Indian Institute of Technology, Kharagpur: A Scientometric study of Research Output

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ABSTRACT

The paper deals with the analysis of publications of Indian Institute of Technology Kharagpur (IIT Kharagpur) during 2000 to 2015 appeared in SCOPUS database. It attempts to analyze the growth and development of research activity of IIT Kharagpur as reflected in publications output. Data for a total of 18927 have been downloaded and analysed according to objectives. The study reveals that the growth of literature follows the exponential growth pattern, journal articles are the most published form of literature (74.37%), Journal of Applied Polymer Science and Journal of Applied Physics are top journals, Jadavpur University and National Institute of Technology are top collaborating institutions/university with Indian Institute of Technology, Kharagpur. The highly productive subject areas are engineering and materials science, computer science, physics and astronomy. US, Germany and UK are the most favored countries for collaborations and authorship pattern analysis shows that degree of collaboration (0.95) significantly high. Suggests that periodically this type of data be reflected along with institutional repositories of the respective institutions.

Keywords: IIT, Scientometrics, Research Output, Institutional Productivity; Institutional Repository

1. INTRODUCTION

The Indian Institute of Technology Kharagpur (IIT Kharagpur) also known as IIT, KGP is a public engineering institution established by the government of India in 1951. It was the first of the IITs to be established, and is recognized as an Institute of National Importance by the Government of India. IIT Kharagpur has 19 academic departments, eight multi-disciplinary
centres/schools, and 13 schools of excellence in addition to more than 25 central research and development units. IIT Kharagpur has been ranked as the top institution in India and among the top 100 in the world, between the ranking range of 71-80 in the first edition of the QS Graduate Employability Rankings. Internationally, IIT Kharagpur is ranked 286th in the QS World University Rankings (Quacquarelli Symonds) of 2015 and 60th in the QS Asian University Rankings of 2014 (Wikipedia. (n.d.).

Numerous studies have been reported earlier, which provide research output of various institutions/universities all over the world as reflected in international source [Courtesy: Web of Science]; Scopus (Chaurasia & Chavan, 2014; Singh, 2015; Balasubramani & Parameswaran, 2014; Maharana, 2013; Bid & Verma, 2011, Parameswaran 2015), but very few in terms of contribution of IIT Kharagpur except by Jeevan and Gupta (2002), who suggest a methodology for studying the quantitative profile of a research university, with a view to get idea about the performance and impact of research produced in each department, and the comparison of the impact of research in various departments. For building a more reliable and objective picture on the contribution of IIT Kharagpur and understanding how this picture has changed overtime, the present study attempts to analyze the growth and development of research activity of IIT Kharagpur as reflected in publications output.

2. **OBJECTIVES**

The specific objectives of the present study addresses the following aspects:

1. To examine the year-wise distribution of publications of IIT Kharagpur, India.
2. To identify the authorship pattern and prolific authors of IIT Kharagpur, India.
3. To study the publication in which authors preferred to publish their work.
4. To analyse the geographical distribution of publications.
5. To identify the journals which were most preferred by the researchers.
3. METHODOLOGY

The contributions from Indian Institute of Technology, Kharagpur finds indexed in the database [Courtesy: Scopus], owned by Elsevier. Scopus is a multidisciplinary bibliographic database. It has information from more than 20,500 of the most prestigious, high impact research journals in the world. It is used to map data on science and technology worldwide. The basic data from Indian Institute of Technology, Kharagpur [2000-15], were collected through advanced search option by using affiliation id (AF ID). Scopus provide individual ID for individual institute/author. By using AF ID of Indian Institute of Technology, Kharagpur (AF ID 60004750) within the time span between 2000 to 2015. As a result, 18927 journal articles were saved in text files and imported to Microsoft Excel for analysis. Citation counts received by the papers which were published and available in database have been used as qualitative measure.

