared to the similar other universities however there is a significant enhancement in the number of publications after 2010. The present study gives hope that this will direct authoritatively, policy makers, funding agencies and the researchers new pathways towards increase of research and development activities thereby enhancing the research output through quality publications.

Keywords: *Scientometrics, Sambalpur University, Indian publications, research, visualization*

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1. Introduction

The research publications produced by an institution emphasized as a means of measuring criteria for highlighting its performance. For an academic institution it is a part of the academic life which builds the system efficient and productive. Further, the government and the funding agencies have started allocating funds on the basis of performance and research output. Scientific publications through collaborations enhance its visibility at global level and bring more recognitions and financial incentives to the organization. Universities develop their research output as a source of new knowledge and also provide academic support to develop the country for the knowledge based society. Research must be carried out scientifically to find solutions to problems using valid and reliable research methodology and tools. Scientometric tools and techniques are effective mechanisms that can be used as research performance assessment measures to indicate the performance and reputation of researchers as well as institutions. As an innovative tool for evaluation scientometrics deal with the assessment of scientific activities including research publications, academic and scientific achievements. Such studies can greatly facilitate the policy makers in analysing the research trends, performance and productivity and to determine the future measures to improve its efficiency.

Sambalpur University is located at Jyoti Vihar in Burla town of Sambalpur district of Odisha state in India. The university was established in 1967 and is being accredited with Grade-A by the National Assessment and Accreditation Council (NAAC), an organisation that assesses and accredits the Higher Education Institutions in India of University Grants Commission (UGC). Being an academic institution to provide quality education and research, the university offers various Post Graduate, M.Phil, Ph.D, and integrated B.Ed/M.Ed degree programs under different disciplines such as finance Control, Biotechnology, Bioinformatics, Food science and technology, etc. Faculties of the university are publishing their research output in different journals which are indexed and recognized by leading publishers and promoters.

The purpose of this study is to examine the research productivity of Sambalpur University using various scientometric parameters. The study illustrates the result of a scientometric assessment of research productivity over the period 1990 to 2019. The tool used to extract the data for the selected period is the Scopus database, a globally leading indexing and citation analysis database of Elsevier. Different criteria and scientometric parameters are used for the

assessment. Various qualitative and quantitative measures are used to perform the analysis and visualization. Findings and conclusions of the study are formulated based on the total publication output, its growth rate, quality of papers published, global ranking, national and international levels of collaborative papers shared, citation impacts etc.

2. Review of Literature

Authors have performed an exhaustive study on the scholarly sources published on scientometric assessments of various organizational research output. There are many such studies conducted by different authors by choosing different organizations at different periods using different data analysing tools. Following are the essence of some of such similar research studies performed to support the present study.

Hugar (2019) analyzed the scientific publications of the University of Goa that appear in the Web of Science (WoS) database for the period 2008 to 2017. In this study, there were a total of 1218 articles, of which 497 articles with international collaborations are chosen for analysis. The study found that the majority of 315 (25.86%) publications are listed under the selected categories belong to Chemistry subjects. Author also observed that the relative growth rate of total research output is decreased gradually and mentioned that SJR and the h-index are the highest for the magazine "Fungal Variety".

Pradhan & Mahapatra (2018) analyzed the research output of Utkal University, which were recorded in the Scopus database. In this study, 1091 documents were taken from the Scopus database for analysis and the authors found that the publishing trend is increasing from year to year, but 2013 and 2017 are lower than in previous years. Physics and Astronomy were the areas in which the university faculties published more works with 197 (11%) publications, and the university also has a number of foreign collaborations with US and Italy. Mishra (2017) also analysed the research productivity of Utkal University from 2004 to 2014. The study's findings suggested that each university department has produced a large number of publications during the period at global level.

Bapte & Gedam (2018) conducted a scientometric study on the publication output of University of Amravati Sant Gadge Baba Amravati (SGBAU) between 1996 and 2017. The Scopus database was chosen for the data collection. A total 1130 papers were published during the study period with 10.65 % average citations per paper. Result of the study indicated that 83.98 % papers were published during 2007 to 2017 which was a highly

productive year compared to 16.02% research output from 1996 to 2006. SGBAU, Amravati has the largest collaboration with Brazil (69) and United States (21) during the period of study. Collaborative authorship pattern has received maximum citations (89.17%) and the average degree of collaboration was shown 0.96 while the average modified collaborative coefficient was 0.6289. It was also found that Journal and Conference papers were the most preferred source of publication by the faculty of SGBAU.

Teli & Dutta (2018) examined the growth of research performance of Vidyasagar University that was reflected in the Web of Science (WoS) database from 1989-2014. During the period the university published a total of 986 articles and received 8,188 citations with an average of 8.3 per article (ACPP). The results showed that authors were dominated by three authors (27.3%), followed by two articles by authors (18.4%) and four articles by authors (18%). The most preferred journal of publication was Carbohydrate Research Journal followed by Applied Mathematical Models and Carbohydrate Polymers.

