Introduction

The word "science" is older than its modern use. The word has become a short-form for "natural science". It is a recent development that society has become the object of an organized body of knowledge which can be standardized and taught objectively, while following its own rules and methodology. Social science is, in its broadest sense, the study of society and the manner in which people behave and influence the world around us. Some social scientists argue that no single definition can cover such a broad range of academic disciplines. Instead they simply define the social sciences by listing the subjects they include. It was Dr. S.R. Ranganathan\(^1\), the Father of Indian Librarianship who defined Social Sciences as an agglomerated subject consisting of Religion, Philosophy, Psychology, Education, Geography, History, Political Science, Economics, Sociology and Law.

History of Social science

The history of the social sciences begins in the roots of ancient philosophy. In Ancient history, there was no difference between mathematics and the study of history, poetry or politics. This unity of science formed according to a deductive reasoning from axioms created a scientific framework. The Age of Enlightenment saw a revolution within natural philosophy, changing the basic

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framework by which individuals understood what was "scientific". In some quarters, the accelerating trend of mathematical studies presumed a reality independent of the observer and worked by its own rules. Social sciences came forth from the moral philosophy of the time and was influenced by the Age of Revolutions, such as the Industrial revolution and the French revolution.

The beginnings of the social sciences in the 18th century are reflected in various grand encyclopedia of Diderot, with articles from Rousseau and other pioneers. The growth of the social sciences is also reflected in other specialized encyclopedias. The modern period saw "social science" first used as a distinct conceptual field. Social science was influenced by positivism, focusing on knowledge based on actual positive sense experience and avoiding the negative; metaphysical speculation was avoided. Auguste Comte used the term "science social" to describe the field, taken from the ideas of Charles Fourier; Comte also referred to the field as social physics.

Following this period, there were five paths of development that sprang forth in the Social Sciences, influenced by Comte on other fields. One of the path that was taken was the rise of social research. Large statistical surveys were undertaken in various parts of the United States and Europe. Another path undertaken was initiated by Émile Durkheim, studying "social facts", and Vilfredo Pareto, opening metatheoretical ideas and individual theories. A third path developed, arising from the methodological dichotomy present, in which the social phenomena was identified with and understood; this was championed by figures such as Max Weber. The fourth path taken, based in economics, was developed and furthered economic knowledge as a hard science. The last path was the correlation of knowledge and social values;
the antipositivism and verstehen sociology of Max Weber firmly demanded on this distinction. In this path, theory (description) and prescription were non-overlapping formal discussions of a subject.

Around the turn of the 20th century, Enlightenment philosophy was challenged in various quarters. After the use of classical theories since the end of the scientific revolution, various fields substituted mathematics studies for experimental studies and examining equations to build a theoretical structure. The development of social science subfields became very quantitative in methodology. The interdisciplinary and cross-disciplinary nature of scientific inquiry into human behavior, social and environmental factors affecting it, made many of the natural sciences interested in some aspects of social science methodology. Examples of boundary blurring include emerging disciplines like social research of medicine, sociobiology, neuropsychology, bioeconomics and the history and sociology of science. Increasingly, quantitative research and qualitative methods are being integrated in the study of human action and its implications and consequences. In the first half of the 20th century, statistics became a free-standing discipline of applied mathematics. Statistical methods were used confidently.

In the contemporary period, Karl Popper and Talcott Parsons influenced the furtherance of the social sciences. Researchers continue to search for a unified consensus on what methodology might have the power and refinement to connect a proposed "grand theory" with the various midrange theories which, with considerable success, continue to provide usable frameworks for massive, growing data banks; for more, see consilience. At present though, the various realms of social science progress in a myriad of ways, increasing the overall
knowledge of society. The social sciences will for the foreseeable future be composed of different zones in the research of, and sometime distinct in approach toward, the field.

**The scope of Social Sciences**

The Social science has a wide scope. The social sciences comprise academic disciplines concerned with the study of the social life of human groups, animals and individuals including anthropology, archeology, communication studies, cultural studies, demography, economics, human geography, history, linguistics, media studies, political science, psychology, social work and sociology.

Mathematics, and study of history, poetry or politics had no difference in the past. With the development of mathematical proof the people perceived the difference between scientific disciplines and others. Aristotle studied poetry and planetary motion at the same time with the same methods, and Plato mixed geometrical proofs with his demonstration on the state of intrinsic knowledge. The study of social sciences is considered as vital for the future of the society throughout the world and provides many degrees in the respective fields.

