CHAPTER II

REVIEW OF RELATED LITERATURE

Review of literature is a significant part of any research study. The investigator acquires information about what has been done in a field of study, to arrive at a fruitful conclusion. The review presents a vivid picture about previous researches in the area in which the study intends. A familiarity with available literature in the area of research is also required by the investigator for making new grounds besides the proper designing of the study. Review of related studies further avoids duplication of work that has already been done in that area. It also helps the investigator to study the different aspects of the problem. It enables the investigator to identify the research gaps or the unexplored areas if any, in order to create new grounds for research. By considering the efficiency of various dimensions of bibliometric studies, the researcher has classified them into nine categories, namely

1. Biomedical Research

2. General Bibliometric studies

3. Literature growth oriented studies

4. Languagewise Contribution studies
2.1 Biomedical Research

Radhamany Sooryamoorthy\textsuperscript{20} pioneered an attempt to find out whether the reported pace of growth in the production of scientific papers in medicine is an effect of partnerships that scholars have with their counterparts within the organization, within the country, or with those in other countries. The paper also presents the unique patterns of scientific research in medicine, taking into account factors such as the count and fractional count of papers, citations, trends of growth, sectoral participation, partners, and publication outlets, and seeks to provide new insights into the directions medical science is taking in South Africa today.

Molatudi et al\textsuperscript{21} reports on the practises of bioinformatics research in South Africa using bibliometric techniques. The search strategy was designed to cover the common concepts in biological data organisation, retrieval and analysis; the development and application of tools and methodologies in biological computation; and related subjects in genomics and structural bioinformatics. The South African literature in bioinformatics has grown by 66.5\% between 2001 and 2006. However, its share of world production is not on par with comparator countries, Brazil, India and Australia.

2.2 General Bibliometric Studies

Adány and Pocsai\textsuperscript{22} studied the status of genetic epidemiology. There was considerable difference in the research areas in Europe and USA. The study resulted that the number of publications increased significantly in Europe in the period covered under the research.

The area of research was related mental disease and behavioral disease genetic epidemiology in Europe whereas USA was with a larger emphasis on cancer.


productivity and prominent contributors, language-wise and year-wise
distribution of articles, country-wise distribution of journals, core journals
in the subject area, and indexing term frequency. Some of the important
findings were

1. Most of the articles (61 percent) were single-authored;
2. Author productivity was not in agreement with Lotka's Law,
   except in one case where number of articles is three;
3. The maximum number of articles published in 2003 were
   with English being the most productive language;
4. Maximum articles were published in the journal D-lib
   Magazine; distribution of articles nearly follows Bradford's
   Law; and USA ranked first for maximum number of journals.

Guilera ...etal., 25(2006) aimed to study scientific productivity with
respect to articles published in Spanish on the issue of Differential item
functioning (DIF). They focused mainly on presenting the frequencies and
percentages of publications with respect to various bibliometric indicators.
The results revealed that interest in the issue of DIF was found to be
increased, and the most productive institutions were identified as
universities. The majority of articles were found to be published in the
journal Psicothema.

25Guilera G. ...etal., Differential item functioning: a bibliometric analysis of journals
Low\textsuperscript{26} used the Bibliometric techniques to analyze the citation patterns of research papers published in the American Journal of Veterinary Research (AJVR). He analyzed more than 25,000 bibliographic references appearing in the AJVR from 2001 to 2003. His findings were that majority of items were found to be journals (88.8%), followed by books (9.8%) and gray literature (2.1%). He identified that Current sources of information were favored; 65% of the journals and 77% of the books were published in 1990 or later.

Weaver…etal.,\textsuperscript{27} aimed to study the research literature on the effects of religion on adolescent tobacco use published between 1990 and 2003. Twenty-two of the 29 studies was reported at least one significant effect of religion on tobacco use, but the researcher found that 31 of 43 separate analyses of religious variables yielding significant negative correlations between religion and tobacco use. They concluded that religion was inversely related to all measures of tobacco use (lifetime, occasional, and regular use).

\textsuperscript{26} Crawley-Low J, Bibliometric analysis of the American Journal of Veterinary Research to produce a list of core veterinary medicine journals, \textit{J Med Libr Assoc.}, 2006, Vol.94(4),Pp.430-4.

