

Scientometrics, Tools and their Software's: A Play for Vital Role in Research

Mr.N.MURUGANANDHAM,
(RESEARCH SCHOLAR, ANNAMALAI UNIVERSITY),
SENIOR TECHNICIAN (LIBRARY),
CENTRAL LIBRARY, IIT MADRAS, CHENNAI-36,
TAMILNADU, INDIA.

Dr.M.MUTHU,
SLIA, CENTRAL LIBRARY, IIT MADRAS,
CHENNAI-36, TAMILNADU, INDIA.

Dr.P.SIVARAMAN,
ASSOCIATE PROFESSOR,
DEPARTMENT OF LIBRARY & INFORMATION SCIENCE,
ANNAMALAI UNIVERSITY,
TAMILNADU, INDIA- 608002.

Abstract:

Scientometrics is the study of measuring and analyzing science, technology and innovation. Major research issues include the measurement of impact, reference sets of articles to investigate the impact of journals and institutes, understanding of scientific citations, mapping scientific fields and the production of indicators for use in policy and management contexts. The term has now established a significant role in the social sciences. Applications have so far been restricted to an exploitation of the citation data provided by ISI but further refinements are now being critically examined. Though the techniques of scientometrics and bibliometrics are closely similar their different roles are distinguished by their very different contexts. This paper is mainly highlights for Historical Evidences, Definitions, Objectives, Characteristics, Scope of the study, Laws and Software's, Techniques, Area of Applications, Benefits and Limitations, Key Points to remember when conducting Scientometrics Analyses and so on in detailed general study for preparing research report for scholars.

Keywords:

Scientometrics, Historical Evidences, Laws and Software's, Techniques, Area of Applications, Benefits and Limitations, Key Points.

1. Introduction:

The effectiveness of scientific research performance could be realized only through a proper communication system. Communication in science could be viewed from the standpoint of a historian, an economist, a sociologist, and a library professional, and so on. Vassily V. Nalimov coined the term 'scientometrics' in the 1960s, this term has grown in popularity and is used to describe the study of science. The Scientometrics was established in 1978. The industrialization of science increase the quality of publication, and research outcomes and rise the computer allowed to effective analysis of data .It is not only used in most used in Library and information science also helps to improve scientific documentation information and communication activities of the subjects which is taken in to account for analysis. It is a science of measuring and analyzing science. In practice, scientometrics is often done using bibliometrics which is a

measurement of the impact of (scientific) publications. Modern scientometrics is mostly based on the work of Derek J. de Solla Price and Eugene Garfield. The latter founded the institute for Scientific Information which is heavily used for scientometric analysis. Methods of research include qualitative, quantitative and computational approaches. One significant finding in the field is a principle of cost escalation to the effect that achieving further findings at a given level of importance grow exponentially more costly in the expenditure of effort and resources.

1.1. Historical Evidences:

The term Scientometrics originated as a Russian term for the application of quantitative methods to the history of science. The term was introduced and came into prominence with the journal launch named "Scientometrics". It deals with analysis and graphical representation of science and technology information. In other words, it tells us "Who is doing what and Where" Modern scientometrics is mostly based on the work of Derek J. de Solla Price and Eugene Garfield. The latter created the Science Citation Index and founded the Institute for Scientific Information which is heavily used for scientometric analysis. A dedicated academic journal, Scientometrics, was established in 1978.

- **Librametrics** as, "Quantitative analysis of various facets of library activities and library documents by the application of mathematical and statistical calculus to seek solution to library problems."
- **Bibliometric** as "the study of the use of documents and patterns of publication in which mathematical and statistical methods have been applied."
- **Informetrics** was used as a generic term to mean the use and development of a variety of measures to study and analyze several properties of information in general and documents in particular. "It covers bibliometrics and scientometrics.
- **Scientometrics** is the study of measuring and analyzing science, technology and innovation.
- **Webometrics/Cybermetrics** as the study of the quantitative aspects of the construction and use of information resources, structure and technologies on the www drawing on bibliometrics and informetric approaches."
- "**Webometrics** displays several similarities to informetric and Scientometrics studies and the application of common bibliometrics methods."
- **Altmetrics** In scholarly and scientific publishing, non-traditional metrics proposed as an alternative to more traditional citation impact metrics, such as impact factor and h-index.

1.2. Definitions:

- **Beck (1978)**, scientometrics has been defined as the quantitative evaluation and intercomparison of scientific activity, productivity and progress.
- **Brookstein (1995)** defined scientometrics as "the science of measuring science". Scientometrics is also considered as a bibliometric measurement for evaluation of scientific development, social relevance and impact of the application of science and technology etc.
- **Nalimov and Mulchenko (1969)**, of Russia, defined scientometrics as the quantitative methods which deal with the analysis of science viewed as an information process.
- Scientometrics is the quantitative study of the disciplines based on published literature and communication.
- This could include identifying emerging areas of scientific research, examining the development of research over time, or geographic and organizational distributions of research.