The Public Administration, one of the main branches of political science, can be described as the development, implementation and study of branches of government policy. The non-government organizations (NGO’s) are working for the betterment of the society throughout the
The Social Sciences are sometimes criticized as being less scientific than the natural sciences in that they are seen as being less rigorous or empirical in their methods. This claim has been made in the so-called science wars and is most commonly made when comparing social sciences to fields such as physics, chemistry or biology in which corroboration of the hypothesis is far more incisive with regard to data observed from specifically designed experiments. Social sciences can thus be deemed to be largely observational, in that explanations for cause-effect relationships are largely subjective. A limited degree of freedom is available in designing the factor setting for a particular observational study. Social scientists however, argue against such claims by pointing to the use of a rich variety of scientific processes, mathematical proofs, and other methods in their professional literature.

The modern world is making progress by leaps and bounds and the social sciences have its vital role in the development of the world. The following main branches of social science deal with the main issues facing by the modern world. The human being is surrounded by the unlimited problems and as a human being one needs to solve them desperately.

Social work is concerned with social problems, their causes, their solutions and their human impacts. Social workers work with individuals, families, groups, organizations and communities. Social Work is the
profession committed to the pursuit of social justice, to the enhancement of the quality of life, and to the development of the full potential of each individual, group and community in society.

**Social work** is unique in that it seeks to simultaneously navigate across and within micro and macro systems in order to sufficiently address and resolve social issues at every level. Social work incorporates and utilizes all of the social sciences as a means to improve the human condition.

Following are the main branches of social sciences that deal with the modern problems of the modern world of 21st century.

**Economics** is a social science that seeks to analyze and describe the production, distribution, and consumption of wealth. The classic brief definition of economics, set out by Robins in 1932, is "the science which studies human behavior as a relation between scarce means having alternative uses." Without scarcity and alternative uses, there is no economic problem.

**Education** encompasses teaching and learning specific skills, and also something less tangible but more profound: the imparting of knowledge positive judgment and well-developed wisdom. Education has as one of its fundamental aspects the imparting of culture from generation to generation. It draws on many disciplines such as psychology,
philosophy, computer science, linguistics, neuroscience, sociology and anthropology.

**Geography** as a discipline can be split broadly into two main subfields: human geography and physical geography. The former focuses largely on the built environment and how space is created, viewed and managed by humans as well as the influence humans have on the space they occupy. The latter examines the natural environment and how the climate, vegetation & life, soil, water and land form are produced and interact. As a result of the two subfields using different approaches a third field has emerged, which is environmental geography.

**History** is the continuous, systematic narrative and research of past events as relating to the human species; as well as the study of all events in time, in relation to humanity. History can be seen as the sum total of many things taken together and the spectrum of events occurring in action following in order leading from the past to the present and into the future. The historical method comprises the techniques and guidelines by which historians use primary sources and other evidence to research and then to write history.

**Law** in common place, means a rule, which (unlike a rule of ethics) is capable of enforcement through institutions. Law is not always enforceable, especially in the international relations context. It has been defined as a "system of rules", as an "interpretive concept" to achieve
justice, as an "authority" to mediate people's interests, and even as "the command of a sovereign, backed by the threat of a sanction". However one likes to think of law, it is a completely central social institution. Legal policy incorporates the practical manifestation of thinking from almost every social sciences and humanity.

**Linguistics** investigates the cognitive and social aspects of human language. The field is divided into areas that focus on aspects of the linguistic signal, such as syntax (the study of the rules that govern the structure of sentences), semantics (the study of meaning), phonetics (the study of speech sounds) and phonology (the study of the abstract sound system of a particular language); however, work in areas like evolutionary linguistics evolutionary linguistics (the study of the origins and evolution of language) and psycholinguistics (the study of psychological factors in human language) cut across these divisions.

**Political science** is an academic and research disciplines that deals with the theory and practice of politics and the description and analysis of political systems and political behavior. Fields and subfields of political science include political economy, political theory and philosophy, civics and comparative politics, theory of direct democracy, apolitical governance, participatory direct democracy, national systems, cross-national political analysis, political development, international relations, foreign policy, international law, politics, public administration,
administrative behavior, public law, judicial behavior, and public policy. Political science also studies power in international relations and the theory of Great powers and Superpowers.

