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Science Research Output pattern of University of Delhi (2015-2019)

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Science Research Output pattern of University of Delhi (2015-2019)

Abstract

The current research has been conducted to tress out the science research output of University of Delhi (DU) in the last five years (2015-2019) after using Web of Science (WOS) database. The present study has used Web of Science databases to collect the science research output of University of Delhi for the specified period. The retrieved data were analyzed using specific parameters. This study investigates the most productive institutes, countries, authors the impact of their output in terms of Relative Citation Impact (RCI) and Citation per Paper (CPP). For visualizing purposes, VOS Viewer has been used. We retrieved 6500 papers from Web of Science, consisting of 87.6% journal articles, 6.29% proceeding papers, and 6.15% review articles. The analysis of data indicates that consistent growth with increasing multi-authorship is the general trend of research. Multiauthored papers with international collaboration have more research impact (CPP, RCI) compared to others. USA, Germany, Korea topped the list of collaborating countries in science research. However, Canada made the very best effect in phrases of CPP and RCI. The University of Delhi has a major collaboration with BHU, JNU, IIT, and CSIR in terms of domestic collaboration. The study can be better used for further identification of research areas in sciences where attention can be given.

Keywords: Science research output, University of Delhi, Web of Science, Productive institutions, Relative Citation Impact (RCI), VOS Viewer, International collaboration.

Introduction

The higher growth of scientific research around the world requires generalization and interpretation of the complexity of the received information to analyze and measure the development, growth, and evolution of information. Scholars and institutions in a specific discipline are evaluated and assessed based on research publications. The Russian statistician Nalimov (1966) suggested the term 'Scientometrics' as a method of quantification to study the growth and development of research output. Scientometrics helps to quantify the literature to evaluate emerging concepts and determine trends in research and publications in specific fields for policymaking and future research (Guzeller & Celikaer, 2017; Kasemodel et al., 2016). It is considered a science that can help understand style and growth, writer productivity, writer model, relative growth rate, cooperation between countries, formal organizations and institutions, etc. (Mulla, 2012). Unfortunately, alternative measures (such as usage measures and legacy measures) are still in the early stages of measuring the impact of studies beyond citations (Hammarfelt 2014; Gorraiz et al., 2014). Hence, scientometrics is still one of the best tools available for science evaluators, policymakers, science administrators, and librarians.

The University of Delhi (DU) is India's premier higher education institution with a rich tradition. It is internationally renowned for its outstanding collaborations to teaching and research, the highest academic level, excellent faculty and staff, and advanced infrastructure. The university's 115 inventions have registered 208 patents in various countries/regions and received 56 applications (University of Delhi, 2020¹). The university's technical colleges, especially chemistry, geology, and zoology, have been called the Advanced Research Center and are centers of excellence for teaching and research in their respective fields. Leading scientists have worked in the Department of Science, such as Prof. D.S. Kothari in Physics, Prof. Shanti Swarup Bhatnagar, Prof. T.R. Sheshadri in Chemistry, Prof. P Maheshwari in Botany, and Prof. M L Bhatia in Zoology. Most scientific departments have established themselves as centers for innovative and pioneering research in a wide range of fields. The Department of Chemistry, sponsored by DST-FIST, is the center of the Royal Society of Chemistry in London and the American Chemical Society. The university has become a symbol of excellence and has become a pioneer of other universities in the country (University of Delhi, 2020²).

The research conducted by the departments of any university is very important to understand the well-being of society as a whole. The basic activities of science are used for continuous improvement and provide information about research policy and management. Scientometrics is the most suitable method of quantifying research activities. Chen et al (2020) Conducted bibliometric research on laser technology and extracted 3,958 records from Web of Science. The study found that China is the most important country. The Journal of Applied Surface Science is the highest-performing journal; Greece has written the most contributing articles; the UC system has the best Hirsch index. The author believes that "laser processing", "microstructure" and "thin-film" are hot topics, and "intelligent laser processing" and "production planning" are key issues in the future. Li, Hu, and Shen (2020) conducted scientometric scientific research on terahertz research. Authors observed extensive research on the topic in subjects like medical sciences, biological imaging, physics, chemistry, communication, food safety, communication, and biology. The authors conducted extensive research on topics such as chemistry, physics, food safety, communications, biology, biochemical, biological imaging, and medical sciences. They found the most influential publication in 2011. Applied Physics Letters is one of the most active journals. China is the most productive country and Osaka University and Cambridge University are the most productive institutions, and Zhang XC, Linfield EH, and Davis AG as the main author in the field. Lee et al. (2020) analyzed 1,386 articles published in the past 20 years, and Scopus interviewed them to assess the important environmental issues of organometallic structures. The study found that China is the country with the most published 626 articles. The Chinese Academy of Sciences is the most productive institution; Jhung SH of the National University of South Korea is the most prolific writer. Rabanne and Gordan (2020) analyzed the development of big data and data science literature. The author noticed the

