CHAPTER – II

REVIEW OF LITERATURE: Foregrounding

This chapter devotes to examine the review of works relating to various aspects of Scientometric studies. It could be observed that there are various research studies highlighting the importance of Scientometric analysis and their applications to Library and Information Science. This type of analysis enables the researcher to identify the research gap in the previous studies. Review of related studies further avoids the duplication work that has already been done in that area. It also helps the researcher to study the different aspects of the problem. It enables the researcher to identify the unexplored areas, in order to create new grounds for research. By considering this efficiency of various dimensions of Scientometric studies, the researcher has presented the literature on the basis of reverse chronological order.

Mulla (2012)\(^1\) has described the bibliometric analysis of 998 articles of on information science and scientometrics (ISS) that appeared in different journals during the period of 2005-2009. The study reveals that, most researchers preferred to publish their research results in journals; as such 91.98% of articles were published in journals. More numbers (329, 32.97%) of articles were published in 2009. The authorship trend shows that, out of 1703 authors who contributed a total of 998 articles, out of which more number of (376, 40.96% ) articles were two authored
papers. The degree of collaboration in ISS was 0.78, and the country wise contribution of articles, India would contribute more documents i.e., 83.99% of the total publications. It also further examines year wise distribution of articles, distribution of types of documents, length of the papers, authorship pattern, degree of collaboration among authors, degree of collaboration among co-authors, degree of collaboration among different category of authors, rank wise distribution of collaborators, institution wise distribution of articles, country wise distribution of contributions, state wise distribution of contributions, journal wise distribution of articles.

Karpagam et al. (2011) have analysed the growth pattern of Nanoscience and Nanotechnology literature in India during 1990-2009 (20 years). The Scopus international multidisciplinary bibliographical database has been used to identify the Indian contributions on the field of nanoscience and nanotechnology. The study measures the performance based on several parameters, country annual growth rate, authorship pattern, collaborative index, collaborative coefficient, modified collaborative coefficient and subject profile. Further the study examines national publication output and impact in terms of average citations per paper, international collaboration output and share, contribution and impact of Indian Institutions and impact of Indian journals.
Raja and Balasubramani (2011) have analyzed plasmodium falciparum research publication in India measured from Histcite software and other tools. The results show that the growth of Indian literature in plasmodium falciparum deposition and make the quantitative assessment of the research in terms of year-wise research output, geographical distribution, nature of collaboration, characteristics of highly productive institutions and the channel of communication used by the scientists.

Bjurstrøm and Polk (2011) have demonstrated that IPCC Third Assessment Report is strongly dominated by Natural sciences, especially the Earth sciences. The Social sciences are dominated by Economics. The IPCC assessment also results in the separation of the Earth, Biological and Social sciences. The integration that occurs is mainly between closely related scientific fields. The research community consequently imposes a physical and economic bias and a separation of scientific fields that the IPCC reproduces in the policy sphere. It is argued that this physical and economic bias distorts a comprehensive understanding of climate change and that the weak integration of scientific fields hinders climate change from being fully addressed as an integral environmental and social problem. If climate change is to be understood, evaluated and responded to in its fullness, the IPCC must broaden its knowledge base and challenge the anthropocentric worldview that places human beings outside of nature.
Zheng, Yanning et al. (2011)\textsuperscript{5} have identified the list of highly-productive countries, institutions, authors, and fields in physics. Based on the analysis, it is found that the USA is the world leader in physics, and Japan has maintained the highest growth rate in physics research since 1990. Furthermore, the research focus at Bell Labs and IBM has played vital important roles in physics. A striking fact is that the five most active authors are all Japanese, but the five most active institutions are all from the USA. In fact, only University of Tokyo is ranked among the top 11 institutions, and only American authors have single-author articles ranked among the top 19 articles. The highest-impact articles are distributed across 25 subjects categories. Physics, Multidisciplinary has 424 articles, and is ranked at No. 1 in total articles; followed by Physics, Condensed Matter. Citations are a way to show how researchers build on existing research to further evolve research. The citation count is an indication of the influence of specific articles. The importance of citations means that it is valuable to analyze the articles that are cited the most. This research investigates highly-cited articles in physics (1979-2008) using citation data from the ISI Web of Science. In this study, 1544205 articles were examined.

Choi, Kyeyoun et al. (2011)\textsuperscript{6} have investigated research trends on smart textile and clothing and to suggest future research directions on smart textile and clothing by using scientometrics approach. The research of smart clothing was divided into five categories: technology, human factors, application, manufacturing, and consumer demands and retailing. Technology has emerged as the dominant
category suggesting technological development of smart materials and wearable input devices have been intensively studied and have provided a solid foundation for smart clothing research. The number of research on output devices and data and power transportation showed a gradually increasing trend since 2000. Analysis on technical collaboration among each research field showed a high correlation between input technology and the three main categories: smart materials, functional application and, manufacturing. Material sciences, electronic engineering and computer sciences were shown to be major research disciplines to lead smart clothing research based on quantity of publications.

Builova and Osipov (2011) have briefed information and analytical survey of the papers that were submitted to the Third International Nanotechnology Forum that was held in Moscow on November 1-3, 2010. Scientometric data on the participants, their origins by region and research center, as well as an analysis of the achievements and problems of Russian research on nanotechnologies, are given.