4. DATA ANALYSIS AND INTERPRETATION

4.1 Growth of Literature:

Table 1
Year-wise Distribution of Publication with Citation

<table>
<thead>
<tr>
<th>SI. No.</th>
<th>Year</th>
<th>Record counts</th>
<th>Percentage (%)</th>
<th>Citation</th>
<th>Impact citation/record</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2000</td>
<td>494</td>
<td>2.61</td>
<td>63</td>
<td>0.12</td>
</tr>
<tr>
<td>2</td>
<td>2001</td>
<td>456</td>
<td>2.40</td>
<td>421</td>
<td>0.92</td>
</tr>
<tr>
<td>3</td>
<td>2002</td>
<td>506</td>
<td>2.67</td>
<td>808</td>
<td>1.59</td>
</tr>
<tr>
<td>4</td>
<td>2003</td>
<td>592</td>
<td>3.12</td>
<td>1381</td>
<td>2.33</td>
</tr>
<tr>
<td>5</td>
<td>2004</td>
<td>783</td>
<td>4.13</td>
<td>2234</td>
<td>2.85</td>
</tr>
<tr>
<td>6</td>
<td>2005</td>
<td>863</td>
<td>4.55</td>
<td>3397</td>
<td>3.93</td>
</tr>
<tr>
<td>7</td>
<td>2006</td>
<td>1145</td>
<td>6.04</td>
<td>4932</td>
<td>4.30</td>
</tr>
<tr>
<td>8</td>
<td>2007</td>
<td>1252</td>
<td>6.61</td>
<td>7021</td>
<td>5.60</td>
</tr>
<tr>
<td>9</td>
<td>2008</td>
<td>1411</td>
<td>7.45</td>
<td>9552</td>
<td>6.76</td>
</tr>
<tr>
<td>10</td>
<td>2009</td>
<td>1500</td>
<td>7.92</td>
<td>12543</td>
<td>8.362</td>
</tr>
<tr>
<td>11</td>
<td>2010</td>
<td>1588</td>
<td>8.39</td>
<td>15700</td>
<td>9.88</td>
</tr>
<tr>
<td>12</td>
<td>2011</td>
<td>1552</td>
<td>8.19</td>
<td>19959</td>
<td>12.86</td>
</tr>
<tr>
<td>13</td>
<td>2012</td>
<td>1645</td>
<td>8.69</td>
<td>23332</td>
<td>14.18</td>
</tr>
<tr>
<td>14</td>
<td>2013</td>
<td>1678</td>
<td>8.86</td>
<td>27458</td>
<td>16.36</td>
</tr>
<tr>
<td>15</td>
<td>2014</td>
<td>1833</td>
<td>9.68</td>
<td>30681</td>
<td>16.73</td>
</tr>
<tr>
<td>16</td>
<td>2015</td>
<td>1629</td>
<td>8.60</td>
<td>27850</td>
<td>17.09</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>18927</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
As indicated in the Table 1 authors from IIT Kharagpur have contributed as many as 18927 papers in different disciplines during the year 2000 to 2015. The average annual rate of the study period is 1182.93 items. In 2000, a total of 494 items published against 1629 in 2015. There was steady growth in number of items published except those of 2001, 2011 and 2015. In 2009, the numbers of articles finds tripled (1500) from the start (494) of the study i.e. 2000 and quadruple (four times) in 2012 (1645).

The study has been carried out from 2000 to 2015 based on number of cited references used by the author of 18927 research articles. The number of references cited by the scientists were studied and changing trend was observed. The total number of citations, citations per article for the last 16 years is shown in the Table 1. Number of citations vary from article to article. Table shows the citations per article, which varies from 0.12 to 17.09 to in different year, the trend shows steady rate.187332 citation were received with average of 9.89 citations per paper with h index of 119. In 2015 citations per article attained the maximum.
Table 2

<table>
<thead>
<tr>
<th>Year</th>
<th>Paper</th>
<th>Quadruple growth rate, Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-03</td>
<td>2048</td>
<td></td>
</tr>
<tr>
<td>2004-07</td>
<td>4043</td>
<td>97.41</td>
</tr>
<tr>
<td>2008-11</td>
<td>6051</td>
<td>49.66</td>
</tr>
<tr>
<td>2012-15</td>
<td>6785</td>
<td>12.13</td>
</tr>
</tbody>
</table>

Quadruple publication output by IIT Kharagpur authors/contributors published 2048 in 2000-03, 4043 in 2004-07, 6051 in 2008-11 and 6885 in 2002-15. Thus the publication growth has been 97.41% for the quadruple period 2000-03 to 2004-07, which decreases to 49.66% during 2004-07 to 2008-11 and 12.13% for the period 2008-11 to 2012-15.