surge in big data reports and the gradual increase in big data reports. Data science and a newly published course that combines the two. They discovered various academic backgrounds and leading publications on these two concepts. They found that the data science literature is the theoretical foundation of big data. Sudhier and Dileepkumar (2020) tested 25,132 biochemical data. "Through the search of Indian scientists and Web of Science from 2004 to 2013. The authors found that the average annual growth rate was 36.84%, and the value of the index was increased through co-authors with 97...46% contributed to publications and major collaborations between Indian researchers and American scientists. Plos One is the highest-rated journal; Roy (2019) assessed the status of research on organic technology by Indian authors from 1901 to 1947. The study concludes that 0.615 is relative mean growth and 1.007 is duplication time, 75% single-authored papers, 0.249 as the degree of collaboration, increasing trend in the collaborative author index of two or more authors, and female researchers' contribution of 0.62% publications. Based on 4027 data recovered from Web of Science, Shanthi and Thanuskodi (2019) analyzed the study guides in the leather-based era at some stage in 2009-2018. The study found that China and India are the most productive nation, with an overall cooperation degree of 0.92, and the Central Leather Research Institute of India is the most prolific research institution. Hadagali et al (2019) made a scientometrics study of research publications in Material Science. The Web of Science databases was used for research papers published during 2002-2016. The study found that Material Science shared 5.61% of the world's scientific publications, China as the most productive country, the exponential growth of Material Science publications, and the USA having more than one Publication Efficiency Index. There are plenty of other scientometrics studies on individual departments, areas, and subjects. These studies assess the volume and development of research in a particular field. Fields and topics such as artificial intelligence (Darko et al., 2020; Bhattacharji, 2019; Gupta and Dhavan, 2018), physics (Nagarkar and Kenger, 2017), environmental management (Amsaveni and Krishnan, 2018), genetic diseases (Shukla, 2019 Years), Astrophysics (Ulaganathan and Senthilkumar 2017), Physics and Astronomy (Khanna et al., 2017), etc.

In recent times a massive range of scientometrics research of various universities had been carried out. Das and Ghosh (2020) studied the productiveness of the 'University of Petroleum and Energy Studies for the length of 2004-2018. The publication growth, document type, authorship pattern, subject productivity, prolific and highly cited author, international collaborations, etc. were examined based on a total of 1319 publications retrieved from SCOPUS databases. Kherde and Bapte (2019) measured studies output of Rashtrasant Tukadoji Maharaj Nagpur University the usage of Lotka's regulation on 4212 data extracted from Web of Science. It studied annual publication trends, subject distribution of publications, co-authorship networks, collaborations in terms of institutions and countries. The studies productivity of the Gujrat University has been analyzed on the SCOPUS database by Patel (2019) during 2008-2017. The author evaluated 1248 records and found 2017 as the most productive year, journals as the preferred

platform for publication, and a higher degree of collaboration (0.96) but less from international institutions. Maurya et al. (2018) evaluated the research productivity of the Mizoram University during 2007-2016 retrieved 404 records from Web of Science in terms of publication trends, productive subjects, authorship pattern, prolific author, collaboration, favored journals, citations, funding agencies, etc. Bapte and Gedam (2018) showed the outline of the scientometrics profile of Sant Gadge Baba Amravati University for 1996-2017. A total of 1130 publications were retrieved and analyzed from the SCOPUS database. It assessed productivity of subjects and authors, average citations, highly productive block, highest h-Index, authorship pattern, international collaborations, a favored platform for publication, etc. Goswami (2019) tested the channel of studies guides and exclusive rating styles of Assam University. Nair, Sreena, and Yasmin (2019) evaluated the productivity of research and the impact of 20 central and 237 state universities for the period 2017-2019 using the SCOPUS database. The University of Delhi turned into discovered getting the very best quotation of 14962 with 7481 common citations according to the year in central universities and Punjab University acquired 7671 citations with 3835.50 common citations per year.

The University of Delhi is a leading university in India in terms of scientific research output. However, so far, no attempt has been made to measure the results of research and examine the scientometric profile of the university. The present study tries to fill this gap with the objectives listed below.

Objectives of the study

The study focuses on the publication output of the University of Delhi (DU) in Sciences with the following objectives-

- (a) To estimate the research output of the University of Delhi in sciences and to observe the growth of the research during in 2015-2019;
- (b) To observe the distribution of research output;
- (c) To find out the most collaborating countries and to observe the citation impact through Citation per paper (CPP) and Relative Citation Impact (RCI);
- (d) To trace out the most collaborating institutions with the University of Delhi and to observe the citation effect of their research output;
- (e) To observe the maximum prolific authors and the effect in their output;
- (f) To map the distribution of citations and to pick out highly cited papers; and
- (g) To examine the most common journals used for communicating by the research scholars.

Methodology and Databases

The data source of this research is the core collection of Web of Science, a product of Clarivate Analytics (USA). The 'science citation index' of the web of science has been selected for downloading the research records of the University of Delhi from 2015 to 2019. The advance search has been conducted and results in 6799 publications. The downloaded information includes different research records such as reviews, research articles, book chapters, proceeding papers, editorial corrections with the name of authors and affiliation, year of publication, source name, country of publication, and citation of each article. The data has been further filtered for articles, review articles, and conference reports. Concerning about the impact of the output, the others forms of publications like corrections, editorial material, and book chapter has been excluded. In the end, 6500 documents were selected for further investigation. The study has been further enriched by the impact factor of publishing sources, the number of publications made by authors, by countries, and by institutions. To achieve the previously defined goals, the downloaded information has been analyzed using MS Excel and SPSS software packages. The VOS Viewer software has been used for visualizing the network of publications.