Poornima et al. (2011) have analysed of 1060 publications published by Indian scientists during 1998 to 2010 and indexed by Web of Science online Database indicates that the publication output in the Indian Research Publication. Centre Food Technology Research Institute, BARC, Indian Institute of Technology, Defense Food Research Lab and institutes are the major producers of research output. Most of the prolific authors are from the highly productive institutions. This work is
to provide a profile of research in Indian Research Publication in India. This includes tracking the number of papers, scatter of papers over journals, and its effect on publication output, authors’ institutional affiliations and authorship patterns.

Konur, Ozcan (2011)⁹ has explored the characteristics of the literature on the algae and bio-energy published during the last three decades, based on the database of Science Citation Index-Expanded (SCIE) and Social Sciences Citation Index (SSCI) and its implications using the scientometric techniques. The results of this work revealed that the literature on the algae and bio-energy has grown exponentially during this period reaching 717 papers in total. Most of document type is in the form of journal articles, reviews, and proceedings, constituting 98% of the total literature and English is the predominant language (97.6%). USA, China, Germany, and England are the four biggest contributing countries on the algae and bio-energy literature publishing, 26%, 8%, 8%, and 8% of the sample, respectively. The Chinese Academy of Sciences is the largest institutional contributor publishing 2.6% of the papers. The most publishing four authors are Wilhelm (13 papers) followed by Wu (15 papers), Mimuro (10 papers), and Zhao (9 papers). "Bioresource Technology" is the most publishing journal with 24 published papers, followed by "Journal of Applied Phycology" (17 papers), and "Biotechnology and Bioengineering" (15 papers). "Biotechnology & Applied Microbiology" is the subject area with 24.3% of the sample published. This is followed by "Energy & Fuels" (16.3%), "Marine & Freshwater Biology" (14.2%), and "Environmental Sciences" (12.3%). The total
number of citations is 11,079, giving a ratio for the "Average Citations per Item" as 15.45 and "H-index" as 52. A list of most-cited 25 authors is produced and Chisti (2007) receives 320 citations with 80 total average citations per year. This paper is followed by Lewis and Nocera (2006; 296 citations), Demirbas (2001; 187 citations). Chisti (2007) has the highest impact on the literature on the algae and energy with total average citations per year of 80. This is followed by Lewis and Nocera (2006, 59.8 annual citations) and Chisti (2008, 41 annual citations).

**Surulinathi et al. (2011)**\(^{10}\) analysed the Indian literature output scanned in Web of Science during 1999–2011 on solar energy research indicates that the growth of the literature. The area of solar fuels and Material sciences multidisciplinary has received maximum attention. Publication output of literature by different countries collaboration follows the trend in basic sciences with USA and South Korea being the major producers with India. The contribution of Indian Institutions and Global Citation Scores, h-index, g-index and gh-index has been analysed.

**Si, Linbo (2010)**\(^{11}\) has carried on the statistical analysis to the published papers, column set, author and citation of Tsinghua Journal of Education (2007-2008) through applying the method of scientometrics, and makes the appraisal of its publication characteristic and academic influence accordingly.
Srinivasa Ragavan et al. (2010)\textsuperscript{12} analysed the Publication pattern of Harvard Business Review (HBR) from 1999-2010 and the journal is a premier periodical in Business and Management published from Harvard Business School, Boston. United States. The study is based on the 3329 research articles received 8167 Global Citation Scores coverage during the study period. The Source of the study is the internationally known and highly used and authentic database, Web of Science. The paper illustrates authorship pattern, growth of publications, source-wise distribution, institutions wise distribution, and h-index based on the analysis of the data. The country wise analysis reveals the USA as major contributor with 47.40\% of total literature.

Builova and Osipov (2010)\textsuperscript{13} have scrutinized the information and the analytical survey of the papers were submitted to the Second International Nanotechnology Forum held in Moscow in October 2009. Scientometric data on the participants, their region oriented origins and research centers, as well as an analysis of the advancements and problems of Russian research in nanotechnologies, are given.

Vinitha et al. (2010)\textsuperscript{14} have attempted to analyse quantitatively the growth and development of water resource management research in India in terms of publication output as reflected in Web of Science database for the period between 1982-2009. Scientometrics is concerned with the quantitative features and
characteristic of science. Large scale scientific research has become a major impetus of scientific advances.

**Li and Hou (2010)** have reviewed the changes of 5 Finance and Economics universities based on the analysis of a series of scientometric indicators. The following indicators are calculated for each university: Peer Review, the quality of research output, the quality of academic staff, Foreign content and faculty/student ratio. The stakeholders of higher education institutions use these scientometric indicators to determine the rankings. For more just and impartial, the main emphasis of this paper uses the h-index to grade or rank journals for evaluating university researcher’s performance. The result of ranking of 5 Finance and Economics universities shows that although the method provided in this paper is considered inherently controversial for not being absolutely objective, they are still used as reference to assist in making certain crucial decisions for many research institutions, government funding agencies.

**Guns and Liu (2010)** have investigated scientific collaborations in China in the context of international collaboration on the basis of a co-authorship network (in the field of scientometrics), using Q-measures as indicators of internationalization in collaboration. The results show that a relatively small group of Chinese researchers is internationally active, and that most of them mainly form bridges between China and other countries. There is a clear dominance of three institutes, viz. ISTIC, Dalian
University of Technology, and Henan Normal university. The main domestic broker for China is Liang Liming, whereas the main foreign broker for China is Ronald Rousseau. A small amount of international collaborations takes place outside the largest component of the network.