2. Objectives:

- To measure monthly-wise / Year-wise distribution of contributions and the average number of contribution per month.
- To analyze the authorship pattern.
- To determine the volume-wise productivity of articles/publications.
- To identify the ranking of authorship pattern
- To estimate the degree of collaboration among authors.

- To study the subfield-wise distribution of citation journal.
- To identify geographical distribution of journal preferred for publication.
- To observe the length of pagination.
- To identify the profession type of author.

3. Characteristics of Scientometrics:

- Scientometrics helps researchers in other subjects to contribute more.
- Scientometrics points out the stronger and weaker area of research.
- Helps not only the focused organization level of research, but also participation of the nation can also be measured.
- The forms of transmission help the researchers to publish their research output which are mainly preferred by the users.
- The geographical distribution of information without approaching wider range information sources.
- The subject dispersion study helps not only the researchers but also the library in procuring information sources and also for obsolescence study purpose.
- The authorship pattern helps the scientists and researchers to collaborate their study irrespective of any geographical and language differentiation.

3.1.Scope of the Study:

- To get a comparative picture of Indian research performance.
- To know the status of India among the various countries of the world.
- To arrive at future course of projections in authorship pattern, language and country of publications.
- To apply the empirical laws of Lotkas; Bradford.

3.2.Needs of the Study:

- Scientometric studies have increasingly been used over the last few years. These studies are useful to understand the evolution of literature or trends in particular fields or within a geographical area.

3.3.Why Scientometrics?

- Nearly all writings about science start with the statement that it is a driving force of our modern society and a starting point for breakthroughs in our knowledge of the world. The funding of science is an important part of investment in the world's future.

3.4.Why Use Scientometrics?

- Demonstrating the importance and impact of your own research and/or that of your research group
- Identifying areas of research strength and weaknesses
- Identifying top performing journals in a subject area
- Identifying top researchers in a subject area

3.5. Purpose of Scientometrics:

The purpose of the study is mentioned below:

- Quantitative analysis of science and technology performance
- Quantitative analysis of the cognitive and organizational structure of science and technology
- To know how a certain science or technology has evolved in a certain period of time

4. Laws and Software's:

4.1. Laws of Scientometrics:

- **Lotka's Law** (1926) Author's Productivity
- **Brodford's Law** (1934) Scattering
- **Zipf's Law** (1949) Word Frequency

4.2. Tools and Software for Scientometrics:

There are many software's are available for Scientometric and Bibliometric analysis. They are such as has given below;

- Bibexcel
- Bibliometrix R Package
- Biblio Tool
- CiteSpace
- CitNetExplorer
- CopalRed
- CRExplorer
- InCite Retrieve
- IN-SPIRE
- Headstart
- HistCite
- Loet Letdesdorff
- Network Workbench
- Publish or Perish
- SAINT
- SciMAT
- Sci2 Tool
- Scientometric Project
- Scopus API R code
- Sitkis
- VOSviewer
- Web of Science API



5. Techniques and Applications:

5.1. Scientometric Techniques:

5.1.1. Productivity Count: It deals with books articles, words in a text, place of publication, subject matter, time and date of publication, publishing institution, authors, author's institution, etc. Nicholas and Ritchie in the book "Literature and Bibliometrics" called it as productivity count or descriptive.

5.1.2. Literature Usage Count: It deals with citation in published works, circulation, frequency of borrowing or browsing different library material, failure and success in search strategies, search option , etc. Nicholas and Ritchie called it as "Evaluative".

5.1.3. Uses of Scientometric Studies: Historically Scientometric methods have been used to trace relationships amongst academic journal citations. The Scientometric research uses various methods of citation analysis in order to establish relationships between authors or their work. The Scientometric studies are used in

- Bibliographic control
- Comparative assessment of the secondary services
- Formulating search strategies in case of automated system
- Indexing and Thesaurus
- Library Management
- Measuring the productivity of an author based on the number of published articles. (Lotka)
- Measuring the scattering of articles on a subject in various periodicals (Bradford)
- Preparation of retrospective bibliographic and Research
- Productivity count of literature
- Ranking of words in a text based on frequency of occurrence of words
- To identify the peers, social change and the core journal, etc.

5.2. Areas of Application of Scientometrics:

- The areas of library and information science are the following, in which the Scientometrics techniques are used.
- To design automated language processing for auto indexing, auto classification and auto abstracting.
- To develop experimental model.
- To develop norms of standardization.
- To estimate comprehensiveness of secondary periodicals.
- To forecast past, present and future publishing trends.
- To formulate an accurate need based acquisition policy within the limited budgetary provision.
- To formulate an accurate weeding and stacking policy.
- To formulate collection development and management policies.
- To formulate stacking and weeding policies.
- To identify authorship and its trends in documents on various subjects.
- To identify core periodicals in different disciplines .(through application of Bradford's law of scattering and citation analysis)
- To identify past, present publishing trends as well as forecast future publishing trends.
- To identify research trends and growth of knowledge.
- To identify users of different subjects.
- To initiate effective multivalve network system.
- To measure the usefulness of retrospective and current awareness service.
- To predict productivity of publishers, individual authors, organizations and countries.
- To study obsolescence and dispersion of scientific literature.
- To study productivity of institutions/ individuals and disciplines.
- To study trends and growth of knowledge.