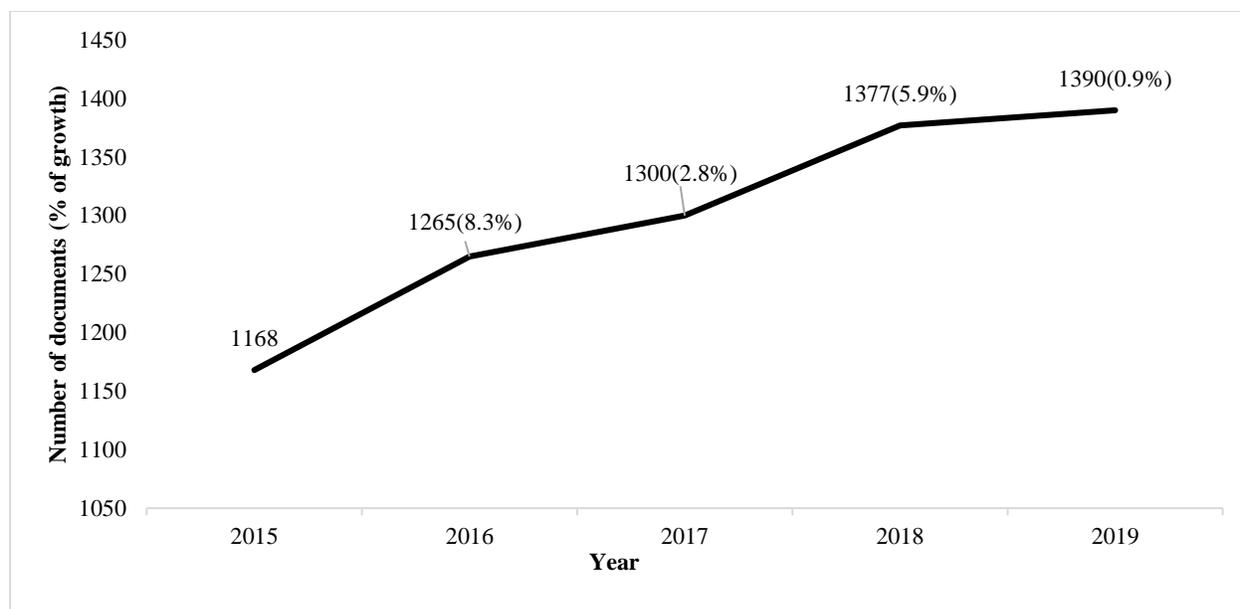
Results and Discussion

Distribution of output through the form of documents

During the period of 5 years 2015-2019, researchers from the University of Delhi published 6500 documents in science. Data shows that the very best range of 5691 (87.6%) of records was published in the form of journal articles, afterward proceeding papers which numbered 409 (6.29%) and review articles 400 (6.15%). These three types of documents have been taken into consideration for further analysis to achieve the above-stated objectives. The remaining data (corrections, editorial material, and book chapter) has no longer included in the analysis because it contains much less scientific evidence and is rarely cited in the literature.

Chronological growth pattern of output

Figure 1 shows the model and annual growth rate of the research results of the Delhi University of Science in 2015-2019. It shows that the research results are increasing steadily. However, the annual output growth is not constant. During 2016 the maximum growth rate was noticed. The highest productivity was in 2019 (1390 publications), while the lowest was in 2015 (1168 publications). Another production evaluation showed that the output in 2018 was three times the output in 2009. The 'compound annual growth rate' (CAGR) calculated using the method available at <https://cagrcalculator.net/result/> was found to be 19% during the period 2015–2019.



‘Fig 1: Publication pattern of Science research output in Delhi University during 2015-2019’

Distribution of output by authors

Table 1 shows the author's style of research productivity in the past five years (2015-2019). It can be seen from this that in different years, articles by more authors have dominated. In the last five years, one author's articles have counted on much fewer publications (98 or 1.5%). Dual authored, multi-authored (3 and 4 authors) and mega-authored (>4) papers acquire 15.6%, 36.3%, and 46.64% of total publications respectively. More than forty authors had acquired 649 or 10% of publications in the last five years. Multiauthor papers ruled in science research of Delhi University.

The co-author structure is shown in Table 1. The Co-Author Index (CAI) is the best way to show the co-author structure of a publication. The CAI score indicates the growing trend of multiple authorship over time. The CAI score for the single author was 166 in 2015 which decreased to 72 in 2019 whereas mega authored papers have the CAI score for 2015 was 95 which increases to 101 in 2019. The collaborative coefficient (CC) is another measure to study the collaboration structure of different authors as time proceeds. The rise in CC score as time proceeds is indicative of rising co-authorship in publication.

‘Table 1: Co-Authorship Index (CAI) of Science research output from Delhi University during 2015-2019.’

| Year | Single authored papers(CAI) | Two authored papers(CAI) | Multi-authored papers(3 & 4)(CAI) | Mega authored papers (>4)(CAI) | Total | CC |
|-------|-----------------------------|--------------------------|-----------------------------------|--------------------------------|-------|-------|
| 2015 | 29(166) | 187(103) | 433(102) | 519(95) | 1168 | 0.700 |
| 2016 | 24(126) | 186(94) | 467(102) | 588(100) | 1265 | 0.709 |
| 2017 | 17987) | 214(106) | 468(99) | 601(99) | 1300 | 0.709 |
| 2018 | 13(63) | 194(90) | 497(99) | 673(105) | 1377 | 0.719 |
| 2019 | 15(72) | 232(107) | 492(98) | 651(101) | 1390 | 0.711 |
| Total | 98 | 1013 | 2357 | 3032 | 6500 | |

Distribution of output by prolific authors and impact of their output

Table 2 listed 10 authors of the University of Delhi who published more than 50 papers. 732 (11.26%) papers of the total output published by these 10 authors. The remaining 88.74% of publications are provided by other authors. This shows the highly distributed output of the authors. This study attempts to point out the CPP and RCI value of most prolific authors. The CPP and RCI scores for the authors named Binay Kumar (Dept Phys & Astrophys), Anuradha Chowdhury (Dept Med Mycol), and Gurmeet Singh (Dept. Chem.) is greater than the average value. The CPP and RCI scores of the remaining authors were below the average score.