Behrens\textsuperscript{28} applied the mathematical and statistical techniques of bibliometrics to the field of crystallography. This study was restricted to inorganic compounds. The data were taken from the Inorganic Crystal Structure Database, which is a well defined and evaluated body of literature and data published from 1913 to 2005. The data were loaded in a relational database system, which allows a widespread analysis. The cumulative growth rate of the number of experimentally determined crystal structures is best described by a third-degree polynomial function. Except for the upper end of the curve, Bradford's plot can be described well by the analytical Leimkuhler function. The publication process is dominated by a small number of periodicals. The probability of the author productivity in terms of publications follows an inverse power law of the Lotka form and in terms of database entries an inverse power law in the Mandelbrot form. In both cases, the exponent is about 1.7. For the lower tail of the data an exponential correction factor has to be applied. Authorship pattern has increased from 1.4 authors per publication to about four within the past eight decades. The author distribution itself is represented by a lognormal distribution.

Anup Kumar Das and Sen\textsuperscript{29} examined 1049 citations appended to 34 research articles pertaining to issue nos. 2 to 4 of volume 20 of Journal of Biosciences for the year 2000. The authorship pattern of the citations shows that 18.68 per cent papers are single-authored, 52.71 per cent are double and triple-authored, and the remaining 28.61 per cent are joint contributions of four or more authors. As in the case of medicine, the team size of this field is bigger than those in the fields of chemistry and physics. As many as 25 articles of mega authorship that is contributions by ten or more authors have been encountered in this study, and one of them was by 22 authors. Of the citations, journal articles comprised 85.89 per cent and monographs 10.1 per cent. Indian contributions comprised 5.53 per cent of the citations. Of the citing articles, 30 are by Indian authors, 3 by foreign authors, and 1 (2.94 per cent) jointly by Indian and foreign authors. Of the total citations, 10.87 per cent are author self citations and 0.57 per cent are journal self citations.

Hawkins\textsuperscript{30} analysed the bibliometric characteristics of electronic journals covering the field of information science have been studied. Twenty-eight e-journals were identified and ranked by number of articles on the subject they published. A Bradford plot revealed that the core is not


well developed yet, but it will likely contain six journals. The publication of information science articles in e-journals began about 1990. In 1995 (the starting date for this study), a modest 26 articles appeared, but publication has now risen to approximately 250 articles per year. The most prolific authors are identified. The vast majority of them are located in the United States or United Kingdom. Only 26 articles have authors from more than one country, showing that electronic technology has not yet strongly influenced international collaboration. About 2/3 of the articles originate in academic institutions. Common topics of e-journal articles in information science include electronic information, electronic publishing, virtual libraries, information search and retrieval and use of the Internet. Seven online databases cover these e-journals; Information Science Abstracts is the only one to cover all 28 journals, and it has the highest number of abstracts from them - over 1,100.

Koehler\textsuperscript{31} examined three e-journals and one paper journal begun in the 1990s within the information science genre. In addition, these journals were compared to what was perhaps the leading information science journal, one that has been published continuously for fifty years. The

journals examined were Cyber Metrics, Information Research, the Journal of Internet Cataloguing, Libres, and the Journal of the American Society for Information Science. It was found that there were a number of important differences among the journals. These include frequency of publication, publication size, number of authors, and the funding status of articles. The study also found differences among journals for distributions of authors by gender and corporate authors by region. Some of the regional differences can be explained by journal maturation; the more mature the journal the greater the dispersion. We also find that women are more likely to publish in the newer journals than in JASIS. The fact that if a journal is or is not an e-journal, it does not appear to affect its presence or "behaviour" as an information science journal.


Synchronous Self-References ranged from 5 (Rubbia) to 88 (Siegbahn); synchronous references to others ranged from 10 (Chandrasekhar) to 255 (Wilson); Synchronous Self-Reference Rates ranged from 6.66 % (Rubbia) to 65.51 % (Chandrasekhar); Single-Authored References ranged from 15 (Klitzing) to 160 (Wilson); Multi-Authored References ranged from 4 (Chandrasekhar) to 194 (Siegbahn); Collaboration Coefficient in the synchronous references ranged from 0.14 (Chandrasekhar) to 0.75 (Klitzing); and Recency (age of 50 % of the latest references) ranged from 2 (Klitzing) to 18 (Chandrasekhar) years. Seventy five per cent of the references belonged to journal articles. Highly referred journals were Astrophysical Journal, Physical Review, Physical Review Letters, Arkiv Fuer Fysik, Surface science, Physics Letters, and IEEE Transactions on Nuclear Science.