Kumar et al. (2017) reviewed 2361 publications from Kurukshetra University as reflected in the Scopus database between 2006 to 2015. Authors used a number of quantitative and qualitative parameters to quantitatively evaluate the research output and found that the average annual growth rate of the university was 13.25%, and with the baseline 4.85 in 2006-2015, which fell from 8.23 in 2006-10 to 3.06 in the period 2011-2015. The share of national and international cooperation publications on the total production was 38.54% and in the period 2006-2015 it was 9.11%. Study showed that the top 23 authors contributed 53.28% and 78.03% to the total production of publications and citations occurred during the period 2006-2015. The University's contribution to the 20 most productive journals represented 20.03% of total publications between 2006 and 2015, representing from 20.48% to 19.77% between 2011-2015.

Nagorajan (2016) conducted a scientometric study to analyze the research output in the field of Science in the Universities of Tamil Nadu between 1991 and 2015. The research trends showed a positive increase in research results at public universities. The authors analyzed the number of publications, the structure of the authors, the distribution of publications on topics and the distribution of publications by country. The three author surveys account for more than a quarter of the total publication.

Senthilkumar and Ulaganathan (2016) analyzed the research output of Annamalai University with the support of data retrieved from the Citation Index of India. Study found that out of 3901, maximum number of 454(11.63%) articles published in 2010 and minimum of 129(3.31%) was appeared in the year 2015.

Vellaichamy & Jeyshankar (2015) evaluated the publication pattern of Pondicherry University based on the data collected from Scopus database from 1987-2013 and found that majority (84.8%) of the researchers preferred to their research papers are joint authorship and the degree of collaboration ranges varies from 0.61 to 0.96. Study also found that Physics and Astronomy which produces more number of papers and S.A. Abbasi was the most prolific author with a contribution of 132 articles. Authors also found that the Journal of Acta Crystallographic a Section E Structure Reports Online (2.17%) is the most favoured journal to publish their work followed by Current Science 1.79%

Balasubramani and Parameswaran (2014) analysed the research productivity of the University of Banaras Hindu Banaras (BHU) during 2000-2011 and found a progressive growth in the number of publications. The average annual outcome of the BHU study was 578 records and was found to be very collaborative. Current Science was one of the most favourite journals and the Institute of Technology leads in publications productivity with 1482(21.3%) articles. Good number of authors have found worked with foreign authors also in their research.

Rautaray, Swain & Swain (2013) examined the research productivity of KIIT University, Odisha, India from the year 2000 to 2013 by measuring the authorship pattern, levels of collaboration, annual distribution of relevant articles and citations, distribution of articles by province, classification and author classification. articles, cooperatives, and other frequently cited variables. Authors found that much of the research conducted through co-authors and the collaborative research development was at its peak. The study also revealed that university authors published the maximum number of articles in computer science and information communication and the university's lead author had published 25 articles indexed by Scopus during the period of study.

Aswathy & Gopikuttan (2013) analysed the publication pattern of faculty members of three selected Universities in Kerala based on the authorship patterns, degree of collaboration, the appropriateness of Lotka's Inverse Square Law and year-wise and designation-wise

distributions. Authors found an increase pattern in the number of publications and found that though some authors were dominant among university teachers and there was no statistically significant difference in experience and productivity. The authors justified based on the level of co-operation by agreement and suggested that the teachers were very co-operative and as he or she gets older and more experienced, the subject becomes more supportive. Lotka 's inverse square law seems to be rejected in the current dataset.

Majhi and Maharana (2012) assess the intellectual output of the physical science researchers of the Sambalpur University since its inception, 1971-2010. Authors found that 120 authors of had contributed 417 items during the period 1971 to 2010 with a per capita productivity of 3.475. The The contributions in physical science literature found to be ranged from single authored publications to more than 10 authors.

From the literature review, authors also found that during the last decades numerous scientometrics studies were conducted and some are pertaining to universities research outcomes.

3. Scope and Limitations

The present study evaluates the research outcomes of Sambalpur University. The data pertaining to the research productivity of the Sambalpur University is extracted from the Scopus database using some selected scientometric indices. The scope of the study was further limited to a period of 30 years from 1990-2019.