‘Table 2 Most prolific authors and impact of their output’

| Sl. No. | Authors | TNP(%) | TNC(%) | CPP | RCI | Dept. |
|---------|----------------------|------------|------------|-------|------|------------------------------|
| 1 | Gupta, Vinay | 162(2.49) | 1120(1.29) | 6.91 | 0.52 | Dept Phys & Astrophys |
| 2 | Tomar, Monika | 119(1.83) | 870(1.0) | 7.31 | 0.55 | Dept Phys |
| 3 | Kumar, Binay | 60(0.92) | 843(0.97) | 14.05 | 1.05 | Dept Phys & Astrophys |
| 4 | Venkatesu, Pannuru | 60(0.92) | 617(0.71) | 10.28 | 0.77 | Dept Chem |
| 5 | Kumar, Vinod | 59(0.91) | 296(0.34) | 5.02 | 0.37 | Dept Zool |
| 6 | Chandra, Ramesh | 58(0.89) | 389(0.45) | 6.71 | 0.50 | Dept Chem |
| 7 | Chowdhary, Anuradha | 55(0.85) | 2066(2.37) | 37.56 | 2.81 | Dept Med Mycol |
| 8 | Singh, Gurmeet | 55(0.85) | 753(0.87) | 13.69 | 1.02 | Dept Chem |
| 9 | Khurana, Jitender M. | 53(0.82) | 390(0.45) | 7.36 | 0.55 | Dept Chem |
| 10 | Gupta, Mridula | 51(0.78) | 219(0.25) | 4.29 | 0.32 | Dept Elect Sci, South Campus |
| | Sub total | 732(11.26) | 7563(8.69) | 10.33 | 0.77 | |

| | | | | |
|--------|-------------|--------------|-------|------|
| Others | 5768(88.74) | 79441(91.31) | 13.77 | 1.03 |
| Total | 6500 | 87004 | 13.39 | 1.00 |

Distribution of citations and highly cited papers

The impact of scholarly communication is indicative of the citation count of research publications. Table 3 indicates the citation style of the papers published in science throughout the year 2015-2019. In this study, 87004 citations were received by 6500 publications from 2015 to 2019. Of these, 2270 (34.9%) publications did not acquire any citations. About 22% (1426) of the overall publications were cited within 1-5 times and 24.6% (1601) papers were cited within 6-20 times. Over 50 citations were obtained by 7.6% (496) of the total publications. The average number of citations increases with the number of authors, which is proved by Pearson correlation analysis (positively correlated with the value of 0.192 at 0.01 significant levels).

‘Table 3 Pattern of distribution of citations’

| Number of citations | Total paper (%) | Total citations | Number of citations | Total paper (%) | Total citations |
|---------------------|-----------------|-----------------|---------------------|-----------------|-----------------|
| 0 | 2270(34.9) | 0 | 11-20 | 748(11.5) | 11184 |
| 1 | 364(5.6) | 364 | 21-30 | 439(6.8) | 11786 |
| 2 | 249(3.8) | 498 | 31-40 | 159(2.4) | 5736 |
| 3 | 305(4.7) | 915 | 41-50 | 109(1.7) | 5303 |
| 4 | 265(4.1) | 1060 | 51-100 | 368(5.7) | 27044 |
| 5 | 243(3.7) | 1215 | 101-200 | 127(2.0) | 14686 |
| 6-10 | 853(13.1) | 6546 | >200 | 1 | 667 |
| | | | Total | 6500 | 87004 |

Highly Cited Papers

The study analyzed 10 frequently cited scientific articles published in the past five years. Tables 4 represent the 10 frequently cited science research papers. These papers report for 1.9% of the overall citation retrieved. Among these ten papers, 6 papers are from the Chemistry field. The remaining four papers were published in the medical field. Maximum frequently cited papers were published by the European countries. The author calculates the number of citations per year (CPY) to standardize the differences in the citation window of the article. The rank of various authors changes when organized according to CPY. For instance, the author who becomes top based on the total number of citations received comes forth according to CPY.

‘Table 4: Highly cited papers’.

| Sl. No | Bibliographic details | TNC | CP Y |
|--------|--|-----|------|
| 1 | Verweij, Paul E.; Chowdhary, Anuradha; Melchers, Willem J. G.; et al. <i>Candida auris</i> : A rapidly emerging cause of hospital-acquired multidrug-resistant fungal infections globally. <i>Plos One</i> . | 240 | 48 |
| 2 | Badhani,B; Sharma,N; Kakkar, R (2015)Gallic acid: a versatile antioxidant with promising therapeutic and industrial applications. <i>RSC Advances</i> , 35. | 200 | 40 |
| 3 | Kathuria S, Singh PK, Sharma C, Prakash A, Masih A, Kumar A, Meis JF, Chowdhary A. 2015. Multidrug-resistant <i>Candida auris</i> misidentified as <i>Candida haemulonii</i> : characterization by matrix-assisted laser desorption ionization–time of flight mass spectrometry and DNA sequencing and its antifungal susceptibility profile variability by Vitek 2, CLSI broth microdilution, and Etest method. <i>J Clin Microbiol</i> 53:1823–1830. doi:10.1128/JCM.00367-15. | 191 | 38 |
| 4 | Chowdhary A, Sharma C, Meis JF (2017) <i>Candida auris</i> : A rapidly emerging cause of hospital-acquired multidrug-resistant fungal infections globally. <i>PLoS Pathog</i> 13(5): e1006290. https://doi.org/10.1371/journal.ppat.1006290 | 178 | 59 |
| 5 | Sharma,R.K; Dutta,S; Sharma,S; Zboril,R; Varma,R; Gawande,M (2016) Fe ₃ O ₄ (iron oxide)-supported nanocatalysts: synthesis, characterization and applications in coupling reactions. <i>Green Chemistry</i> , 11 | 153 | 38 |
| 6 | De, S; Saha, B; Luque, R. (2015) Hydrodeoxygenation processes: advances on catalytic transformations of biomass-derived platform chemicals into hydrocarbon fuels. <i>Bioresource Technology</i> , 178, 108-118. | 147 | 37 |
| 7 | Gawande, M.B; Monga, Y; Zboril, R; Sharma, R.K (2015) Silica-decorated magnetic nanocomposites for catalytic applications. <i>Coordination Chemistry Reviews</i> , 288, 118-143. | 141 | 28 |
| 8 | Bohre, A; Dutta, S; Saha, B; Abu-Omar, M (2015) Upgrading Furfurals to Drop-in Biofuels: An Overview. <i>ACS Sustainable Chem. Eng.</i> , 3 (7), 1263-1277. | 140 | 28 |
| 9 | Singh, R; Kumar, M; Mittal, A; Mehta, P.K (2016) Microbial enzymes: industrial progress in 21st century. <i>Biotech</i> , 6.174 | 137 | 34 |
| 10 | Chauhan, Meenakshi; Reddy, Kasala Prabhakar; Gopinath, Chinnakonda S.; et al. (2017) Copper Cobalt Sulfide Nanosheets Realizing a Promising Electrocatalytic Oxygen Evolution Reaction. <i>CAS Catalyst</i> , 7(9), 5871-5879. | 128 | 43 |

