

## Pattern of Research Collaboration in the Discipline of Pure Sciences in the Universities of Odisha: A Scientometric Study

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**Abstract** - A sum of 3058 papers recovered from the Thomson Reuters' Web of Science database which was circulated by the PS employees of 323 establishments of 42 countries amidst 1991 to 2015. Out of the total papers, 33% were International, 510 were local and only 36 were worked domestically. Among all the nations, India conveyed the most lifted 2558 papers and hold the principal position in the joint exertion. The investigation also shows that among twenty very cooperative organizations, the most elevated sixteen are from India. The majority of the papers were worked together in the middle of 2006 and 2010 and Chemistry was the main ideal subjects of the PS employees amid the period under investigation.

**Keywords:** Pure science, collaboration, co-authorship index, domestic collaborative index, international collaborative index

### Introduction

Nowadays, collaboration has been transforming into a key point in each field of research. Keeping this in sense, Governments in various nations are taking exercises to redesign adequacy among investigators through various community-oriented research programs, both at the national and international levels. Because of the collaboration in research, growth, and development of productivities vary from one subject to another, one branch to another branch of the same subject and from one country to another country (Beaver, D., & Rosen, 1978). Multiple-author publication frequently treated as a co-authored publication has been used as a basic counting unit to measure collaborative activity (Katz & Martin, 1997). In light of this sort of contributors, their designations, and official affiliations, collaboration can comprehensively be ordered into three classes, i.e. as local, domestic, and international. A local collaboration happens when at least two researchers of a similar establishment working mutually and a domestic collaboration happens when at least two researchers from a similar nation working together. International collaborations happen when at least two scientists from various nations work jointly to take care of an issue (Glänzel, Schubert, & Czerwon, 1999). Practically the international collaboration has extremely considered in the various field of modern research.

## **Review of Literature**

There are so many collaborative studies have been examined at both national and international level. In 2014, (Garg & Dwivedi, 2014b) examined 2074 papers listed in Science Citation Index-Expanded amid 1991 to 2010 and distributed by various nations on "Various Aspects of Japanese Encephalitis (JE)". The examination demonstrates that JE is a highly collaborative discipline as judged by the values of co-authorship index and the collaborative coefficient for various nations and its sub-disciplines. Out of the distributed papers, around 66% were collaboratively composed. Among all the nations, USA was found as the most collaborative partner. The share of collaborative papers expanded right around four times in 2001-2010 when contrasted with 1991-2000. Among 17 exceedingly collaborative institutions, the most remarkable papers (six) are from India, and Liverpool University (UK) had the most astounding number of globally collaborative papers, followed by Centre for Disease Control and Prevention (USA).

In 2014, a study was conducted on "Scientometrics of collaboration pattern in solar cell research in India". The information was listed in 'Web of Science' for a time of 20 years from 1991-2010. "CSIR-National Physical Laboratory-Delhi" situated the most noteworthy productive organizations amid the period under investigation. Among 31 nations, Indian scientists, made a team work in South Korea, Japan, USA, Germany, England, France and Greece. To examine collaborative research activity, various bibliometric indicators were used. The examination additionally found that the international collaborative outputs were more effective than the domestic collaboration (Dutt & Nikam, 2014).

## **Objectives of the study**

The collaborations have been measured by using different scientific parameters. The specific objectives of the examination are to

- Identify the pattern of collaboration and their changes in PS by place of publications (Countries);
- Identify the pattern of collaboration and their changes in PS by research area (sub-disciplines of PS);
- Identify the pattern of collaboration and their changes by year of publications (in different periods); and
- Identify the most prolific affiliated institutions and their pattern of collaboration.