Daisy Jacobs\textsuperscript{33} analysed the publication patterns of a selected group of academic and research scientists of ten universities of South Africa for a period of five years, 1992-96. The subject fields surveyed are Physics, Chemistry, Plant and Animal Sciences, and Microbiology/Biochemistry. These ten universities vary considerably with respect to standards of education, quantity of research and publication and overall progress. The findings of this study point towards the role played by status, prestige and

funding in the productivity of the scientists. The study therefore suggested some measure in order to increase the research activity and publication especially among the junior members who are still aspiring towards achieving their doctorate. The measures therefore suggested are concerned with increased incentives towards achieving doctorate, encouragement towards post-doctoral projects, remuneration on published articles and at the same time lessen the work load of junior staff to allow more research. An increased co-operation between national and international co-operation would open newer horizons for research and publication.

Sevukan and Sharma\textsuperscript{34} made a detailed analysis of research performance of biotechnology faculties in central universities of India from 1997-2006. The data used for the study were retrieved from two database sources, namely, PubMed, NCBI (National Centre for Biotechnology Information); and ISI Web of Science database—Science Citation Index Expanded (SCIE). Bibliometric techniques have been employed to analyse the data. The results indicate that the growth of literature in biotechnology has steadily increased from 15 articles in 1997 to 43 articles in 2006; two-authored publications predominate amongst the pattern of authorship; applicability of Lotka’s law is validated from the

values $n = 2.12$, $C = 0.669$, and $D = 0.027$ obtained using least square method. However, the application of Bradford’s law does not fit to the literature analysed.

Dansey\textsuperscript{35} made a statistical analysis of the professional literature of librarians and information scientists in an attempt to uncover the patterns of information flow and to evaluate the abstracting services provided for information workers. Citation analysis of some English language information science journals threw light on the principal sources used by British and American information scientists and the linguistic and national biases in the citations given. The growth of the subject matter published in the field of information science is displayed. Five abstracting services were evaluated. Their scope in terms of the language, country of origin, subject matter and format of the material selected and abstracted is determined. Coverage is assessed in comparison with three bibliographies in this subject area. Currency is determined from NRLSI acquisition dates. Key journals are found from productivity analysis of the abstracted journals. Conclusions are drawn as to the adequacy of the present services and suggestions.

Leydesdorff\textsuperscript{36} analysed the co-words which have been considered as carriers of meaning across different domains in studies of science, technology and society. The empirical focus was on three recent scientific controversies: Monarch butterflies, Franken foods and stem-cell therapies. This study explored new avenues that relate the study of co-word analysis in context with the sociological quest for the analysis and processing of meaning.

Chiu\textsuperscript{37} used Honor index in his study to determine the scientific productivity of stem cell research in the Asian Four Dragons (Hong Kong, Singapore, South Korea and Taiwan) from 1981 to 2001. The methodology applied in this study represents a synthesis of universal indicator studies and bibliometric analyses of subfields at the micro-level. Honour Index, a method to evaluate research performance within different research fields, was derived from the impact factor. It can be used to rate and compare different categories of journals. The study discussed several comparisons and concluded the developmental trend in stem cell research for two decades.


2.3 Literature Growth Oriented Studies

Kansay\textsuperscript{38} aimed at evaluation of significant research literature of microbiology and performance of three relevant bibliographic sources: Biological Abstracts, Chemical Abstracts and Index Medicus. A sample data of 2073 citations was taken from the 1967 issues of 06 journals. In all, 1382 citations were collected from the main samples of each of the three sources. Subject dispersion study showed considerable interdependence and interaction between microbiology, general biology, physiology, biochemistry and medicine.

Bolles\textsuperscript{39} worked on the American Quarterly and developed a profile of the literature of American Studies. A list of 21 sub-fields of American studies has emerged through analysis of subject dispersion. An analysis of the articles of American Quarterly revealed that history, political science and drama works combine to provide 64.29 per cent classes of the Library of Congress classification scheme represent various disciplines and each class is related to the data available within American studies. The study indicates the fact that the classes most often cited outside a particular discipline are those related to history and literature.

\textsuperscript{38} Kansay, J.E. “Citation Characteristics and Bibliographical Control of the Literature of Microbiology”. Dissertation Abstracts: University of Pittsburgh. 32, 1971, 1542.

Shukla, Saksena and Riswadkar applied Bradford’s Law of scattering and Lotka’s Law of productivity to bio-energy literature and to verify if the law holds good for ten abstracting services (eight international and two Indian). It has been verified that literature related to bio-energy conforms to Bradford's law of scattering and that grouping of services (all services together) also yields a Bradford distribution. The new model developed in this study fits the data very satisfactorily - r value ranged from 0.952 to 0.998 (for papers from journal titles) and 0.989 to 0.998 (for papers from conference proceedings). The value of p (multiplication factor) for bio-energy literature ranged from 2.19 to 4.09 for articles from journal titles and from 2.02 to 4.59 for papers from conference titles. Results of linear regression showed that Lotka’s distribution holds good for bio-energy literature and the value of n ranged between 2.5 and 4.5. The K-S test confirmed these findings.

