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Module : 01 Librametry, Bibliometrics, Scientometrics, Informetrics and Webometrics: Historical Development

ज्ञान-विज्ञान विमुक्तये

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Module-1

Librametry, Bibliometrics, Scientometrics, Informetrics and Webometrics: Historical Development

I. Objectives

The objectives of this module are:

- To discuss the concept, meaning Definition and historical development from Librametrics to Altmetrics.
- To explain the Bibliometrics/Scientometrics scope and application in relation to LIS students' learning.
- To explain the model of Bibliometrics/Informetrics to LIS students.
- To show the systematic development of the quantitative analysis study in LIS and its application in measuring scientific productivity for any given audience.
- To develop an assessment tool for LIS students on Bibliometrics/Scientometrics assignment.
- To provide an existing information available in India and world.

II. Learning Outcome

After successful completion of this module you will understand the scope and definition of different terminologies used in Scientometrics;

III. Module Structure

1. Introduction
2. Librametry, Meaning and Definition
3. Bibliometrics, Meaning and Definition
4. Scientometrics, Meaning and Definition
5. Informetrics, Meaning and Definition
6. Webometrics, Meaning and Definition
7. Bibliometrics, theoretical and philosophical foundation
8. Summary
9. References

1. Introduction

Prof. P. C. Mahalanobis, founder of the Indian Statistical Institute, in the early 1950's argued that Statistics is a "Key technology" – as it is required for all socio-economic development activities, and since statistical techniques are used in all development and forecasting studies. In recent past, statistics has been applied to a number of areas such as perspective planning, industrial and agricultural development, etc. Library and Information managers have adopted a number of quantitative methods in recent years in order to evaluate library resources and services more objectively and effectively. Scientometrics/ Informetrics refer to quantitative techniques applicable to measure the records of human communication. Over the years, several new terms have appeared on the horizon representing quantitative studies in library and Information Science.

The History of comparative Anatomy Part-I: A Statistical Analysis by Cole and Eale (10) is considered to be the first bibliometric study in 1917. Hulme (19) was the first to use the expression 'statistical bibliography' in 1923; later several studies have been conducted. Gross and Gross (18) study is considered to be the third study in the field based on citations. After Hulme, the term statistical bibliography was used by Henkle[4] in 1938 in his article "The periodical literature of Biochemistry" and Gosnell (16,17) in his dissertation in 1943, and later in his article 1944. The historical development of the term statistical bibliography has been traced by Witting (38) in a foot note. As the term was considered very clumsy, not very descriptive, and can be confused with statistics itself or bibliographies on statistics.

2. Librametry, Meaning and Definition

In 1948 at the Aslib's conference in Lamington Spa, Ranganathan introduced the term Librametry for the first time. He suggested to develop Librametry on the lines of biometry, econometry, and psychometry (2). His suggestions were avidly welcomed at the conference by Bernal and others. The term Librametrics has two roots: Libra and Metry. The word 'Libra' connotes 'library' and 'metrics' means measurement. Further, as the librarian of the Madras University Library, he practiced various librametric techniques way back in 1925, in order to solve day today library problems and to streamline the day-to-day library activities, services for their clientele and also for the betterment of library professional as a whole (31)

The scope of the library is limited to the quantitative study of books, readers and staff. Here the books, readers and staff are the three constituent elements or factors of the library. The absence of any one of the three will make the library cease to exist. Each has its own potentiality and it is only a sum of the three that makes a library. Thus we can measure all the Characteristics of books, readers and staff.

The library book selection, acquisition, accessioning, classification, cataloguing, stack arrangement, publicity, reference service, circulation activities can be measured. The library reader's book use behaviour can be quantifiable. The library staff-their

satisfaction, dissatisfaction-also can be measured. Even we can include library accounting, budgeting and manpower planning.

Ranganathan (27) in his paper presented in the DRTC 7th Annual Seminar (1969) suggested a few examples of statistics to library science. Based on his experience and the experiments carried out at the Documentation Research and Training Centre, Neelameghan (23) outlined the applications for Librametrics:

- Determination of the strength of library staff;
- Disposition of library staff for circulation work during different library hours;
- Disposition of library staff for reference service during different library hours
- Organization of library system; Establishing the distinction between "service library" and "dormitory library";
- Design of library building, fittings, and furniture;
- Book selection;
- Absolute syntax and facet syntax in relation to classification;
- Length of class number;
- Variation in style in writing catalogue entries; and
- DOC-Finder.