## **Material and Methodology**

Data was recovered from the Thomson Reuters' Web of Science database. Data examination was constrained to articles appropriated from 1991 to 2015; Data assignments from 2016 were rejected from the examination since securing in the midst of the present year was not yet mean. Data were obtained with the term different general universities of Orissa (Odisha) (i.e. Sambalpur University) in the last week of August-2016 by using the search interface 'address'. A total number of 3058 records were isolated out by using the 'analyze' arrange open in WoS. Assembling, orchestrating and dissecting the system of estimations were done at the start of developed scientometric techniques. The downloaded records were changed into Microsoft Office Excel 2007 and organized to design tables and figures.

### Domestic Collaborative Index (DCI)

Generally, this measure is utilized for mapping of the collaborative pattern in different disciplines. This measure was used as a part of the year 2014 by (Garg & Dwivedi, 2014a) in the study, "Pattern of collaboration in the discipline of Japanese encephalitis" for figuring the relative yield of locally co-wrote papers individually. Mathematically DCI is written as

$$DCI = \{(D_i|D_{i0})|(D_0|D_{00})\} \times 100$$

Where,

$D_i$  = number of domestically co – authored papers from country i

$D_{i0}$  = total number of papers from country i

$D_0$  = number of domestically co – authored papers from all countries

$D_{00}$  = total number of papers from all countries

### International Collaborative Index (ICI)

Practically, this measure is used for mapping of the shared example in various disciplines. The estimation of ICI has been acquired by strategies for processing the comparing yield of all around co-made papers. This technique additionally utilized by (Garg & Dwivedi, 2014a). The technique for the ICI is composed as

$$ICI = \{(I_i|I_{i0})|(I_0|I_{00})\} \times 100$$

Where,

$I_i$  = number of internationally co – authored papers from country i

$I_{i0}$  = total number of papers from country i

$I_0$  = number of internationally co – authored papers from all countries

$I_{00}$  = total number of papers from all countries

DCI or ICI = 100 Here, country's co – authorship effort relates to the world's normal

DCI or ICI > Here, country's co – authorship effort higher than world's

DCI or ICI < 100 Here, country's co – authorship effort is less than world's

### Results and Discussions

The joint effort of the different country is analyzed in the Table-1. Out of the aggregate 3058 papers passed on by 42 nations, 16.68% (510) were Local, 1.18% (36) was Domestic and 82.15% (2512) was International collaborative papers. The amount of papers written in worldwide joint exertion is just around five times of the number of papers written in domestic collaboration. Among all the countries recorded in Table-1, India has the most raised number of share in generally co-made papers followed by Spain, Japan, USA, and France.

The detailed account of organized exertion in the distinctive sub discipline of PS is portrayed in Table-2. The aggregate 3058 papers captured in 45 sub-disciplines of PS and out of the 28.35% (867) were Chemistry, 26% (795) were Physics, 7.62% (233) were Plant Sciences and 5.89% (180) were Mathematics papers. Among these four sub disciplines, Chemistry postures most noteworthy positioned in which Local papers were 168, Domestic papers were just 8 and internationally teamed up papers were the most astounding 691. In like manner, Physics ranked the second position followed by Plant Sciences and Mathematics where Local papers were 122, Domestic papers were just 8 and International co-composed papers were 665. The International Collaborative Index is discovered ten times more prominent than the Domestic Collaborative Index.

