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# Citations behaviour of Indian scientists from an interdisciplinary research institute: A case study of CSIR-NIIST

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The paper analyses the characteristics of cited references in papers published from CSIR-NIIST for understanding the preferences of authors in choosing the research work for citing. It has been observed that authors frequently cite articles from journals subscribed by the Institute. A number of citations are found from open access journals too. NIIST authors refer and cite articles from journals with higher impact factor than that of the source journal, where the research is being published. More than 40% of the references are of very recent (less than 5year old) works. Most research is (64%) based on authors' previous work. Journal self-citations are found in more than half of the research papers.

**Keywords**: Citation behaviour; Citing pattern; CSIR; Self-citations

## Introduction

Researchers publish articles in reputed academic journals to communicate the new discoveries, ideas, findings etc. New discoveries and findings are built on the works of previous researchers. Isaac Newton said, "If I have seen further than others, it is by standing upon the shoulders of giants". Acknowledging previous work is a normal practice and has become a key part of academic publishing since seventeenth century. Over time, authors sought to improve the credibility of their ideas by referring to previously documented works, and the concept of citation was born.[1,2,3] Nowadays, citations are an irrevocable part of scientific research in all disciplines.[4,5]

Garfield listed the following reasons for citing, which refer to both the normative theory of citing behavior and the constructive view: Paying homage to pioneers, giving credit for related work (homage to peers); identifying methodology, equipment, etc; providing background reading; correcting one's own work; correcting the work of others; criticizing previous work; substantiating claims; alerting forthcoming work; providing leads to poorly disseminated, poorly indexed, or uncited work; authenticating data and classes of fact (physical constants, etc.); identifying original publications in which an idea or concept was discussed; identifying original publication or other work describing an eponymic concept or term; disclaiming work or ideas of others (negative claims); disputing priority claims of others (negative homage).[6] Thus, researchers cite articles because they perceive them to be relevant or they want to acknowledge and draw attention to the ideas expressed in those works.

A large number of studies have investigated the question as to the extent to which scientists cite works based on those premises or whether they are motivated by other factors to cite certain publications. Citation counts do not yield insight into the authors' motives for their citing behavior, nor do they tell us what informational unit they are targeting in the cited work.[7] Authors use citations with different intentions and meanings.[8] A substantial body of literature has shown that the number of citations to scientists' publications are correlated with other assessments of scientists' impact or influence, such as awards, honors, and Nobel laureateships; departmental prestige, research grants, academic rank and peer judgments.[9-15]

CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram is one of the top performing science and technology laboratories under the Council of Scientific and

Industrial Research, India. The institute has been consistently ranked as one of the outstanding laboratories in terms of the quantity and quality of research publications produced by scientists. The major research areas are agro-processing, natural products, biotechnology, chemical sciences & technology, materials science & technology and process engineering and environmental technology.[16] The institute has eminent scientists who have bagged many prestigious awards including Bhatnagar prize for Science and Technology, Infosys Award, Thomson Citation Laureate Award and many other awards instituted by prominent academic and scientific agencies. Many scientists have membership in highly acclaimed national and international societies.

NIIST always figures within the top three highly productive institutes within CSIR with respect to number of papers in high Impact journals and the quality of the papers. This CSIR Institute was rated to be a 'rising star' by Kirsten Bound and Ian Thornton, authors of 2012 report on science in India.[17] According to them NIIST "publishes the highest proportion of world-class papers of any institute in India – world-class research accounts for 14 per cent of the total institutional output." The excellent research record and the interdisciplinary nature are the main reasons to choose this institution as a sample for studying the citation behaviour of Indian authors analytically.

## Objectives of the study

- To gain an insight into the citing behaviour of CSIR-NIIST authors by analyzing the citations referred by them in their scientific publications and to portray their citing characteristics.