Statistical techniques are also useful in

- Transfer of a big library from one building to another;
- Periodical changes in the sequence of subjects in shelving of books in the stack room in relation to saving of the time of readers.
- Estimation opinion of readers about library services received by them;
- Estimation of library use; and
- Accuracy in cataloguing work.

The librametric studies if developed properly as suggested by Ranganathan could become a good indicator for measuring various activities of librarianship both quantitatively and qualitatively. It is therefore imperative on the professional schools of library and information science to incorporate Librametrics as a foundation course. Such a step would help us to have an objective as systematic approach to the field of library and information science.

3. Bibliometrics, Meaning and Definition

The term Bibliometrics was first coined by Prichard (25) in 1969 in preference to existing terminology 'statistical bibliography'. The word "Bibliometrics" has two roots: 'biblio' and 'metrics**.** The term 'biblio' is derived from the combination of Latin and Greek word 'biblion' equivalent to Bylos, meaning book, paper which in turn was derived from the word Bylos, a city of Phenonicia, a noted city for export trade in paper. The word 'metrics', on the other hand, indicates the science of meter, i.e., measurement and is derived either from Latin or Greek word 'metricus' or 'metricos' respectively, each managing measurement. This term was coined for the first time by Alan Pritchard. He

used the term to describe all 'studies which seek to quantify the process of written communication'. Fairthorne (13) also defined it as 'the quantitative treatment of the properties of recorded discourse and behaviour pertaining to it.'

Bibliometrics studies include studies of the growth of the literature in some subject, how much literature is contributed by various individuals, groups, or organisations or countries; how much exists in various languages; how the literature on some subject is scattered (e.g., over documentary types, language journals); and how quickly the literature on some subject becomes out-of-date (Studies of obsolescence). Another important group of bibliometric studies relates to what sources author cite. Day-by-day this study is attaining sophistication and complexity, having national, international and inter disciplinary character. The backbone of Bibliometrics lies in its sound theoretical foundation most effectively laid by some pioneers like Lotka (20), Bradford (3), Zipf (39), Duck J de Sola Price (24), Bookstein(4), Mandelbrot (21), Brookes (5,6,7,8), Garifield (14,15), Egghe (12) and many others, and their techniques are capable of throwing light on various complicated problems faced by information scientists to quantify the process of written communication. The bibliometric tools can be applied to

- Studies related to scattering of articles
- Geographical distribution, language-wise distribution, institution-wise distribution of articles
- Age distribution of documents
- Distribution of citations - subject, author, language, type, journal etc.
- Use of information storage and retrieval
- Application, in the Library Use Studies.
- To study the trends in research, and identifying the growth of literature.
- To identify authorship trends in documents on various subjects.
- to measure the utility of library services
- To evaluate the library collection, etc.

These definitions of librametry and bibliometrics show that Librametry primarily aims at the quantitative analysis of the management of libraries and bibliometrics is limited to recorded knowledge. The publication in both the fields suggests that in Librametry and bibliometrics, one examines the statistical distributions of the processes relating to the utilization of documents, Library staff, and Library users, to establish a theory for the structural aspects of library. Bibliometrics and Librametry may therefore be commonly defined as areas in which one studies ‘information processes and information handling in libraries and information centers by quantitatively analyzing the characteristics and behavior of documents, library staff, and library users.’ (28)

4. Scientometrics, Meaning and Definition

In the 1960s, particularly in Eastern Europe, the term “scientometrics” was used to denote “measurement of informatics process.” The term informatics was then widely used to mean “documentation / information handling activities;” obviously, there is not

much difference between bibliometrics of the West and the scientometrics of the East Europe. The term Scientometrics originated as a Russian term for the application of quantitative methods to the history of science, which studies the quantative aspects of science. It was suggested by Dolrov and Kormoni (11), often used with same meaning as the bibliometrics to mean 'the application of quantitative methods to history of science'. This term came into prominence with the founding of the journal named 'Scientometrics' by T. Braun in 1977, originally published in Hungary and currently from Amsterdam, The Netherlands. Scientometrics used to mean communication process in science including socio-cultural aspects, and appears to be almost synonymous with science of science with more stress on its quantitative aspects. It is also used as a generic term for a system of knowledge, which endeavours to study the scientific (and technological) system by using a variety of approaches within the area of science and technology studies.

