Measuring the Research Productivity of Deenbandhu Chhotu Ram University of Science and Technology during 2011-2021: A Scientometric Analysis

Rohit
School of Library and Information Science, Central University of Gujarat, Gandhinagar, Gujarat, INDIA.

ABSTRACT: This paper presents a scientometric analysis of Deenbandhu Chhotu Ram University of Science and Technology research performance as seen through the Scopus database from 2011 to 2021. The study intended to investigate the annual growth of research and citation impact, top-productive authors, authorship pattern, core sources and level of collaborations, etc. Bibliometrix R-Package, MS-Excel, and VOSviewer software are used for data analysis and visualisation. The results show that out of 1502 papers, the maximum publications 256 published in 2021 and a minimum of 34 in 2011 (2%), “AIP Conference Proceedings” was the most preferred source for research communication (72 papers), Sanjeev Maken ranked first among all authors with 74 articles, and the 3-authored (451 articles) was the favoured authorship pattern. Furthermore, the authors published the maximum number of papers in the Engineering discipline. This study shows the trends of scholarly contributions at DCRUST. These study findings can help to understand the publication trends, research's uniqueness and impact.

Keywords: Scientometric, DCRUST, Scopus, Haryana, Research Productivity.

INTRODUCTION

The scientometric method is used to assess research performance and impact. These are the essential tools to measure research and development in a quantitative and qualitative manner. Using various scientometric indicators, one can easily quantify an institution’s research growth and performance and easily understand growth trends in many fields. Deenbandhu Chhotu Ram University of Science and Technology (DCRUST) is one of the premieres among all universities in Haryana state. The Haryana Government founded it in 1986 as an Engineering College in Sir Chhotu Ram’s memory. Later in 2006, this college was upgraded into a university through the state government Act 29 (2006). This university accreted with grade ‘A’ by NAAC in 2017. So far, no assessment study has applied to this university.

To display a more precise picture of the university’s contribution and understand how it changed over time, the present study attempts to analyse the growth and development of the university’s research productivity indexed in the Scopus.

LITERATURE REVIEW

The literature review is essential to find a new research topic and research gap. Over time, many researchers have conducted assessment studies to map the research outcomes of an institute, particularly in the HEI sector in India. Siwach and Parmar, studied the research trends at Haryana Agricultural University. They collected citation data from Scopus database from 2001 to 2015 and observed that nearly half of the articles were published in ten sources, and Annals of Biology was the most preferred journal. Lakshman and Devi, analysed the research output of Kerala University from 2001 to 2018. They collected 1972 documents through the Web of Science database, including 166 Government funding agencies. The study results show that Chemistry has the highest funded publications, while 25 agencies...
Rohit.: Measuring the Research Productivity of DCRUST

