CHAPTER – I

INTRODUCTION

1.0 BACKGROUND

1.0.1 Bibliometrics

Bibliometrics is a quantitative study of various aspects of literature on a topic and is used to identify the pattern of publication, authorship and secondary journal coverage with the objective of getting an insight into the dynamics of growth of knowledge in the areas under consideration. This consequently leads to the better organization of Information resources which is essential for its most effective and efficient use. Bibliometrics today has attained sophistication and complexity having national, international, and interdisciplinary character.¹ It is a tool by which the state of science and technology can be observed through the traces of communication in the science-technology system, most notably the published documents which comprise books, monographs, reports, theses, papers in serials and periodicals, and nowadays also e-books and e-journals as well as – in the broadest sense – the WEB². Researchers in several disciplines have been interested in publication productivity as a means of assessing scholarly excellence of individual researchers within a field.³–⁷ Publication productivity, as measured by the number of papers, has also been regarded as one of the main indicators of reputation of institutions in general⁸–¹¹ and academic institutions in particular.¹²–¹³
There is a growing awareness that the advantages of basing research, and subsequent political choices, on criteria that lend themselves for more quantitative evaluation. The researchers of Library and Information Science extensively use bibliometrics as a tool to identify the pattern of publication, authorship and secondary journal coverage with the objective of getting an insight into the dynamics of growth of knowledge in the areas under consideration. This consequently leads to better organization of information resources which is essential for its most effective and efficient use.

1.0.1.1 Origin of the term ‘Bibliometrics’

The terms ‘bibliometrics’ and ‘scientometrics’ were almost simultaneously introduced by Pritchard and by Nalimov and Mulchenko in 1969. While Pritchard explained the term bibliometrics as “the application of mathematical and statistical methods to books and other media of communication”, Nalimov and Mulchenko defined scientometrics as “the application of those quantitative methods which are dealing with the analysis of science viewed as an information process”. According to these interpretations the speciality scientometrics is restricted to the measurement of science communication, whereas bibliometrics is designed to deal with more general information processes. The anyhow fuzzy borderlines between the two specialities almost vanished during the last three decades, and nowadays both terms are used almost as synonyms. Instead, the field informetrics took the place of the originally broader speciality bibliometrics. The term informetrics was adopted by VINITI and stands for a more general subfield of information science dealing with mathematical and statistical analysis of
communication processes in science. In contrast to the original definition of bibliometrics, informetrics also deals with electronic media and thus includes topics such as the statistical analysis of the (scientific) text and hypertext systems, library circulations, information measures in electronic libraries, models for Information Production Processes and quantitative aspects of information retrieval as well.

1.0.1.2 Definitions of Bibliometrics

The term ‘bibliometrics’ has been defined differently by the people engaged in the study of information. Some of the well-known definitions are provided below chronologically:

The term ‘Bibliometrics’ was coined by two words ‘biblio’ and ‘metrics’. The word ‘biblio’ is derived from combination of a Latin and Greek word ‘biblion’ means book, paper. On the other hand the word ‘metrics’ indicates the science of metre i.e. measurement.

Merton and Garfield\textsuperscript{16} defined it as the “field of inquiry given over to the quantitative analysis of science and scientific field”.

Pritchard\textsuperscript{17} defined it as “the application of mathematical and statistical methods to books and other media of communication”. He also explained it as “the metrology of the information transfer process and its purpose is analysis and control of the process”.

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Fairthrone\textsuperscript{18} defined the term as, “the quantitative treatment of the properties of recorded discourse and behaviour pertaining to it”.

The British Standard Glossary of Documentation of Terms\textsuperscript{19} explained bibliometrics as, “the study of the use of documents and patterns of publication in which mathematical and statistical methods have been applied”, which is basically similar to Pritchard’s definition.

Hawkins\textsuperscript{20} interpreted bibliometrics as “quantitative analysis of the bibliographic features of a body of literature.” Nicholas and Ritchie\textsuperscript{21} in their book entitled literature on bibliometrics stated that bibliometrics “provides information about the structure of knowledge and how it is communicated”

Potter\textsuperscript{22}, Editor of \textit{Library Trends} defined the term as “the study and measurement of the publication patterns of all forms of written communication and their authors”.