**Table-1 Pattern of collaboration by place of publications (Countries)**

| SI No | Country            | LCP        | DCP       | Total      | DCI        | ICP         | ICI        | Total       |
|-------|--------------------|------------|-----------|------------|------------|-------------|------------|-------------|
| 1.    | India              | 488        | 35        | 523        | 101        | 2035        | 97         | <b>2558</b> |
| 2.    | Spain              | 7          | 0         | 7          | 0          | 171         | 117        | <b>178</b>  |
| 3.    | Japan              | 1          | 0         | 1          | 0          | 83          | 120        | <b>84</b>   |
| 4.    | USA                | 0          | 0         | 0          | 0          | 45          | 122        | <b>45</b>   |
| 5.    | France             | 6          | 0         | 6          | 0          | 23          | 97         | <b>29</b>   |
| 6.    | Germany            | 5          | 0         | 5          | 0          | 19          | 96         | <b>24</b>   |
| 7.    | South Korea        | 2          | 0         | 2          | 0          | 16          | 108        | <b>18</b>   |
| 8.    | England            | 0          | 0         | 0          | 0          | 14          | 122        | <b>14</b>   |
| 9.    | Russia             | 0          | 0         | 0          | 0          | 11          | 122        | <b>11</b>   |
| 10.   | Italy              | 0          | 0         | 0          | 0          | 10          | 122        | <b>10</b>   |
| 11.   | Taiwan             | 0          | 1         | 1          | 1517       | 8           | 108        | <b>9</b>    |
| 12.   | Canada             | 0          | 0         | 0          | 0          | 7           | 122        | <b>7</b>    |
| 13.   | New Caledonia      | 0          | 0         | 0          | 0          | 6           | 122        | <b>6</b>    |
| 14.   | Sweden             | 0          | 0         | 0          | 0          | 6           | 122        | <b>6</b>    |
| 15.   | South Africa       | 0          | 0         | 0          | 0          | 5           | 122        | <b>5</b>    |
| 16.   | Turkey             | 0          | 0         | 0          | 0          | 5           | 122        | <b>5</b>    |
| 17.   | Australia          | 0          | 0         | 0          | 0          | 4           | 122        | <b>4</b>    |
| 18.   | Bulgaria           | 0          | 0         | 0          | 0          | 3           | 122        | <b>3</b>    |
| 19.   | China              | 0          | 0         | 0          | 0          | 3           | 122        | <b>3</b>    |
| 20.   | Egypt              | 0          | 0         | 0          | 0          | 3           | 122        | <b>3</b>    |
|       | Other 22 countries | 1          | 0         | 1          | 0          | 35          | 118        | <b>36</b>   |
|       | <b>Total</b>       | <b>510</b> | <b>36</b> | <b>546</b> | <b>100</b> | <b>2512</b> | <b>100</b> | <b>3058</b> |

Here, LCP: Local Collaborative Papers, DCP: Domestic Collaborative Papers, DCI: Domestic Collaborative Index, ICP: International Collaborative Papers, ICI: International Collaborative Index

The period wise growth of pure sciences research and their pattern of collaboration are pictured in Table-3. A 25 years information were recorded and set in five noteworthy blocks resulted from 1991 to 2015 which shows that period 2006-2010 was the most raised improvement years in where the PS faculties conveyed the most noteworthy 1115 papers. In 2006-2010, the Local papers were 19.19% (214), Domestic papers were just 1.70% (19) and worldwide papers were 79.10% (882). The sharing of Domestic Collaborative Index and International Collaborative Index was in like manner extraordinary in 2006-2010 which was 124 and 96. The PS proficiency was low in the period 1991-1995. In the midst of these years a total 418 papers were recorded and out of them, 82.54% (345) was International, 16.99% (71) were Local and only 0.48% (2) were Domestic. When contrasted with the sharing of joint effort, International Collaborative Index was particularly higher than the Domestic Collaborative Index amid the period under investigation.

The highly collaborative institutions are displayed in Table-4. In the midst of the period under scrutiny, an aggregate of 3058 papers was passed on by 323 organizations, and out of them, Utkal University, Bhubaneswar appropriated the most lifted 717 papers in where 186 were Local and 531 were International. Sambalpur University, Odisha took secondly situated and delivered an aggregate of 395 papers amid the period under investigation and out of them, 89 were Local and 306 were International. Berhampur University made an aggregate of 346 papers amidst the period under examination and ranked the third position. Like as SOA

University, Bhubaneswar scattered 158 papers and represents the fourth place in where 22 papers were Local and 136 were International.