performed a scientometric analysis of Tumkur University’s publication output. They extracted 646 documents from Scopus Database for fifteen years. This study analyses the research growth rate, citation impact and authorship pattern. The study results in 2015, the maximum number of publications was published, and the university authors contributed more collaborative papers than single-authored. Santhakumar et al.\textsuperscript{5} studied the research productivity of Madras University for ten years. They retrieved 3283 records from the Web of Science database and found that productivity has a diverging trend in the publication pattern. The study findings conclude that the university produces the largest share of papers in chemistry, and authors prefer UK-based journals to publish their research. Singh et al.\textsuperscript{6} examined the Forest Research Institute’s research productivity from 1990 to 2019 by collecting data from the Scopus database. The study findings reveal the maximum publications and citations recorded in 2008 and 2007, respectively. Agri and Biological Sciences, Environmental Studies and Biochemistry are the key research areas at Forest Research Institute. Chaturbhuj and Motewar,\textsuperscript{7} conducted a scientometric study of the research output of Savitribai Phule Pune University from 2001 to 2019. A total of 6449 documents were retrieved from the Web of Science database to analyse the specialisation index and research priority index. The study also measures various rankings such as author’s production, top-cited authors, most-cited sources and most preferred journals. Kappi et al.\textsuperscript{8} analysed the research output of universities in Karnataka state from 2010 to 2019 by collecting bibliographic data from the Web of Science database. They selected Karnataka University, Bangalore University and Mysore University. This study observed a continuous increase in research output, and Mysore University produced a larger share of total research output. Mondal and Chakrabarti,\textsuperscript{9} assessed the growth research of IISERs as seen through the Web of Science. They explained that IISER Pune had contributed the maximum number of papers. Chemistry and Physics were the key research areas. These IISERs collaborate with the Tata Institute of Fundamental Research at the domestic level and globally with Germany, USA and UK. Pandya et al.\textsuperscript{10} mapped the research output of newly established twelve central universities in various states. They collected 3927 records using Scopus from 2010 to 2019, and research publications revealed significant growth. The highest number of 765 publications contributed by Central University of Rajasthan amid the selected universities, and chemistry was the top contributed subject area. Shettar and Hadagali,\textsuperscript{11} analysed the research collaboration pattern of NITs for 20 years from 1999 to 2018, using the clarivate’s citation database. They applied several parameters: collaboration degree, collaboration index, and modified collaborative coefficient. The study results reveal that the collaboration degree lies between 0.88 to 0.98 during the period. Mukherjee and Sing,\textsuperscript{12} examined the collaboration pattern of 3 top-ranked universities based on NIRF ranking using the Web of Science from 2000 to 2020. They observed that Jawahar Nehru University has the most significant collaboration with the University of Delhi, and physics has more collaborative documents.

**OBJECTIVES**

The primary study objectives are the following:

- To study the publication growth and impact of DCRUST.
- To estimate the growth rate.
- To examine the pattern of authorship and collaborative measures.
- To know the core sources preferred by researchers.
- To know the most occurred author’s keywords.
- To know the top research collaborators domestic and globally.
- To know the major research themes.

**MATERIALS AND METHODS**

The current study intends to measure the research output of Deenbandhu Chhotu Ram University of Science and Technology. The scientometric analysis method has been employed to evaluate the research productivity from 2011 to 2021. This method includes quantitative measurement of scholarly research, publishing trends, prolific authors, country, organisation, etc. Scopus,\textsuperscript{13} database was chosen for its broad coverage, and the data was retrieved using the affiliation search tag. The string used to extract data is given as follows:

\[
AF-ID ("Deenbandhu Chhotu Ram University of Science and Technology" 60076923) AND (LIMIT-TO (PUBYEAR, 2011-2021)).
\]

A total of 1502 articles were fetched and downloaded in the csv format. Various bibliometric indicators were used to analyse the data to fulfil the research objectives; data was processed using the Biblioshiny from the R-Bibliometrix,\textsuperscript{14} package, and VOSviewer software was used to visualise the citation graph.

**DATA ANALYSIS AND DISCUSSION**

**Annual Publication Growth**

Table 1 shows the annual growth of DCRUST publications from 2011 to 2021. The authors published 1502 publications with 12377 citations received during this period. The university has an $h$-index of 47 and an ACPP of 8.82. The maximum number of 256 publications were published in 2021, followed
by 2020 and 2019, 248 and 193 articles. The minimum number of papers (34) was published in 2011. The average per paper citation was highest in 2017 (16.40), followed by 2015 (16.00). Figure 1 illustrates publication and citation annual growth.

Form-wise Distribution
Research documents were published in many formats during the study time. Different types of publications analysed in the current study are given in Table 2.

Discipline-wise Contribution
Table 3 depicts the distribution of DCRUST’s contributions discipline-wise. The university’s main subject area for research is Engineering, with the largest share (585 articles), followed by Materials Science (403), Physics and Astronomy (357) and Computer Science (325). The actual number of articles is much more, as Table 3 depicts only the top ten subject areas. The mean citation per paper was found highest for Chemistry (14.28), followed by Biochemistry (12.15) and Materials Science (12.12). Materials Science has the highest h-index (37), followed by Physics and Engineering (32).

