A bibliometric analysis of publications of the Chemistry Department, University of Pune, India, 1999-2012
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The bibliometric parameters including number of papers, number of citations received, institutional collaborations, productivity of journals, subject categories and authorship pattern have been used to carry out the analysis of the research contributions made by the faculty members of the Department of Chemistry at University of Pune. The data set was collected from the Web of Science (WoS) database for the period of about 14 years (1999-2012). The data reveals that thirty faculty members have published 811 papers in 258 journals with 8948 citations. Most of the papers are published in peer-reviewed international journals having high impact factor. These are core journals in the field of chemistry being published in the countries like USA, UK and Germany, etc. The study reveals that there is a continuous growth in publications. About 30% of the papers were published during 2010-2012. The average number of citations received per paper is 11.03. The highest number of citations (905) were received for 41 papers published in the Journal of Physical Chemistry A. This study indicates that majority of the papers published are in the area of physical chemistry. Authorship pattern indicates that highest number of citations are received for papers written by four authors in collaboration.

Keywords: Bibliometrics; Citation analysis; Chemistry; University of Pune; Network analysis

Introduction
The Department of Chemistry, University of Pune is rated as one of the best in the country for its teaching and research activities. It has been selected as the Centre for Advanced Studies in chemistry by the University Grants Commission, India since 1998. The Department has a close collaboration with National Chemical Laboratory, Pune; which is one of the Council of Scientific and Industrial Research (CSIR) laboratories in India. The department has four specializations – physical, organic, inorganic and biochemistry. The present study focuses on the citation analysis of the research contributions made by the faculty members of the Department during the period 1999-2012.

Citation analysis is used as an indicator of the impact, influence or quality of a scholarly work. It is most often used for measuring the quality of research and facilitating collection development in libraries as well as for judging scientific research output at local, national and international levels. Citation counts help to assess the impact of individual research scientists as well as contribution of the organization as a whole. Apart from number of papers and citations received, various other parameters are used to measure the research output viz., impact factor of the journal, author h-index, international collaborations, etc.

Citation databases such as Web of Science, Scopus and Google Scholar are used to obtain the citation data. These databases are enriched with advanced features to enable detailed citation analysis along with h-index value. Apart from various indicator measures, various data visualization tools (CiteSpace, VOSviewer, Pajek etc.) are also being used for visualizing bibliographic coupling of authors, institutes and keywords. Citation visualization tool HistCite launched by Eugene Garfield, identifies the most cited authors within a field, and reconstruct the history and development of a research field.
Review of literature

Various citation analysis studies have been carried out for measuring the individual research and organizational contributions\(^{12-17}\). Torres and others have studied the contributions by 864 researchers from 50 Health Science Departments of the University of Navarra (Spain). They compared the difference in the number of citations provided by WoS and Scopus in the context of evaluating a single university. They ranked top 50 researchers and the departments and found that in both the databases, there is no major difference in the first position\(^{18}\).

Another study based on bibliometric analysis was conducted by Molinari and Molinari for ranking scientific institutions. They named their method as “Impact Index” which is complementary to h-index\(^{19}\). Miyairi and Chang analyzed bibliometric characteristics of highly cited papers published from 2000 to 2009 by scientists of Taiwan. The measures they have used for the analysis were citations, international collaborations, and top ten categories in which scientists have contributed\(^{20}\). Fu and others have conducted a study of bibliometric evaluation of highly cited papers from China published during the period from 1999 to 2009 by scientists of Taiwan. For the analysis they used various measures like journals, subject categories, internationally collaborating countries, national inter-institutionally collaborating institutions, and most-cited papers in 22 scientific fields\(^{21}\). Results of both these studies reveal the position of Taiwan and China on the world map in case of publications and citations received for a particular time period.

Many studies have been conducted to evaluate the chemistry research worldwide. Research contributions of Indian chemists are also studied by many researchers. These studies are carried out using citation counts\(^{22-25}\). Evaluation of Indian contributions in organic chemistry during 1907-1926 was carried out by Guay\(^{26}\). Kademani and others have studied research productivity of scientists of Chemistry division of Bhabha Atomic Research Centre\(^{27-28}\). Bishop and others conducted research in the field of Chemoinformatics which was based on citation analysis of 321 papers published during the period 1980-2002\(^{29}\).

This literature review reveals that citation analysis has been used by Indian researchers for evaluating research contributions of Indian scientists. Barring few studies, it has been observed that, hardly any study has been done to map or evaluate the contribution of a single department of an individual Indian university.