4. Objectives of the study

The main objective of this study is to assess the research output of the Sambalpur University published during the past three decades ranging from 1990-2019. However the study aims to achieve the following specific objectives:

- To find out the year-wise growth pattern of research publications of Sambalpur University;
- To find out the Annual growth rate (AGR), relative growth rate (RGR) and doubling time (DT);
- To find out the degree of collaboration (DC) and Collaboration coefficient (CC);

- To identify the highly prolific authors and authorship pattern in research publications;
- To find out the most highly cited publications.
- To find out the Institutions collaboration and countries wise collaboration;
- To find out the highly preferred sources for publications;

5. Materials and Methods

Bibliometric analysis referred to the application of quantitative and statistical analytical techniques to publications, such as articles and their respective citations and used to evaluate research performance (Ellegaard et al., 2017, p.31). The purpose of this study is to put forward the image of University scientific development and trends in their published literature over 30 years. The source of data for the present bibliometric study was Scopus is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings, a product of Elsevier, Netherlands. Research work published by Sambalpur University during 1990-2019 was retrieved from the Scopus, the largest abstract and citation database, using the keywords "Sambalpur University ". The search string used for the study is AF-ID ("Sambalpur University " 60005302) and PUBYEAR after 1990 and Before 2019 and (limit-to (PUBSTAGE , "final")). A total 1527 records were found in the search result. Further, the study is based on the complete count of year-wise growth patterns of publications, authorship pattern, collaborative institutions, countries and document types. The retrieved data was analysed using the MS-excel sheet and for visualisation of data the Vosviewer software used.

5.1 Annual Growth Rate (AGR)

In scientometric studies often uses two measures to assess the growth rate of literature in any field. The first is the annual growth rate (AGR) and the second one is the relative growth rate (RGR). The annual growth rate (AGR) is determined using the following formula.

$$AGR = (end\ value - first\ value) / (first\ value) \times 100$$

5.2 Relative Growth Rate (RGR)

$$RGR = (1 - 2^r) = (\ln(w_2) - \ln(w_1)) / (T_2 - T_1)$$

Where,

w₁ = Total Number of Publications at Initial time.

w_2 = Total Number of Publications at Final.

$T_2 - T_1$ = Difference between the initial year and the final year the year can be taken here as the unit of time.

5.3 Doubling Time (DT)

The doubling time is used to indicate the amount of time it takes for a quantity to double in size or value. The formula used to calculate the doubling time is as follows:

$$\text{Doubling Time} = D(t)0.693/RGR$$

5.4 Degree of Collaboration (DC)

The DC is defined as the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period. The formula suggested by Subramanyam (1983) is used. It is expressed as:

$$DC = Nm/(Nm + Ns)$$

Where, DC- is the degree of collaboration in a discipline,

N_m - Is the number of multi-authored research papers in the discipline published during the year.

N_s - Is the number of single-authored papers in the discipline published during the same year.

5.5 Collaboration Coefficient (CC)

To measure the strength of collaboration the following formula of Collaboration Coefficient as suggested by Ajiferuke, Burell, & Tague (1988) has been used. The collaboration the Coefficient is a numerical value between 0 and 1. The more it is bigger than 0.5 the better is the collaboration rate among the authors. When it is near 0, it means that authors have a weak collaboration rate.

$$CC = 1 - (\sum_{j=1}^k (1/j) f_j) / N$$

Where; f_j = Total number of authored research papers

N = Total number of research papers published in a year

K = The greatest number of authors per paper in a discipline

6. Results and Discussions

6.1 Year-wise growth of publications and citations

Table 1 shows year-wise growth of publications and average citations per paper. A total of 1527 publications were discovered between 1990 and 2019. The highest number of publications i.e. 147 (9.62%) appeared in the year 2019 and the least 10 (0.65%) were in the year 1994. To know the publication quality, average citations per article is calculated. A total of 15,440 citations were received for all 1,527 publications. The average number of citations per article is ranged from 1.25 (2019) to 55.39 (2000) and the year 2000 has got the highest 1274 of citations followed by 2004 with 1198 citations. However, over the 20 years a fluctuating and gradual growth is observed both in publications and citations. Figure 1 represents the year wise statistics of publications with the citations.

Table-1: Year growth of publications and citations

| Year | TNP | % | TNC | ACPP | Year | TNP | % | TNC | ACPP |
|------|-----|------|------|-------|--------------|------|--------|-------|-------|
| 1990 | 24 | 1.57 | 187 | 7.79 | 2006 | 33 | 2.16 | 509 | 15.42 |
| 1991 | 23 | 1.50 | 486 | 21.13 | 2007 | 32 | 2.09 | 841 | 26.28 |
| 1992 | 13 | 0.85 | 187 | 14.38 | 2008 | 44 | 2.88 | 735 | 16.70 |
| 1993 | 12 | 0.78 | 149 | 12.42 | 2009 | 52 | 3.40 | 739 | 14.21 |
| 1994 | 10 | 0.65 | 104 | 10.40 | 2010 | 45 | 2.94 | 836 | 18.58 |
| 1995 | 15 | 0.98 | 354 | 23.60 | 2011 | 91 | 5.95 | 956 | 10.51 |
| 1996 | 36 | 2.35 | 277 | 7.69 | 2012 | 91 | 5.95 | 685 | 7.53 |
| 1997 | 28 | 1.83 | 423 | 15.11 | 2013 | 82 | 5.37 | 527 | 6.43 |
| 1998 | 32 | 2.09 | 231 | 7.22 | 2014 | 99 | 6.48 | 757 | 7.65 |
| 1999 | 30 | 1.96 | 287 | 9.57 | 2015 | 83 | 5.43 | 476 | 5.73 |
| 2000 | 23 | 1.50 | 1274 | 55.39 | 2016 | 116 | 7.59 | 548 | 4.72 |
| 2001 | 21 | 1.37 | 401 | 19.10 | 2017 | 99 | 6.48 | 528 | 5.33 |
| 2002 | 29 | 1.89 | 263 | 9.07 | 2018 | 136 | 8.90 | 435 | 3.20 |
| 2003 | 29 | 1.89 | 404 | 13.93 | 2019 | 147 | 9.62 | 184 | 1.25 |
| 2004 | 23 | 1.50 | 1198 | 52.09 | Total | 1527 | 100.00 | 15440 | |
| 2005 | 29 | 1.89 | 459 | 15.83 | | | | | |