4.2 Authors Pattern

Table 3
Authorship Pattern of Papers Published

<table>
<thead>
<tr>
<th>Year</th>
<th>One</th>
<th>Two</th>
<th>Three</th>
<th>Four</th>
<th>Five</th>
<th>Six</th>
<th>Seven</th>
<th>Eight</th>
<th>Nine</th>
<th>Ten</th>
<th>Ten&gt;</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>42</td>
<td>172</td>
<td>170</td>
<td>74</td>
<td>12</td>
<td>12</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>494</td>
<td>2.61</td>
</tr>
<tr>
<td>2001</td>
<td>36</td>
<td>160</td>
<td>152</td>
<td>66</td>
<td>24</td>
<td>12</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>456</td>
<td>2.41</td>
</tr>
<tr>
<td>2002</td>
<td>32</td>
<td>175</td>
<td>153</td>
<td>88</td>
<td>42</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>506</td>
<td>2.67</td>
</tr>
<tr>
<td>2003</td>
<td>31</td>
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<td>172</td>
<td>83</td>
<td>48</td>
<td>17</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>592</td>
<td>3.13</td>
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<tr>
<td>2004</td>
<td>46</td>
<td>248</td>
<td>238</td>
<td>137</td>
<td>62</td>
<td>22</td>
<td>8</td>
<td>11</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>783</td>
<td>4.14</td>
</tr>
<tr>
<td>2005</td>
<td>39</td>
<td>295</td>
<td>293</td>
<td>135</td>
<td>58</td>
<td>16</td>
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<td>8</td>
<td>2</td>
<td></td>
<td>5</td>
<td>863</td>
<td>4.56</td>
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<tr>
<td>2006</td>
<td>47</td>
<td>389</td>
<td>368</td>
<td>187</td>
<td>73</td>
<td>37</td>
<td>18</td>
<td>12</td>
<td>8</td>
<td>2</td>
<td>4</td>
<td>1145</td>
<td>6.05</td>
</tr>
<tr>
<td>2007</td>
<td>51</td>
<td>411</td>
<td>434</td>
<td>205</td>
<td>76</td>
<td>38</td>
<td>17</td>
<td>11</td>
<td>7</td>
<td></td>
<td>2</td>
<td>1252</td>
<td>6.61</td>
</tr>
<tr>
<td>2008</td>
<td>46</td>
<td>456</td>
<td>459</td>
<td>243</td>
<td>106</td>
<td>51</td>
<td>28</td>
<td>9</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>1411</td>
<td>7.45</td>
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<tr>
<td>2009</td>
<td>53</td>
<td>475</td>
<td>502</td>
<td>228</td>
<td>107</td>
<td>68</td>
<td>24</td>
<td>25</td>
<td>11</td>
<td>2</td>
<td>5</td>
<td>1500</td>
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<tr>
<td>2010</td>
<td>86</td>
<td>469</td>
<td>509</td>
<td>257</td>
<td>131</td>
<td>60</td>
<td>36</td>
<td>19</td>
<td>8</td>
<td>3</td>
<td>10</td>
<td>1588</td>
<td>8.39</td>
</tr>
<tr>
<td>2011</td>
<td>54</td>
<td>505</td>
<td>490</td>
<td>248</td>
<td>121</td>
<td>72</td>
<td>23</td>
<td>18</td>
<td>10</td>
<td>4</td>
<td>7</td>
<td>1552</td>
<td>8.2</td>
</tr>
<tr>
<td>2012</td>
<td>56</td>
<td>486</td>
<td>482</td>
<td>283</td>
<td>179</td>
<td>65</td>
<td>38</td>
<td>16</td>
<td>12</td>
<td>6</td>
<td>22</td>
<td>1645</td>
<td>8.69</td>
</tr>
<tr>
<td>2013</td>
<td>37</td>
<td>489</td>
<td>488</td>
<td>325</td>
<td>150</td>
<td>93</td>
<td>34</td>
<td>17</td>
<td>22</td>
<td>7</td>
<td>16</td>
<td>1678</td>
<td>8.87</td>
</tr>
<tr>
<td>2014</td>
<td>55</td>
<td>569</td>
<td>500</td>
<td>304</td>
<td>173</td>
<td>107</td>
<td>61</td>
<td>21</td>
<td>19</td>
<td>7</td>
<td>17</td>
<td>1833</td>
<td>9.68</td>
</tr>
<tr>
<td>2015</td>
<td>53</td>
<td>480</td>
<td>434</td>
<td>291</td>
<td>159</td>
<td>82</td>
<td>47</td>
<td>39</td>
<td>14</td>
<td>9</td>
<td>21</td>
<td>1629</td>
<td>8.61</td>
</tr>
<tr>
<td>total</td>
<td>764</td>
<td>6001</td>
<td>5844</td>
<td>3154</td>
<td>1521</td>
<td>763</td>
<td>364</td>
<td>215</td>
<td>128</td>
<td>53</td>
<td>120</td>
<td>18927</td>
<td>100</td>
</tr>
<tr>
<td>%</td>
<td>4.04</td>
<td>31.71</td>
<td>30.88</td>
<td>16.66</td>
<td>8.04</td>
<td>4.03</td>
<td>1.92</td>
<td>1.14</td>
<td>0.68</td>
<td>0.28</td>
<td>0.63</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Table 3 shows the authorship pattern. Out of 18927 papers, the maximum number of papers were 6001 (31.71 per cent) from two authors followed by three authors 5844 (30.88%), four authors 3154 (16.66), five authors 1521 (8.04%), one author 764 (4.04) and so on. Data reveals that authors from IIT Kharagpur have tendency to publish their work with two or more authors.