Table-2 Pattern of collaboration by research area (sub-disciplines of PS)

| Sl No | Subject                    | LCP        | DCP       | Total      | DCI        | ICP         | ICI        | Total       |
|-------|----------------------------|------------|-----------|------------|------------|-------------|------------|-------------|
| 1.    | Chemistry                  | 168        | 8         | 176        | 69         | 691         | 97         | <b>867</b>  |
| 2.    | Physics                    | 122        | 8         | 130        | 93         | 665         | 102        | <b>795</b>  |
| 3.    | Plant Science              | 32         | 2         | 34         | 89         | 199         | 104        | <b>233</b>  |
| 4.    | Mathematics                | 43         | 4         | 47         | 129        | 133         | 90         | <b>180</b>  |
| 5.    | Materials Science          | 32         | 2         | 34         | 89         | 116         | 94         | <b>150</b>  |
| 6.    | Environmental Science      | 8          | 4         | 12         | 506        | 93          | 108        | <b>105</b>  |
| 7.    | Biochemistry               | 13         | 1         | 14         | 108        | 76          | 103        | <b>90</b>   |
| 8.    | Biotechnology              | 10         | 0         | 10         | 0          | 62          | 105        | <b>72</b>   |
| 9.    | Astrophysics               | 11         | 0         | 11         | 0          | 58          | 102        | <b>69</b>   |
| 10.   | Biology                    | 12         | 0         | 12         | 0          | 52          | 99         | <b>64</b>   |
| 11.   | Microbiology               | 11         | 0         | 11         | 0          | 46          | 98         | <b>57</b>   |
| 12.   | Engineering                | 5          | 0         | 5          | 0          | 34          | 106        | <b>39</b>   |
| 13.   | Zoology                    | 3          | 0         | 3          | 0          | 36          | 112        | <b>39</b>   |
| 14.   | Genetics                   | 5          | 1         | 6          | 253        | 28          | 100        | <b>34</b>   |
| 15.   | Pharmacology               | 3          | 1         | 4          | 379        | 29          | 107        | <b>33</b>   |
| 16.   | Toxicology                 | 3          | 1         | 4          | 379        | 25          | 105        | <b>29</b>   |
| 17.   | Medicine                   | 4          | 2         | 6          | 506        | 18          | 91         | <b>24</b>   |
| 18.   | Oceanography               | 5          | 0         | 5          | 0          | 17          | 94         | <b>22</b>   |
| 19.   | Life Science               | 5          | 0         | 5          | 0          | 16          | 93         | <b>21</b>   |
| 20.   | Agriculture                | 4          | 1         | 5          | 303        | 15          | 91         | <b>20</b>   |
|       | Other (25 sub-disciplines) | 11         | 1         | 12         | 126        | 103         | 109        | <b>115</b>  |
|       | <b>Total</b>               | <b>510</b> | <b>36</b> | <b>546</b> | <b>100</b> | <b>2512</b> | <b>100</b> | <b>3058</b> |

Here, LCP: Local Collaborative Papers, DCP: Domestic Collaborative Papers, DCI: Domestic Collaborative Index, ICP: International Collaborative Papers, ICI: International Collaborative Index

Table-3 Pattern of collaboration by year of publications (periods)

| Block        | Period       | LCP        | DCP       | Total      | DCI        | ICP         | ICI        | Total       |
|--------------|--------------|------------|-----------|------------|------------|-------------|------------|-------------|
| A            | 1991-1995    | 71         | 2         | 73         | 42         | 345         | 100        | <b>418</b>  |
| B            | 1996-2000    | 72         | 0         | 72         | 0          | 406         | 103        | <b>478</b>  |
| C            | 2001-2005    | 70         | 5         | 75         | 101        | 367         | 101        | <b>442</b>  |
| D            | 2006-2010    | 83         | 10        | 93         | 163        | 512         | 103        | <b>605</b>  |
| E            | 2011-2015    | 214        | 19        | 233        | 124        | 882         | 96         | <b>1115</b> |
| <b>Total</b> | <b>25yrs</b> | <b>510</b> | <b>36</b> | <b>546</b> | <b>100</b> | <b>2512</b> | <b>100</b> | <b>3058</b> |