Growth Rate and Doubling Time
Table 4 describes the rate of relative growth with a doubling time of the DCRUST records from 2011 to 2021. RGR is calculated to evaluate the publication’s growth over time. The highest growth rate (0.928) was observed in 2014, and a 21.828 doubling time value was in 2021 during the study period. The following formula is used to calculate the $T_d$ for papers:

$$T_d = \frac{0.693}{\text{RGR}}$$

Research Collaboration
DCRUST authors collaborated with many domestic and global institutions for their research. The top ten institutions which collaborated with DCRUST are shown in Table 5. The university has a leading research collaboration with Maharshi Dayanand University having 139 publications along with 763 citations and 18 h-index. Guru Jambheshwar University (GJUST) has the second-highest collaboration (83 papers; 989 citations; 19 h-index), Kuruikshetra University has 67

---

Table 1: Annual publication growth and Citation received.

<table>
<thead>
<tr>
<th>Year</th>
<th>TP</th>
<th>TP (%)</th>
<th>TC</th>
<th>WSC</th>
<th>AC100</th>
<th>ACPP</th>
<th>h-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>34</td>
<td>2.26</td>
<td>428</td>
<td>365</td>
<td>0</td>
<td>12.59</td>
<td>10</td>
</tr>
<tr>
<td>2012</td>
<td>86</td>
<td>5.73</td>
<td>1062</td>
<td>890</td>
<td>2</td>
<td>12.35</td>
<td>17</td>
</tr>
<tr>
<td>2013</td>
<td>75</td>
<td>4.99</td>
<td>999</td>
<td>776</td>
<td>1</td>
<td>13.32</td>
<td>16</td>
</tr>
<tr>
<td>2014</td>
<td>101</td>
<td>6.72</td>
<td>894</td>
<td>633</td>
<td>0</td>
<td>8.85</td>
<td>18</td>
</tr>
<tr>
<td>2015</td>
<td>130</td>
<td>8.66</td>
<td>2080</td>
<td>1567</td>
<td>3</td>
<td>16.00</td>
<td>29</td>
</tr>
<tr>
<td>2016</td>
<td>120</td>
<td>7.99</td>
<td>1265</td>
<td>912</td>
<td>2</td>
<td>10.54</td>
<td>19</td>
</tr>
<tr>
<td>2017</td>
<td>106</td>
<td>7.06</td>
<td>1738</td>
<td>1353</td>
<td>2</td>
<td>16.40</td>
<td>23</td>
</tr>
<tr>
<td>2018</td>
<td>153</td>
<td>10.19</td>
<td>1553</td>
<td>1178</td>
<td>1</td>
<td>10.15</td>
<td>20</td>
</tr>
<tr>
<td>2019</td>
<td>193</td>
<td>12.85</td>
<td>1157</td>
<td>886</td>
<td>0</td>
<td>5.99</td>
<td>17</td>
</tr>
<tr>
<td>2020</td>
<td>248</td>
<td>16.51</td>
<td>965</td>
<td>730</td>
<td>0</td>
<td>3.89</td>
<td>18</td>
</tr>
<tr>
<td>2021</td>
<td>256</td>
<td>17.04</td>
<td>236</td>
<td>175</td>
<td>0</td>
<td>0.92</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>1502</td>
<td>100</td>
<td>12377</td>
<td>9465</td>
<td></td>
<td>8.24</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 2: Form-wise distribution.

<table>
<thead>
<tr>
<th>Publication Type</th>
<th>TP</th>
<th>TC</th>
<th>ACPP</th>
<th>h-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article</td>
<td>1,003</td>
<td>9819</td>
<td>9.79</td>
<td>45</td>
</tr>
<tr>
<td>Conference Paper</td>
<td>361</td>
<td>934</td>
<td>2.59</td>
<td>15</td>
</tr>
<tr>
<td>Review</td>
<td>73</td>
<td>1491</td>
<td>20.42</td>
<td>19</td>
</tr>
<tr>
<td>Book Chapter</td>
<td>42</td>
<td>102</td>
<td>2.43</td>
<td>6</td>
</tr>
<tr>
<td>Erratum</td>
<td>15</td>
<td>7</td>
<td>0.47</td>
<td>1</td>
</tr>
<tr>
<td>Editorial</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Data Paper</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Book</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Letter</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Retracted</td>
<td>1</td>
<td>32</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>1502</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Discipline-wise Contribution.