Distribution of output by collaborating countries and their citation impact

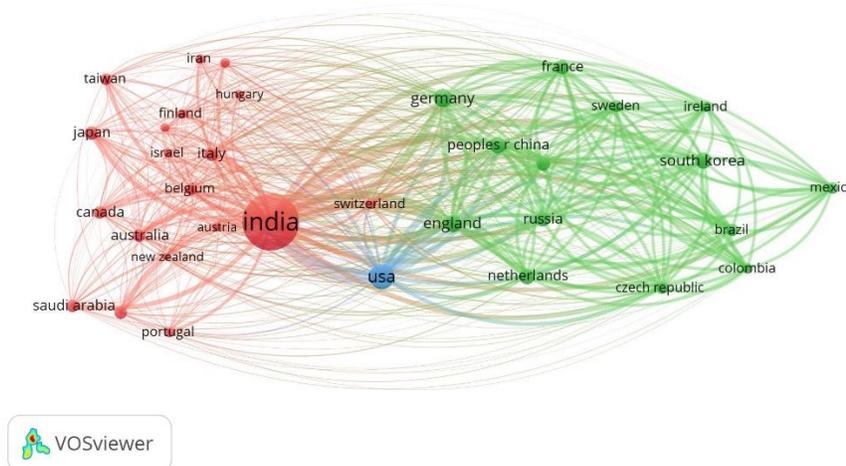
Scientific publications of the University of Delhi have appeared in 58 collaborating countries around the world. Table 5 recorded the 10 most productive collaborating countries. These 10 collaborating nations published around four-fifth (83.86%) of the overall output. Other remaining 16.14% output was produced by the remaining 48 collaborating nations. Among the most productive nations, the USA topped the list with 148 (2.28%) of total papers, followed by Germany contributing 0.80% of the total output.

Data represented in Table 5 suggests that the score of CPP for the research output from the University of Delhi in sciences is 13.39. Among the 10 countries listed in Table 5, except for China, CPP is above average.

The maximum score of CPP is for Canada (23.55) followed by Korea (21.69%). The value of RCI is also higher for these ten most collaborating countries except China. The score of RCI has also followed the same pattern as CPP e.g. highest for Canada (1.76) followed by Korea (1.62).

‘Table 5: Most prolific collaborating countries and impact of their output’

| Country | TNP (%) | TNC (%) | CPP | RCI |
|----------|-------------|--------------|-------|------|
| India. | 5035(77.46) | 69059(79.37) | 13.72 | 1.02 |
| USA. | 148(2.28) | 2812(3.23) | 19.00 | 1.42 |
| Germany. | 52(0.80) | 722(0.83) | 13.88 | 1.04 |
| Korea. | 42(0.65) | 911(1.05) | 21.69 | 1.62 |
| Russia. | 40(0.65) | 559(0.64) | 13.98 | 1.04 |
| China. | 33(0.51) | 416(0.48) | 12.61 | 0.94 |
| England. | 33(0.51) | 565(0.65) | 17.12 | 1.28 |
| Arabia. | 24(0.37) | 362(0.42) | 15.08 | 1.13 |
| Japan. | 24(0.37) | 348(0.40) | 14.50 | 1.08 |
| Canada. | 20(0.31) | 471(0.54) | 23.55 | 1.76 |
| Subtotal | 5451(83.86) | 76225(87.61) | 13.98 | 1.04 |
| Others | 1049(16.14) | 10779(12.39) | 10.28 | 0.77 |
| Total | 6500 | 87004 | 13.39 | 1.00 |



‘Fig: 2 collaborating country network in science research (2015-2019)’

Research collaboration between different nations is a useful parameter for obtaining the wideness and impact of research. Fig. 2 shows the collaborating nation's network of scientific research of the University of Delhi through VOS viewer. A researcher from the University of Delhi has established important cooperative relations among the United States, Germany, Russia, the United Kingdom, China, South Korea, and other countries. The network line thickness indicates increased collaboration (Figure 2). The University of Delhi has maintained close cooperation among the above-mentioned countries in the field of scientific research.