Modak analysed the scientometric parameters for chemical engineering publications. They compared the number of journal publications and citations by various countries and institutions. The publication record in terms of quantitative aspects of the number of publications from China has increased exponentially over the last decade.

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and has overtaken USA. However, the citation analysis indicated that there is ample scope for improvement. Thus, USA continues to maintain its leadership position with regard to impact in the field. Analysis of the output of selected Indian universities/organizations against that of the top universities in the world indicated that the records of top institutions from India are not comparable to the best universities in USA, but are comparable to the best in Asia and are significantly better than the best universities in China.

Parvathamma\textsuperscript{42} and Gunjal examined that the doubling time in the growth of Indian Earth Science literature during the period 1978-88 was found to be 4.8 years.

Groneberg-Kloft\textsuperscript{43} assessed benchmarking of research output by using large data bases research output was categorized and analysed. Specific areas of major research activity were identified by comparing publication density on different organ systems and inter and intra field comparison was performed for selected countries. Novel density-equalizing mappings were constructed that illustrate trends of publication activity and identify subsets of major interest in a total of 5,527,558 published items. A dichotomy was present between Western countries


such as the US, UK or Germany and Asian countries such as Japan, China or South Korea concerning research focuses.

Kumaravel\textsuperscript{44} analysed the data downloaded from Dialog’s Biotechnology and chemical engineering abstracts database for the period from 1988 and 2000. The population and GNP are taken out for a particular year and correlated with the research output. Research shows the collaborative authorship trend and that there is no significant relation between research output and the total population or the GNP.

Deo\textsuperscript{45} investigated 4066 citations collected from the doctoral dissertations on the English language and literature accepted by Babasaheb Ambedkar Marathwada University has been carried out to determine the use pattern of the literature by the researchers in English. Amongst the first ten most frequently cited authors, six are from USA and two each are from UK and India. English citations account for 99% and only one percent of the citations are shared by the two other languages, marathi and Sanskrit. Countrywise distribution of periodicals and chronological distribution of citations indicate substantial use of older literature with a half-life value of 27.5 years. Authorship study indicated increasing trend towards multiple authorship.

Swapan Kumar Patra\textsuperscript{46} analysed growth pattern, core journals and authors' distribution in the field of bibliometrics using data from Library And Information Science Abstracts (LISA). Growth of literature did not show any definite pattern. Bradford's law of scattering is used to identify core journals and determines 'Scientometrics' as the core journals in this field. Lotka's law was used to identify authors' productivity patterns. It is observed that authors' distributions do not follow original Lotka's law. Study also identified 12 most productive authors with more than 20 publications in this field.

Parameshwaran and Smitha\textsuperscript{47} made a bibliometric analysis of library and information science abstracts (1994-1998). Their findings were

1. Maximum numbers of publications fall under the broad fields information and communication technology with 13.41 percent coverage.
2. More people write individually, that is, single authorship amounts to 77.5 percent and double authorship is 15.83 percent indicating that solo research predominates in the field of LIS.


3. The portion of Indian contribution to LIS research is very meagre. (1.142%)

Nederhof, et al\textsuperscript{48} made a bibliometric study to analyse the performance of departments in the field of Natural and Life sciences, the social and behavioural sciences and Humanities. The result explained that early one third of the departments publications were not covered in the Science Citation Index.

Klaic\textsuperscript{49} examined the research activity of chemists from the Rugjer Boskovic, Yugoslavia during 1976-1985 covering 2018 research papers of scientific work. The papers were classified according to subfields used in the journal Citation Reports.

\subsection*{2.4 Language Of Contribution Studies}

Louttit\textsuperscript{50} identified the language preference of writing research papers by Psychologists, Chemists and Physicists. It was observed that references made by writers in English language journals were 92.5 percent were English, in German journals 91 percent were German and in French journals 64.6 per cent were French. Further it was said that


\textsuperscript{50} Louttit, C.M. “The Use of Foreign Languages by Psychologists, Chemists and Physicists”. American Journal of Psychology. 70.3(1957):314-316.
numerous studies in Social Sciences show reference in American sources having around 90 percent in English.

Heussman and Pulmer\textsuperscript{51} analysed the literature kept in the general library catalogue of Michigan University. It was noted that out of the total literature, 89.52 percent were in English.