**Psychology** is an academic and applied field involving the study of behavior and mental processes. Psychology also refers to the application of such knowledge to various spheres of human activity, including problems of individuals' daily lives and the treatment of mental illness.

**Sociology** is the study of society and human social action. It generally concerns itself with the social rules and processes that bind and separate people not only as individuals, but as members of associations, groups, communities, and institutions, and includes the examination of the organization and development of human social life. The sociological field of interest ranges from the analysis of short contacts between anonymous individuals on the street to the study of global social processes. Most sociologists work in one or more subfields.

There are so many other fields that enhance the scope of social sciences in the century of machines.

*How social science shapes our lives*

Social scientists influence our lives usually without us being aware they are doing so. For example:
the role of governments in an increasingly market-based society has been determined by famous thinkers such as John Maynard Keynes and Karl Popper

- it was an economist who came up with the idea of the National Health Service
- the payment of billions of pounds of state benefits for the needy has been influenced by the work of social scientists.

Social science research findings continue to provide invaluable information whether you are a parent, a local councilor, a police officer, or a business executive.

**Social Research**

The origin of the survey can be traced back at least early as the Domesday Book in 1086, whilst some scholars pinpoint the origin of demography to 1663 with the publication of John Graunt's Natural and Political Observations upon the Bills of Mortality Social research began most intentionally, however, with the positivist philosophy of science in the 19th century.

In contemporary usage, "social research" is a relatively autonomous term, encompassing the work of practitioners from various disciplines which share in its aims and methods. Social scientists employ a range of methods in order to analyze a vast breadth of social phenomena; from census survey data derived from millions of individuals, to the in-depth analysis of a single agent's social experiences; from monitoring what is happening on contemporary streets, to the investigation of ancient historical documents. The methods originally rooted in
classical sociology and statistical mathematics have formed the basis for research in other disciplines, such as political science, media studies, and market research.

Social research methods may be divided into two broad schools:

- Quantitative designs approach social phenomena through quantifiable evidence, and often rely on statistical analysis of many cases (or across intentionally designed treatments in an experiment) to create valid and reliable general claims.

- Qualitative designs emphasize understanding of social phenomena through direct observation, communication with participants, or analysis of texts, and may stress contextual and subjective accuracy over generality

Social scientists will commonly combine quantitative and qualitative approaches as part of a multi-strategy design. Questionnaires, field-based data collection, archival database information and laboratory-based data collections are some of the measurement techniques used. It is noted the importance of measurement and analysis, focusing on the (difficult to achieve) goal of objective research or statistical hypothesis testing. A mathematical model uses mathematical language to describe a system. The process of developing a mathematical model is termed 'mathematical modeling' (also modeling). Eykhoff (1974) defined a mathematical model as 'a representation of the essential aspects of an existing system (or a system to be constructed) which presents knowledge of that system in usable form'. Mathematical models can take many forms, including but not limited to dynamical systems, statistical
models, differential equations, or game theoretic models.

These and other types of models can overlap, with a given model involving a variety of abstract structures. The system is a set of interacting or interdependent entities, real or abstract, forming an integrated whole. The concept of an integrated whole can also be stated in terms of a system embodying a set of relationships which are differentiated from relationships of the set to other elements, and from relationships between an element of the set and elements not a part of the relational regime. Dynamical system modeled as a mathematical formalization has fixed "rule" which describes the time dependence of a point's position in its ambient space. Small changes in the state of the system correspond to small changes in the numbers. The evolution rule of the dynamical system is a fixed rule that describes what future states follow from the current state. The rule is deterministic: for a given time interval only one future state follows from the current state.

Social Theory

Social scientists emphasize the subjective nature of research. They share social theory perspectives that include various types of the following:

- Critical theory is the examination and critique of society and culture, drawing from knowledge across social sciences and humanities disciplines.
- Dialectical materialism is the philosophy of Karl Marx, which he formulated by taking the dialectic of Hegel and joining it to the Materialism of Feuerbach.
- Feminist theory is the extension of feminism into theoretical, or philosophical discourse, it aims to understand the nature of gender inequality.

- Marxist theories, such as revolutionary theory and class theory, cover work in philosophy which is strongly influenced by Karl Marx's materialist approach to theory or which is written by Marxists.