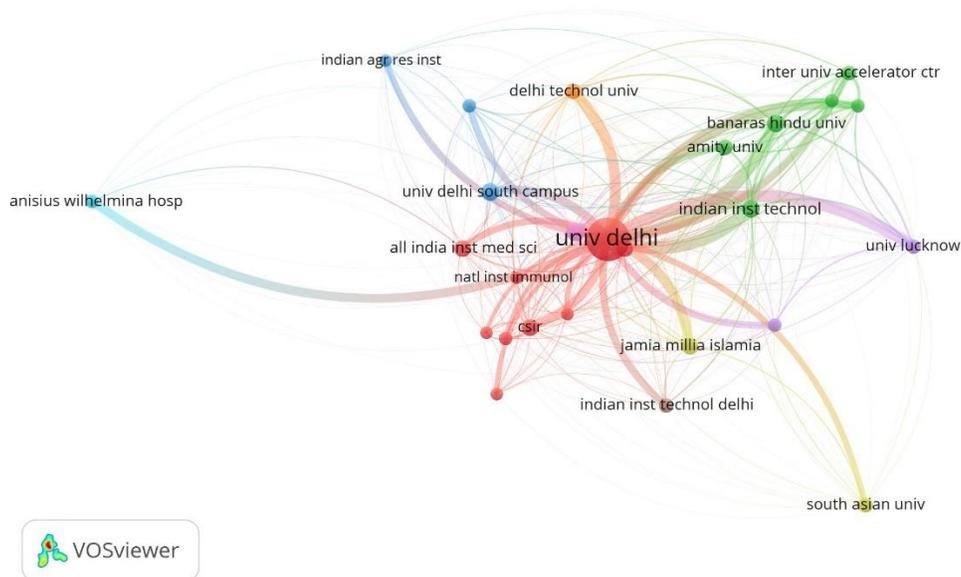
Distribution of output by collaborating institutions

All science research at the University of Delhi comes from 889 cooperative academic and research institutions in different regions of the world. Table 6 lists 10 frequently productive collaborating organizations with their CPP and RCI values. The organizations which published more collaborated articles throughout the research period have been classified as prolific institutes. Around 57.22% of the total output contributed by these ten most collaborated prolific institutes. Among these, the University of Delhi published most research papers (50.68% for North campus and 1.09% for South campus out of a total of 6500 publications) as a corresponding author followed by Banaras Hindu University 63 (0.97%). The other prolific institute that publishes research in collaboration with the University of Delhi are JNU (60 or 0.92%), CSIR institutes (43 or 0.66), IIT's (40 or 0.62%), DTU (39 or 0.60%), SAU (38 or 0.58%), JMI (37 (0.57%), etc. All the institutes recorded in Table 6 have higher than average CPP values except BHU and SAU. In all the listed institutes the greatest value of CPP (23.40) is for the IIT's. The RCI value also follows the same pattern as CPP. Like CPP the maximum RCI value is also for the IIT's (1.75) followed by CSIR (1.49).

'Table 6 Most prolific collaborating institutions and the impact of their output'

| Institutions | TNP (%) | TNC (%) | CPP | RCI |
|---------------------------|-------------|--------------|-------|------|
| Univ Delhi | 3294(50.68) | 45200(51.95) | 13.72 | 1.02 |
| Univ Delhi South Campus | 71(1.09) | 1044(1.20) | 14.70 | 1.10 |
| Banaras Hindu Univ | 63(0.97) | 818(0.94) | 12.98 | 0.97 |
| Jawaharlal Nehru Univ | 60(0.92) | 966(1.11) | 16.10 | 1.20 |
| CSIR | 43(0.66) | 85890.99) | 19.95 | 1.49 |
| Indian Inst Technol | 40(0.62) | 936(1.08) | 23.40 | 1.75 |
| Delhi Technol Univ | 39(0.60) | 533(0.61) | 13.67 | 1.02 |
| South Asian Univ | 38(0.58) | 472(0.54) | 12.42 | 0.93 |
| Jamia Millia Islamia | 37(0.57) | 493(0.57) | 13.32 | 1.00 |
| Indian Inst Technol Delhi | 34(0.52) | 249(0.29) | 7.32 | 0.55 |
| Sub-Total | 3719(57.22) | 51569(59.27) | 13.87 | 1.04 |
| Others | 2781(42.78) | 35435(40.73) | 12.74 | 0.95 |
| Total | 6500 | 87004 | 13.39 | 1.00 |

Research collaboration among national and international institutions increases the influence and audience of research. Figure 3 shows the network of collaborative research in scientific institutions of the University of Delhi through VOS viewer. BHU, JNU, CSIR, IIT, JMI are the main research institutes with which the University of Delhi University created major collaboration (Figure 3).



‘Fig: 3 collaborating institutes network in science research (2015-2019)’

