

**RESEARCH PRODUCTIVITY OF
SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES
AND TECHNOLOGY, THIRUVANANTHAPURAM:
A SCIENTOMETRIC STUDY**

Dissertation

**Submitted to the University of Kerala in partial fulfillment of the requirement for
the Degree of Master in Library and Information science**

by

**BINU BABU
Reg. No. 20002**

Under the Supervision of

Dr. K.G. SUDHIER



**SCHOOL OF DISTANCE EDUCATION
UNIVERSITY OF KERALA
THIRUVANANTHAPURAM-695 034**

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CERTIFICATE

This is to certify that the dissertation entitled " *Research Productivity of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram: A Scientometric Study*" Submitted by Mr. Binu Babu (Reg. No. 20002) in partial fulfillment for the requirements of the Degree of Master Library & Information Science is an original work carried out by him under my guidance.

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Countersigned by,

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DECLARATION

I hereby declare that the Dissertation entitled "***Research Productivity of Sree Chitra Tirunal Institute For Medical Sciences And Technology, Thiruvananthapuram: A Scientometric Study***" is a bonafide record of research work carried out by me in partial fulfillment of the requirements for the Degree of Master in Library & Information Science (2014-2015) of the School of Distance Education, University of Kerala, Thiruvananthapuram. This work is original and has not previously presented before any university by anybody for the award of any Degree, Diploma, Fellowship/Associateship or other similar title or recognition of any University or Society.

Thiruvananthapuram

24.06.2016

Binu Babu

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24.06.2016

Binu Babu

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Science and technology are the major driven forces of our society. They are also assuming an increasingly important role in the conduct and Structure of domestic and foreign business. The scientific discoveries and inventions are of great value to the mankind. Invention leads to research. Research is carried out for the development of new knowledge or improvement of existing knowledge and providing solutions to specific problems and for improving processes and practices. Since research find outs have significant value for society, research has attained an important place in all fields of knowledge. Medical Sciences & Technology is an important than all other fields, which plays vital role in health care and allied fields of the human life.

Evaluation is a very important component of any research and development activity in an institution. One well known productivity indicator is the number of publications produced by scientists, institutions, or research groups. Studies like this will highlight the contribution of the division or department as well as the contribution of all the individual scientists engaged in research activity. This will also provide some insights into the complex dynamics of research activity and enable the Science and Technology policy makers and science administrators to provide adequate facilities and direct the research activities in a proper direction. Individuals are the source of ideas.

Medical sciences and technology is the application of the technological or engineering principles to the fields of biology and health care. Bioengineers or Scientists work with doctors, therapists and researchers to develop systems, equipments and devices in order to solve clinical problems. Biomedical technologists have developed a number of life enhancing and life saving technologies. Biomedical

engineering and technology has evolved over the years in response to advancement in medical sciences and technology. Throughout the history, humans have made increasingly more effective devices to diagnose and treat diseases and to alleviate, rehabilitate or compensate for disabilities or injuries.

1.2 Scientometrics

Knowledge pertaining to Science and Technology has expanded and advanced at an increasing pace since the end of the last century. The field of Science and Technology has witnessed a qualitative shift in the generation of information and knowledge and its investment has led to significant changes in productive methods. This has had a profound impact on the social and natural environment. The gap between the human capacity to invest Scientific and Technological expertise in meeting ever-increasing demands and safeguarding environmental and social balance has widened. The scientific community can only fulfil its roles as fact checker, visionary, whistleblower, and cheerleader if it has trusted information about the work of community members. Scientists distribute information about their ideas in many ways; informally communicating with colleagues, making presentations at conferences, writing books, etc.; among these different modes of communication, reviewed journal articles are especially important.