4.3 Degree of Collaboration (DC)

Table 4
Authorship Pattern with Degree of Collaboration Measures (DC)

<table>
<thead>
<tr>
<th>Publication Type</th>
<th>Number of Publication</th>
<th>Percentage of Total Publication (%)</th>
<th>Nm + Ns</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of Single/Multi-Authored</td>
<td>18927</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Publications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Co-Authored Publication (NM)</td>
<td>18163</td>
<td></td>
<td>18927</td>
<td>0.95</td>
</tr>
<tr>
<td>Number of Single-Authored Publication (NS)</td>
<td>764</td>
<td></td>
<td></td>
<td>0.03</td>
</tr>
<tr>
<td>Number of two-Authored Publication</td>
<td>6001</td>
<td>31.70</td>
<td>6765</td>
<td>0.88</td>
</tr>
<tr>
<td>Number of three-Authored Publication</td>
<td>5844</td>
<td>30.87</td>
<td>6608</td>
<td>0.88</td>
</tr>
<tr>
<td>Number of Four-Authored Publication</td>
<td>3154</td>
<td>16.66</td>
<td>3918</td>
<td>0.80</td>
</tr>
<tr>
<td>Number of Five-Authored Publication</td>
<td>1521</td>
<td>8.03</td>
<td>2285</td>
<td>0.66</td>
</tr>
<tr>
<td>Number of Six-Authored Publication</td>
<td>763</td>
<td>4.03</td>
<td>1527</td>
<td>0.49</td>
</tr>
<tr>
<td>Number of Seven-Authored Publication</td>
<td>364</td>
<td>1.92</td>
<td>1128</td>
<td>0.32</td>
</tr>
<tr>
<td>Number of Eight-Authored Publication</td>
<td>215</td>
<td>1.13</td>
<td>979</td>
<td>0.21</td>
</tr>
<tr>
<td>Number of Nine-Authored Publication</td>
<td>128</td>
<td>0.67</td>
<td>892</td>
<td>0.14</td>
</tr>
<tr>
<td>Number of Ten Authored Publication</td>
<td>53</td>
<td>0.28</td>
<td>817</td>
<td>0.06</td>
</tr>
<tr>
<td>Number of Eleven and above-Authored Publication</td>
<td>120</td>
<td>0.63</td>
<td>884</td>
<td>0.13</td>
</tr>
</tbody>
</table>

DC calculates the proportion of co-author publications among total publications. In order to determine the degree of collaboration or the collaborative research pattern in quantitative terms, an indicator or the formula suggested by Subramanyam (1982) has been used and results are given in Table 4. The formula is

\[ DC = \frac{Nm}{Nm + Ns} \]
Where C is degree of collaboration in a discipline, “Nm” is number of multi-authored papers during specific period in some discipline, “Ns” is number of single authored papers in a discipline during the same period of time. For calculation of DC, the data is shown in Table 5. The computed data in the column of the Table 4 shows 0.9 as the highest degree of collaboration [2000-15]. The value of DC is lowest among ten-author publications, which is 0.06 and second highest of 0.88 two-authored publications, indicating the trend towards multi-authorship papers.

Calculation: DC = Nm / (Nm + Ns)

Based on the data in the Table 5, DC for two authored publications;
Nm = 6001 & Ns = 764
DC= 6001/(6001+764)= 0.887