- Phonetic social science is a theory and methodology for doing social science focusing on ethics and political power, based on a contemporary interpretation of Aristotelian phronesis.

- Post-colonial theory is a reaction to the cultural legacy of colonialism.

- Postmodernism refers to a point of departure for works of literature, drama, architecture, cinema, and design, as well as in marketing and business and in the interpretation of history, law, culture and religion in the late 20th century.

- Rational choice theory is a framework for understanding and often formally modeling social and economic behavior.

- Social constructionism is a knowledge that considers how social phenomena develop in social contexts.

- Structuralism is an approach to the human sciences that attempts to analyze a specific field (for instance, mythology) as a complex system of interrelated parts.

- Structural functionalism is a sociological paradigm which addresses what social functions various elements of the social system perform in regard to the entire system.

Other fringe social scientists delve in alternative nature of research.
These writers share social theory perspectives that include various types of the following:

- Intellectual criticalism describes a sentiment of critique towards, or evaluation of, intellectuals and intellectual pursuits.
- Scientific criticalism is a position critical of science and the scientific method.

The growth and development of any subject depends upon the quantum of literature available on that subject. Bibliometrics is an important tool to quantify the literature on a subject.

**What is Bibliometrics**

Metrics is a measurement of particular events. Bibliometrics is the statistical analysis of texts and information. In a research environment a common example of bibliometrics is the use of citation analysis to determine how many times a researcher’s work has been cited in key literature. The term was coined by Alan Pritchard in a paper published in 1969, titled Statistical Bibliography or Bibliometrics. He defined the term as "the application of mathematics and statistical methods to books and other media of communication". Bibliometrics is a set of methods to quantitatively analyze scientific and technological literature. Citation analysis and content analysis are commonly used bibliometric methods. While bibliometric methods are most often used in the field of library and information science, bibliometrics have wide applications in other areas. In fact, many research fields use bibliometric methods to explore the impact of their field, the impact of a set of researchers, or the impact of a particular paper.
Bibliometrics are now used in quantitative research assessment exercises of academic output which is starting to threaten practice based research.

Hence Bibliometrics is a set of methods to quantitatively analyze scientific and technological literature. Originally, work was limited to collecting data on numbers of scientific articles and publications, classified by authors and/or by institutions, fields of science, country, etc., in order to construct simple “productivity” indicators for academic research. Subsequently, more sophisticated and multidimensional techniques based on citations in articles (and more recently also in patents) were developed. The resulting citation indexes and co-citation analyses are used both to obtain more sensitive measures of research quality and to trace the development of fields of science and of networks.

Bibliometrics – Origin and Development

Bibliometrics has become a standard tool of science policy and research management during the last few decades. All significant compilations of science indicators heavily rely on publication and citation statistics subjected to more sophisticated bibliometric techniques. Bibliometrics attempt to make sense of the literature output world through measurement. It specifically focuses on the sub-domain of information to supply a "series of techniques that seek to quantify the process of written communication"\(^2\).

Today, bibliometrics is one of the truly interdisciplinary research fields to extend to almost all scientific areas. Bibliometric studies need a subject field to apply on inevitably.

Bibliometrics -- Historical Perspective

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 of 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 specialties 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.

According to Gorkova\(^3\), the term informetrics was adopted by VINITI and stands for a more general subfield of information science dealing with mathematical, 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.

The Pioneers of Bibliometrics

The statistical analysis of scientific literature began almost 50 years before the term “bibliometrics” was coined. A subject was born to be named later. In 1926, Alfred J. Lotka 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/n² 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, 80 years after its publication.

At almost the same time, in 1927, Gross and Gross\(^5\) published their citation-based study in order to aid the decision which chemistry periodicals should best 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 to be the first citation analysis, although it is not a citation analysis in the sense of present-day bibliometrics.

Eight years after Lotka’s article appeared, Bradford (1934) 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 (1949) 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 to be a generalization of the laws by Lotka and Bradford. Zipf, formulated the following underlying principle of his law although he has never shown how this principle applies to his equation. "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…." (Zipf, 1949).

Cole and Eale’s⁶ “Study on the “The history of comparative Anatomy Part – I A : Statistical analysis” is considered to be the first bibliometric study in 1917, in which the expression ‘statistical analysis’ has been used in the literature.