Communication behavior

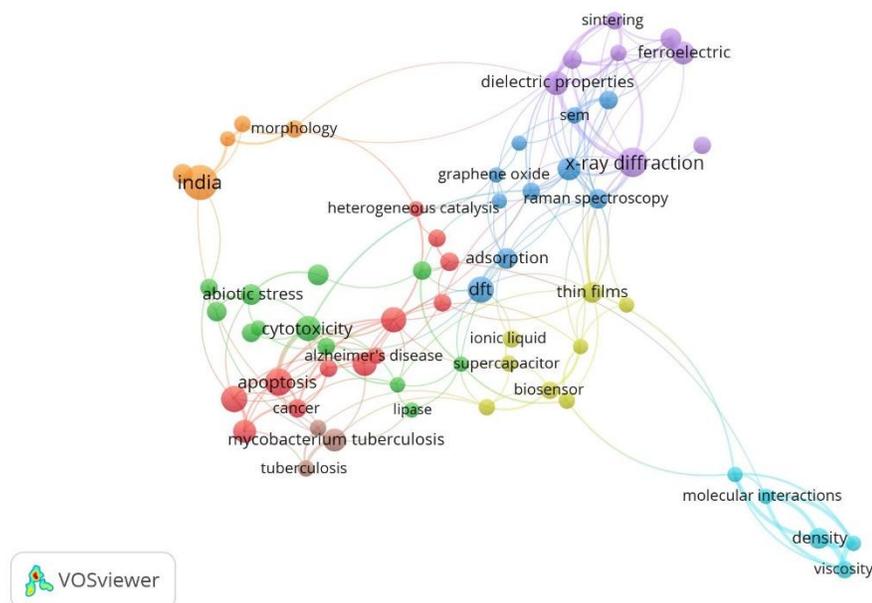
Researchers publish their work in various journals around the world. The communication pattern shows that all works have been published in 1,688 different journals from 59 countries. The top ten prolific journals published 1060 (16.3%) papers and the remaining 5440(83.7%) papers had been published in 1,678 journals. Table 7 lists 10 journals that published 50 or more papers with impact factors and publishing nations. Of these USA, England, Switzerland, and Germany hold four, three, two, and one each. This shows that the output of scientific research of the University of Delhi is highly distributed in terms of journals also. The analysis shows that approximately 40% of articles are published in more than three impact factor journals. Among them, the ‘Physical Review Letter’ published from the USA has the highest impact factor of all journals.

‘Table 7 Distribution of research output in prolific journals’

| Journals | No of papers | Total Citation | CPP | RCI | If | Publishing Country |
|--------------------------------|--------------|----------------|-------|------|------|--------------------|
| JOURNAL OF HIGH ENERGY PHYSICS | 196(3.0) | 1856(2.1) | 9.47 | 0.71 | 5.8 | USA |
| PHYSICS LETTERS B | 137(2.1) | 1496(1.7) | 10.92 | 0.82 | 3.8 | Switzerland |
| RSC ADVANCES | 135(2.1) | 1624(1.9) | 12.03 | 0.90 | 3.04 | ENGLAND |
| PHYSICAL REVIEW D | 122(1.9) | 1540(1.8) | 12.62 | 0.94 | 4.3 | USA |
| EUROPEAN PHYSICAL JOURNAL C | 99(1.5) | 749(0.9) | 7.57 | 0.57 | 4.8 | Switzerland |
| SCIENTIFIC REPORTS | 92(1.4) | 2132(2.5) | 23.17 | 1.73 | 4.2 | ENGLAND |
| PLOS ONE | 80(1.2) | 1266(1.5) | 15.83 | 1.18 | 2.9 | USA |
| CHEMISTRYSELECT | 73(1.1) | 1117(1.3) | 15.30 | 1.14 | 1.7 | Germany |
| PHYSICAL REVIEW LETTERS | 73(1.1) | 1083(1.2) | 14.84 | 1.11 | 8.64 | USA |
| NEW JOURNAL OF CHEMISTRY | 53(0.8) | 802(0.9) | 15.13 | 1.13 | 3.06 | ENGLAND |
| Sub-total | 1060(16.3) | 13665(15.7) | 12.89 | 0.96 | | |
| Others | 5440(83.7) | 73339(84.3) | 13.48 | 1.01 | | |
| Total | 6500 | 87004 | 13.39 | 1.00 | | |

Keyword Pattern

Keywords are specific terms mentioned in the document to highlight the main content and easily searchable by researchers during the search process. The current research analyzes the appearance of keywords frequently used by authors. The VOS viewer map of the keyword network has been shown in Figure 4. Keywords such as X-ray diffraction, dialectical properties, dft, cytotoxicity and Raman spectroscopy have been encountered at the highest frequencies of scientific research. The thickness of the network line is representative of intra-association among keywords. Thicker the line stronger the link. Here the line is thicker for the above-mentioned keywords (Fig 4).



‘Fig: 4 Author keyword network in science research (2015-2019)’

Conclusions

The present study has been conducted to understand the scientometric profile of science research published during 2015-2019 from the University of Delhi. Most outputs appeared in the form of articles, and the number of publications has increased over time. . Multiple authorship is a common trend in scientific research. Over time, multiple authors and collaborations in countries have increased. Most prolific writers came from chemistry, physics, and the medical field of science. The Citation structure also follows the general style e.g. the number of citations rises as the number of authors rises or multiauthor paper got more citations. Most of the frequently cited articles came from the medicine or chemistry field. The most active countries for publishing research papers with the University of Delhi are the United States, Germany, South Korea, Russia, etc. The universities like, BHU, JNU, DTU, SAU, JMI, and institutes like, CSIR, IIT-Delhi are the most collaborating organizations which published research paper with the University of Delhi. Most productive journals are from the United States, Britain, and Switzerland. Interdisciplinary open access journals got more citations than formal journals.

Conflicts of interest

The authors declare no conflict of interest.