The research outputs are measured using statistical techniques like bibliometrics, informetrics, librmetrics, webometrics etc. In science, it is termed as scientometrics. Scientometrics has typically been defined as the “quantitative study of science and technology” Van Raan (1998). In other words scientometrics is concerned with the quantitative feature and characteristics of science and scientific research. Emphasis based on investigation in which the development and mechanism of science are studied by the statistical mathematical methods. Since V. V. Nallimov coined the term ‘scientometrics’ in 1960’s this term has grown in popularity and is used to describe the study of science of growth, structure, interrelationship and productivity of literature. In practice, scientometrics is often done using bibliometrics which is a measurement of the impact of publication.

In medical sciences and technology broadly refers to the application of engineering and technology principles to the domain of living or biological systems. Usually inclusion of the term 'biomedical' denotes a principal emphasis on problems related to human health and diseases, whereas terms like biotechnology can be medical, environmental, or agricultural in application. But most terms in this general realm still lack clear boundaries. Biomedical engineering and technology alike are often loosely called Biomedical Technology or Bioengineering.

The twentieth century may be described as the century of the development of metric science. Among the different metrics, scientometrics is the most interesting subject area in the field of library and information science, which can be applied to any discipline irrespective of their period of evolution. It involves quantitative studies of scientific activities. It is also one such useful metrics/technique which helps to solve the problems, challenges posed by so called information explosion. Over the years, several new terms have appeared in library and information science.

Scientific productivity, in the form of intellectual contributions to the advancement of science and ultimately communicated in written form, is commonly considered to be of fundamental importance to scientific career advancement. This conception dates from times when scientific fields were smaller and intellectual contributions to various disciplines more readily recognized than they are today. In this study, mathematical and statistical methods are used for measuring quantitative and qualitative work published in books, journals and others.

1.3 Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram

Originally established by the Government of Kerala as an advanced centre for medical specialties, Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST) metamorphosed into an Institute of National Importance with the status

of a University in 1980 under the Department of Science and Technology, Govt. of India by an Act of Parliament (Act 52 of 1980). The joint culture of medicine and technology that the Institute pioneered more than three decades ago has come of age and gained unprecedented acceptance in India. Imbued with an inclination to venture into less-trodden domains, the Institute focuses on patient care of high quality, technology development of industrial significance and health research studies of social relevance. The emphasis is on development of facilities less readily available elsewhere in the country such as interventional radiology, cardiac electrophysiology, pre-surgical evaluation and surgery for epilepsy, microsurgery and deep brain stimulation for movement disorders, new biomedical devices and products, evaluation of medical devices to global specifications, new academic programmes and global public health networks. The Institute has three wings - the Hospital, Biomedical Technology Wing and the Achutha Menon Centre for Health Science Studies. Excellent research and teaching facilities are available at these centres. This uniquely poised Institute has a dedicated team of clinicians, scientists and engineers devoted to high quality biomedical research and developing technologies in health care with emphasis on cardiovascular and neurological diseases.

The Biomedical Technology Wing (BMT Wing) located at the Satelmond Palace at Poojappura, Trivandrum consists of culturally diverse and pluralistic team committed to medical device development, research & teaching. The broad areas of activities of the wing include Medical devices, Biomaterials, Biocompatibility, Tissue Engineering, Product incubation and commercialization. BMT Wing has been instrumental in establishing a medical device industry base in India by successfully developing and commercializing technologies of a number of devices and implants. Some of the commercialized technologies include blood bag, membrane oxygenator, hydrocephalus shunt, artificial heart valve, dental materials, hydroxyapatite based materials and implants.

The medical research community has long considered research to be vital to the health and wealth of the societies. It can provide important information about

diseases, trends and risk factors, outcomes of treatment or public health interventions, functional abilities, patterns of care and health care costs and use. The different approaches to research provide complementary insights. The different forms of health research have led to significant discoveries, the development of new therapies and a remarkable improvement in health care and public health. Research publications are the most important one because it is the only way research productivity reach to the target population.