Hulme⁷ was the first to use the expression ‘statistical bibliography’ in 1923 and later it was used by many others. The study of Gross and Gross⁸ is considered to be the third study in the field based on citations. Allen Pritchard suggested the word ‘Bibliometrics’ in 1969 in preference to statistical

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bibliography. The terms ‘Librametry’, ‘Scientometrics’ and ‘Informetrics’ are also in use in the literature with different scope though basically remain identical. Bibliometrics is analogous to Ranganathans’ ‘Librametry’, in the context that Library related studies began to apply statistical principles.

Kopelock\textsuperscript{9} points out that during the period 1969-1977; altogether 52 different terms have been used to describe bibliometrics before getting established ultimately.

**Scope of Bibliometrics**

Bibliometrics is the technical name for a range of analytical methods using Information-quo-information found organized in bibliographic description of reading materials such as books, periodical articles, reports, patents, software, designs, prototypes, and blueprints to develop descriptive statistics, multidimensional analyses, and graphical representations of the output of science’. Bibliometrics is often used to clarify and assist in the analysis and formulation of science policy by

- highlighting the networks of players or subjects that make up scientific research;
- providing strategic analysis of the relative position of research performers;
- sketching profiles of the activities and performance of individual centers;

- graphically presenting studies of strategic or innovative subjects.
- publication counts, involving counting of scientific publications published by a researcher or a research group;
- citation counts, involving identifying the number of times a specific article is cited in other scientific journal publications; these measures are considered to address questions of quality, influence, and the transfer of knowledge;
- co-citation analysis, identifying pairs or groups of articles that are cited together in other articles or publications; from these pairs or groups of articles a 'cognitive structure' can be derived, providing information on the direction and flow of scientific thought;
- co-word analysis, involving assigning keywords to a paper or article by a professional reader; papers which have the same keywords and sets of words are linked to each other via a clustering technique;
- scientific mapping, involving developing a visual model or 'map' of the realm of scientific fields representing the structure of literature output of particular scientific fields."

Bibliometric studies fall mainly into two broad groups -- those describing the characteristics or features of literature (descriptive studies), and those examining the relationships formed between components of
literature (behavioral studies, sometimes referred to as citations studies, but not restricted to them).

The descriptive studies are probably the most easily understood, and can be thought of as resembling in many ways the population census. Both have to provide comprehensive and accurate data about rapidly changing population in one case of people and in other of literature. Literature descriptions are assembled from the bibliographic study those that provide data on the condition or character of the literature as a whole. There is, therefore, an important distinction between bibliographic and bibliometric data.

**Descriptive Studies**

`Literature descriptions concern themselves with the following features or characteristics of documents.

1. Bodies responsible for the production and transmission of the information
2. Form of transmission (eg. journal, monograph),
3. Medium of communication (eg. article, letter),
4. Nature of information conveyed subject and language characteristics
5. Timing and frequency with which information is conveyed

Descriptive studies are not only concerned with representing
faithfully the features present in the current literature, but also they are interested in the condition of past literature, particularly in areas where past literature constitutes an important part of current research scholarship or interest.

**Behavioural Studies**

All documents rely on information contained within previously published documents. Inside the literature there exists, in fact, a web of relationships. By exploring the full bibliographic ramifications of these relationships (by matching for instance, the bibliographic description of the most publication with that of the cited publications), the nature and strength of each relationship can be determined.

Information Scientists divide Bibliometrics into two as follows:

1. Productivity Count (Descriptive)
   a. Geographic (Countries)
   b. Time periods (Eras)
   c. Discipline (Subjects)

2. Literature usage counts (Evaluative)
   a. Reference
   b. Citation

Fundamentally, both categories of divisions are similar and do not
contradict with each other. Metrics are rapidly forming the methodology or a system of methodologies, which may put them as candidates to be considered as forming a new scientific branch. Works of many pioneers such as Price, Garfield, Small, and their contributions played vital role in formulating the requirements of the methodology.

**Bibliometric Laws**

The three fundamental laws which laid the foundation to bibliometrics are

a. Bradford's law of scattering of scientific papers

b. Zipf's law of word occurrence

c. Lotka's inverse square law of scientific productivity

**Bradford's Law of Scattering**

Bradford revealed a pattern of how literature in a subject is distributed in journals. “If scientific journals are arranged in order of decreasing productivity of articles on a given subject, they may be divided into a nucleus of periodicals more particularly devoted to the subject and several other groups of zones as the nucleus.”