*TNP=total number of publications, TNC=Total number of Citations, ACPP=average citation per paper

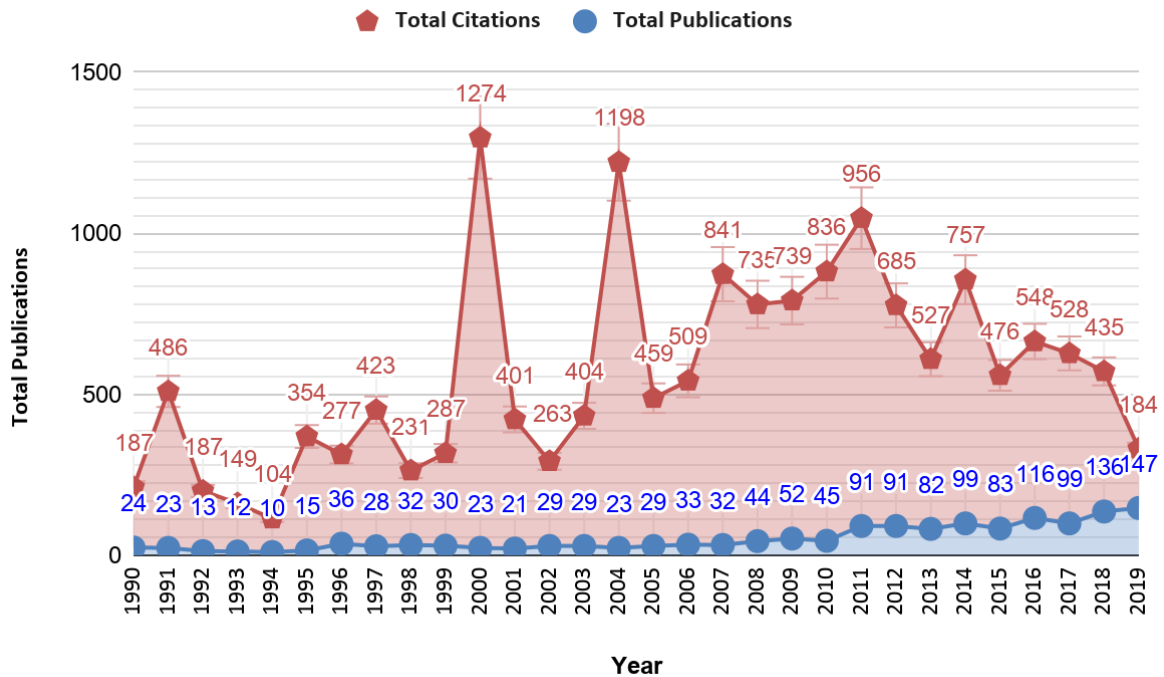


Fig.1: Year-wise distribute of publications with citations

6.2 Annual Growth Rate (AGR), Relative Growth Rate (RGR) and Doubling time (DT)

Figure 2 depicts the outline of annual growth rate (AGR), relative growth rate (RGR), doubling time (DT) of research papers published between 1990 and 2019. The Average Growth Rate, Relative Growth Rate, and Doubling Time are the measurement indicators used in scientometric analysis to assess the growth rate of the literature in any field. The AGR was calculated according to the formula and method used above and found a significant high of AGR 140 in 1996 and a low of -43.48 in 1992. Whereas, significant high of RGR 0.15 in 2011 and a low of 0 in 1990. Further, doubling times was calculated and varied between 0 to 10.13 and the highest 10.13 number occurred in 2004. The tendency of AGR, RGR and DT over the 20 years is inversely proportional in the Sambalpur University literature.