Surulinathi et al. (2010)\(^{17}\) have analysed the research publication performance of Wi-Fi Communication research literature which is an important aspect of the content and meaning of the present study. Scientometric studies are used to identify the pattern of publications, authorship, citation and secondary journals coverage in the hope that such regularities can give and insight into the dynamics are under consideration.

Vinkler (2009)\(^{18}\) has highlighted several simple and sophisticated scientometric indicators generally applied in the literature (e.g. total number of publications and citations, citations per journal paper, relative citedness indexes, Hirsch index, etc.), which may characterize the publications of scientists both qualitatively and quantitatively. The calculation methods generally use data referring to the total set of papers studied. Scientific progress, however, may be attributed primarily to information in the highly cited publications. Therefore, a new indicator (\(\pi\)-index) is suggested for comparative assessment of scientist’s activity in similar subject fields. The \(\pi\)-index is equal to one hundredth of the number of citations
obtained to the top square root of the total number of journal papers ranked by the decreasing number of citations.

**Suluimanov, Frolova and Khasenova (2009)** have analysed the results of the scientometric analysis of foreign publications by Kazakh authors that reflected in the SCOPUS database in 1991-2008. The publication activity is expressed in 3883 documents, the citation index of which is 10 132. The average share of Kazakh publications in the total worldwide flow is equal to 0.017%. The citation rate of publications was revealed to have significantly grown since the 1996-2000 period. It is shown that most articles were written in English and published in periodical editions. The main themes of publications are represented by physics and chemistry. The leading foreign partners of Kazakhstan in the scientific sphere were determined. Kazakh-Russian scientific cooperation is developing most fruitfully in the present century.

**Jacsó (2009)** discussed the Publish or Perish (PoP) software and finds that is a swift and elegant tool to provide the essential output features that Google Scholar does not offer. It is found that PoP allows the user to edit the result lists presented in a compact, efficient grid-format. It facilitates the identification and removal of duplicate entries by offering dynamic sorting of the set by eight metadata elements, un-checking items and instant recalculation of the indicators. Some changes are recommended to enhance this useful utility by allowing users to clean and edit the
erroneous entries in the result set, and then back-load it to PoP for the recalculation of the indicators. It is also suggested that the option to upload into PoP the result lists produced in CSV format from Web of Science and Scopus (which have much more reliable and reproducible data than Google Scholar) should also be offered. The result of recent experiments in calculating the h-index and other bibliometric and scientometric indicators from Google Scholar with the Publish or Perish software.

Vinkler, Peter (2007)\textsuperscript{21} has indicated that calculating scientometric indexes for individuals, self-citations should be excluded and the effect of the different bibliometric features of the field should be taken into account. Scientometrics cannot offer a simple consistent method for measuring the scientific eminence of individuals. The h-index method introduced by Hirsch was found applicable for evaluating publications of senior scientists with similar publishing features only. The correctness of the indexes used for evaluating journal papers of individuals should be investigated on the individual level also. Some simple methods using the number of citations and journal papers, and the number of citations obtained by the most frequently cited papers are suggested and tested to demonstrate the advantages and disadvantages of indexes.

Surulinathi et al. (2008)\textsuperscript{22} attempted to analyse quantitatively the growth and development of Knowledge Management Research in India in terms of publication output as reflected in Scopus database. During 1999-2007 a total of 51 papers were
published by the Knowledge Management researchers to various domains: Business, Management and Accounting (24), Engineering (18), Social Sciences (7), Computer Science (6), Decision Sciences (6), Multidisciplinary (4), Mathematics (3), Environmental Science (2), Agricultural and Biological Sciences (1), Earth and Planetary Sciences (1), Economics, Econometrics and Finance (1), Materials Science (1). Year-wise growth of publications and input of records to Scopus database by India is analyzed. More than 80 percent of publications were published in journals. The most preferred journals were International Journal of Information Technology and Management (7), Journal of Scientific and Industrial Research (4), Electronic Library (2), Human Systems Management (2), Journal of Knowledge Management (2), International Journal of Technology Management (2), International Conference on Information and Knowledge Management Proceedings (2), Proceedings Frontiers in Education Conference (2), others journals each (1). There were as many as 24 (47.06) papers contributed by single author. There were five authors contributions is zero and more than 5 authors contribution is less than 1(1.96). The publication behavior indicates that the Knowledge management researchers were lowly selective in publishing.

Ivancheva (2001)\textsuperscript{23} has an attempted made to give an answer to the question: Why do most Bibliometric and scientometric laws reveal characters of Non-Gaussian distributions, i.e., have unduly long "tails"? application of the approach of the so-called "Universal Law," discovered by G. Stankov (1997, 1998) is implemented. The
basic principle used is that of the reciprocity of energy and space. A new "wave concept" of scientific information has been propounded, in which the terms of the well-known Bibliometric and scientometric distributions find a rather satisfactory explanation. One of the made corollaries is that $\alpha = 1$ which is the most reasonable value for the family of Zipf laws, applied to information or social phenomena.