<table>
<thead>
<tr>
<th>Subject</th>
<th>TP</th>
<th>TC</th>
<th>ACPP</th>
<th>h-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>585</td>
<td>4154</td>
<td>7.10</td>
<td>32</td>
</tr>
<tr>
<td>Materials Science</td>
<td>403</td>
<td>4884</td>
<td>12.12</td>
<td>37</td>
</tr>
<tr>
<td>Physics and Astronomy</td>
<td>357</td>
<td>3039</td>
<td>8.51</td>
<td>32</td>
</tr>
<tr>
<td>Computer Science</td>
<td>325</td>
<td>1946</td>
<td>5.99</td>
<td>24</td>
</tr>
<tr>
<td>Chemistry</td>
<td>222</td>
<td>3170</td>
<td>14.28</td>
<td>33</td>
</tr>
<tr>
<td>Mathematics</td>
<td>170</td>
<td>391</td>
<td>2.30</td>
<td>10</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>150</td>
<td>1582</td>
<td>10.55</td>
<td>26</td>
</tr>
<tr>
<td>Energy</td>
<td>146</td>
<td>1739</td>
<td>11.91</td>
<td>21</td>
</tr>
<tr>
<td>Biochemistry, Genetics and Molecular</td>
<td>117</td>
<td>1422</td>
<td>12.15</td>
<td>20</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>76</td>
<td>343</td>
<td>4.51</td>
<td>13</td>
</tr>
</tbody>
</table>
Table 4: Growth Rate and $T_d$

<table>
<thead>
<tr>
<th>Year</th>
<th>Publications</th>
<th>$\log_2 W_i$</th>
<th>$\log_2 W_f$</th>
<th>RGR</th>
<th>$T_d$</th>
<th>$\bar{x}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>34</td>
<td>0</td>
<td>3.53</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2012</td>
<td>86</td>
<td>3.53</td>
<td>4.45</td>
<td>0.928</td>
<td>0.747</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>75</td>
<td>4.45</td>
<td>4.32</td>
<td>-0.137</td>
<td>-5.064</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>101</td>
<td>4.32</td>
<td>4.62</td>
<td>0.298</td>
<td>2.328</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>130</td>
<td>4.62</td>
<td>4.87</td>
<td>0.252</td>
<td>2.745</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>120</td>
<td>4.87</td>
<td>4.79</td>
<td>-0.080</td>
<td>-8.658</td>
<td>1.452</td>
</tr>
<tr>
<td>2017</td>
<td>106</td>
<td>4.79</td>
<td>4.66</td>
<td>-0.124</td>
<td>-5.586</td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>153</td>
<td>4.66</td>
<td>5.03</td>
<td>0.367</td>
<td>1.888</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>193</td>
<td>5.03</td>
<td>5.26</td>
<td>0.232</td>
<td>2.984</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>248</td>
<td>5.26</td>
<td>5.51</td>
<td>0.251</td>
<td>2.764</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>256</td>
<td>5.51</td>
<td>5.55</td>
<td>0.032</td>
<td>21.828</td>
<td></td>
</tr>
</tbody>
</table>

RGR = Relative Growth Rate; $T_d$ = Doubling time; $\bar{x}$ = mean.

Table 5: Collaborative Institutions.

<table>
<thead>
<tr>
<th>Name</th>
<th>TP</th>
<th>TC</th>
<th>ACPP</th>
<th>$AC_{10}$</th>
<th>$h$-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maharshi Dayanand University</td>
<td>139</td>
<td>763</td>
<td>5.49</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Guru Jambheshwar University of Sci. and Tech.</td>
<td>83</td>
<td>989</td>
<td>11.92</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Kurukshetra University</td>
<td>67</td>
<td>344</td>
<td>5.13</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>National Institute of Technology Kurukshetra</td>
<td>61</td>
<td>593</td>
<td>9.72</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>University of Delhi</td>
<td>50</td>
<td>403</td>
<td>8.06</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Indian Institute of Technology Delhi</td>
<td>49</td>
<td>713</td>
<td>14.55</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Delhi Technological University</td>
<td>45</td>
<td>441</td>
<td>9.80</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Gyeongsang National University</td>
<td>43</td>
<td>69</td>
<td>1.60</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Thapar Institute of Engineering and Technology</td>
<td>31</td>
<td>304</td>
<td>9.81</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Hindu College, Sonepat</td>
<td>28</td>
<td>237</td>
<td>8.46</td>
<td>0</td>
<td>11</td>
</tr>
</tbody>
</table>