Scientometrics is concerned with the quantitative features and characteristics of science and scientific research. Emphasis is placed on investigations in which the development and mechanism of science are studied by statistical mathematical methods. Scientometrics is now considered as a part of the sociology of science and is applied to science policy making. Thus Scientometrics involves studies in:

- Sociology of Science,
- History of science,
- Growth of literature
- Behaviour of of scientists,
- Science indicators, etc.

Derek John de Solla Price (22 January 1922 – 3 September 1983) (24) was credited as the father of scientometrics. He was a physicist, a historian of science, an information scientist and worked as a teacher of applied mathematics at Raffles College (which was to become part of the University of Singapore in 1948). It was there that he formulated his theory on the exponential growth of science, an idea that occurred to him when he noticed the growth in the Philosophical Transactions of the Royal Society between 1665 and 1850. – He had the complete set in his home while Raffles College had its library built. Further, Garfield's contribution (14, 15) to scientometrics is quite significant; his contributions are evolved through his Science Citation Index. Merton also had his view on scientometrics; it is based on Mathew Effect (23).

5. Informetrics, Meaning and Definition

Information, in its most restricted technical sense, is a sequence of symbols that can be interpreted as a message. Information can be recorded as signs, or transmitted as signals. Information is any kind of event that affects the state of a dynamic system. Conceptually, information is the message being conveyed. The English word was apparently derived from the Latin stem (information-) of the nominative (information): this noun is in its turn derived from the verb "informare" (to inform) in the sense of "to give form to the mind", "to discipline", "instruct", "teach":. Metrics means measuring. Informetrics is the

study of quantitative aspects of information. This includes the production, dissemination and use of all forms of information, regardless of its form or origin.

According to Brookes (9) the word 'Informetrics' was first proposed by Otto Nacke of West Germany in 1979. FID constituted a committee with this name and Nacke was its first Chairman. Rajan (26), the next Chairman of the Committee, reformulated the objectives of informetrics as to (1) provide reliable data for research and development, policy-making, planning; (2) to evaluate institutions, projects, articles, products, and other academic activities, and (3) to identify or to develop the techniques to trace the origins and development of concepts. In a short communication on "Informetrics vis-à-vis Bibliometrics: Scope and its Development", Ravichandra Rao (29) mentioned that it is a field wherein the flow of information and behavior of information are analyzed, measured and quantitative relationships are established. It is a scientific field wherein the developments of measurement of impact of information are assessed continuously. Bibliometrics may therefore be treated as synonymous to informetrics having a scope to analyze quantitative characteristics of information. An FID Committee constituted with broadly defined objectives in the provision of research and technical data subsequently gave this name.

Third International conference on Informetrics was held in Bangalore in 1991. 'Informetrics' was used as a generic term to mean "The use and development of a variety of measures to study and analyse several properties of information in general and documents in particular the study of the quantitative aspects of information in any form, not just records or bibliographies. Informetrics is the study of quantitative aspects of information. This includes the production, dissemination and use of all forms of information, regardless of its form or origin. As such, informetrics encompasses the fields of which studies quantitative aspects of science. It is mostly concerned with development of models to explain and identify the various characteristics of the literature. It also discusses scientific productivity, collaborative research, etc.

6. Webometrics, Meaning and Definition

The science of webometrics (also cybermetrics) tries to measure the World Wide Web to get knowledge about the number and types of hyperlinks, structure of the World Wide Web and usage patterns. According to Björneborn and Ingwersen (2004), the definition of webometrics is "the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the Web drawing on bibliometric and Informetrics approaches." The term webometrics was first coined by Almind and Ingwersen (1). A second definition of webometrics has also been introduced, "the study of web-based content with primarily quantitative methods for social science research goals using techniques that are not specific to one field of study" (35), which emphasizes the development of applied methods for use in the wider social sciences. The purpose of this alternative definition was to help publicize appropriate methods outside of the information science discipline rather than to replace the original definition within information science.

Cybermetrics is one of the recently emerged fields in the line of metric studies. It has gained much popularity since the mid-1990 with the advent of Information Technology. As it is mainly concerned with the computer-science-based approaches, it has superseded all other metric studies in this Internet Era. Cybermetrics is proposed as a generic term for "The study of the quantitative aspects of the construction and use of information resources, structures and technologies on the whole Internet drawing on bibliometric and Informetrics approaches." Cybermetrics thus encompasses statistical studies of discussion groups, mailing lists, and other computer – mediated communication on the internet, including the www. Besides covering all computer-mediated communication by using internet applications, this definition of cybermetrics also covers quantitative measures of the internet backbone technology, topology and traffic. The breadth of coverage of cybermetrics implies large overlaps with proliferating computer-science-based approaches in analyses of web contents, link structures, and web usage and web technologies. The Webometrics which studies are the quantitative aspects of the World Wide Web. The Cybermetrics which is similar to webometrics; but broadens its scope; which include namely the electronic resources. Research of all network-based communications by using Informetrics or other quantitative measures is called webometrics.