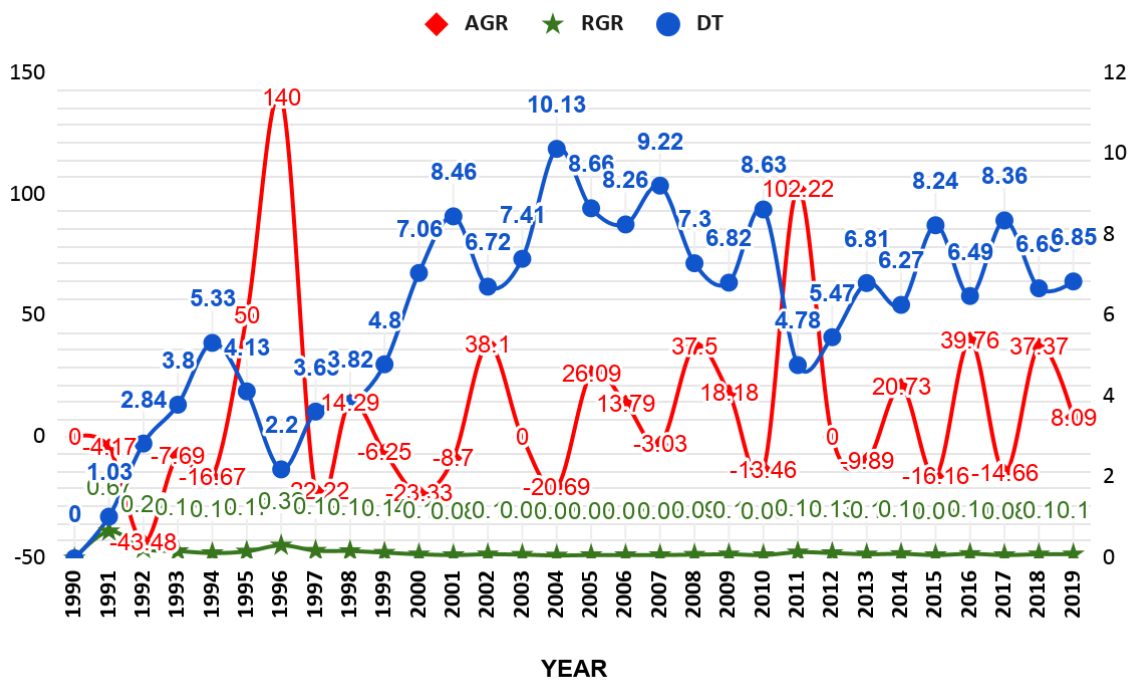


Fig.2: AGR, RGR & DT

6.3 Authorship Pattern, DC & CC

The authorship pattern appearing in the results of a publication by the Sambalpur University were calculated, and it was found that most publications (429) were prepared under three authorship patterns. This was followed by two authors 400, four authors 307, five and more authors 289, with the contribution of each author's contribution being less than 76. Table 2 illustrates the annual performances of the author patterns and shows that most publications follow co-writing standards rather than individual research.

Whereas collaboration coefficient is a measure which takes a more detailed account of multiple authorship in comparison to Degree of Collaboration and Figure 2 Shows year wise values of the collaboration coefficient (CC), it is calculated by the formulae (3) which discreetly accounts for various number of authors' contribution to a single publication. From the figure it is inferred that till 2019 collaborative publications had been very infrequent. The years 2013 and 2019 had seen larger collaborative contributions. In the year of 2012 collaboration was minimum with a value of CC as 0.09. Since 2012 CC has decreased trend and reached 0.66 in 2016. Over all in the past more scholars had been publishing on their own, but now more publications are being contributed by collaborative scholarly efforts, which is an indication of knowledge sharing among the authors of Sambalpur University.