When a concept is ordered, the possibility of statistical application lends to inferences and formulae.

**Bradford Formula**

\[ F = \frac{N}{K} \]

Bradford’s scientific treatment of concepts in his studies led to the establishment of a set of mathematical formulae.

\[ R (n) = N \log n/s (1<=n<=N) \]

Where \( R (n) \) = Cumulative total of items contributed by the sources of rank 1 to n.

\( N \) = the total number of contributing sources.

\[ R (N) = N \log N/S \] is the total number of items contributed by \( N \) sources.

In other words Bradford\(^{11}\) describes that "If all the scientific journals relevant to a given subject are assigned ranks according to the number of articles they carry on the subject, and the journals are grouped into ‘m’ zones each containing the same number of articles, with the first zone containing the highest number of journals, and the last zone containing the lowest number of journals, then the number of journals in the succeeding zones form a geometric series with a common ratio ‘Pm’ depends only on ‘m’.

The statistical regularity pointed out by Bradford's law provides an objective means of determining zones of relative richness or value to a given kind of literature. This has implications to the various processes in a library. For example, a library can safely stock the journals which

\[^{11}\text{Bradford, S C. Documentation, London: Crossword Lockwood, 1948.}\]
belong to the core or nuclear zone. It is advisable to extend the purchase list to the next zones till the budget limits permit. If at all the library budget is elastic, a point will be reached at which it would be desirable to obtain copies of articles in the journals on demand rather than subscribing to the whole journal.

Lancaster\(^{12}\) provides an excellent hypothetical example of applying Bradford's law in periodical collection building, while discussing the principle of diminishing returns.

Brookes\(^{13}\) is of the view that if the total expenditure on periodical provision is limited to the fraction ‘f’ of the sum needed to cover the subject completely, the buying of periodicals may be supplemented by the buying of photocopies of the relatively few relevant papers published in the peripheral periodicals. While preparing bibliographies we are faced with the problem of coverage, the journals that are to be scanned etc. Size of a bibliography and the periodicals that should necessarily be included in the list of items to be covered. On the application side of this Bradford's distribution can be fruitfully used to estimate the total law, the studies of


Goffman and Morris and I.K. Ravichandra Rao\textsuperscript{14} are significant.

Goffman and Morris found that the pattern of journal usage in the Allen Memorial Library follows a Bradford distribution. Ravichandra Rao, through his analysis of circulation data collected from six Canadian University Libraries, proved that the rank distribution of transactions follow a Bradford distribution. Bradford's law is very much akin to the Pareto's law relating to wealth distribution and the 80-20 principle used in warehouse management and the Mandelbrot distribution.

**Performing a Bradford Analysis**

1. should start with some subject area of interest (e.g. citation analysis).
2. locate all articles that cover the subject during some time period (e.g., 1990-2000). Using a database with comprehensive coverage like Library Literature, can speed things up.
3. record the number of relevant articles found as a function of the journals names where the articles originated.
4. summarize the data by counting how many journals have published x relevant articles (e.g. One journal published 5 articles; One journal published 4 articles; Two journals published 2 articles each; 12 journals published 1 article each).

\textsuperscript{14} Ravichandra Rao, I.K., Distribution of Transactions over Users and over Documents in Canadian Academic Libraries, London: School of Library and Information Science, University of Western Ontario, 1976.
5. rank the results in decreasing order with the most prolific journal
given the rank 1.

6. arbitrarily select a core of ‘j’ journals. The number of articles
found in the core j journals is denoted as a zone. Denote the
first grouping (i.e., the core) as zone 0. (e.g., select a core of 3
journals (j=3) which will have 12 articles associated with it (a =
12)).

7. divide the remaining data into "Bradford Zones" such that each
zone contains a articles (12 articles), dividing the data into
Bradford Zones.

Bradford's law states that there is some constant 'k' such that the
‘z’ th zone containing articles consists of ‘kzj’ journals where the initial, or
core zone, is the 0 th zone. K is also known as the "Bradford multiplier" and
is determined by the data. The proportion k0:k1:k2:k3:... is another view
of the same phenomenon. To proceed further, one has to determine the
value of k by considering the following:

Zone 0 contains 3 journals

Zone 1 contains 6 journals

Zone 2 contains 12 journals

Thus these data contain the proportion 3:6:12 = 1:2:4 = 20:21:22
Therefore, \( k = 2 \).