## Methodology

The publications indexed in Web of Science were downloaded in plain text format for the organisation affiliation for the period 2004 to 2008 using the query string *"AD=((((((NAT* INST* INT* SCI* TECH* OR NIIST) SAME INDIA) OR ((REG* RES* LAB* OR RRL) SAME KER*)))))"*. The period 2004 to 2008 was considered because at least five years after publication of article is required to assess its citations. Also, the CSIR-NIIST has enhanced its information resources base by subscribing to electronic resources in a consortium mode from 2003 onwards. The cited references of the resultant set were also downloaded from Web of Science. The data were analysed using Bibexcel. Impact factor was collected from JCR-2009. Union catalogue of CSIR laboratory library holdings was referred for checking the availability of the cited resources in the organisations.

## Results and discussion

Analysis of 926 documents published from NIIST during year 2004 to 2008 and indexed in SCI database shows that 806 (87%) papers are of research articles, 60 (6.5%) are review papers and 47(5%) are conference proceedings papers (Table1). The total number of references appended to these papers is 29351. It is observed that like any other research group, NIIST authors also cited more references in review articles i.e., 21% of total references are from 6.5% of review articles at an average of 118 references for each paper. Average cited reference per research article is 31.13 amounting to 75% cited references from 87% research articles. The number of documents cited show an increasing trend during the period of study.

It was found that journal articles (91%) are the most cited reference documents of NIIST authors. Books account for 6% of citations, patents 1% and the remaining 2% include conference proceedings, encyclopedias, abstracts and unpublished information.

## Age of cited references

The research documents authored by NIIST scientists cited most recent developments and findings in the respective area while they also referred very old documents. The pattern of age distribution of cited references show that majority of the references (41.53%) are less than five years old, 26.61% are between 6 to 10 years and 19.63 % between 11 to 20

Table 1—Year-wise distribution of articles & cited reference under different document category during 2004 -2008

| Document type | No. of documents | | | | | Average no. of references per document | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | 2007 | 2008 | 2004 | 2005 | 2006 | 2007 | 2008 |
| Article | 113 | 132 | 169 | 185 | 207 | 26.65 | 28.20 | 32.33 | 32.92 | 32.88 |
| Proceedings paper | 6 | 8 | 7 | 12 | 14 | 23.50 | 24.63 | 21.43 | 18.25 | 25.79 |
| Review | 11 | 11 | 14 | 10 | 14 | 108.36 | 137.36 | 113.64 | 131.00 | 104.57 |
| Others | 3 | 4 | 1 | 4 | 1 | 5.33 | 28.50 | 7.00 | 21.00 | 0.00 |
| Total | 133 | 155 | 191 | 211 | 236 | 32.78 | 35.77 | 37.76 | 36.51 | 36.57 |

years, clearly indicating the tendency among NIIST fraternity to cite recent publications. About 11 percent of the references are between 21 to 50 years old and less than 1.3 % references are more than 50 years old.

**Quality of cited references**

NIIST research output excessively cited journals indexed in Science Citation Index rather than Non-SCI journals. It is interesting to note that 89% of the referred articles are from high quality SCI covered journals. It was also found that 55.46% of the references are from journals with impact factors higher than the source journals.

**Most cited journals**

It was found that the five year research output (926) of NIIST is concentrated in 230 journals, whereas the 29351 cited references in these publications are from 1450 journals out of which 1190 journals are SCI-indexed. The citations are concentrated in few journals and the first 20% cited references are from 9 journals only; 40% cited references are from 30 journals and 80 % of the cited references are from 195 journals which is equal to 13.5% of the total journals referred. [The Pareto principle (also known as the 80–20 rule, the law of the vital few, and the principle of factor sparsity) states that, for many events, roughly 80% of the effects come from 11.66% of the causes.] The distribution of cited references in these journals is very uneven and concentrated in few journals. The distribution cited references in journals is shown as Lorenz curve[18] in Fig. 1.

Table 2 shows the frequency of occurrence of the top 30 most cited journals of NIIST Researchers. *Journal of the American Chemical Society* is seen to be the most referred journal with 1501 citations followed by *Angewandte Chemie - International Edition* with 697 citations.

**Open access journals**

NIIST researchers cited 345 articles i.e. 1.29 % of total cited references from open access journals. Among them *Analytical Sciences* (69 Articles), *Nucleic Acid Research* (42), *Journal of Scientific & Industrial Research* (27), *Bulletin of Materials Science* (27), *Food Technology and Biotechnology* (24), *Current Science*(24), *Brazilian Archives of Biology and Technology* (18), *Materials Research Bulletin* (16), *The Memórias do Instituto Oswaldo Cruz* (11) and *Journal of the Brazilian Chemical Society* (11) are the most cited.