Table-2: Authorship Pattern, DC & CC

| Year | One Author | Two Authors | Three Authors | Four Authors | Five and more authors | DC | CC |
|-------|------------|-------------|---------------|--------------|-----------------------|------|------|
| 1990 | 2 | 12 | 7 | 2 | 1 | 0.92 | 0.54 |
| 1991 | 1 | 9 | 5 | 7 | 1 | 0.96 | 0.60 |
| 1992 | 1 | 7 | 4 | 1 | 0 | 0.92 | 0.53 |
| 1993 | 2 | 6 | 1 | 1 | 2 | 0.83 | 0.50 |
| 1994 | 1 | 5 | 3 | 1 | 0 | 0.90 | 0.53 |
| 1995 | 3 | 5 | 4 | 2 | 1 | 0.80 | 0.50 |
| 1996 | 2 | 13 | 11 | 9 | 1 | 0.94 | 0.59 |
| 1997 | 0 | 9 | 8 | 7 | 4 | 1.00 | 0.65 |
| 1998 | 2 | 17 | 6 | 5 | 2 | 0.94 | 0.56 |
| 1999 | 2 | 12 | 7 | 5 | 4 | 0.93 | 0.59 |
| 2000 | 1 | 6 | 9 | 5 | 2 | 0.96 | 0.62 |
| 2001 | 0 | 8 | 7 | 5 | 1 | 1.00 | 0.63 |
| 2002 | 3 | 9 | 8 | 5 | 4 | 0.90 | 0.58 |
| 2003 | 0 | 8 | 8 | 3 | 9 | 1.00 | 0.67 |
| 2004 | 1 | 7 | 2 | 8 | 4 | 0.95 | 0.64 |
| 2005 | 2 | 4 | 14 | 5 | 4 | 0.93 | 0.63 |
| 2006 | 1 | 9 | 8 | 6 | 9 | 0.97 | 0.65 |
| 2007 | 0 | 8 | 11 | 6 | 7 | 1.00 | 0.67 |
| 2008 | 0 | 11 | 15 | 12 | 4 | 1.00 | 0.66 |
| 2009 | 2 | 8 | 13 | 17 | 9 | 0.96 | 0.67 |
| 2010 | 0 | 16 | 10 | 12 | 7 | 1.00 | 0.65 |
| 2011 | 1 | 17 | 26 | 22 | 22 | 0.99 | 0.68 |
| 2012 | 4 | 14 | 34 | 21 | 16 | 0.96 | 0.65 |
| 2013 | 6 | 18 | 27 | 13 | 16 | 0.93 | 0.62 |
| 2014 | 6 | 24 | 22 | 17 | 26 | 0.94 | 0.63 |
| 2015 | 5 | 15 | 24 | 15 | 21 | 0.94 | 0.64 |
| 2016 | 8 | 24 | 32 | 21 | 31 | 0.93 | 0.64 |
| 2017 | 5 | 19 | 33 | 21 | 21 | 0.95 | 0.65 |
| 2018 | 7 | 38 | 33 | 29 | 29 | 0.95 | 0.63 |
| 2019 | 8 | 42 | 37 | 24 | 31 | 0.94 | 0.62 |
| Total | 76 | 400 | 429 | 307 | 289 | 0.95 | 0.63 |

DC=Degree of Collaboration, CC=Collaboration Coefficient

6.4 Highly Prolific Authors

Table 3 shows the ten top highly productive authors with their contributions. It is observed that Mishra, B. K. has achieved first rank by contributing 124 papers with an ACPP of 38.11 and 29 h-index is calculated, followed by Nayak, P. 78 papers with an ACPP of 12.73 and 21 h-index stands second rank, and Behera, A. B. 73 papers with an ACPP 19.33 and 21 h-index. It also observed that the scientist Patel, though he has published 41 publications,

received a good number (2425) of citations with an impressive s h-index. Similarly, it is evident from the study that there are other authors, as indicated in the table, who have contributed a good number of research papers and attracted a good number of citations and h-index.

Table-3: Top 15 Highly Prolific Authors

| Author | TNP | TNC | ACPP | H-Index |
|------------------|-----|------|-------|---------|
| MISHRA, B. K. | 124 | 4726 | 38.11 | 29 |
| NAYAK, P. | 78 | 993 | 12.73 | 16 |
| BEHERA, B. | 73 | 1411 | 19.33 | 21 |
| DASH, G. N. | 57 | 305 | 5.35 | 9 |
| MOHAPATRA, P. K. | 49 | 974 | 19.88 | 18 |
| MISRA, P. K. | 44 | 756 | 17.18 | 17 |
| PATI, S. P. | 44 | 337 | 7.66 | 9 |
| BEHERA, A. K. | 43 | 647 | 15.05 | 11 |
| BEHERA, P. K. | 41 | 1729 | 42.17 | 14 |
| PATEL, S. | 41 | 2425 | 59.15 | 18 |

6.5 Top ten highly cited Publications

The table 4 shows the top ten highly preferred sources of publications to publish research articles by the authors of Sambalpur University. It is evident that the researchers publish their work in a wide range of journals which have different impact factors (Vellaichamy and Jeysankar,2015). The data observed from the table that the Indian Journal of Chemistry Section A Inorganic Physical Theoretical and Analytical Chemistry tops the list with 36 (15.4%) articles contributed. It was followed by Astrophysics and Space Science stands 2nd rank with a total share of 32 (13.7%). Journal of the Indian Chemical Society stands 3rd rank with 31 (13.2%), AIP Conference Proceedings stands 4th most prolific journal with a share of 28 (12%) publications, Library Philosophy and Practice stands 5th rank with 24 (10.3%), Journal of Physics G Nuclear and Particle Physics and Molecular Crystals and Liquid Crystals shares 20 (8.5%) publications each and stands 6th rank Other journals have placed under the top ten prolific journals with a share of fewer than 20 publications are shown in the below table.