There has been a revolutionising symbiosis between computer and communication technologies in the west over the past ten years. The invention of World Wide Web (www) a part of the 'INTERNET', which is the mother of networks, has practically webbed the information globally under less than one roof. There has been a shift in navigational approaches from syntactical to semantic (i.e., from sentences to words), as an ever increasing number of research institutes, universities and business organisations are currently providing information about themselves in the form their articles, publications, reports, catalogues and other information resources on the INTERNET in general and the www in particular. This is now becoming the accepted method of disseminating and sharing information resources in hypermedia. Information science research has also changed, with much research to find out, how the new technologies are being used, particularly e-mail and the web. In addition to user studies there have been attempts to extract new kinds of information from the web.

Being a global document network initially developed for scholarly use, it is now inhabited by a diversity of users, and the web constitutes an obvious research area for bibliometrics, scientometrics and informetrics.

7. Bibliometrics, theoretical and philosophical foundation

Bibliometrics is concerned with theoretical and philosophical foundations. Some of the important studies on theoretical and philosophical foundations are in the area of (3, 20, 32, 33, 39,):

- Law of Scattering (Bradford's law)
- Author productivity (Lotka's law)
- Word productivity (law of Least Efforts)

- Success-breeds success phenomenon
- Circulation theory
- Information Product and Processes (IPP) and Duality in IPPs

There are other theoretical studies, especially in the area of circulation theory, citation analysis, sources-items relation, etc. Some of these are discussed in ( ):

- Quantitative Method for Library and Information Science. By I K Ravichandra Rao. Wiley-Eastern. New Delhi. 1983.
- Proceedings of the ISSI Conferences in Scientometrics and Informetrics (held bi-annually since 1987)
- Introduction to Informetrics: Quantitative Methods in Library, Documentation and Information Science. By Leo Egghe and Ronald Rousseau. Elsevier. Amsterdam. 1990
- Power Laws in the Information Production Process: Lotkaian Informetrics. By Leo Egghe. Elsevier. Amsterdam. 2005.

Studies based on citation data have several limitations. They are (34):

- Citation studies are mostly dependent on data from databases such as Web of Science, SCOPUS, etc. which cover only a limited number of journals and its coverage does not remain constant since new journals are added regularly and some are dropped,

- Solutions to problems of eliminating self-citation are cumbersome.

A primary objective of bibliometric research is the development of a general and systematic set of theories from which hypotheses can be generated and tested. Scientometric studies vary from each other from several points of view. They adopt different methods of data collection as well as different techniques. Even there are no universally accepted terminologies. In addition, use of algebraic symbols varies from one study to another. Under these circumstances, it would be difficult to think of "bibliometric or scientometric standards," let alone formulating them (31, 32, 34)

Most of the Scientometrics studies are empirical in nature. In such circumstances, to reproduce the research, one has to repeat the survey and analyze the data right from the beginning. Even then, we may not get the same result! In natural sciences, it is possible and quite common that research may be repeated in laboratories. But in social sciences this is not only difficult, but is not possible. Further, an important cause of the overall unreliability and therefore a cause of invalidity in any basic research in the social sciences are due to space and time factors. It is therefore difficult to reproduce the results of research (31, 32, 34)

The fact, whether we call our research area as librametry or Bibliometrics or Scientometrics or Informetrics most of the topics we deal with are (31, 32, 34):

- Quantitative aspects of library and information studies, especially use and user studies, growth of collection, age distribution of documents, circulation statistics, etc.
- Journal productivity (by coverage, by use, by citation, cost-effectiveness measures, impact factor, h-index, sources of citations, immediacy of citations, age of sources cited, coverage in databases, etc.)
- Measures of productivity or author productivity, including studies related to multiple authorship (number of publications. cost-effectiveness measures, impact factor, h-index, reprints request, photo copies made, sources of citations, immediacy of citations, number of reviews, adoption rates (text books), etc.)
- Obsolescence and growth of literature
- Co-citation, bibliographic coupling, co-word analysis, rank distribution of words, etc.
- Quantitative analyses of science (science indicators -- country-wise, language-wise, subject-wise, etc.)
- Identifying relationships among various disciplines, structure of subjects, etc.
- Evaluation of scientific research (by institutions, by individuals, by countries, etc.)