Vinkler (2000)$^{24}$ has reviewed that the evaluation of real scientometric systems needs compromises among the parties interested and between the practical applicability and the theoretical requirements of scientometrics. In the Chemical Research Center of the Hungarian Academy of Sciences, special scientometric indicators have been used for evaluating publication activity of research teams for about 30 years. Modified Garfield impact factors for journals as well as relative citedness of papers are applied as indicators because of differences among subfields in scientometric features of the publications assessed.

Vinkler (2010)$^{25}$ has determined the eminence of scientific journals, a new indicator stressing the importance of papers in the "elite set" (i. e., highly cited papers) is suggested. The number of papers in the elite set ($P_{\pi v}$) is calculated with the equation: $(10 \log P) - 10$, where $P$ is the total number of papers in the set. The one-hundredth of citations ($C$) obtained by $P_{\pi v}$ papers is regarded as the $\pi_v$-index which is field and time dependent. The $\pi_v$-index is closely correlated with the citedness ($C/P$) of $P_{\pi v}$ papers, and it is also correlated with the Hirsch-index. Three types of Hirsch-
sets are distinguished, depending on the relation of the number of citations received by the Hirsch-paper (ranked as h) and the paper next in rank (h + 1) by citation. The h-index of an Anomalous Hirsch-set (AH) may be increased by a single citation to a paper outside the Hirsch-core. (A set of papers may be regarded as AH, where the number of citations to the Hirsch-paper is higher than the h-index and the next paper in rank shows as many citations as the value of the h-index.).

Abbasi and Biglu (2011) have analyzed quality and quantity of scientific productions originated by Iranian medical sciences Universities during 1999-2008. All raw data was extracted from the database of Web of Science during 1999-2008. The findings of study showed that the number of scientific productions emanated by Iranian Medical Sciences Universities has increased through the study period. The number of scientific productions increased from 259 documents in 1999 into 15852 documents in 2008, an increase of greater than 60 times. Articles were the most frequent document type indexed in the WoS. English language was the dominant language of publications. Pharmacology and pharmacy have been the most interesting subject area for researchers in theses universities. Despite fluctuations in the number of received citations in scientific productions and H-index of these universities during study period, the number of self-citations has increased significantly, but in terms of citation average per paper, a descending order was observed during the study decade.
Khan et al. (2011) have founded that e-government literature in developing countries has somewhat adopted a balanced approach and is moving away from a merely theoretical or conceptual bases toward an empirical foundation. However, the literature lacked depth and balance in terms of issues/topics discussed and methodologies applied. In the light of the findings, strengths, limitations, and future directions for e-government research in developing countries are discussed. Utilizing scientometrics approach, The authors have analyzed and synthesized e-government (EG) literature that deals with the issues/topics in developing countries from the lens of socio-technical theory (STT). 145 articles from 7 core e-government journals published during the last decade were selected and reviewed for analyzing e-government literature related to developing countries. The growth pattern of e-government literature shows that e-government studies pertaining developing countries issues/topics have rapidly increased during the last decade covering a range of topics/issues studied from socio-technical aspects.

Opthof and Leydesdorff (2010) have highlighted the Center for Science and Technology Studies at Leiden University and advocate the use of specific normalizations for assessing research performance with reference to a world average. The Journal Citation Score (JCS) and Field Citation Score (FCS) are averaged for the research group or individual researcher under study, and then these values are used as denominators of the (mean) Citations per publication (CPP). Thus, this normalization is based on dividing two averages. This procedure only generates a legitimate
indicator in the case of underlying normal distributions. Given the skewed distributions under study, one should average the observed versus expected values which are to be divided first for each publication.

Waltman et al. (2011) highlighted the crown indicator as a well-known bibliometric indicator of research performance developed by our institute. The indicator aims to normalize citation counts for differences among fields. They critically examined the theoretical basis of the normalization mechanism applied in the crown indicator. They also make a comparison with an alternative normalization mechanism. The alternative mechanism turns out to have more satisfactory properties than the mechanism applied in the crown indicator. In particular, the alternative mechanism has a so-called consistency property. The mechanism applied in the crown indicator lacks this important property. As a consequence of our findings, we are currently moving towards a new crown indicator, which relies on the alternative normalization mechanism.

Yang (2010) has used the Web of Science, this article researched recent developments and changes in the Scientometrics by bibliometrics analysis of articles, proceedings papers, letters and reviews published in the journal Scientometrics during 2000 to 2010 and the citation to these papers. The research indicates that Scientometrics is in the active stage of development in recent years. The United States, Spain, Belgium and China are the most active countries in the field of
Scientometrics. The study also identified the most active research institutes, researchers, and subject areas the Scientometrics applied to.

Si (2010)\textsuperscript{31} has carried on the statistical analysis to the published papers, column set, author and citation of Tsinghua Journal of Education (2007-2008) by applying the method of scientometrics, and makes the appraisal of its publication characteristic and academic influence accordingly.

Garfield (2009)\textsuperscript{32} has highlighted Scientometrics and Bibliometrics that are now at least half a century old. Indeed, the field can be traced to early quantitative studies in the early 20th century. In the 1930s, it evolved to the "science of science." The publication of J.D. Bernal's Social Function of Science in 1939 was a key transition point but the field lay dormant until after World War II, when D.J.D. Price's books Science Since Babylon and Little Science, Big Science were published in 1961 and 1963. His role as the "Father of Scientometrics" is clearly evident by using the HistCite software to visualize his impact as well as the subsequent impact of the journal Scientometrics on the growth of the field. Scientometrics owes its name to V.V. Nalimov, the author of Naukometriya, and to Tibor Braun who adapted the neologism for the journal. The primordial paper on citation indexing by Garfield which appeared in Science 1955 became a bridge between Bernal and Price. The timeline for the evolution of Scientometrics is demonstrated by a HistCite tabulation.
of the ranked citation index of the 100,000 references cited in the 3000 papers citing Price.