Morales\textsuperscript{23} uses the term informetrics to cover almost all the aspects of bibliometrics and librametrics. According to Broadus\textsuperscript{24} “Bibliometrics is the quantitative study of physical published units or bibliographic units or of surrogates of either.”

Sengupta\textsuperscript{25} viewed bibliometrics as “organisation, classification, and quantitative evaluation of publication patterns of all macro and micro communications along with their authorship by mathematical and statistical calculus.”
1.0.1.3 The Pioneers of Bibliometrics

Lotka

The statistical analysis of scientific literature began almost 50 years before the term ‘bibliometrics’ was coined. In 1926, Alfred J. Lotka\(^26\) published his pioneering study on the frequency distribution of scientific productivity determined from a decennial index (1907-1916) of Chemical Abstracts. Lotka concluded that:

“the number (of authors) making \(n\) contributions is about \(1/n^2\) of those making one; and the proportion of all contributors, that makes a single contribution, is about 60 per cent.”

This result can be considered as a rule of thumb even today, 75 years after its publication.

Gross and Gross

At almost the same time, in 1927, Gross and Gross\(^27\) published their citation-based study in order to aid the decision which chemistry periodicals should be purchased by small college libraries. In particular, they examined 3633 citations from the 1926 volume of the Journal of the American Chemical Society. This study is considered the first citation analysis, although it is not a citation analysis in the sense of present-day bibliometrics.
**Bradford**

Eight years after Lotka’s article appeared, *Bradford (1934)*\(^{28}\) published his study on the frequency distribution of papers over journals. He found that:

“if scientific journals are arranged in order of decreasing productivity on a given subject, they may be divided into a nucleus of journals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the numbers of periodicals in the nucleus and the succeeding zones will be as 1: b : b^2 ...”

**Zipf**

*Zipf (1949)*\(^{29}\) formulated an interesting law in bibliometrics and quantitative linguistics that he derived from the study of word frequency in a text. According to *Zipf rf = C*, where \(r\) is the rank of a word, \(f\) is the frequency of occurrence of the word and \(C\) is a constant that depends on the text being analysed. It can be considered a generalisation of the laws by Lotka and Bradford. He formulated the following underlying principle of his law:

"The Principle of Least Effort means... that a person...will strive to solve his problems in such a way as to minimize the total work that he must expend in solving both his immediate problems and his probable future problems...."
1.0.1.4 The Three Components of Present-day Bibliometrics and Their Applications

Present-day bibliometric research is aimed at the following three main target-groups that clearly determine topics and sub-areas of contemporary bibliometrics:

❖ Bibliometrics for Bibliometricians (Methodology)

This is the domain of basic bibliometric research and is traditionally funded by the usual grants. Methodological research is conducted mainly in this domain.

❖ Bibliometrics for Scientific Disciplines (Scientific information)

The researchers in scientific disciplines form the bigger, but also the most diverse interest-group in bibliometrics. Due to their primary scientific orientation, their interests are strongly related to their speciality. This domain may be considered an extension of science information by metric means. Here we also find joint borderland with quantitative research in information retrieval.

❖ Bibliometrics for Science Policy and Management

This is the domain of research evaluation, at present the most important topic in the field. Here the national, regional, and institutional structures of science and their comparative presentation are in the foreground.
In light of the above, Figure 1.1 presents diagrammatically how bibliometrics/scientometrics is linked with related fields and application services.

![Figure 1.1 Links of bibliometrics with related fields and application services](Source: Glänzel, 2003)

1.0.2 Information Age and Knowledge Age

Information is important for any individual to survive in the information society. It has been a fact irrespective of time. It is evident from the fact that the present era as the ‘Information Age’. Information Age is a term applied to the period where movement of information became faster than physical movement, more narrowly applied to the late 20th century and early 21st century post 1970, during which, the information became easily accessible through publications and through the manipulation of information by computers and computer networks. It is often used in conjunction with the term post-industrial society. The availability of information easily has been a boon to the researchers. It acts as catalyst to their
research. Also, the availability of information has resulted in the development and growth of knowledge.