4.4 Most Prolific Authors

<table>
<thead>
<tr>
<th>Author Name</th>
<th>No. of publication</th>
<th>Percentage (%)</th>
<th>Department/Centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhowmick, A.K.</td>
<td>289</td>
<td>1.52</td>
<td>Department Rubber Technology Centre</td>
</tr>
<tr>
<td>Chakraborty, S.</td>
<td>287</td>
<td>1.51</td>
<td>Mechanical Engineering</td>
</tr>
<tr>
<td>Choudhary, R.N.P.</td>
<td>251</td>
<td>1.32</td>
<td>Department of Physics, Institute of Technical Education and Research, Bhubaneswar</td>
</tr>
<tr>
<td>Pal, T.</td>
<td>218</td>
<td>1.15</td>
<td>Department of Chemistry</td>
</tr>
<tr>
<td>Das, C.K.</td>
<td>207</td>
<td>1.09</td>
<td>Materials Science Center</td>
</tr>
<tr>
<td>Chattaraj, P.K.</td>
<td>204</td>
<td>1.07</td>
<td>Department of Chemistry</td>
</tr>
<tr>
<td>Ray, S.K.</td>
<td>186</td>
<td>0.98</td>
<td>Department of Physics</td>
</tr>
<tr>
<td>De, S.</td>
<td>178</td>
<td>0.94</td>
<td>Department of Chemical Engineering</td>
</tr>
<tr>
<td>Maiti, C.K.</td>
<td>175</td>
<td>0.92</td>
<td>Department of Electrical &amp; Computer Engineering</td>
</tr>
<tr>
<td>Ram, S.</td>
<td>172</td>
<td>0.90</td>
<td>Materials Science</td>
</tr>
<tr>
<td>Misra, S.</td>
<td>171</td>
<td>0.90</td>
<td>School of Information Technology</td>
</tr>
<tr>
<td>Maiti, T.K.</td>
<td>163</td>
<td>0.86</td>
<td>Department of Biotechnology</td>
</tr>
<tr>
<td>Manna, I.</td>
<td>161</td>
<td>0.85</td>
<td>Department of Materials Science and Engineering, IIT Kanpur</td>
</tr>
<tr>
<td>Pramanik, P.</td>
<td>155</td>
<td>0.81</td>
<td>Department of Chemistry</td>
</tr>
<tr>
<td>Chakraborty, C.</td>
<td>139</td>
<td>0.73</td>
<td>Medical Science &amp; Technology</td>
</tr>
<tr>
<td>Adhikari, B.</td>
<td>135</td>
<td>0.71</td>
<td>Materials Science</td>
</tr>
<tr>
<td>Ray, K.K.</td>
<td>127</td>
<td>0.67</td>
<td>Department of Metallurgy and Material Engineering</td>
</tr>
</tbody>
</table>
Table 5 presents a list of most productive/prolific authors from IIT Kharagpur. From this table it has been found that Bhowmick, A.K. of Department of Rubber Technology, IIT Kharagpur, published highest numbers of articles, i.e. 289 followed by Chakraborty, S. of Department of Mechanical Engineering published 287 articles with second position, Choudhary, R.N.P., Department of physics with 251 articles with third position. Now Choudhary, R.N.P. is working in Department of Physics, Institute of Technical Education and Research, Bhubaneswar. Pal, T. of Department of Chemistry published 218 articles with fourth position, Das, C.K. of Material Science Center published 207 articles with fifth position. Dasgupta, P. of Department of Computer Science and Engineering get lowest rank with 112 articles.

4.5 Type of Publications:

<table>
<thead>
<tr>
<th>Document Type</th>
<th>Records Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article</td>
<td>14077</td>
<td>74.37</td>
</tr>
<tr>
<td>Conference Paper</td>
<td>3906</td>
<td>20.63</td>
</tr>
<tr>
<td>Review</td>
<td>344</td>
<td>1.81</td>
</tr>
<tr>
<td>Article in Press</td>
<td>205</td>
<td>1.08</td>
</tr>
<tr>
<td>Book Chapter</td>
<td>146</td>
<td>0.77</td>
</tr>
<tr>
<td>Editorial</td>
<td>77</td>
<td>0.40</td>
</tr>
<tr>
<td>Erratum</td>
<td>65</td>
<td>0.34</td>
</tr>
<tr>
<td>Letter</td>
<td>48</td>
<td>0.25</td>
</tr>
<tr>
<td>Note</td>
<td>39</td>
<td>0.20</td>
</tr>
</tbody>
</table>
Table 6 presents the distribution of published literature according to type. The researchers output was in the form of journal articles with 14077 (74.37) followed by conference papers 3906 (20.63), reviews with 344 (1.81) and so on. The majority of literature appeared in scholarly journals by means of which they disseminate their research findings.