Kumaravel\textsuperscript{52} analysed the literature output on Genomics and found that English was the Lingua franca with respect to language of publication of research in Genomics.

\textbf{2.5. Country Of Publication}

Braun\textsuperscript{53} classified all the scientific publications on the basis of the data obtained from the Institute for Scientific Information, Philadelphia. All countries which published at least 50 single authored papers in the field in question during the study period were included. The source journals during the period 1980-84 and 1985-89 were considered as source items and citations to the respectively.

Uzun\textsuperscript{54} examined 21 core journals in the field of library and information science during 1980-99 for articles with either principal or co-authors from developing countries (DCs) and the formerly socialist Eastern European countries (EECs). He resulted on that only 826 (7.9\%) of a total of 10,400 articles published in 21 journals are from DCs or EECs. The numbers of articles with authors from China, Saudi Arabia, Turkey, Botswana, Ghana, Kuwait and Taiwan considerably increased and those of India, Nigeria, Pakistan, Brazil and Poland decreased. Also concluded that among the countries with declining trends in the numbers of articles, Library and information science research is receiving high priority in Nigeria and Pakistan. Information retrieval, information need and information use is among the topics of relatively high interest for the researchers working in DCs in Asia and Africa.

Rangarajan and Poonam Bhatnagar\textsuperscript{55} analysed the bibliometric data complied from physics Abstracts on research papers published in the field of Mossbauer effect studies over a period of two decades from its discovery in respect of media choice. The findings indicated that there was a world-wide trend to publish in journals outside the country of origin of the research work.

\textsuperscript{54} Uzun, A. “Library and Information Science Research in Developing Countries and Eastern European Countries: A Brief Bibliometric Perspective”. The International Information and Library Review. 34.1(2002):21-33.

Cano\textsuperscript{56} reviewed 17 years of research in Library and Information Science in Spain for a period from 1977-1994. He identified that the Spanish research in Library and Information Science had concentrated more on information retrieval, description of services and studies of scientific communication. Authorship patterns suggested a prevalence for individual authorship (68 per cent).

Constantinos and et al\textsuperscript{57} studied the status of analytical chemistry publications among the member states of the European Union (EU) during the cumulative 7 years period covering 1993-1999. For assessing the scientific publication productivity in analytical chemistry and its impact among the EU countries the following were calculated.

1. The total number of publications from each country
2. The number of publications per head of population
3. The mean impact factor for each country
4. The preference to publish in specific journals per country

They reported that a number of publications in analytical chemistry from the member states of the EU increased by 32.8\% in comparison to the 1986-1992 period. Most analytical chemistry articles in the EU were published by German scientists. Swedish scientists were the most

\textsuperscript{56} Cano,V. “Bibliometric Overview of Library and Information Science Research in Spain” JASIS. 50.8(1999): 675-680.

productive in relation to the country's population, having published 206 papers per million inhabitants. Scientists from Sweden published in the highest impact analytical journals, with a mean impact factor of 1.98, while the EU mean impact factor was 1.75. It is noteworthy, and may be also surprising, that the contribution by European analytical chemists to the Journal of Analytical Chemistry is very modest.

2.6. Pattern Of Authorship And Literature Output

To analyse the authorship, Elliott⁶⁸ studied the available records pertaining to biographical data of the scientists, in relation to the decades of birth and area of the interest of the scientists. The period of the study was 1800-63. He used the Royal Society Catalogue of Scientific papers to collect the desired data. The criteria for selection of cases for the study were those who have to their credit three or more papers in American Science Journals. The data comprised 503 names. The study revealed that in the first half of Nineteenth Century, the American Scientists mainly belong to North-Eastern part of the country. Their fathers were members of professional, commercial or medical schools. Further, social structure of science differs according to the scientific interests of the scientists.

Bankapur\textsuperscript{59} analysed all the scientific publications of Indian Institute of Horticultural Research, Bangalore. He identified a steep growth in contributors and contributions which was 17 and 2 in 1968 to 165 and 246 in 1981 respectively. Also identified that most of the contributors were foreigners and less were Indian. The sub-discipline of homology has highest recall by subject-wise dispersion. The crop improvement and protection received the highest ranking.

Daniel\textsuperscript{60} studied to determine the identification of those persons who mostly influenced psychologists’ research productivity. For this aim, 20 core journals were selected from the year 1950. The data was arranged into four groups, that is, gross impact, productivity, outstanding achievement and breadth. The same process was followed in another study carried out in the year 1975 considering a similar sample. The study revealed that 18 per cent top contributors maintained a strong influence over this span of 25 years and these ranked as leading contributors. In other words, 18 per cent authors retained their positions since 1950 and continued at the same level even in 1975. These trends of the leading psychologists and a further study in same indexing source like Social Science Index reveal more facts and interesting features about these authors, subject preferences and other references.