1.1 INTRODUCTION

Bibliometrics method has been employed to conduct the research as it is especially useful when studying a research intensive subject field such as Biotechnology, Biochemistry, Microbiology, where the industry is likely to have close relations with public research organizations (e.g. universities).\textsuperscript{30} It is the quantitative evaluation of scientific literature. Scientific productivity is influenced by a large number of factors, including individual characteristics such as age, gender, psychological traits, and educational background, as well as structural features like funding, institutional context, and the organization of the actual research\textsuperscript{31-33}. Bibliometric analysis is used in the science and technology policy arena to determine the knowledge outputs of the national systems of innovation.

1.2 STATEMENT OF THE PROBLEM

As mentioned earlier, bibliometrics is concerned with analysis of the characteristics of published literature including: studies of dispersion of literature on various topics; statistical analyses of content types, references, etc.; and citation and co-citation studies within and across particular disciplines. In academic and scientific work, research publication is the chief means of communicating research, a primary means of recognition and reward, and hence a central social process in the Universities.
Research is the primary function of any educational institution. Qualitative research provides a pedestal to any university. India has prospered as far as the number of educational institutions is concerned. Starting with 28 universities in 1950–51, it has grown to 354 today registering manifold increase. National Institutes of Technology in India are the premier institutions in the country next to Indian Institute of Technology. The Government of India intends to increase the number of NITs and IITs in the country to produce as many qualitative engineers and technologists as possible which will ultimately influence the development of nation in various aspects. Growth in numbers is expected to cater to the increasing number of students. Research in an educational institution speaks of the fertile minds and an environment of intellectual interaction in the institution which will ultimately add credentials to the researchers as well as the institutions concerned. It is a well known fact that scientific literature is expanding very fast. It is estimated that it doubles every five years. Immediately, it comes to mind to assess the performance of faculties in National Institutes of Technology in India to what extent they have contributed to engineering and technology literature.

In view of the above, the researcher intended to undertake as it was observed that there was no such study in the literature about the publication productivity of faculties in National Institutes of Technology in India. The research topic of the study was on “Evaluation of Research Performance by Faculties in National Institutes of Technology in India: A Scientometric Analysis”. The study aims to ascertain the growth of literature, sources of publications, identification of prolific authors, institutions, identification of core
journals, etc. in the field of engineering and technology by faculties in National Institutes of Technology in India for the period 2001 – 2010. Applicability of Lotka’s law and Bradford’s law has also been tested.

1.3 OPERATIONAL TERMINOLOGY

The following concepts have operationally been defined for the purpose of the present study.

*Relative Growth Rate*

Relative growth rate is a tool to measure the pattern of information growth when the growth rate of a function is always proportional to the function's current size. Such growth is said to follow an exponential law. This implies for any exponentially growing quantity, the larger the quantity gets, the faster it grows.

*Doubling Time*

The doubling time is the period of time required for a quantity to double in size. It can be applied to growth of literature, population, inflation, and many other things which tend to grow over time. When the relative growth rate is constant, the quantity undergoes exponential growth and has a constant doubling time or period which can be calculated directly from the growth rate. This time can be derived by dividing the natural logarithm of 2 by the exponent of growth.
Authorship Pattern

It denotes the percentage concentration of single authored papers in relation to multi-authored papers.

Author Productivity

The productivity of scientific researchers which is normally referred to as scientific productivity is measured in terms of their scientific output which is published through different forms viz. papers, reports, books and technical output. These measures of scientific productivity have been generally accepted and used since the beginning of the twentieth century. It examines the prevailing trend in carrying out the research process in science in terms of the extent to which the research performance is concentrated by single authors.

Degree of Collaboration

It is an indicator used for measuring the extent and strength of collaboration among the researchers in terms of their research contributions. It explains the prevalence of proportion of single authored papers and multi-authored papers in research output.
REFERENCES