References

- Amsaveni, N., and Krishnan, H. C. (2018). A scientometric analysis of environmental management research output during 1989 to 2014. *Library Philosophy and Practice*, Vol. 1.
- Bapte, V. D., and Gedam, J. (2018). A Scientometric Profile of Sant Gadge Baba Amravati University, Amravati During 1996-2017. *DESIDOC Journal of Library & Information Technology*, 38(5), 326-333.
- Bhattacharjee, K. K. (2019). Research Output on the Usage of Artificial Intelligence in Indian Higher Education-A Scientometric Study. In *2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)* (pp. 916-919). IEEE.
- Chen, Y., Cheng, Z., Wang, C., Chen, Y., Li, S., Wan, Y., and Jin, Q. (2020). A bibliometric analysis for the research on laser processing based on Web of Science. *Journal of Laser Applications*, 32 (2).
- Darko, A., Chan, A. P., Adabre, M. A., Edwards, D. J., Hosseini, M. R., and Ameyaw, E. E. (2020). Artificial intelligence in the AEC industry: Scientometric analysis and visualization of research activities. *Automation in Construction*, 112.
- Das, S., and Ghosh, A. (2020). Research Productivity of University of Petroleum and Energy Studies during 2004-2018: A Scientometric Analysis. *Library Philosophy and Practice*, 3928.
- Gorraiz, J., Gumpfenberger, C., and Schlögl, C. (2014). Usage versus citation behaviours in four subject areas. *Scientometrics*, 101(2), 1077-1095.
- Goswami, R. (2019). Ranking Pattern of Publication Channel: A Scientometric Study on Assam University. *International Journal of Advanced Science and Technology*, 28 (12), 535-541.
- Gupta, B. M., and Dhawan, S. M. (2018). Artificial Intelligence Research in India: A Scientometric Assessment of Publications Output during 2007-16. *DESIDOC Journal of Library & Information Technology*, 38(6), 416-422.
- Guzeller, C. O., and Celiker, N. (2017). Gastronomy from past to today: A bibliometrical analysis. *Journal of Tourism and Gastronomy Studies*, 5 (2), 88–102.
- Hammarfelt, B. (2014). Using altmetrics for assessing research impact in the humanities, *Scientometrics*, 101(2), 1419–1430
- Hadagali, G. S., Hiremath, R. S., Gourikeremath, G. N., and Bulla, S. D. (2019). Scientometric Analysis of Materials Science Research. *Library Philosophy and Practice*, 1-20.
- Kasemodel, M. G. C., Makishi, F., Souza, R. C. and Silva, V. L. (2016). Following the trail of crumbs: a bibliometric study on consumer behavior in the Food Science and Technology field. *International Journal of Food Studies*, 5(1), 73–83.
- Khanna, S., Singh, N. K., Tewari, D., and Saini, H. S. (2017) Scientometric Analysis of the Research Output of Physics and Astronomy of Guru Nanak Dev University during 2006-15. *DESIDOC Journal of Library & Information Technology*, 37(5), 337-345.

- Kherde, M. R., and Bapte, V. D. (2019). An Institutional Collaboration and Application of Lotka's Law to the Research Output of Rashtrasant Tukadoji Maharaj Nagpur University. *Library Philosophy and Practice*, 1-14.
- Li, B., Hu, K., and Shen, Y. (2020). A Scientometric Analysis of Global Terahertz Research by Web of Science Data. *IEEE Access*, 8, 56092-56112.
- Li, J., Wang, L., Liu, Y., Song, Y., Zeng, P., and Zhang, Y. (2020). The research trends of metal-organic frameworks in environmental science: a review based on bibliometric analysis. *Environmental Science and Pollution Research*, 1-20.
- Maurya, S.K.; Shukla, A. and Ngurtinkhuma, R.K. (2018). Scholarly communications of Mizoram University on Web of Science in global perspective: A scientometric assessment". *Libr. Philos. Pract.* (accessed on 21 February 2019). <http://digitalcommons.unl.edu/libphilprac/1857>
- Mulla, K.R. (2012). Identifying and mapping the information science and scientometric analysis studies in India (2005-2009): A bibliometric Study. *Library Philosophy and Practice*, 772.
- Nagarkar, S., and Kengar, M. (2017). Analysis of physics research output of SP Pune University during the period 1990-2014". *Annals of Library and Information Studies (ALIS)*, 64(2), 106-112.
- Nair, V., Sreena, M., and Yasmin, M. (2019) Research developing in Indian universities: A bibliometric analysis of publication in Scopus. *International Journal of Civil Engineering and Technology*, 10(12), 50-59.
- Nalimov, V.V. (1966). Kolichestvennye metody issledovaniya protsesa razvitiya nauki. *Voprosy filisofii*, 12, 38- 47.
- Patel, P. (2019). Quantitative Synthesis of Published Research: A Study of Gujarat University. *Library Philosophy and Practice*, 1-16.
- Raban, D. R., and Gordon, A. (2020). The evolution of data science and big data research: A bibliometric analysis. *Scientometrics*, 122(3), 1563-1581.
- Roy, S. B. (2019) Research Output of Biological Science during 1901-1945: A Scientometric Analysis. *DESIDOC Journal of Library & Information Technology*, 39(3), 96-103.
- Shanthi, B., and Thanuskodi, S. (2019) Leather Technology Research Output: A Scientometric Analysis on Web of Science Database (2009-2018). *Library Philosophy and Practice*, 1-10.
- Shukla, R. (2019) Indian research output on genetic disorder publication using the Scopus database: A scientometric study. *Collnet Journal of Scientometrics and Information Management*, 13(1), 91-102.
- Sudhier, K. G., and Dileepkumar, V. (2020). Scientometric Profile of Biochemistry Research in India: A Study Based on Web of Science. *DESIDOC Journal of Library & Information Technology*, 40(1), 388-396.
- Ulaganathan, G., and Senthilkumar, R. (2017). Scientometric Analysis of Astrophysics Research Output in India: A Study Based on Web of Science Database. *Journal of Advances in Library and Information Science*, 6 (4), 324 – 328

University of Delhi. (2020),¹ Available at <http://du.ac.in/du/index.php?page=intellectual-property-rights>.
(accessed 1st Jun 2019)

University of Delhi. (2020)² Available at <http://du.ac.in>

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