As depicted in Table 6, DCRUST has the most worldwide collaborative papers with South Korea (84 publication), followed by the USA (47 publication) and Germany (17 publication). The university has the highest $h$-index (14) in collaboration with the United States of America.

Preferred Sources for Publication

The authors published their articles in many periodicals and conferences. In Table 7, the top ten sources preferred by researchers are listed for research communication. These sources covered 18.97% of the total articles. The most preferred channel for scholarly communication by DCRUST’s authors is “AIP Conference Proceedings”, in which 72 papers were published. The “Journal of Molecular Liquids” published 41 articles. The following most preferred journals are “Advances in Intelligent Systems and Computing” (30 papers), “International Journal of Pure and Applied Mathematics” (26 papers), “Ceramics International” (25 papers), and “Materials Today: Proceedings” (21 papers). The cites per paper of these sources were also calculated. The ACPP (14.28) was seen highest for the Ceramics International and followed by Journal of Molecular Liquids (ACPP=12.02) and Journal of Materials Science: Materials in Electronics (ACPP=5.89).

Most Prolific Authors

Table 8 represents the ten most productive authors of the university. Among these ten authors, three are from the Department of Materials Science and Nanotechnology,
two are from the Department of Physics, and one is from chemistry, mathematics, physics, chemical and electrical engineering. Sanjeev Maken is found the most prolific author with 74 publications, Sanjay Kumar with 70 publications and Satish Khasa with 63 publications. The $h$-index is highest for Satyapal Nehra and Vijay K Tomer (24 each), followed by Surender Duhan (22) and Sanjeev K Maken (18) during the study period.

Authorship Pattern and Collaborative Measures

The annual structure of the authorship pattern is shown in Table 9.

Degree of Collaboration (DC)

This indicator measures co-authored documents published in a particular year and the total documents published in a field. The degree devised by Subramanyam calculated by the formula mentioned below:

$$C = \frac{N_m}{N_m + N_s}$$

Using data in Table 9, in the year 2021;

$$C = \frac{321}{321 + 3} = \frac{253}{256} = 0.988$$

$N_m$ = multi-authored papers, $N_s$ = one-author papers.

In the current study, the highest value of DC observed in 2021 is 0.988, followed by 2020 (0.980), (0.962) in 2015 and 2017, respectively.

Collaboration Index (CI)

Lawani, determined the Collaborative Index, an average of authors per document. The formula is as follows:

$$CI = \frac{\sum_{j=1}^{k} j(f_j)}{N}$$

Table 9 shows that the CI value was highest (3.885) in 2015 and the lowest (3.000) in 2012.

Collaborative Coefficient (CC)

Ajiferuke et al. developed the collaborative co-efficient to eliminate the shortcomings related to CI and DC. The formula is as below:

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

The highest value of CC was observed for the year 2015, which was 0.697; 0.673 in 2020 and 0.663 in 2017. The lowest value was 0.607 in the year 2012.

Most Cited Papers and Citation Profile

The citation profile of 1502 publications is displayed in Table 10. It was found that others cited 73.57% of the total publications. Furthermore, ten papers (0.67%) received more than one hundred citations, 29 (1.93%) received between 51 to 100, 24 (1.60%) received between 41 to 50, and 566 documents (37.68%) received citations between 1 to 5.