4.6 Subject-wise Distribution of Publications

Table 7

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>Record Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>6994</td>
<td>36.95</td>
</tr>
<tr>
<td>Materials Science</td>
<td>5038</td>
<td>26.61</td>
</tr>
<tr>
<td>Computer Science</td>
<td>3677</td>
<td>19.42</td>
</tr>
<tr>
<td>Physics and Astronomy</td>
<td>3642</td>
<td>19.24</td>
</tr>
<tr>
<td>Chemistry</td>
<td>3054</td>
<td>16.13</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>2086</td>
<td>11.02</td>
</tr>
<tr>
<td>Mathematics</td>
<td>1651</td>
<td>8.72</td>
</tr>
<tr>
<td>Biochemistry, Genetics and Molecular Biology</td>
<td>1314</td>
<td>6.94</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>1189</td>
<td>6.28</td>
</tr>
<tr>
<td>Earth and Planetary Sciences</td>
<td>1109</td>
<td>5.85</td>
</tr>
<tr>
<td>Agricultural and Biological Sciences</td>
<td>1080</td>
<td>5.70</td>
</tr>
<tr>
<td>Energy</td>
<td>733</td>
<td>3.87</td>
</tr>
<tr>
<td>Medicine</td>
<td>707</td>
<td>3.73</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>536</td>
<td>2.83</td>
</tr>
<tr>
<td>Pharmacology, Toxicology and Pharmaceutics</td>
<td>369</td>
<td>1.94</td>
</tr>
<tr>
<td>Decision Sciences</td>
<td>306</td>
<td>1.61</td>
</tr>
<tr>
<td>Business, Management and Accounting</td>
<td>277</td>
<td>1.46</td>
</tr>
<tr>
<td>Immunology and Microbiology</td>
<td>239</td>
<td>1.26</td>
</tr>
<tr>
<td>Multidisciplinary</td>
<td>194</td>
<td>1.02</td>
</tr>
<tr>
<td>Arts and Humanities</td>
<td>104</td>
<td>0.54</td>
</tr>
<tr>
<td>Economics, Econometrics and Finance</td>
<td>83</td>
<td>0.43</td>
</tr>
<tr>
<td>Health Professions</td>
<td>74</td>
<td>0.39</td>
</tr>
<tr>
<td>Psychology</td>
<td>57</td>
<td>0.30</td>
</tr>
<tr>
<td>Neuroscience</td>
<td>38</td>
<td>0.20</td>
</tr>
<tr>
<td>Nursing</td>
<td>16</td>
<td>0.08</td>
</tr>
</tbody>
</table>
Table 7 shows that the research output studied during 2000-2015 under various subjects as defined by Scopus. The table lists the Top twenty five subjects regarding which the authors of IIT Kharagpur have mostly contributed articles. From the data in the table, it is clearly understood that Engineering is the most favoured area of research among the contributors of IIT Kharagpur with 6994 (36.95%) followed Materials Science with 5038(26.61), Computer Science with 3677(19.42), Physics and astronomy 3642 (19.24), Chemistry with 3054(16.13) publications and followed by other subjects.

4.7 Collaboration with other Countries

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Country/Territory</th>
<th>Record Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>India</td>
<td>18776</td>
<td>99.20</td>
</tr>
<tr>
<td>2</td>
<td>United States</td>
<td>1109</td>
<td>5.85</td>
</tr>
<tr>
<td>3</td>
<td>Germany</td>
<td>550</td>
<td>2.90</td>
</tr>
<tr>
<td>4</td>
<td>United Kingdom</td>
<td>344</td>
<td>1.81</td>
</tr>
<tr>
<td>5</td>
<td>Canada</td>
<td>288</td>
<td>1.52</td>
</tr>
<tr>
<td>6</td>
<td>Japan</td>
<td>202</td>
<td>1.06</td>
</tr>
<tr>
<td>7</td>
<td>South Korea</td>
<td>200</td>
<td>1.05</td>
</tr>
<tr>
<td>8</td>
<td>Italy</td>
<td>157</td>
<td>0.82</td>
</tr>
<tr>
<td>9</td>
<td>France</td>
<td>152</td>
<td>0.80</td>
</tr>
<tr>
<td>10</td>
<td>Australia</td>
<td>146</td>
<td>0.77</td>
</tr>
<tr>
<td>11</td>
<td>Spain</td>
<td>101</td>
<td>0.53</td>
</tr>
<tr>
<td>12</td>
<td>Singapore</td>
<td>94</td>
<td>0.49</td>
</tr>
<tr>
<td>13</td>
<td>Malaysia</td>
<td>91</td>
<td>0.48</td>
</tr>
<tr>
<td>14</td>
<td>South Africa</td>
<td>82</td>
<td>0.43</td>
</tr>
<tr>
<td>15</td>
<td>Taiwan</td>
<td>79</td>
<td>0.41</td>
</tr>
<tr>
<td>16</td>
<td>China</td>
<td>72</td>
<td>0.38</td>
</tr>
<tr>
<td>17</td>
<td>Sweden</td>
<td>71</td>
<td>0.37</td>
</tr>
<tr>
<td>18</td>
<td>Hong Kong</td>
<td>53</td>
<td>0.28</td>
</tr>
<tr>
<td>19</td>
<td>Brazil</td>
<td>45</td>
<td>0.23</td>
</tr>
<tr>
<td>20</td>
<td>Mexico</td>
<td>44</td>
<td>0.23</td>
</tr>
</tbody>
</table>
It is evident from the above Table 8 that authors/ contributors of IIT Kharagpur were collaborating with many countries to publish their papers. United States is at the top with 1109 documents followed by Germany with 550 papers, with, United Kingdom 344 papers, Canada with 288 papers, Japan with 202 papers, South Korea with 200 papers. It shows that contributors of IIT Kharagpur not only collaborated within the country but also with most developed countries like United States, Germany, United Kingdom, Australia, Asian countries like, Japan, Singapore and South Korea.