2.6.1. Co-Authorship Studies

Gupta and Karisiddippa\textsuperscript{61} have studied the collaborative pattern of scientific papers in theoretical population Genetics for a period ranging from 1956 to 1980 and concluded that

1. The United States contributed 43.66 percent to the world’s total international co-authored publications. It was among the countries with a significant percentage of co-authorship (47.02 percent), but it ranked in the low end in terms of overall percentage of publications involving international collaboration (11.53) percent during 1956-60 to 15.81 percent during 1976-80). This occurred solely as a result of its large publication base.

2. The United Kingdom contributed 16.23 percent to the world’s international co-authored publications. It was among the countries with 32.15 percent of its total publications appearing as co-authored publications, but ranks in lower end in terms of its overall percentage of publications involving international collaboration (6.25 percent during 1956-60 to 24.13 percent during 1976-80).

3. Australia contributed 7.45 percent to the world’s total international co-authored publications. Its percentage of co-authored publications were 23.41 percent, but its contribution in terms of

publications involving international collaboration decreased from 50 percent during 1956-60 to 33.33 percent during 1976-80) were counted during the periods 1980-89 Japan contributed to the world’s total international co-authored publication and its percentage of co-authored publications was 43.05 per cent.

4. Canada contributed 13.59 percent to the world’s total co-authored publications and its percentage of co-authored publications was 43.05 percent

2.6.2 Collaborative Authorship

Many studies have been reported in the literature on the nature of collaboration among scientists in different disciplines. One of the earliest studies was undertaken by De Solla Price\textsuperscript{62} who in one of his investigations reports that the incidence of collaboration had increased steadily over time and has been rapidly growing since the beginning of twentieth century.

Since then, a series of studies have shown that an increase in collaborations is evident in most areas of science and technology and that the extent of collaboration varies from one discipline to another. Clarke\textsuperscript{63} in his study on Bibliometric papers criticized the view of Price and


concluded with a generalization as regards the increasing trend towards multiple authorship is not valid for science as a whole.

“There has been consistent trend towards increased collaboration in all major branches of sciences over the years in the present (twentieth) century”, reports Meadows⁶⁴

At the same time, the rate of increase in multiple authorship varies from one subject area to another. In Physics the proportion of the single-author papers have fallen from 75 percent in the 1920s to 39 percent in the 1950s. The corresponding figures for psychology are from 84 percent to 55 percent, reports Merton⁶⁵.

Kundra⁶⁶ investigated the collaborative research trends in Indian Medical Sciences 1900-1945 and drew general and broad conclusion. There is a perceptible increase in the collaborative research and substantial decrease in the single-authored papers in medical science in India during the period 1925-45. In 1900, not a single collaborative paper was reported. But by 1925, 12.4 percent collaborative papers were reported and the single-authored papers were 87.57 percent. The figure

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rose to 33.6 percent co-authored papers in 1945 while the single-authored papers declined to 66.36 percent. There was almost three times increase in collaborative research. The other findings were

1. Of the total number of co-authored papers published in the 1900-45, 21.95 per cent collaborative papers were from basic research while 7.63 per cent were from applied research. This confirms the findings of Frame and Carpenter.

2. A rise is not only seen in the collaborative papers but also in the nature of collaboration. In 1925 only 22.9 per cent authors participated in collaborative research which rose to 49.7 per cent in 1945, a two fold increase.

3. The collaborative authorship pattern steadily increased from 1.00 per paper in 1900 to 1.39 per paper in 1945. But the average authorship remained 1.2 authors per paper.

4. The growth pattern suggests that a large proportion of co-authored papers in a discipline or a journal depend to some extent on the type of research and the discipline involved. As a result, it is not impossible to have a relatively lower proportion of collaborative papers in a particular sample, even when collaborative research overall has become the normal practice.
5. The collaborative and authorship trend discussed in the study suggests that medical science was still in the developing stage in India in the period 1900-1945, and there was possibility of its expansion in the near future.