Ying (2009)\textsuperscript{33} has described a method that can solve the selection problem of peer review experts - scientometrics. From the external part of the scientific community, we can deal with the expert selection of peer review that is the internal part of the scientific community in essence. Only the scientific selection of peer review experts can guarantee the scientific evaluation of the objectiveness, impartiality and fairness.

LaRowe et al. (2009)\textsuperscript{34} examined the Scholarly Database aims to serve researchers and practitioners interested in the analysis, modelling, and visualization of large-scale data sets. A specific focus of this database is to support macro-evolutionary studies of science and to communicate findings via knowledge-domain visualizations. Currently, the database provides access to about 18 million publications, patents, and grants. About 90\% of the publications are available in full text. Except for some datasets with restricted access conditions, the data can be retrieved in raw or pre-processed formats using either a web-based or a relational database client. It explains the database design, setup, etc., and reports the temporal, geographical, and topic coverage of data sets currently served via the database.
Trimble (2009)\textsuperscript{35} has reviewed that counting papers and citations is one of the way to estimate the significance of particular astronomical telescopes and other facilities in the long time gap between the verdict of history and the referee's report on the recent proposal. This has been done for 2,184 observational astronomy papers published between 1960 and 1964 (with 14,237 citations in 1965-1969) and the numbers looked at in various ways. The extreme dominance of California in optical astronomy and of the UK and Australia in radio astronomy provides the background against which ESO, NOAO, NRAO, and A&A were founded, with equality of access to facilities having increased enormously in the intervening 40 years, but inequality of results have increased slightly

Hou, Kretschmer and Liu (2008)\textsuperscript{36} have explained the structure of scientific collaboration networks in scientometrics is investigated at the level of individuals by using bibliographic data of all papers published in the international journal Scientometrics retrieved from the Science Citation Index (SCI) of the years 1978-2004. Combined analysis of social network analysis (SNA), co-occurrence analysis, cluster analysis and frequency analysis of words is explored to reveal: (1) The microstructure of the collaboration network on scientists' aspects of scientometrics; (2) The major collaborative fields of the whole network and of different collaborative sub-networks; (3) The collaborative center of the collaboration network in scientometrics.
Kademani et al. (2008) attempted to analyse the growth and development of Vacuum research in Nuclear Science and Technology, as reflected in publication output covered by International Nuclear Information System (INIS) database during 2002-2006. A total of 12027 papers were published in the field of vacuum science. United States topped the list with 1936 (16.10%) publications followed by Japan with 1770 (14.70%) publications. The highest number of publications (3276) were published in 2004. The average number of publications published per year were 2405.4. The highest number of publications were in 'Physics of Elementary Particles and Fields' with 2644 (21.98%) publications. The authorship of collaboration trend is towards multi-authored papers. The highly productive institutions were: Japan Atomic Energy Research Institute (Japan) with 366 publications, University of Tokyo (Japan) with 274 publications, Hiroshima University (Japan) with 245 publications, Osaka University Japan (Japan) with 224 publications and Chinese Academy of Science (P-R-China) with 223 publications. The most preferred journals for publication were: Journal of Vacuum Science and Technology-A with 857 papers, Physical Review -D with 765 papers, Journal of High Energy Physics with 500 papers, Thin Solid Films with 311 papers, Journal of Electron Spectroscopy and Related Phenomena with 309 papers, and AIP Conference Proceedings with 308 papers.

Sangam, Kiran Savanur and Manjunath (2007) emphasised on Ramaseshan scientific contributions in various journals and some classic papers. In
his entire career as a scientist he has collaborated with 47 eminent scientists and students and has published a total of 178 papers during the years 1944–2000. His field of interest has been varied and thus classified into 4 main area, i.e.: Crystallographic studies, Magneto-optics & Optics, Solid State Physics and Miscellaneous topics. S. Ramaseshan has contributed for the better understanding of various subjects in which he specialized during his years at the Indian Institute of Science, University of Madras and the Raman Research Institute.

Pouris (2007)\(^{39}\) has reported the findings of a scientometric analysis of nanoscale research in South Africa during the period 2000-2005. The ISI databases were identified as the most appropriate information platform for the objectives of the investigation and were interrogated for the identification of South African authors publishing in the field. The article identifies trends over time, major institutional contributors, journals in which South African authors publish their research, international collaborators and performance in comparison to four comparator countries (India, Brazil, South Korea and Australia). The major findings of the investigation are as follows: nanoscale research in South Africa is driven by individual researchers interests up to date and it is in its early stages of development; the country's nanoscale research is below what would one expect in light of its overall publication output; the country's nano-research is distributed to a number of Universities with subcritical concentration of researchers.
Kademani et al. (2007) attempted to analyse the growth and development of science and technology (S&T) activities in India, as reflected in publication output covered by Science Citation Index (SCI) during 1990-2004. The Indian scientists published a total of 1,82,111 papers in SCI covered journals during the above period. The present study analyses the broad features of Indian S&T by focusing on its publication growth characteristics, language, format and media of communication, research quality, institutional productivity, patterns of research collaboration, and broad and narrow subject areas of interests of Indian institutions and scientists. A broad comparison of India's research output with select countries, particularly with China, has also been made.