The present study focuses on one of the greatest science and technology institution in India, Sree Chitra Tirunal Institute for medical Sciences & Technology, Thiruvananthapuram that supports all levels of research and developments in medical sciences, health care and allied fields. Scientometric indicators give policy-makers objective, reproducible and verifiable information. Scientometrics specializes in the production and analysis of scientometric data. This expertise enables to extract value-added information on scientific activities from various databases of scientific publications. Scientometrics develops and utilizes advanced scientometric methods to delineate and measure scientific activities in very specific or emerging fields.

1.4 Relevance of the study

Research and Development institutions contribute the socio- economic development of the nation by producing high quality research outputs in various fields. Growth in each field is measured by applying some statistical methods, generally termed as 'bibliometrics'. In science it is called as "scientometrics". This study will helpful for forecasting the trends in each field. In India, Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Thiruvananthapuram is a major research and development institution provides new knowledge and developments in the field of medical sciences and technology especially biomedical technology. .

Statistical measurement of research productivity of the institution is help to know the overall growth of the institution in year-wise, subject-wise and strength and weakness of research in medical sciences & technology. This organised data is most useful for researchers also for the government.

1.5 Title of the Study

The title of the study is '**Research Productivity of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram: A Scientometric Study.**'

1.6 Definition of Key terms

Research Productivity

Cambridge learner's dictionary defines productivity means the rate at which goods is produced. In the present study 'Research Productivity' means research outcomes or research products presented or published through research papers/articles by faculty, researchers/the scientists of an institution.

Sree Chitra Tirunal Institute for Medical Sciences & Technology

Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST), Trivandrum is a Science and Technology institution formed with the status of national importance under Department of Science and Technology, Government of India.

Thiruvananthapuram

Thiruvananthapuram formerly known as Trivandrum, is the capital and largest city of the Indian state, Kerala, where the SCTIMST is situated.

Scientometric Study

'Scientometric study' is the study of measuring and analysing science technology and innovation. Major research issues include the measurement of impact, reference sets of articles to investigate the impact of journals and institutes,

understanding of scientific citations, mapping scientific fields and the production of indicators for use in policy and management contexts.

1.7 Objectives of the study

1. To ascertain year-wise growth of publications of research productivity.
2. To examine the communication channel preferred for research publication.
3. To make a rank list of most productive authors.
4. To ascertain authorship pattern and degree of collaboration of publications.
5. To find out the year-wise distribution of articles in foreign and Indian journals
6. To examine the authorship pattern of journal articles
7. To find out the geographical distribution of journals
8. To analyse the ranking of journals
9. To calculate the h-index of journals.

1.8 Methodology

The method used for this study is Scientometrics techniques. The study covers different departments and units of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram. The major departments are biomedical engineering and technology, biomaterials research, biological research, health policy management, community research, epidemiology and biostatistics, cardiology, neurology, radiology, neurosurgery, pathology, anaesthesiology etc. The research outputs of different departments of SCTIMST, Thiruvananthapuram are published in the institution's own website. For the purpose of the study, publication list of institutional website used as the basic data. The data record as in the form of datasheets containing details such as author(s), title, year, etc. The present study

covers latest 05 years, i.e.2011-2015. APA style manual is used for the reference entries.

1.9 Scope and Limitations of the study

Many researches are carried out in the field of medical sciences and technology for attaining the proficient development of the health care of the nation. The growth of the scientific research is measured using statistical techniques. The present study has value in general and government in which field the research is mostly done the study period and its effects on the health and allied industries.

The present study covers latest five years i.e. 2011-2015. The scientific research is an ongoing process and the productivity of a research work we can measure only when it complete. In spite of the fact there is immense research being carried out in the institute, many are still in the process of infancy which require many more years to complete and attain the final format of publication, hence could not been able to account for the list of publications in the above mentioned time period.

1.10 Organization of the Study

Chapter 1: Introduction

This chapter presents the topic of study; title of the study, definition of key terms, objectives of the study, methodology, Scope and limitation of the study.

Chapter 2: Review of Literature

A brief review of literature relating to scientometric study is analyzed in this chapter.