While applying the ‘kzj’ formula to the data, the number of journals needed to provide multiples of the cores quickly grows to very large numbers. This is a classic example of the scattering effect i.e Bradford's law of scattering provides a measure of the rate of obsolescence by distinguishing the usage of the levels of items. Essentially, this is a method of clustering.

For example, 9 journals have 429 articles, the next 59 have 499, and the last 258 have 404. One may roughly get three groupings (ranging from 404 to 499) of articles. Three groupings are 9 titles, 9*5 titles, 9*5*5 titles.

Zipf's Law

In the field of 'Language' studies statistics on word frequencies have been compiled for over a century. The first major work is by Dewey - Relative frequency of English words published in 1923. The major effort at statistical analysis of word frequencies was made by Zipf in the psychology of language published in 1935. Striking regularities in the frequency distributions of words, number of different words \( W \) occurring \( k \) times were noted \( W(k) \) in different languages, authors and types of literature. In a very elaborate subsequent work Zipf extended the investigation beyond language in economics, geography, etc.
established a universal law of frequency distribution encompassing a wide diversity of statistical data.

Zipf also propounded a principle of least effort as a rationale for the rank-frequency distribution. Zipf had developed and extended an empirical law, governing a relation between the rank of a word and the frequency of its appearance in a long text. If \( r \) is a rank of a word and \( f \) is its frequency then Zipf's law is stated as follows:

\[
rf = c
\]

Where \( c \) is a constant. Zipf derived his law from a general principle of least effort. Words whose cost of wage is small or whose transmitted demands the least effort are frequently used in a large text. It states that in a long textual matter, if the words are arranged in their decreasing order of frequency then the rank of any given word of the text will be inversely proportional to the frequency of occurrence of the word.

Mathematically zipf's law can be written as

\[
r = \frac{1}{f} \quad \text{or} \quad rf=c;
\]

Where \( r \) denotes rank of a word, \( f \) stands for frequency of occurrence of the word and \( c \) which is a constant. Zipf's law can be effectively used in the generation of semi-automatic or automatic indexes useful for an information retrieval system. Its use has increased
tremendously with the emergence of natural language indexing of textual matter especially in electronic form. Several studies aimed at finding out the pattern of frequency distribution of descriptors of a thesaurus and the distribution of indexing terms are available.

A prominent one among them is those of Fedorowicz\textsuperscript{15}, Zunde and Zunde\textsuperscript{16} developed a function for the optimum distribution of indexing terms by the number of postings. This should make it possible to transmit information with maximum efficiency. Zipf's law provides a measure of the richness in vocabulary of a text by an author. This technique can be used for deciding the correct authorship of disputed works.

For example, if there is difference of opinion as to the correct author of a work, the work predilections of the attributed authors can be analysed either manually or using a computer. Once the frequency of occurrence of favourite words are decided the disputed text can be analysed to see similarity and thereby decide the author conclusively.

The law is also used for identifying words more frequently used in different foreign languages. These words are taught first in the


instructional programmes of foreign languages. Emilie C White\textsuperscript{17} observes that the super-imposition of the Bradford distribution over the linear Zipf distribution, which demonstrates the emergence of more used and popular items may yield a technique to describe the pattern of books used by library patrons. She feels that this law, when applied to circulation data, these formulations can support such policies as shortened loan periods for heavily used books and the identification of a core collection.

For analysis, this can be applied by counting all of the words in a document excluding the stop-words (a, an, the, therefore, etc. by creating an avoid.dbf) with the most frequent occurrences representing the subject matter of the document. The descriptors alone shall be taken into count. One could also use relative frequency instead of absolute frequency to determine when a new word is entering into the vocabulary list. Naranan\textsuperscript{18} has shown some striking similarities to Zipf’s Law In any democromatic election in which two or more candidates contest, the candidates are ranked in order of decreasing frequency of the votes they individually attract. In this example the candidates are the sources and the votes are the items.

\textbf{Lotka’s law}

\textsuperscript{17} White, Emilie C., Bibliometrics: Curiosity to Convention, Special Libraries. Winter 1985, Pp. 35-42.