4.8 Institution-wise Distribution of Papers

<table>
<thead>
<tr>
<th>Rank</th>
<th>Affiliation</th>
<th>Record Count</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Indian Institute of Technology, Kharagpur</td>
<td>18927</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Jadavpur University</td>
<td>277</td>
<td>1.46</td>
</tr>
<tr>
<td>3</td>
<td>National Institute of Technology Rourkela</td>
<td>196</td>
<td>1.03</td>
</tr>
<tr>
<td>4</td>
<td>Bengal Engineering and Science University</td>
<td>193</td>
<td>1.01</td>
</tr>
<tr>
<td>5</td>
<td>Vidyasagar University</td>
<td>165</td>
<td>0.87</td>
</tr>
<tr>
<td>6</td>
<td>Bhabha Atomic Research Centre</td>
<td>151</td>
<td>0.79</td>
</tr>
<tr>
<td>7</td>
<td>University of Calcutta</td>
<td>147</td>
<td>0.77</td>
</tr>
<tr>
<td>8</td>
<td>Indian Statistical Institute, Kolkata</td>
<td>144</td>
<td>0.76</td>
</tr>
<tr>
<td>9</td>
<td>Indian Institute of Technology, Guwahati</td>
<td>129</td>
<td>0.68</td>
</tr>
<tr>
<td>10</td>
<td>Indian Institute of Technology, Kanpur</td>
<td>129</td>
<td>0.68</td>
</tr>
<tr>
<td>11</td>
<td>National Institute of Technology, Durgapur</td>
<td>120</td>
<td>0.63</td>
</tr>
<tr>
<td>12</td>
<td>Indian Institute of Technology, Madras</td>
<td>118</td>
<td>0.62</td>
</tr>
<tr>
<td>13</td>
<td>National Metallurgical Laboratory India</td>
<td>118</td>
<td>0.62</td>
</tr>
<tr>
<td>14</td>
<td>Indian Institute of Technology Delhi</td>
<td>117</td>
<td>0.61</td>
</tr>
<tr>
<td>15</td>
<td>Indian Institute of Science</td>
<td>105</td>
<td>0.55</td>
</tr>
<tr>
<td>16</td>
<td>Indian Institute of Technology Roorkee</td>
<td>94</td>
<td>0.49</td>
</tr>
<tr>
<td>17</td>
<td>IEEE</td>
<td>90</td>
<td>0.47</td>
</tr>
<tr>
<td>18</td>
<td>Indian Institute of Technology Patna</td>
<td>90</td>
<td>0.47</td>
</tr>
<tr>
<td>19</td>
<td>Indian Space Research Organization</td>
<td>87</td>
<td>0.45</td>
</tr>
<tr>
<td>20</td>
<td>Defence Metallurgical Research Lab India</td>
<td>86</td>
<td>0.45</td>
</tr>
<tr>
<td>21</td>
<td>Indian School of Mines University</td>
<td>83</td>
<td>0.43</td>
</tr>
<tr>
<td>22</td>
<td>Tata Iron &amp; Steel Company Limited</td>
<td>83</td>
<td>0.43</td>
</tr>
</tbody>
</table>
It is observed from the above figure and Table 9 that authors/ contributors of IIT Kharagpur were collaborating with many institutions to publish their papers with Jadavpur University 277 documents, 196 papers with National Institute of Technology Rourkela, 193 papers with Bengal Engineering and Science University, 165 papers with Vidyasagar University, 151 papers with Vidyasagar University and followed by other institutions. It has been found that within top 10 institutions 5 institutions/ university are from West Bengal and two from neighboring states Orissa and Assam.