Table-4: Top ten highly cited Publications

| Source | Country | TNP | h-index | Cite Score | SJR | SNIP |
|---|---------|-----|---------|------------|-------|-------|
| Indian Journal of Chemistry Section A Inorganic Physical Theoretical and Analytical | India | 36 | 38 | 1.2 | 0.178 | 0.278 |

| | | | | | | |
|---|-------------|----|----|-----|-------|-------|
| Chemistry | | | | | | |
| Astrophysics and Space Science | Netherlands | 32 | 65 | 3.2 | 0.458 | 0.759 |
| Journal of the Indian Chemical Society | India | 31 | 32 | 0.5 | 0.111 | 0.104 |
| AIP Conference Proceedings | USA | 28 | 64 | 0.6 | 0.190 | 0.373 |
| Library Philosophy and Practice | USA | 24 | 17 | 0.3 | 0.220 | 1.399 |
| Journal of Physics G Nuclear and Particle Physics | UK | 20 | 99 | 6.6 | 1.299 | 1.217 |
| Molecular Crystals and Liquid Crystals | UK | 20 | 49 | 1.2 | 0.209 | 0.271 |
| Journal of Materials Science Materials in Electronics | Netherlands | 16 | 67 | 3.9 | 0.477 | 0.686 |
| Indian Journal of Environmental Protection | India | 14 | 17 | 0.1 | 0.124 | 0.136 |
| Pramana Journal of Physics | India | 13 | 46 | 2.2 | 0.380 | 0.652 |

6.6 Most Collaborative Institutions

Figure 3 demonstrates the top ten research collaborations with other institutions by the researchers of University of Sambalpur. (Mary and Dorairajan, 2016). It was analyzed that the average output of these ten institutes is 1931 papers. Of the total institutes, only Sambalpur University has published above the average output of these institutes during 1990-2019. Sambalpur University has published a total 1527 (79.01%) publications. The remaining 404 (20.9%) publications were published from these nine institutions.

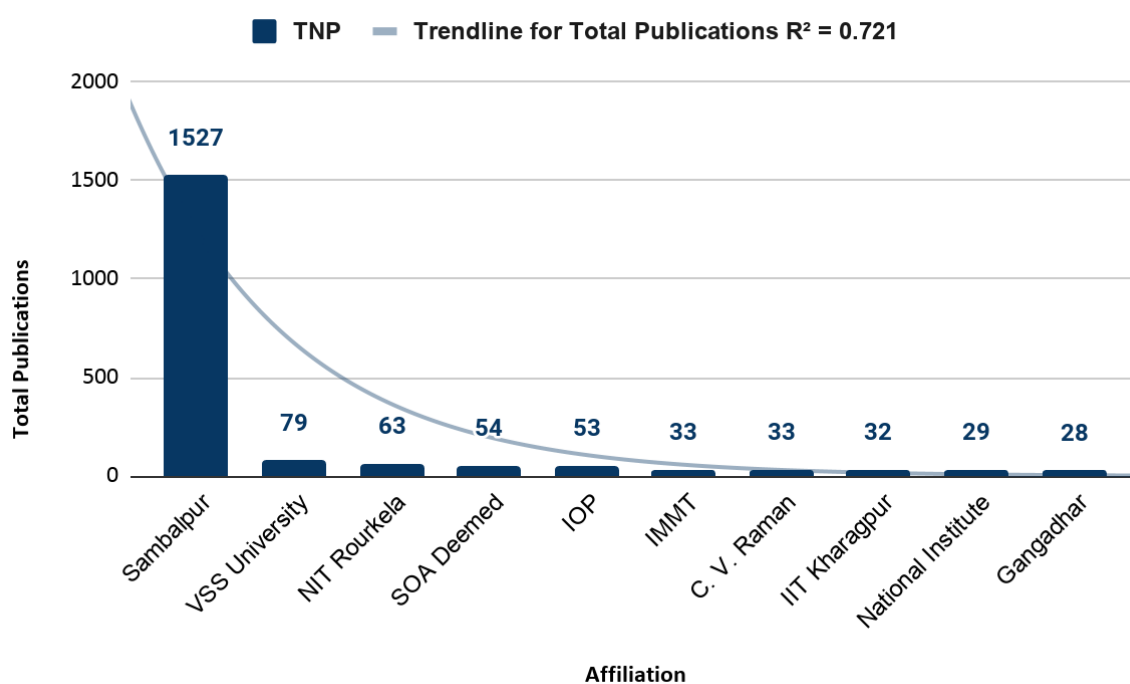


Fig.3: Most Prolific Institutions

6.7 Country-wise collaboration

At the international level of research collaboration of Sambalpur University identified and presented in the table 5. It has observed that the highest number of collaborative papers with United States 57(3.38%). It was followed by Japan with 26 (1.54%), United Kingdom with 21 (1, 24%), Germany 13 (0.77%), South Korea 12 (0.71%), China 11 (0, 65%), Spain 11 (0, 65%), Italy 9 (0.53%) and Australia 8 (0.47%).