6. Benefits and Issues:

6.1. Benefits of Scientometric Studies:

- Comparative assessment of the secondary services
- Consistent and repeatable.
- Easy to access, understand, and to use
- Establish benchmarks
- Formulating search strategies in case of automated system
- Historically bibliometric methods have been used to trace relationships amongst academic journal citations
- Indexing and Thesaurus
- Library Management
- Measuring the productivity of an author based on the number of published articles. (Lotka)
- Measuring the scattering of articles on a subject in various periodicals (Bradford)

- Preparation of retrospective bibliographic and Productivity count of literature
- Ranking of words in a text based on frequency of occurrence of words
- Research
- The bibliometric research uses various methods of citation analysis in order to establish relationships between authors or their work
- To identify the peers, social change and the core journal, etc
- Universal and mathematical (=objective) nature

6.2. Limitations and Issues of Scientometrics:

Scientometrics may be gaining in importance and popularity because they are objective and relatively easy to calculate and understand but they still have a number of limitations including:

- A paper may be cited in a negative rather than a positive way yet the citation would still be counted.
- Citation patterns vary from subject to subject.
- Citations patterns can differ greatly between disciplines, for example, in certain disciplines research outputs may be cited more frequently than in other disciplines. Therefore it is important to compare researchers, or groups of researchers against those from the same or similar discipline.
- Citations to a paper may not reflect its quality.
- Experienced researchers will have an advantage over early career researchers when using certain metrics as they will have produced more outputs. Therefore it is important to compare researchers who are at the same stage of their career.
- Manipulation of the system by researchers inappropriately self-citing, citing colleagues, splitting outputs into many articles etc. can distort the data. A number of bibliometric tools now allow you to exclude self-citations.
- Metrics do not tend to account for the age of a researcher
- More formula oriented
- Only a tiny proportion of published research is covered by resources.
- Review articles tend to be more highly cited than standard articles.
- Scientometrics were initially based on the model of publishing articles in peer-reviewed journals. This is not the norm for many disciplines particularly in the arts, humanities and social sciences.
- Self-citations can be distort in metrics.
- The tools used to gather bibliometric data do not cover all research areas and do not index all publications. Results will vary depending on the tool you use.
- This causes problem while ranking the authors on the basis of the frequency of their getting citations

6.3. Co-Authorship as a measure of Scientific Collaboration- (DeB. Beaver, 2001):

- Access to equipment, resources, or “stuff” one doesn’t have
- Access to expertise
- Efficiency: multiplies hands and minds; easier to learn the tacit knowledge that goes with a technique
- For fun, amusement, and pleasure
- Improve access to funds
- To advance knowledge and learning
- To educate [a student, graduate student, or, oneself]
- To enhance productivity
- To find flaws more efficiently, reduce errors and mistakes
- To get to know people, to create a network, like an “invisible college”
- To keep one more focused on research, because others are counting on one to do so
- To make progress more rapidly
- To obtain prestige or visibility; for professional advancement
- To reduce isolation, and to recharge one’s energy and excitement
- To retool, learn new skills or techniques, usually to break into a new field, subfield, or problem
- To satisfy curiosity, intellectual interest

- To share the excitement of an area with other people
- To tackle “bigger” problems [more important, more comprehensive, more difficult, global]

6.4. Key Points to remember when conducting Scientometrics Analyses:

- Always compare like with like, for example:
 - ❖ Groups and individuals in the same or similar discipline
 - ❖ Groups and individuals in the same stage of their academic career
 - ❖ Journals in the same discipline or category
 - ❖ Similar size institutions
- Be aware that some disciplines rely less on publishing in journals than others and will therefore fare less favorably.
- Don't rely on a single Scientometric tool; results can vary depending on the tool used because the content covered by each tool varies, as does the depth of coverage and discipline coverage.
- Put the data in context using a combination of metrics and other qualitative information where appropriate.

7. Conclusion:

- Scientometrics is a type of research method used in library and information science.
- Scientometrics is a major sub-discipline of quantitative research. This is a tool used by the library and information science professionals for studying the communication processes, information flows, and others for better understanding and effective management and dissemination of information.
- Scientometrics techniques are being used for a variety of purposes like determination of various scientific indicators, evaluation of scientific output, selection of journals for libraries and even forecasting the potential of a particular field.
- Scientometrics is a methodological approaches in which the scientific literature itself becomes the subject of analysis. In a sense, they could be considered a science of science. Scientometrics researchers often attempt to measure the evolution of a scientific domain, the impact of scholarly publications, the patterns of authorship, and the process of scientific knowledge production.
- Scientometrics often involve the monitoring of research, the assessment of the scientific contribution of authors, journals or specific works, as well as the analysis of the dissemination process of scientific knowledge. Researchers in such approaches have developed methodological principles on ways to gather information produced by the activity of researchers' communications, and have used specific methods such as citation analysis, social network analysis, co-word and content analysis, as well as text-mining to achieve these goals.

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