Amit Kumar Bandyopadhyay\textsuperscript{67} analysed the references appended to 92 doctoral theses submitted to Department of Mathematics, Physics, Mechanical Engineering, Philosophy and Political Science, University of Burdwan. The findings revealed that authorship collaboration is high in Physics. Moderate collaboration exists in Mathematics and Mechanical Engineering. The collaboration is very low in Political Science and Philosophy excluding Psychology. It is highest in Nuclear Physics followed by Optics. Although the multiple authorship trends has increased steadily through decades (1950-1990) in all the branches of physics and mathematics and also in Psychology: in Mechanical Engineering, Philosophy excluding Psychology and in all the branches of Political Science the multiple authorship trend has declined for certain periods.

Maheswarappa, et al\textsuperscript{68} examined the collaborative research in Indian Science and Technology based on authorship data collected from the Indian Science Abstracts covering the periods 1965-70, 1975-80 and


The findings revealed that two authored papers were maximum in Science and Technology as whole. The single authored papers constitute more than one fourth of publication.

Ramesh and et al\textsuperscript{69} investigated the papers published in Oryza the Quarterly International Rice Journal from 1986-1995. The analysis showed that multiple author contributions constituted the maximum proposition (87.82 percent) and the degree of collaboration over this period varied from 0.90-0.95. The length of the articles between 1-5 pages were found to be at the maximum with 78.3 percent.

Maclas-Chapula and Muanoos-Nolasco\textsuperscript{70} analysed the AIDS documents produced on Sub-Saharan Africa and found out that the main countries participating in aids research were Democratic Republic of Congo and Cameroon. The results indicated a high pattern of collaboration through multiple authorship. The subject content of the documents were found to be focused mainly on epidemiology, complications and prevention and control issues of AIDS.


Halkar, et al\textsuperscript{71} made a bibliometric study on the journal of Family Welfare and drew the following conclusions:

1. Maximum number of articles published in 1993 was the same as in 1997, that is 37. (13.40 per cent).

2. Authorship pattern showed that most of the papers were contributed by single authors (52.18 percent) and went on decreasing by two and more authors.

3. India contributed the maximum number of articles, that is 80.07 percent since the journal under coverage was from India.

4. The average length of the papers was between 4 and 9 pages constituting 60.05 percent.

Ravi\textsuperscript{72} analysed the nuclear science research productivity of Indian scientist and found that

1. Nuclear science research papers were published mainly in journals.

2. Among the international sources of publications United States and United Kingdom predominated in publishing Indian nuclear science research papers.


3. Two authored and three authored papers were more than the single authored and other multi-authored papers.

Munshi\textsuperscript{73} studied research collaboration in agricultural sciences amongst the scientists working in six agricultural universities of India. The result of finding revealed that only 15.36 per cent of the total publications constituted single author research output while 84.63 per cent is collaborative. Interestingly, the collaboration of 2 and 3 authors was more prevalent.

Chakravarthy\textsuperscript{74} studied the patterns of multiple authorship. It is proved to be the trend for geology from 1940 to 1970 ranging from 84.97 per cent in single authors to 48.36 per cent, rest being two authors and multiple authors. The Indian contributions gained 76.74 per cent in 1940, 52.56 per cent in 1970 from the single authors.

Gaddagimath and Kalyane\textsuperscript{75} analysed the contributions made by Narayan L, a leading botanist. His contributions which appeared in the Indian Journal of Botany (Vol. 13, 1990) formed source of data. The analysis indicated a total of 175 contributions, of these 26 were single authored papers, remaining were a result of multiple authorship: 86 with

two authors, 44 with three authors and 19 with four authors. Interestingly, the single authorship was on the top only by the way of contribution, between the years 1955-75, while the following period demonstrated that multiple authorship was totally dominant. Area-wise publication analysis revealed the highly preferred areas and less preferred areas. The data was scattered in ten sub-fields, with overwhelming majority of four, viz. Chemotaxonomy, floral anatomy, embryology and systematic taxonomy with 162 papers. These trends may imply that scientific literature are inclined to have more collaborative research and scatter is highly concentrated in a few papers.

2.7 Bibliometric Analysis Of Bibliometric Literature

Humayoon Kabir76 investigated the characteristics of bibliometric literature by analysing the issues of Library and Information Science Abstract (LISA) from 1964 to 1990. The LISA has counted 27 years of literature on bibliometrics. The data regarding the author, title of the article, name of the journal/conference proceedings/other forms of publications, language and year of publication were recorded. The study reveals that single author contributions are maximum and the team research is not popular among the researchers in bibliometrics. The ratio between single and multi-authored papers is 2:2:1. Multi-authored papers

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were increasing slightly during the period. It was found that there was not even a single entry of bibliometrics in LISA up to 1968. The world literature of 10 years since 1969. English language was the predominant language of communication accounting for more than 76 percent of all. Other languages of publication included Russian, Spanish, French, Japanese, German, Portuguese, etc., More than 90 per cent of bibliometrics literature was published in journals with scientometrics occupying the first rank. The use of conference proceedings, monographs and theses/dissertations as media of bibliometrics literature publishing increased, while reports decreased. The articles based on library science studies come to approximately 40 per cent.