A list of the top ten most cited documents is created in Table 11. It was observed that all of these papers were published in

---

**Table 8: Prolific Authors.**

<table>
<thead>
<tr>
<th>Name</th>
<th>Department</th>
<th>Papers</th>
<th>TC</th>
<th>ACPP</th>
<th>$h$-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanjeev K Maken</td>
<td>Chemistry</td>
<td>74</td>
<td>799</td>
<td>10.80</td>
<td>18</td>
</tr>
<tr>
<td>Sanjay Kumar</td>
<td>Mathematics</td>
<td>70</td>
<td>151</td>
<td>2.16</td>
<td>7</td>
</tr>
<tr>
<td>Satish Khasa</td>
<td>Physics</td>
<td>63</td>
<td>640</td>
<td>10.16</td>
<td>17</td>
</tr>
<tr>
<td>Surender Duhan</td>
<td>Materials Science and Nanotechnology</td>
<td>58</td>
<td>1237</td>
<td>21.33</td>
<td>22</td>
</tr>
<tr>
<td>Satyapal Nehra</td>
<td>Energy and Environmental Studies</td>
<td>55</td>
<td>1207</td>
<td>21.95</td>
<td>24</td>
</tr>
<tr>
<td>Manju Rani</td>
<td>Chemical Engineering</td>
<td>52</td>
<td>590</td>
<td>11.35</td>
<td>16</td>
</tr>
<tr>
<td>Dinesh K Jain</td>
<td>Electrical Engineering</td>
<td>46</td>
<td>375</td>
<td>8.15</td>
<td>9</td>
</tr>
<tr>
<td>Vijay K Tomer</td>
<td>Materials Science and Nanotechnology</td>
<td>46</td>
<td>1237</td>
<td>26.89</td>
<td>24</td>
</tr>
<tr>
<td>Ashish Agarwal</td>
<td>Physics</td>
<td>45</td>
<td>638</td>
<td>14.18</td>
<td>17</td>
</tr>
<tr>
<td>Ashok K Sharma</td>
<td>Materials Science and Nanotechnology</td>
<td>41</td>
<td>487</td>
<td>11.88</td>
<td>17</td>
</tr>
</tbody>
</table>

**Table 9: Authorship Pattern and Collaborative Indicators.**

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>≥ 11</th>
<th>Total</th>
<th>CC</th>
<th>CI</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>3</td>
<td>7</td>
<td>14</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>34</td>
<td>34</td>
<td>0.609</td>
<td>3.147</td>
<td>0.912</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>6</td>
<td>20</td>
<td>41</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>86</td>
<td>86</td>
<td>0.607</td>
<td>3.000</td>
<td>0.930</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>6</td>
<td>13</td>
<td>29</td>
<td>20</td>
<td>2</td>
<td>5</td>
<td>75</td>
<td>75</td>
<td>0.621</td>
<td>3.187</td>
<td>0.920</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>5</td>
<td>21</td>
<td>36</td>
<td>22</td>
<td>12</td>
<td>5</td>
<td>101</td>
<td>101</td>
<td>0.641</td>
<td>3.297</td>
<td>0.950</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>5</td>
<td>10</td>
<td>41</td>
<td>33</td>
<td>21</td>
<td>20</td>
<td>130</td>
<td>130</td>
<td>0.697</td>
<td>3.885</td>
<td>0.962</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>5</td>
<td>24</td>
<td>37</td>
<td>30</td>
<td>11</td>
<td>13</td>
<td>120</td>
<td>120</td>
<td>0.657</td>
<td>3.475</td>
<td>0.958</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>4</td>
<td>25</td>
<td>27</td>
<td>17</td>
<td>14</td>
<td>19</td>
<td>106</td>
<td>106</td>
<td>0.663</td>
<td>3.651</td>
<td>0.962</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018</td>
<td>6</td>
<td>42</td>
<td>44</td>
<td>29</td>
<td>14</td>
<td>18</td>
<td>153</td>
<td>153</td>
<td>0.642</td>
<td>3.373</td>
<td>0.961</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>9</td>
<td>53</td>
<td>57</td>
<td>32</td>
<td>17</td>
<td>25</td>
<td>193</td>
<td>193</td>
<td>0.637</td>
<td>3.363</td>
<td>0.953</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>5</td>
<td>65</td>
<td>63</td>
<td>30</td>
<td>29</td>
<td>56</td>
<td>248</td>
<td>248</td>
<td>0.673</td>
<td>3.730</td>
<td>0.980</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>3</td>
<td>82</td>
<td>62</td>
<td>39</td>
<td>30</td>
<td>40</td>
<td>256</td>
<td>256</td>
<td>0.660</td>
<td>3.512</td>
<td>0.988</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DC=Degree of Collaboration, CI=Collaboration Index, CC=Collaborative Coefficient
Table 10: Citation Impact.