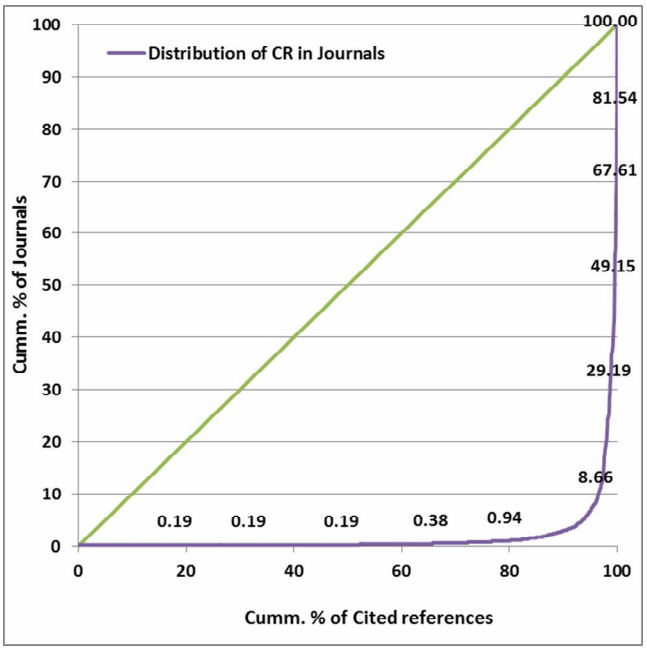


Fig. 1—Distribution of cited references in journals

**Journal self-citations**

The scientific quality of a journal is generally measured in impact factors provided by ISI Web of Knowledge Journal Citation Reports and the journals are ranked. Most journal editors try to accept the best articles which fit within the scope of the journal, and these articles are often those that are most cited. However, this might not always be enough to maintain or increase the journal's impact. An editor might even suggest that a certain number of citations to be added to articles previously published in their journal, which will then artificially inflate the impact factor of that journal. An increasing misuse of journal impact factors by editors, requesting authors to cite additional papers published recently in the editor's journal, has been highly criticized.[19,20] However, Huang's findings indicated that JIF and JII values changed only slightly regardless of the inclusion or exclusion of self-citations, suggesting that the influence of self-citation on journals was insignificant.[21] Owing to excessive self-citation or because of 'citation stacking' (in which journals cite each other to excessive amounts), a record number of journals — 66 of them, including 37 new offenders — have been banned from 2013's impact-factor list.[22]

Authors make it a practice to cite articles from the same journal in order to get their paper published in a particular journal. However, contrary to this usual pattern, number of references cited from the same source journal is found for very less in numbers in