Cheng and Liu (2006) highlighted the top 500 world universities are classified into 21 types according to their disciplinary characteristics using clustering method. The indicators used to represent the disciplinary characteristics of an institution are the proportion of publications in six broader disciplinary areas: Arts/Humanities & Social Sciences, Natural Sciences & Mathematics, Engineering/Technology & Computer Sciences, Life Sciences, Clinical Medicine, and Interdisciplinary & Multidisciplinary Sciences. Institutions have been classified into types of having focus in a disciplinary group, having priority in a disciplinary group, having orientation in a disciplinary group, and balanced. The distribution of different types of institutions with respect to countries and ranks are analyzed.
Jucher, Schlögl and Stock (2006)\textsuperscript{42} have reviewed the dimensions of the scientometrics of journals with reference to the components that are (1st) journal production (articles, authors), (2nd) journal content,(3rd) journal reception(readers),(4th) formal scholarly communication (references, citations), (5th) journal editing (editorial politics, publication). The journal "BuB - forum für Bibliothek und Information "(BuB) is analyzed scientometrically. BuB is the library and information studies journal with the highest circulation in German speaking countries. 4,297 journal articles including 6,803 references from the observation period 1990 to 2003 were taken into consideration. Contrary to what was expected with regard to informetric laws, BuB shows remarkable specific characteristics: There is no single top author, but a homogeneous group of authors dominating the literature production. The references present a very high concentration on the own journal. BuB is like an island, to which only few strange information will be washed ashore. Though men and women each produce exactly 50\% of all articles, there are gender-specific differences: male authors produce more literature reviews and long articles, female authors write more short articles and conference reports. The references' half-life is with 2.7 years very low, the half-life of cited monographs is higher than that of cited journal articles.

McKiernan (2005)\textsuperscript{43} has described the bibliometrics as traditionally associated with the quantitative measure of documentary materials and embraces all studies which seek to quantify the process of written communication. These include
science studies, research evaluation, knowledge management, environmental scanning, trend analysis, and the optimization of library and information resources. Significant Web resources relating to bibliometrics and related approaches are now available.

Kumar and Garg (2005)\(^{44}\) have analysed 2058 papers published by Chinese authors and 2678 papers published by Indian authors in the field of computer science during 1971-2000 which indicates that India's output is significantly higher than the Chinese output. However, China is catching up fast. Chinese researchers prefer to publish their research results in domestic journals, while Indian researchers prefer to publish their research results in journals published in the advanced countries of the West. Also the share of papers in journals covered by SCI for India was higher than from China. However, no significant difference has been observed in the impact of the research output of the two countries as seen by different impact indicators. Team research is more common in India as compared to China.

Uzun (2004)\(^{45}\) reported the findings from a study of patterns of foreign authorship of articles, and international composition of journal editorial boards in five leading journals in the field of information science, and scientometrics. The study covered an American journal and four European journals. Bibliographic data about foreign authors and their national affiliation from five selected years of publication were analyzed for all journals. The foreign inputs of articles were
extremely high in Information Processing & Management, and Scientometrics, and were relatively low in the other three journals. The numbers of foreign countries contributing in all journals have increased rapidly since 1996. Canada, England, Belgium, Netherlands, China, and Spain were the countries with high contributions in JASIST. The authors from the USA have dominated the foreign-authored articles in all European journals. A simple linear regression analysis showed that 60% of variation in the proportion of foreign-authored articles in the set of five journals over the selected years could be explained by the percentage of foreign members on the editorial boards of the journals.

Bharvi, Garg and Bali (2003)\textsuperscript{46} have analysed 1317 papers published in first fifty volumes during 1978 to 2001 of the international journal Scientometrics indicates the heterogeneity of the field with emphasis on scientometric assessment. The study indicates that the US share of papers is constantly on the decline while that of the Netherlands, India, France and Japan is on the rise. The research output is highly scattered as indicated by the average number of papers per institution. The scientometric output is dominated by the single authored papers, however, multi-authored papers are gaining momentum. Similar pattern has been observed for domestic and international collaboration.

Chen et al. (2002)\textsuperscript{47} have integrated approach to scientometric studies with emphasis to the use of information visualization and animation techniques. This
study drawn upon citation and co-citation patterns is derived from articles published in the journal *Scientometrics* (1981–2001). The modeling and visualization take an evolutionary and historical perspective. The design of the visualization model adapts a virtual landscape metaphor with document co-citation networks as the base map and annual citation rates as the thematic overlay. The growth of citation rates is presented through an animation sequence of the landscape model. Issues concerning the visual-spatial design are discussed from a citation analysis point of view.