Here, LCP: Local Collaborative Papers, DCP: Domestic Collaborative Papers, DCI: Domestic Collaborative Index, ICP: International Collaborative Papers, ICI: International Collaborative Index

Table-4 Highly collaborative institutions

| Rank | Name of the Institutions                      | No. Of collaborative papers |           |               | Total       |
|------|---|-----------------------------|-----------|---------------|-------------|
|      |   | Local                       | Domestic  | International |             |
| 1.   | UtkalUniv, Bhubaneswar, Odisha                | 186                         | 0         | 531           | <b>717</b>  |
| 2.   | SambalpurUniv, Sambalpur, Odisha              | 89                          | 0         | 306           | <b>395</b>  |
| 3.   | Berhampur Univ, Berhampur, Odisha             | 75                          | 0         | 271           | <b>346</b>  |
| 4.   | SOA Univ, Bhubaneswar, Odisha                 | 22                          | 0         | 136           | <b>158</b>  |
| 5.   | IRTA Tarragona, Spain                         | 6                           | 0         | 110           | <b>116</b>  |
| 6.   | RavenshawUniv, Cuttack, Odisha                | 20                          | 0         | 83            | <b>103</b>  |
| 7.   | North OdishaUniv, Baripada, India             | 33                          | 0         | 51            | <b>84</b>   |
| 8.   | BPUT, Bhubaneswar, Odisha                     | 14                          | 0         | 68            | <b>82</b>   |
| 9.   | KIIT Univ, Bhubaneswar, Odisha                | 2                           | 0         | 76            | <b>78</b>   |
| 10.  | IOP Bhubaneswar, Odisha                       | 4                           | 0         | 52            | <b>56</b>   |
| 11.  | IMMT Bhubaneswar, Odisha                      | 1                           | 0         | 51            | <b>52</b>   |
| 12.  | OUAT, Bhubaneswar, Odisha                     | 17                          | 0         | 32            | <b>49</b>   |
| 13.  | High Energy Accelerator Res Org<br>KEK, Japan | 0                           | 0         | 39            | <b>39</b>   |
| 14.  | Fakir Mohan Univ, Balasore,<br>Odisha         | 8                           | 0         | 30            | <b>38</b>   |
| 15.  | VSSUT, Sambalpur, Odisha                      | 2                           | 0         | 35            | <b>37</b>   |
| 16.  | Univ of Barcelona, Spain                      | 1                           | 0         | 24            | <b>25</b>   |
| 17.  | IIT Kharagpur, India                          | 0                           | 1         | 16            | <b>17</b>   |
| 18.  | Hiroshima Univ, Japan                         | 0                           | 0         | 14            | <b>14</b>   |
| 19.  | ILS Bhubaneswar, Odisha                       | 1                           | 0         | 13            | <b>14</b>   |
| 20.  | Univ of Calcutta, WB, India                   | 0                           | 0         | 14            | <b>14</b>   |
|      | Other (303 institutions)                      | 29                          | 35        | 560           | <b>624</b>  |
|      | <b>Total</b>                                  | <b>510</b>                  | <b>36</b> | <b>2512</b>   | <b>3058</b> |

## Conclusion

By using different co-creation and collaborative indicators the examination perceived the case of co-authorship and joint effort of PS assets among different countries. The examination shows that the synergistic case in the field of Pure Science is depicted by basically the multi and mega made papers, not by any single-molded. Papers appropriated in the International made effort are practically five times of the papers composed locally. The proportion of papers recorded in both locally and universally expanded altogether in 2006-2010 when contrasted with different periods under study. The examination in like way shows that out of the 323 affiliations, most of the establishments were from India which proves that among all the nations, India was the most productive country amidst the period under investigation.

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