<table>
<thead>
<tr>
<th>Citation Range</th>
<th>TP</th>
<th>TP (%)</th>
<th>TC</th>
<th>TC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncited</td>
<td>397</td>
<td>26.43</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1-5</td>
<td>566</td>
<td>37.68</td>
<td>1379</td>
<td>9.96</td>
</tr>
<tr>
<td>6-10</td>
<td>176</td>
<td>11.72</td>
<td>1403</td>
<td>10.13</td>
</tr>
<tr>
<td>11-20</td>
<td>178</td>
<td>11.85</td>
<td>2646</td>
<td>19.10</td>
</tr>
<tr>
<td>21-30</td>
<td>76</td>
<td>5.06</td>
<td>1927</td>
<td>13.91</td>
</tr>
<tr>
<td>31-40</td>
<td>46</td>
<td>3.06</td>
<td>1588</td>
<td>11.46</td>
</tr>
<tr>
<td>41-50</td>
<td>24</td>
<td>1.60</td>
<td>1094</td>
<td>7.90</td>
</tr>
<tr>
<td>51-100</td>
<td>29</td>
<td>1.93</td>
<td>1937</td>
<td>13.98</td>
</tr>
<tr>
<td>&gt;100</td>
<td>10</td>
<td>0.67</td>
<td>1877</td>
<td>13.55</td>
</tr>
<tr>
<td>Total</td>
<td>1502</td>
<td>100</td>
<td>13851</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 11: Most Cited Papers.

<table>
<thead>
<tr>
<th>Paper</th>
<th>DOI</th>
<th>TC</th>
<th>TCpY</th>
<th>NTC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duhan JS, 2017</td>
<td>10.1016/j.btre.2017.03.002</td>
<td>360</td>
<td>60.00</td>
<td>20.33</td>
</tr>
<tr>
<td>Rattan D, 2013</td>
<td>10.1016/j.infsof.2013.01.008</td>
<td>226</td>
<td>22.60</td>
<td>16.41</td>
</tr>
<tr>
<td>Pukazhselvan D, 2012</td>
<td>10.1016/j.nanoen.2012.05.004</td>
<td>168</td>
<td>15.27</td>
<td>13.27</td>
</tr>
<tr>
<td>Tomer VK, 2016</td>
<td>10.1039/c5ta08336b</td>
<td>164</td>
<td>23.43</td>
<td>14.73</td>
</tr>
<tr>
<td>Chander S, 2015</td>
<td>10.1016/j.egyr.2015.03.004</td>
<td>138</td>
<td>17.25</td>
<td>8.11</td>
</tr>
<tr>
<td>Total Citations</td>
<td></td>
<td>1877</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DOI = Digital Object Identifier, TCpY = Per Year Citations, NTC = Normalized TC

various sources. A total of 1877 citations were received by these ten papers, with an average of per paper 187 cites. The paper authored by Duhan et al. (2017), “Nanotechnology: The new perspective in precision agriculture”, received 360 citations and was published in Biotechnology Reports.

Thematic map of DCRUST’s Publications

Figure 2 visualises four themes of centrality and density with a thematic map. One hundred words were selected to draw the plot, five times least occurrence and 3 cluster levels.

1. The motor theme is x-ray diffraction, shown in cluster 2. This cluster is represented by 24 keywords: x-ray diffraction, nanoparticles, high-resolution transmission electron microscopy, particle size, synthesis, transmission, etc.

2. The basic theme is scanning electron microscopy, represented by cluster 1. This cluster consists of 26 words (scanning electron microscopy, fourier transform, nanocomposites, energy gap, temperature, adsorption, glass, zinc oxide, silica, etc.