Garg and Padhi (2002)\(^{48}\) have analysed 952 publications published by Indian scientists and abstracted by Journal of Current Laser Abstracts during 1970-1994 which indicates that laser research in India picked up during 1978-1994 and reached its peak in 1980. The Indian output in the field of laser research forms an integral part of the mainstream science as reflected by the pattern of publications and their citations in the international literature. Laser research performed in India improved considerably during 1985-1994 as compared to 1970-1984 as seen by different impact indicators such as citation per paper, proportion of high quality papers, and publication effective index. India’s citation rate per paper for highly productive authors is at par with the world citation rate per paper. The study indicates that the proportion of mega authored papers increased during 1990-1994 and the international collaboration is mainly with the USA.
Garg (2002)\(^{49}\) has analysed 1223 papers published by India (347 papers) and China (876 papers) at conferences and in journals during 1993 and 1997 in the field of laser S&T indicates that China"s output was twice to that of India. However, Activity Indices for both the countries in 1993 and 1997 were almost the same. Chinese scientists preferred to publish in domestic journals, while Indian scientists published in foreign journals. The impact made by Indian papers was more than for Chinese papers, as reflected by normalized impact per paper, proportion of papers in high quality journals, and publication effective index. Indian papers also got more citations per paper than Chinese papers. Team research appears to be better in China than in India, as reflected by the number of mega-authored papers produced by the two countries.

Peritz and Bar-Ilan (2002)\(^{50}\) have examined the extent to which the field of bibliometrics and scientometrics makes use of sources outside the field. The research was carried out by examining the references of articles published in Scientometrics in the course of two calendar years, 1990, 2000. The results show that in 2000, 56.9% (and 47.3% in 1990) of the references originated from three fields: scientometrics and bibliometrics; library and information science; and the sociology, history and philosophy of science.

Uzun (2002)\(^{51}\) has surveyed a set of ten scholarly journals that publish the mainstream of papers in the field of Scientometrics, Informetrics, and Bibliometrics
(SIB). The survey is limited only to the research articles published in the field for the two decades period 1981-2000. Each journal was examined issue by issue for the institutional affiliations of contributing authors. Institutional rankings for the total period and the two decade periods; 1981-1990 and 1991-2000 were determined by awarding credit to the authors’ institutions based on authorship. In the composite of ten journals, the University Sheffield (England), the University of North Carolina (USA), the University of Leiden (Netherlands), the City University of London (England), the National Institute of Science, Technology and Development Studies (India), the University of Sussex (England), the University of Illinois (USA), the University of Michigan (USA), the Hungarian Academy of Sciences Library (Hungary), and Indiana University (USA) emerged as the ten most productive institutions for the period 1981-2000.

Granovskiy (2001)\textsuperscript{52} has devoted to the scientometric research of Professor V.V. Nalimov (1910-1997) of Moscow State University. His first scientometric article was published in 1959: mathematical models of world science growth were examined and logical grounds for the applicability of these models were also given. In his further works, V.V. Nalimov continued to stress the importance of quantitative studies of science development. In 1969, the monograph on scientometrics by V. V. Nalimov and his co-author Z. M. Mulchenko was published. One of the latest works by Nalimov was an analysis of articles published by The Journal of Transpersonal
Psychology: Here the scientometric approach was used to study the origin and development of a new scientific branch.

**Jansz (2000)**\(^{53}\) revealed in 1988 Le Pair postulated the existence of a citation gap for technological research. Several cases were studied, which confirmed his hypothesis. In the same period the use of bibliometric indicators for policy purposes increased. Here he saw the citation gap causing a disadvantage for application-oriented research groups. This is not merely an injustice, it also leads to sub optimum use of available funds, to the detriment of science as a whole. In addition, it may, in the long term, undermine the reputation of scientometrics as a science in its own right.

**Garg and Padhi (2000)**\(^{54}\) have analysed of 766 publications by prolific authors in scientific journals indicate that prolific authors produce about 25% of the total scientific output in periodical literature in laser science and technology. The average productivity per author is about 2. Prolific authors from most of the countries belonged either to academic or research institutions except in USA and Japan. Prolific authors on average made more impact than non-prolific authors. However the situation varied from country to country.

**Karki and Garg (1999)**\(^{55}\) attempted to assess the performance of Indian organic chemistry research during the 70s and 80s. It identifies the significant work
and its impact using mainstream connectivity, surrogate measures of quality and relative impact indicators. It is observed that the organic chemistry research performed in India during the later period (80s) has improved slightly as compared to the previous period (70s).

Garg and Padhi (1999) have analysed 4650 publications abstracted in Journal of Current Laser Abstracts Vol. 27 (April 1990-March 1991) and it indicates that 14 countries contributed about 94% of the research output with USA topping the list followed by Japan and the erstwhile USSR. Technical reports and patents, besides articles in scientific journals constitute an important source of information on laser science and technology. "Spectroscopy of laser output" is the sub-speciality which has received maximum emphasis. USA has paid almost equal emphasis for theoretical, experimental and applications of laser research, while such pattern is not applicable for other countries. For USSR, China, and India, the impact of research did not commensurate with the publication effort.

Cunningham (1997) has presented the results of an examination of a selection of published European evaluations. The incidence of quantitative and scientometric approaches has been reviewed and an assessment made of their contributory role in each evaluation. The various approaches have been broadly categorised according to the type of data they draw upon, and by the issues they attempt to address. The author analyses such approaches with regard to the degree of
success in meeting the objectives of the evaluation. In the light of this some likely future trends are suggested.