4.9 Journal-wise Distribution of Papers

Table 10

<table>
<thead>
<tr>
<th>Rank</th>
<th>Source Title</th>
<th>Record count</th>
<th>Percentage (%)</th>
<th>IF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Journal of Applied Polymer Science</td>
<td>262</td>
<td>1.38</td>
<td>1.76</td>
</tr>
<tr>
<td>2</td>
<td>Journal of Applied Physics</td>
<td>151</td>
<td>0.79</td>
<td>2.18</td>
</tr>
<tr>
<td>3</td>
<td>Rsc Advances</td>
<td>134</td>
<td>0.70</td>
<td>3.84</td>
</tr>
<tr>
<td>4</td>
<td>Journal of Materials Science</td>
<td>117</td>
<td>0.61</td>
<td>2.37</td>
</tr>
<tr>
<td>5</td>
<td>Journal of Alloys and Compounds</td>
<td>113</td>
<td>0.59</td>
<td>2.99</td>
</tr>
<tr>
<td>6</td>
<td>Tetrahedron Letters</td>
<td>101</td>
<td>0.53</td>
<td>2.37</td>
</tr>
<tr>
<td>7</td>
<td>Proceedings of the IEEE International Conference on VLSI Design</td>
<td>88</td>
<td>0.46</td>
<td>4.93</td>
</tr>
<tr>
<td>8</td>
<td>Current Science</td>
<td>88</td>
<td>0.46</td>
<td>0.92</td>
</tr>
<tr>
<td>9</td>
<td>Materials Letters</td>
<td>87</td>
<td>0.45</td>
<td>2.48</td>
</tr>
<tr>
<td>10</td>
<td>Langmuir</td>
<td>86</td>
<td>0.45</td>
<td>4.45</td>
</tr>
<tr>
<td>11</td>
<td>International Journal of Heat and Mass Transfer</td>
<td>84</td>
<td>0.44</td>
<td>2.38</td>
</tr>
<tr>
<td>12</td>
<td>Journal of Physical Chemistry B</td>
<td>84</td>
<td>0.44</td>
<td>3.30</td>
</tr>
<tr>
<td>13</td>
<td>IEEE Region 10 Annual International Conference Proceedings TENCON</td>
<td>83</td>
<td>0.43</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Aip Conference Proceedings</td>
<td>78</td>
<td>0.41</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>Applied Physics Letters</td>
<td>77</td>
<td>0.40</td>
<td>3.30</td>
</tr>
<tr>
<td>16</td>
<td>Bioresource Technology</td>
<td>75</td>
<td>0.39</td>
<td>4.49</td>
</tr>
<tr>
<td>17</td>
<td>Journal of Nanoscience and Nanotechnology</td>
<td>75</td>
<td>0.39</td>
<td>1.55</td>
</tr>
<tr>
<td>18</td>
<td>Proceedings of SPIE the International Society for Optical Engineering</td>
<td>74</td>
<td>0.39</td>
<td>0.20</td>
</tr>
</tbody>
</table>
Table 10 shows the top 20 publication sources in which the contributors from IIT Kharagpur published their papers. It is found that Journal of Applied Polymer Science gets the highest number of publications with 262 titles followed by Journal of Applied Physics with 151 titles, Rsc Advances with 134 titles, Journal of Materials Science with 117 titles and followed by other sources. It is found that within top 20 sources there is only one journal i.e. Current Science from India. It shows that authors from IIT Kharagpur have tendency to publish their work in reputed and international journals with more impact factor.

5. CONCLUSION

The study shows that IIT Kharagpur has contributed 18927 papers with average annual rate 1182.93 papers. It shows steady growth rate and it was found that contribution of papers become double in 9 years and tripled in next 3 years. It received 187322 citations with 9.89 average citation per paper. The contributors of IIT Kharagpur have tendency to publish their work with two or more authors which indicates the multi author pattern and shows that the contributors of IIT Kharagpur is collaborative in nature. The ranking of authors based on their publication shows that Bhowmick, A.K. ranked first with 289 papers. Contributors from IIT Kharagpur have a tendency to publish their papers in scholarly journals followed by conference proceedings. Engineering is the top priority subject followed by material science, computer science, physics and astronomy in which the contributors contribute their paper. The US was at the top position in the list of collaborating countries with IIT Kharagpur. It not only collaborates with developed countries but also with Asian countries like Japan, Singapore and South Korea. As in terms of institutional collaboration, Jadavpur University ranked first with 277 documents. It has been found that within top 10 institutions 5 institutions/ university are from West Bengal and two each from neighboring states i.e. Orissa and Assam. The source title Applied Polymer Science gets the highest number of publications. It has been found that contributors from IIT Kharagpur have tendency to publish their work in international journals having more impact factor. It is suggested that such types of studies be carried out periodically and data reflected along with the
institutional repositories of the respective institution. This step would ensure value addition and scope for better collaboration with other institutions.

REFERENCES


Subramanyam K & Stephens Elsie M (1982), Research collaboration and funding in biochemistry and chemical engineering, International Forum on Information and Documentation, 7(4), pp26-29