2.8 Scientometrics And Webometrics

Shailendra investigated to explore the information sources in history of science in India from the selected research journals and analysed them with the aid of suitable scientometric techniques, over a period from 1905 to 1986. The literature in the history of science is extremely significant for determining the contribution of Indian scientists to the growth and development of scientific literature. The study presented the scientometric indicators, such as growth of the subject, authorship pattern, highly productive authors, content analysis, as well as citation

pattern; also a machine readable database on the history of science was created to facilitate analysis, proper control of the literature and its expeditious retrieval. The study is an attempt in the direction of bibliographic control of literature of history of science because the vast quantities of literature generated at a considerable cost of time and energy are lying scattered almost unknown and unused.

Gopalkrishnan, Ambuja and Seetharama\textsuperscript{78} found World Wide Web has created a sea change in information transfer. Information scientists have undergone a perceptible change and have become IT centred, which is evidenced by their citing pattern. This article examines the nature and pattern of citations of information scientists in seminar proceedings of Indian origin and also one volume of an international journal in the field of library and information science. The study reveals that the trend of citations has changed over time and web citations would replace other citations in future.

Gupta and Dhawan\textsuperscript{79} analysed India’s publications output in three major international multidisciplinary databases, as indexed during 1981-2005. It reports on India’s comparative strength in world science and


technology output, its growth and decline, its strong and weak subject areas of research, media of communication, its collaborative profile and quality of Science and technology output, institutional productivity and quality, and dynamics of Indian research at institutional and sectoral levels. The study also provides suggestions for improving the quantity and quality of scientific research in India.

Modak\textsuperscript{80} analysed the scientometric parameters for chemical engineering publications. We have compared the number of journal publications and citations by various countries and institutions. The publication record in terms of quantitative aspects of the number of publications from China has increased exponentially over the last decade and has overtaken USA. However, the citation analysis indicates that there is ample scope for improvement. Thus, USA continues to maintain its leadership position with regard to impact in the field. Analysis of the output of selected Indian universities/organizations against that of the top universities in the world indicated that the records of top institutions from India are not comparable to the best universities in USA, but are comparable to the best in Asia and are significantly better than the best universities in China.

2.9 Pattern Of Subject Dispersion

Robinson\textsuperscript{81} studied political science journals from 1910 to 1960 to see the subject dispersion. The study aimed at the change in the nature of the quantity and distance of the subject dispersion in 1910, 1920, 1930, 1940, 1950 and 1960. The dispersions measured by using the LC classification scheme. Twenty five per cent random samples were taken from references in 14 journals of basic interest of political science. The findings are:

- Interdisciplinary borrowing was an integral and continuing aspect of political science, 70 per cent sources were non-political
- While the hypothesis of quantity and weight of dispersion was proved correct, there was no significant association between subject dispersion and maturity.

Kesarwani\textsuperscript{82} and others studied with research publications of the National Environmental Engineering Research Institute, Nagpur to investigate the trends in subject scatter. The source of data is the bibliography of contributions of NEERI staff, covering a time span of 25 years (1958-83). The study revealed that 1548 articles are scattered in more than ten subjects. The most productive subjects are: water, wastes


and air pollution, over 7 per cent of the papers appeared in subjects like agriculture, botany and chemical technology. This scatter evidently places the subject of environment under the banner of inter-disciplinary field.

Bhattacharya and Sen\textsuperscript{83} investigated the growth of a new field. The study aimed at finding the rate of explosion of the literature and identifying core journals of the field of super-gravity. The Science Citation Index was the main source of data, covered period of 10 years (1975-84) with 47 journals and 631 articles. It is found that there has been a tremendous increase in numbers: from 3 papers in 1975 to 158 in 1984 and from one journal in 1975, dealing specifically with the discipline of super-gravity, to 24 journals in 1984. The annual output has been increasing exponentially, creating a major problem of bibliographical control.

\subsection*{2.10 Conclusion}

The above survey of literature is mostly on the peripheral side, attempting to bring out mainly the bibliometric and scientometric studies. Reviews reveals that no effort has been made to analyse the growth biomedical research in India by applying scientometric techniques. The present study therefore focuses attention on Scientometric analysis of Biomedical research literature from India.

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