Van Raan (1997)\textsuperscript{58} argued that the core research activities of scientometrics fall in four interrelated areas: science and technology indicators, information systems on science and technology, the interaction between science and technology, and cognitive as well as socio-organisational structures in science and technology. He emphasizes that an essential condition for the healthy development of the field is a careful balance between application and basic work, in which the applied side is the driving force. In other words: scientometrics is primarily a field of applied science. This means that the interaction with 'users' is at least as important as the interaction with colleague-scientists. He states that this situation is very stimulating, it strengthens methodology and it activates basic work. He considers the idea of scientometrics lacking theoretical content or being otherwise in a 'crisis-like' situation as groundless. Scientometrics is in a typical developmental stage in which the creativity of its individual researchers and the 'climate' and facilities of their institutional environments determine the progress in the field and, particularly, its relation with other disciplines.

The survey by Haiqi and Yuhua (1997)\textsuperscript{59} is based on the data recorded in the Science Citation Index (SCI) database between 1987 and 1993, and it is intended to study the research performance in the People's Republic of China. The 35,087 papers
published in domestic or foreign periodicals were selected for analysis and evaluation of the distribution of publications and citations, for the numerical characterization of research performance in China. The findings indicate that 17,687 papers covered by the Source Indexes of the SCI in the period 1990-1992 had received 7944 citations in the year 1993 and that the mean citation rate is 0.45. The number of cited papers is 4491 and the proportion of cited papers to the total is 0.25. Research performance in China has increased appreciably during the past few years, both in regard to relative output of publications and in their impact on the international research productivity.

Cahlik and Jioina (1996) demonstrated the use of the scientific field of artificial neural networks, an approach to dynamic analysis of scientific fields. A computer program Lexidyn has been developed to make the dynamic analyses possible. Seeing the evolution of a scientific field through time can be a help in evaluating potential of further research in a given field or in some of its themes. Vlachý (1994) examined turning under the aegis of our (former) classic once again: The World is ruled by spontaneity which escapes rationally oriented science. Indeed, it is worth having a choice occasionally.

Sitarska (1987) has described the curriculum subject matter and its placement in the didactic processes at the Institute of Library and Information Science at the Warsaw University comparing some elements with other academic schools in Poland. Bibliographic traditions, and traditions in teaching the history of
science are indicated as the basis for the present state of affairs. In addition to the
discussion of classes and topics dealing with bibliometrics and scientometrics, also
problems of reading list repertoire and subject matter of research work, connected
with the didactic activity considered, are discussed.

Subbiah Arunachalam and Garg (1986)\(^63\) have analysed of papers
published over a two-year period from the five ASEAN Countries, viz. Indonesia
(182), Malaysia (452), the Philippines (241), Singapore (258) and Thailand (447),
and covered in Science Citation Index 1979 and 1980; and citations to them in the
international literature of science as seen from SCI 1979-1983 reveals that despite the
relative economic affluence, science in these countries is still on the periphery.
Except in the Philippines, the thrust in these countries seems to be in medical
research as is evident from the large number of papers published in medical journals.
In the Philippines, medicine comes a close second to agriculture, which leads, largely
thanks to the contributions of the International Rice Research Institute (IRRI).
Prolific authors, and institutions and journals often used by ASEAN scientists, and
the better-cited papers are identified. Most papers are published in low-impact
journals and are rarely cited

Subbiah Arunachalam and Singh (1985)\(^64\) highlighted the Prolific
institutions and authors have been identified as well as journals most often used, and
highly cited papers. Many of the papers appeared in high impact international
journals, with Physical Review B (26), Journal of Low Temperature Physics (11) and Solid State Communications (10) leading the field. Among the five institutions active in the area, Tel Aviv University (68) accounts for more than half of Israel's publication output. Hebrew University (32) and Technion Institute of Technology (22) are the other major centres of research in superconductivity. Five of the 130 papers have won more than 20 citations each up to 1982, and 22 papers more than 10 citations. Israeli papers in superconductivity seem to belong to the mainstream literature in the area as seen from their decent citation record, which is better than that of Canada and almost close to that of the USA. Most of these papers are theoretical/computational and about 30% of them are experimental.

**Rip and Courtial (1984)**\(^{65}\) have analysed developments of scientific fields, scientometrics provides useful tools, provided one is prepared to take the content of scientific articles into account. Such cognitive scientometrics is illustrated by using as data a ten-year period of articles from a biotechnology core journal. After coding with key-words, the relations between articles are brought out by co-word analysis. Maps of the field are given, showing connections between areas and their change over time, and with respect to the institutions in which research is performed. In addition, other approaches are explored, including an indicator of 'theoretical level' of bodies of articles.
Conclusion

To conclude, it can be stated that research in this field takes different and variegated moulds that ensure the reliability of findings in Green Computing research. It is found from the review of existing literature that the standard Scientometric and Bibliometric techniques such as Bradford’s, Lotka’s and Zipf’s laws are used by the previous studies. In addition, some of the research papers reviewed could found the applications of citation scores, the recent techniques of scientometrics were incorporated in their studies. Accordingly, the present study has used all the conventional scientometric techniques and also recently emerged techniques such as g-index, h-index, gh-index, p-index and so on. The researcher also has used some of the techniques which are not used in earlier studies such as citation map, co-author visualizer map, Historiographic map, Bibliographic coupling map, co-word map, Knowledge visualize map and so on. It is also found that the theses on scientometric that were reviewed were not covered all the important techniques that are recently used in scientific research assessment. The existing literature analysis also reveals that only a few number of research studies were carried on Green Computing and related aspects. Hence, the present study could enable to bridge the research gap on scientometric output of Green Computing, particularly using most of the recent scientometric techniques.
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