Objective of the study

To analyse the research contributions of the faculty members of the Department of Chemistry, University of Pune.

Methods

The data set for papers published during the period of 14 years (1999-2012) by the faculty members of the Department of Chemistry, University of Pune was collected from the Web of Science (WoS) database. The database was searched with necessary refinements and the Chemistry Department Knowledgebase (CDK) was created. CDK contains 811 papers published in 258 journals by thirty faculty members with 8948 citations.

Histcite (http://thomsonreuters.com/products_services/science/science_products/a-z/histcite/) software was used by many researchers for quantitative analysis of citations, authorship pattern, collaborations at national and international levels, etc. McCain and McCain used HistCite to study the Nash Equilibrium during 1950-2009\(^{30}\). In India, it was used by researchers especially for mapping of research in specific areas viz, mapping of tapioca research\(^{31}\), cholera research\(^{32}\), nanoscience and nanotechnology\(^{33}\).

The network figure of international collaborations is drawn with the help of DOS based IntColI program by Loet Leydesdorff (http://www.leydesdorff.net/index.htm) and Pajek – Program for Large Network Analysis tool (http://vlado.fmf.uni-lj.si/pub/network/pajek). The data collected was analyzed with the help of the tools mentioned above.

Analysis

Author productivity and citations

Table 1 shows that thirty faculty members have published 811 papers during the 14 years (1999-2012) with an average 58 papers per year.

The table indicates that the Department’s research publications are increasing every year. The 811 papers received total 8948 citations i.e. 11.03 citations
per paper. However, more than 30% of papers (262) have been published in last three years (2010-2012) receiving 1917 citations. In 2012, 96 (11.8%) papers were published. This is the highest number of papers published in a single year. The highest number of citations 1276 were received for the 77 papers published in 2006.

**H-index and self-citations**

Individual h-index though available for each faculty member is not listed in this paper as the objective is not to rank them. As per the WoS database, Department of Chemistry has h-index 43 during the period under study. Self-citations in the collection are 1241 (13%).

**Collaborations**

**International collaboration**

Collaborations help extend horizon of ideas and it multiplies interpretations. Universalization and generalization of research is another advantage of collaborations. All the countries appearing in affiliation as entered in address field of the papers were analyzed. In CDK, the total 811 papers are written by thirty faculty members with collaboration of more than 1000 researchers from all over the world. With the help of HistCite, list of countries, number of papers and citations received were checked. The top ten countries, number of papers, citations, percentage and number of authors are listed in Table 2.

It is seen that USA leads in regard of the number of papers and citations followed by Germany, UK, France, Japan and others.

Number of authors were checked for papers published in collaboration with the top ten countries. Number of collaborations ranges from 2-31 authors. It was further found that a single paper is contributed by a faculty member with the collaboration of 30 other authors from USA, Germany UK, and Italy.

**Network of collaborating countries**

Out of the total 811 papers, only 12 papers have single authors and remaining 799 are published in collaboration with scientists from 34 countries. Figure 1 shows network of countries with which the faculty members have collaborated.

Red circles in Fig. 1 represent individual countries. Arrows show collaborations among the various countries. The figure does not indicate the number of papers but red circle with single line and arrow indicates the collaboration between the two countries viz. India and Iran, India and Malaysia, India and Portugal, etc. Multiple lines and multiple arrows indicates the collaboration between more than two countries viz. India, USA and Germany etc.

The collaboration network affirms that the Department has international collaborations with many countries of the world.
National collaboration

Table 3 lists institutions with which at least minimum five papers have been authored in collaboration.

There are total 393 papers published in collaboration with scientists at national level. Maximum number (29%) of collaborations is with National Chemical Laboratory (NCL) which is one of the laboratories under Council of Scientific Industrial Research (CSIR). Bhabha Atomic Research Centre (23%) is the next institute that the Department researchers collaborate with. Other CSIR Labs excluding NCL (16%) and Indian Institutes of Technology (16%) follow.

Preferred publishers for publications

Table 4 represents 14 journal publishers with their countries. These publishers are selected by the criterion of having published minimum ten and above papers.

Among the total 656 papers published, publishers from the USA (55%) and UK (30%) are predominant, followed by Germany (8%) and India (5%). A number of papers are published in prominent society journals viz., American Chemical Society, American Institute of Physics, etc.

Among the Indian publishers, CSIR-National Institute of Science Communication and Information Resources (NISCAIR) and Indian Academy of Sciences’ journals are preferred.