Table 2—Most referred journals by NIIST Authors during 2004-08

| Sl. no. | Journals | Impact factor | Cited references | |
|---|---|---|---|---|
| | | | % | Cumulative % |
| 1 | *Journal of the American Chemical Society* | 8.58 | 5.94 | 5.94 |
| 2 | *Angewandte Chemie - International Edition* | 11.829 | 2.76 | 8.69 |
| 3 | *Tetrahedron Letters* | 2.66 | 2.29 | 10.98 |
| 4 | *Journal of the American Ceramic Society* | 1.944 | 2.10 | 13.08 |
| 5 | *Journal of Organic Chemistry* | 4.219 | 1.71 | 14.80 |
| 6 | *Analytica Chimica Acta* | 3.757 | 1.67 | 16.47 |
| 7 | *Chemical Reviews* | 35.957 | 1.49 | 17.96 |
| 8 | *Macromolecules* | 4.539 | 1.44 | 19.39 |
| 9 | *Organic Letters* | 5.42 | 1.42 | 20.81 |
| 10 | *Journal of Physical Chemistry B* | 3.471 | 1.32 | 22.13 |
| 11 | *Chemical Communications* | 5.504 | 1.22 | 23.35 |
| 12 | *Journal of the European Ceramic Society* | 2.09 | 1.21 | 24.56 |
| 13 | *Physica C: Superconductivity and its Applications* | 0.723 | 1.18 | 25.73 |
| 14 | *Physical Review B* | 0.000 | 1.18 | 26.91 |
| 15 | *Tetrahedron* | 3.219 | 1.12 | 28.04 |
| 16 | *Process Biochemistry* | 2.444 | 1.03 | 29.07 |
| 17 | *Talanta* | 3.29 | 0.95 | 30.02 |
| 18 | *Journal of Physical Chemistry* | 0.000 | 0.92 | 30.94 |
| 19 | *Japanese Journal of Applied Physics* | 1.138 | 0.92 | 31.85 |
| 20 | *Superconductor Science and Technology* | 2.694 | 0.90 | 32.75 |
| 21 | *Chemistry of Materials* | 5.368 | 0.89 | 33.64 |
| 22 | *Nature* | 34.48 | 0.87 | 34.51 |
| 23 | *Accounts of Chemical Research* | 18.203 | 0.85 | 35.35 |
| 24 | *Enzyme and Microbial Technology* | 2.638 | 0.83 | 36.18 |
| 25 | *Journal of Applied Physics* | 2.072 | 0.83 | 37.01 |
| 26 | *Langmuir* | 3.898 | 0.81 | 37.82 |
| 27 | *Advanced Materials* | 8.379 | 0.80 | 38.62 |
| 28 | *Bioresource Technology* | 4.253 | 0.80 | 39.41 |
| 29 | *Applied Physics Letters* | 3.554 | 0.79 | 40.20 |
| 30 | *Journal of Applied Polymer Science* | 1.203 | 0.78 | 40.97 |

papers published from NIIST. Only 6.76% of the references are from the same journal where the article is published. It is seen that 52.16% of published papers have at least one journal self-citation. Table 3 gives the list of journals with number of articles cited from source journal itself in the order of rate of journal self-citation. The table shows that *Journal of the American Oil Chemists' Society* has received as high as 39.33% citations 20% from the same journal.

**Author and institution self-citation**

Authors generally refer to their previous work in their research communications. We selected a subset of 109 most cited articles which were cited 1305 times (~5% of total cited references) altogether by NIIST authors during 2004-08. This subset was analyzed to see the author self-citation. It has been found that 696 cited references from 1305 (53.33%) are author self-citations. And we found that 64.69% of all the published papers are having author self-citations.

As for institution self-citation, only 38 out of 1305 citations (about 3%) were institution self-citation wherein authors cited other authors from NIIST.

**Availability of cited articles to researcher**

It has been reported that works cited are not read by the vast majority of people who reference them[23]. Many times researchers refer secondary sources or review papers for collecting their citation. We observed that majority of the works cited by NIIST scientists (69.27%) are from the information sources available or accessible within the organization and 22.91% are from resources available in other CSIR

Table 3—Journals with high number of journal self-citation

| Sl. no. | Journal | Impact Factor | Total citations | % of journal self-citation |
|---|---|---|---|---|
| 1 | *JAOCS, Journal of the American Oil Chemists' Society* | 1.803 | 89 | 39.33 |
| 2 | *Physica C: Superconductivity and its Applications* | 0.723 | 118 | 27.97 |
| 3 | *Macromolecules* | 4.539 | 248 | 25.00 |
| 4 | *Water Research* | 4.355 | 112 | 25.00 |
| 5 | *Journal of the American Chemical Society* | 8.58 | 672 | 20.09 |
| 6 | *Inorganic Chemistry* | 4.657 | 281 | 19.22 |
| 7 | *AnalyticaChimicaActa* | 3.757 | 326 | 19.02 |
| 8 | *AngewandteChemie - International Edition* | 11.829 | 614 | 17.26 |
| 9 | *Superconductor Science and Technology* | 2.694 | 730 | 15.89 |
| 10 | *Tetrahedron Letters* | 2.66 | 497 | 14.49 |
| 11 | *Journal of the American Ceramic Society* | 1.944 | 526 | 14.45 |
| 12 | *Materials Science & Engineering A: Structural Materials: Properties, Microstructure and Processing* | 1.901 | 232 | 14.22 |
| 13 | *Talanta* | 3.29 | 501 | 11.78 |
| 14 | *Journal of Applied Polymer Science* | 1.203 | 264 | 11.36 |
| 15 | *Journal of Polymer Science, Part A: Polymer Chemistry* | 3.971 | 528 | 10.80 |
| 16 | *Journal of Physical Chemistry B* | 3.471 | 737 | 10.45 |
| 17 | *Organic Letters* | 5.42 | 680 | 10.00 |
| 18 | *Bioresource Technology* | 4.253 | 601 | 7.15 |
| 19 | *Tetrahedron* | 3.219 | 659 | 6.98 |
| 20 | *Chemistry - A European Journal* | 5.382 | 564 | 4.43 |