3. The niche theme is article human nonhuman placed in cluster 3. This cluster involves 30 keywords (article, human, nonhuman, controlled study, chemistry, humans, unclassified drug, female, carbon, India, electroencephalography, procedures, etc.

4. The emerging or declining theme is binary mixtures exemplified by cluster 4 and composed of 20 keywords (binary mixtures, artificial intelligence, matlab, particle swarm optimization, optimization, signal processing, power quality, finite element method etc.

Mapping of Keyword Co-occurrence

Figure 3 shows the map of the most frequent keywords. Therefore, out of 11914 keywords, 200 were selected to draw the visualisation graph. These keywords are categorised and visualised in eight clusters.

The 1st cluster comprises 66 keywords (activation energy, barium compounds, bismuth, bismuth compounds, chemical coprecipitation methods, cobalt, combustion, crystal structure, crystallite size, dielectric losses etc.) The second cluster includes 37 keywords (adult, animal, animals, article, biosensing techniques, biosensors, carbon nanotube, chemistry, controlled study etc.) The third cluster comprises 32 keywords (adsorption, antibacterial activity, anti-infective agent, aromatic compounds, bacteria, biodegradation, carbon, carbon nanotubes, cellulose, chemical analysis etc.) The 4th cluster represents 20 keywords (algorithms, artificial intelligence, biomedical signal processing, diagnosis, diseases, electroencephalography, energy efficiency, feature extraction, fuzzy logic, genetic algorithm etc.) The 5th
cluster consists of 17 keywords (atmospheric humidity, field emission microscopes scanning, electron microscopy, humidity sensors, hydrothermal etc.) The 6th cluster consists of 15 keywords (binary mixtures, ethers, excess molar volume, graph theoretical approach, graph-theory, intermolecular interactions, ketones etc.) The 7th cluster consists of 7 keywords (chlorine compounds, compressive strength, fly ash, geopolymer concrete, geopolymers, tensile strength). The 8th cluster consists of 6 keywords (annealing, ii-vi semiconductors, substrates, thin films, zinc oxide, zinc sulfide).

Author Collaboration Map

Figure 4 shows the author “Kumar S” got the highest rank in research collaboration regarding publication (138) with total link strength (298), and in Figure 5, one can see that “Duhan S” got the highest citations (1643) with total link strength (178). “Kumar P” (96), “Kumar R” (93), and “Kumar A” (91) have research collaborations with 932, 707, and 1060 citations, respectively.

CONCLUSION

The present study uncovers the research impact and publication growth of the Deenbandhu Chhotu Ram University of Science and Technology as seen through the Scopus database from 2011 to 2021. During the study period, various countries’ authors have jointly published their articles with DCRUST. It was observed that the three author-publication pattern was most favoured, and there was a small number of single-authored publications. In 2021, the maximum number of publications was recorded at 256 (17.04%), followed by 248 (16.51%) publications in 2017. The study found that the maximum number of documents published were in the form of 1003 (66.77%) article followed by conference papers 361 (24.03%). Sanjeev Maken, Sanjay Kumar and Satish Khasa were the most prolific authors. AIP Conference Proceedings and the Journal of Molecular Liquids were the most preferred sources during the study period. DCRUST has a strong collaboration with Maharshi Dayanand University (139 publications) at the domestic level and globally with South Korea (84 publications). It should suggest that well-known journals should be preferred to publish research to get a broad impact. This analysis provides a satisfactory sign of the research activities and research pattern. The university should make more effort to develop a professional research environment and pay more additional attention to multidisciplinary research.

ACKNOWLEDGEMENT

The author would like to acknowledge the UGC-Junior Research Fellowship for providing the financial support for this research work.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.
ABBREVIATIONS

DCRUST: Deenbandhu Chhotu Ram University of Science and Technology; HEI: Higher education institutions; TP: Total number of publications; WSC: Without self-citation; TC: Total number of citations; ACPP: Average citations per paper; RGR: Relative growth rate; Td: Doubling time; AC100: Papers having at least hundred citations or more; SJR: SCImago Journal Rank; NTC: Normalised citations.

REFERENCES