International journals preferred

Table 5 lists 22 international journals in which 239 papers are published. The international journals were selected on the basis of citations received (100 and above).

The Impact Factor (IF) of these 22 journals was further checked. The papers published in these

![Fig. 1—International collaborations](image)

Table 3—National collaborations

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Institute</th>
<th>Publications</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>National Chemical Laboratory Pune (laboratory under CSIR, India).</td>
<td>113</td>
<td>29</td>
</tr>
<tr>
<td>2.</td>
<td>Bhabha Atomic Research Centre, Mumbai</td>
<td>89</td>
<td>23</td>
</tr>
<tr>
<td>3.</td>
<td>Council of Scientific Industrial Research (CSIR) India</td>
<td>64</td>
<td>16</td>
</tr>
<tr>
<td>4.</td>
<td>Indian Institutes of Technology (IITs), India</td>
<td>63</td>
<td>16</td>
</tr>
<tr>
<td>5.</td>
<td>Shivaji University, Kolhapur</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>National Center for Cell Sciences, Pune</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>7.</td>
<td>High Energy Material Research Laboratory, Pune</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>Jawaharlal Nehru Center For Advanced Scientific Research, Bangalore</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>North Maharashtra University, Jalgaon</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Bharati Vidyapeeth, Pune</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>11.</td>
<td>Centre for Materials for Electronic Technology, Pune</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>12.</td>
<td>Dr Babasaheb Ambedkar Marathwada University, Aurangabad</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>393</strong></td>
<td><strong>100</strong></td>
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</table>
journals received total 5091 citations. The average impact factor of these journals is 3.381. It is noticed that, 57% of the total citations (8948) received for the papers, are published in these journals.
Indian journals preferred

Table 6 lists nine Indian journals in which the faculty members have contributed 41 papers.

The highest number of papers (17) are published in Indian Journal of Chemistry Section A, have received highest number (79) of citations. It indicates that contributions are more in physical, inorganic and analytical chemistry in case of publications in Indian journals.

Areas of research

Table 7 lists subject areas according to WoS categories in which more than 10 papers are published by the faculty members of the Department.

The table shows that physical chemistry tops the list with 24.2% of total publications. Organic chemistry ranks second with 21.3%. Interdisciplinary research is seen from the areas like nanotechnology, biotechnology, environmental sciences, etc.

Authorship pattern and citation trends

Table 8 shows authorship pattern of publications by the faculty members.

There are 12 papers written by single faculty member receiving 55 citations. Highest numbers of papers (197) are authored by four researches which eventually got highest number of citations followed by, publications (169) by three authors with 1729 (19%) citations. It is noticed that there is one paper jointly written by 31 authors with 132 (1%) citations. This and other data in the table indicates that multi-authored papers received more citations than single author papers.

Findings

- Faculty members of the Department of Chemistry, University of Pune, have published 811 publications during 14 years (1999-2012) in various areas of chemistry in
which physical chemistry dominates. There is a continuous growth in publications. Highest number of papers were published in 2012. 30% of the total papers were published after 2010.

• Most of the faculty members disseminate their research output through international journals. Approximately 57% citations are received for papers published in 22 foreign journals. Core international journals like Journal of Physical Chemistry A, Tetrahedron, Journal of Chemical Physics, etc. are preferred by the faculty members. Nine Indian journals were selected to report research contributions which are indexed in WoS.

• H-index of the department is 43 during the period under study. Highest number of citations are received for 77 papers published in 2006.

• As far as international collaboration is concerned, highest number of papers are published with the researchers from the USA. Within the country, collaborations with National Chemical Laboratory dominates.

• International journals published by USA, UK and Germany are preferred by the faculty members.

• Most of the papers are published in journals having an impact factor more than one.

• The authorship pattern varies from 2 to 31 authors and there are very few papers by a single author in the CDK.

Conclusion
The quantitative analysis of papers published by faculty members of the Department of Chemistry, University of Pune shows that the faculty members are very active in research and their contribution is well recognized at national and international level. They prefer core journals having high impact factor to publish their research. The number of their contributions is growing especially in the years 2010-2012. Though the main area of research is physical chemistry the faculty members also do research in interdisciplinary areas like computational chemistry, nanotechnology, etc.

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References
4. Garfield E, Citation analysis as a tool in journal evaluation, Science, 178 (4060) (1972) 471-479.
7. Meho L I, Yang K, Impact of data sources on citation counts and rankings of LIS faculty: Web of Science versus Scopus