Table 4—Most cited articles

| Sl. no. | Cited reference | Citations received as on 10 Sep 2015 | Citations during 2004 -08 | Citations from NIIST during 2004-08 | |
|---|---|---|---|---|---|
| | | | | Nos. | % |
| 1. | Krupka J, *MEAS Sci Technol*, 9 (1998) 1751. | 218 | 78 | 44 | 56.41 |
| 2. | Chong I, *Science*, 276(1997) 770. | 173 | 50 | 20 | 40.00 |
| 3. | Motohashi T, *Phys Rev B*, 59 (1999) 14080. | 113 | 40 | 15 | 37.50 |
| 4. | Bae SY, *Anal ChimActa*, 397 (1999) 173. | 90 | 46 | 16 | 34.78 |
| 5. | Wersing W, *Curr Opin Solid ST M*, 1 (1996) 715. | 263 | 116 | 15 | 12.93 |
| 6. | Courtney WE, *IEEE T Microw Theory*, 18 (1970) P476. | 754 | 213 | 20 | 9.39 |
| 7. | Shannon RD, *J ApplPhys*, 73 (1993) 348. | 951 | 244 | 19 | 7.79 |
| 8. | Hakki BW, *Institute of Radio Engineers Transactions On Microwave Theory And Techniques*, 1960, VMTT-8, | 1964 | 638 | 39 | 6.11 |
| 9. | Law Ky, *Chem Rev*, 93(1993) 449. | 1117 | 269 | 16 | 5.95 |
| 10. | Basavaiah D, *Chem Rev*, 103(2003) 811. | 1332 | 621 | 18 | 2.90 |
| 11. | Miller GL, *Anal Chem*, 31 (1959) 426. | 10819 | 1804 | 27 | 1.50 |
| 12. | De Silva AP, *Chem Rev*, 97 (1997) 1515. | 4653 | 1313 | 19 | 1.45 |
| 13. | Shannon RH, *ActaCrystallogr A*, 32 (1976) 751. | 31283 | 6108 | 24 | 0.39 |
| 14. | Lee CT, *Phys Rev B*, 37 (1988) 785. | 51000 | 13753 | 18 | 0.13 |
| 15. | Lowry OH, *J BiolChem*, 193 (1951) 265. | 324603 | 17821 | 22 | 0.12 |
| 16. | Becke AD, *J ChemPhys*, 98 (1993) 5648. | 57955 | 15610 | 16 | 0.10 |

institutions. Only 3.75 % research papers are cited from sources outside the subscribed/ available content of NIIST and its sister labs.

### Most cited works

Table 4 lists the most cited articles in NIIST research output excluding author self-citation and institution self-citation. It is found that these papers are citation classics are most relevant to the research areas of NIIST, as these papers received most of its citations in NIIST papers.

## Conclusion

A large extent of information requirement of NIIST researchers is met from subscribed content of the Institute. The authors cite most recent research papers

(more than 68% of the references are from research conducted within last ten years) which is an indicator of the institute carrying out contemporary research. The researchers are mostly referring SCI indexed journals (89%) rather than the non-SCI journals. They also prefer to cite the journals with higher impact factor than that of the journals in which the paper is getting published. Further studies on co-citation and influencing factors can shed more light on the reasons and motivational factors behind journal self-citations, institutional self-citations and also on resource requirement.

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