Table-5: Collaborative Countries

| Country/Territory | TNP | % |
|-------------------|------|--------|
| India | 1520 | 90.05 |
| United States | 57 | 3.38 |
| Japan | 26 | 1.54 |
| United Kingdom | 21 | 1.24 |
| Germany | 13 | 0.77 |
| South Korea | 12 | 0.71 |
| China | 11 | 0.65 |
| Spain | 11 | 0.65 |
| Italy | 9 | 0.53 |
| Australia | 8 | 0.47 |
| Total | 1688 | 100.00 |

6.8 Document-wise Distributions

Figure 4 provides an overview of the main sources of research publications by the University of Sambalpur that were covered in the Scopus database. Of the total 1527 publications majority i.e. 1249 (81.79%) are research articles, while 169 papers on conference proceedings (11.07%), review 53 (3.47%), book chapter 33 (2.16%), and letters 6 (0.39%), Further a near percentage of publications that have been published in the form of Erratum, Note, editorial, Short survey and books.

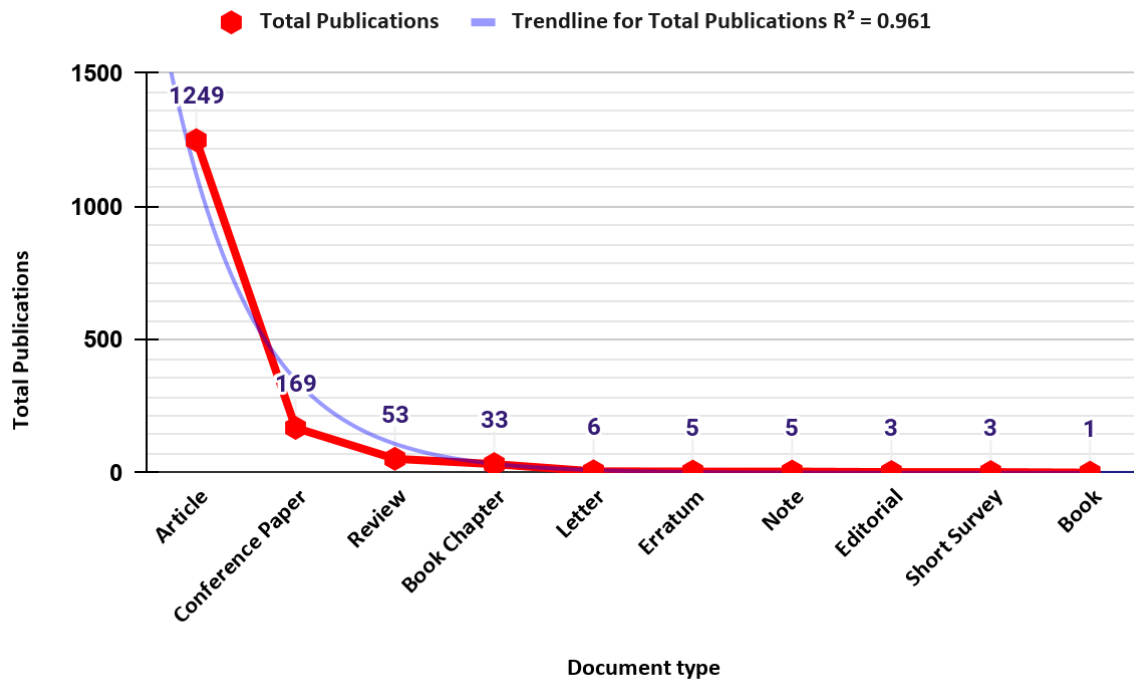


Fig.4: Types of Document

7. The significant finding of the study

The following statements are made out of the research study:

- It is found from the study that over the 20 years a fluctuating and gradual growth is observed both in publications and citations.
- It is evident from the analysis that the tendency of AGR, RGR and DT is found inversely proportional.
- The study found that most publications (429) were emerged under three authorship patterns. The performances of the author's patterns show that most publications follow co-writing standards rather than individual research.
- It is identified from the study that MISHRA, B.K. was labelled as the most productive author among all the other authors of SU university with the highest contribution of 124 articles within 30 years.
- It is analyzed and found from the study that among the total 1527 publications retrieved during the period, a significant portion of them appeared under the category of research articles. Further, it is identified that the Journal of Clinical and Diagnostic Research and BMJ Case Reports is the most preferred source item to publish authors research publications.
- The study found that the participating countries and Institutions collaborating with Sambalpur University are the United Kingdom and the United state of America.

8: Conclusion

This present study was administered to look at the research productivity of Sambalpur University during the year 1990 to 2019. Reputation and recognition of any institution greatly depend on its research performance, productivity and publication output. Scientometric studies enable the policy makers and funding agencies to take appropriate decisions. The Sambalpur University published a total 1527 publications in different disciplines during 1990-2019. Two decades of publications indexed in Scopus database has accumulated 15,440 citations with an annual growth rate varying from -43.48 to +140. From the analysis it is clear that though there is a slow growth in the number of scopus indexed publications till 2017, the last two years found flourishing with a value more than 100. It is an indication that the university is going to make remarkable contributions in the years to come. However, authors suggest that faculties are to be contributed more which can further enhance the reputation of the university. The study suggest the need for expanding the research results of the Sambalpur University and improving the quality and impact of its research publications in order to compete with other competing universities in India as well as abroad.

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