Lotka’s\textsuperscript{19} proposition led to a whole gamut of studies on scientific productivity. Such productivity studies have gained momentum in the post-second world war period. This in fact, has culminated in the rise of a new discipline called Scientometrics. “It is defined as the `study of the measurement of scientific and technological progress.”\textsuperscript{20} It provides an understanding of the structure of scientific activity, the disciplines being researched, the organisations involved, the strength and deficiency in the scientific groups and their communication channels and at different levels of aggregation. It follows a trajectory of econometrics in the use of quantitative data, concepts and models and extensive use of mathematical and statistical techniques of modeling and data analysis.

Scientific productivity studies have been made from different approaches. Impact of social change on scientific productivity, relationship of publication output on scientific recognition, identification of elites in different disciplines, occurrence of discoveries in different cultures etc. are some of the approaches made in this line.

An interesting study of scientific productivity made three decades back is that of Yuasa\textsuperscript{21}. Yuasa's was a statistical study of the scientific achievements in various countries that showed the shifting of the

\begin{footnotesize}
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  \item Ibid.
  \item Yuasa, M., Centre of Scientific Activity, its Shift from the 16\textsuperscript{th} to 20\textsuperscript{th} century, Japanese Studies in the History of Science, 1962, 1, p. 527.
\end{itemize}
\end{footnotesize}
world scientific dominance from one country to another. He found out that this dominance shifted from Italy to Britain, then to France, from France to Germany and finally to USA in the 20th Century. Price\textsuperscript{22}, who had traced the development of science in Babylon and plotted the growth of big science from little science, had observed that Lotka’s law applied equally well to the productivity of scientists in the 17\textsuperscript{th} as well as in the 20\textsuperscript{th} century. This meant that majority of publications originated from a handful of scholars. This is very much similar to the already existing ‘Price’s square root law’. Similarly, the conclusion of an extensive review of early studies of scientific productivity made by Naranan was that scientific talent was highly concentrated in a limited number of individuals.

Generally, Lotka’s law is an inverse square law that for every 10 authors contributing one article, 25 will contribute two; 11 will contribute three, and 6 will contribute four each. There is a general decrease in performance among a body of authors following $1:n^2$, this ratio shows that some produce are much more than the average which seems agreeably true for all kinds of content creation.

Thus, it can be inferred that Lotka’s law may not be constant in value, but in following Inverse Square. The challenge will then be to find the correct square in different mediums and fields. Other authors like the Spanish scientist A Lara, the Russian, Marschakova the German, D

Schmidmayer, the Belorussian, V Lazarev, the Lithuanian, O. Voveriene, to name a few, proposed their own solutions, defining the limits of competence of these three-metrics.

**Significance of the Study**

The significant characteristic of Bibliometrics is that it enables predictive studies, and also strategic prognostications. Further, as a research field it incorporates empirical, as well as theoretical types of research dealing mostly with mathematical modelling. To this effect, scientometric studies enable the identification of various scientific facts and regularities, difficultly reachable by other modes of research. This concerns the problem of quantification the application of mathematical means of research and analysis itself is not only a token of methodological maturity of the scientific discipline, but it provides also a possibility for creation of models, rich in content and enabling the revealing of new phenomena and processes herein is their heuristic role. A characteristic example in this connection is the revealing the structure of research networks or scientific disciplines, the identification of emerging research fields, the revealing of similarities and differences in research conduct or policies, ascertaining the degree of coherence between different spheres and prediction of future development of science.

**Choice of the Topic**

The present study is concerned with a Bibliometric analysis of Social
Science research literature. It aims to apply the empirical laws of bibliometrics on the data/records of Social Science research literature. The study includes an analysis of Social Science research literature as covered by Thomsons Web of Science between 1999 and 2011 (Thirteen years) in the context of country of contributions, language of contributions, authorship pattern and percapita aspects of contributions. The study is mainly exploratory in nature in identifying the research output of scientists in Social Science and is also analytical in nature with suitable statistical tools application in strengthening the empirical validity.

**Chapterisation**

The study includes the following chapters

**Chapter 1**  
Introduction

**Chapter 2**  
Review of Literature

**Chapter 3**  
Research Design

**Chapter 4**  
Analysis and Interpretation
Chapter 5  Findings, Conclusion and Suggestions.

References