Acceptance of a single term to define a subject and acceptance of its scope are necessary for any scientist. Otherwise, it is difficult to include it in a syllabus. It is also difficult to get research grant from different agencies. It helps us in identifying the research groups especially at national and international levels. At present, the term 'scientometrics' is used as synonym to both 'bibliometrics' and 'informetrics'.

In order to encourage communication and exchange of professional information in the field of scientometrics and informetrics, a Society, called 'the International Society for Informetrics and Scientometrics' (ISSI) was founded in 1993. It is an association of professionals active in the emerging interdisciplinary fields of informetrics, bibliometrics / scientometrics, technometrics and webometrics. Among its membership are scientists from over 30 countries representing all five continents. The Articles of Association state that the aim of ISSI is the advancement of the theory, methods and explanations through the following two main streams:

i. Quantitative Studies related to

   - Scientific, technological and other scholarly substantive information.
   - Science of science and technology, social sciences, arts and humanities'.
   - Generation, diffusion and use of information.
   - Information systems, including libraries, archives and databases

ii. Mathematical, Statistical, and Computational Modelling and Analysis of Information Processes.

The Society was founded at the International Conference on Bibliometrics, Informetrics and Scientometrics held in Berlin, 11-15 September in 1993. This conference was the fourth of a series of prominent biennial conference that subsequently have been held

under the auspices of the Society. The first three earlier conferences were held in Diepenbeek, Belgium (1987, Chairman: Dr. Leo Egghe), London, Ontario, Canada (1989, Chairman: Dr J M Tague) and in Bangalore, India (1991, Chairman: Dr I K Raviachandra Rao). The Society was incorporated with formal **Articles of Association** in 1994 in the Netherlands (Utrecht.) Dr Hildrun Kretschmer was elected its first President (32)

With Berlin as its virtual center COLLNET was set up on January 1st, 2000, under the leadership of Hildrun Kretschmer, in her capacity as coordinator. The network is to comprise the prominent scientists, who work at present mostly in the field of quantitative science studies, coming from 15 countries of America, Asia, Australia and Europe. The intention is to work together in co-operation both on theoretical and applied aspects. COLLNET conducts every year International conference in scientometrics.

There are three important journals in scientometrics -- Journal of Scientometrics, Journal of Informetrics and COLLNET Journal of scientometrics and Information Managements. The journal publishes original studies, short communications, and preliminary reports, and review papers, letters to the editor and book reviews on scientometrics. Due to its fully interdisciplinary character, the journal is indispensable to research workers and research administrators. It provides valuable assistance to librarians and document lists in central scientific agencies, ministries, research institutes and laboratories.

On 27th March 2011at Tumkur in India**,** Institute of Scientometrics was founded by Prof S L Sangam, with an objective to promote research in Scientometrics. It is a virtual and non-profit organization. which has been set up by. Much of the research works in this area were carried out in National Institute of Science Communication and Information Resources (NISCAIR, a wing of CSIR) (formerly known as INSDOC), National Institute of Science Technology and Development Studies (NISTADS, a wing of CSIR) and Documentation Research and Training Centre of the Indian Statistical Institute. In recent times, a number of research works were published from Department of Library and Information Science of many Universities in India. In 2009, UGC recognized Department of Library and Information Studied of the Karnataka University a Special Assistant Program (SAP) in scientometrics.

8. Summary

From the point of view of the library and information centres, it is essential to evaluate and study the research trends from time to time, so that it would be quite easy for designing, organising and managing the various information services and products to cater to the information needs of researchers effectively, expeditiously and exhaustively. The field of cybermetrics exceeds the boundaries of bibliometrics, because some activities in cyberspace normally are not recorded, but communicated synchronously as in chat rooms. Cybermetric studies of such activities still fit in the generic field of Informetrics as the study of the quantitative aspects of information “in any form” and ‘in any social group” as stated by Tague-Sutcliffe (1992). The inclusion of webometrics expands the field of bibliometrics, as webometrics inevitably will contribute to further

methodological developments of web-specific approaches. As ideas rooted in bibliometrics, scientometrics and Informetrics contributed to the emergence of webometrics, ideas in webometrics might also contribute to the development of these all embracing fields.

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