**Chapter 3: Sree Chitra Tirunal Institute for Medical Sciences Technology : An
Overview**

This Chapter deals with the background of the study

Chapter4: Data Analysis and Interpretation

This chapter attempt to analyze data collected.

Chapter 5: Findings and Conclusion

The findings of the study, the conclusions are presented in this chapter.

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Appendix

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CHAPTER 2

REVIEW OF LITERATURE

2.1 Introduction

The main aim of this chapter is 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.

This review has been prepared on the basis of the studies included in some of the primary journals available in the libraries in Thiruvananthapuram, the internet and the Library and Information Science Abstracts (LISA). The relevant literature pertaining to this study is presented under the following:

2.2 Literature Review

Bid (2016) analysed the publications of of Indian Institute of Technology Kharagpur (IIT Kharagpur) during 2000 to 2015 appeared in SCOPUS database. It attempted to analyzed the growth and development of research activity of IIT Kharagpur as reflected in publications output. Data for a total of 18927 have been downloaded and analysed according to objectives. The study revealed that the growth of literature follows the exponential growth pattern, journal articles were the most published form of literature (74.37%), Journal of Applied Polymer Science and Journal of Applied Physics are top journals, Jadavpur University and National Institute

of Technology are top collaborating institutions/university with Indian Institute of Technology, Kharagpur. The highly productive subject areas were engineering and materials science, computer science, physics and astronomy. US, Germany and UK are the most favored countries for collaborations and authorship pattern analysis shows that degree of collaboration (0.95) significantly high and Suggested that periodically this type of data be reflected along with institutional repositories of the respective institutions.

Yazdani et. al. (2015) studied a 5-year Scientometric analysis of research centers affiliated to Tehran University of Medical Sciences, Iran. It was a cross-sectional study performed to evaluate a 5-year scientific performance of research centers of TUMS. Since Tehran University of Medical Sciences (TUMS) has the oldest and highest number of research centers among all Iranian medical universities, this study was conducted to evaluate scientific output of research centers affiliated to Tehran University of Medical Sciences (TUMS) using scientometric indices and the affecting factors. Moreover, a number of scientometric indicators were introduced. Data were collected through questionnaires, annual evaluation reports of the Ministry of Health, and also from Scopus database. They used appropriate measures of central tendency and variation for descriptive analyses. Moreover, uni-and multi-variable linear regression were used to evaluate the effect of independent factors on the scientific output of the centers. The results can help policy makers and research managers to allocate sufficient resources to improve current situation of the centers. Newly adopted and effective Scientometric indices are suggested to be used to evaluate scientific outputs and functions of those centers.

Jeyshankar (2015) analysed the research productivity of the scientists of Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam (Chennai). The purpose of this study was to evaluate the research publication trend among scientists of Indira Gandhi Centre for Atomic Research during the period 1989-2013. Data were analyzed based on type of publication, year of publication, language, source, country, institutions, most preferred journals and most prolific authors among other variables. The study revealed that majority (96.26%) of the researchers preferred to publish

their research papers in joint authorship only and the degree of author collaboration ranges from 0.84 to 0.99 and its mean value is 0.95. It also revealed that IGCAR scientists preferred to publish their work in the Journal of Nuclear Materials and Transactions of the Indian Institute of Metals. The top three collaborative institutions with IGCAR are Indian Institute of Technology, Chennai, Bhabha Atomic Research Centre, Mumbai and Anna University, Chennai.

Suma and Sudhier (2014) attempted to highlight the quantitative growth and development of the CSIR- National Institute of Interdisciplinary Science & Technology (NIIST), Thiruvananthapuram in terms of publication output for the years 2007-2011. During the period, a total of 1080 publications and 110 patents were published. The average number of publications per year was 216. The highest numbers of papers (242) were published in 2008 and 41 patents awarded in the same year. Authorship and collaboration trend were towards multi-authored paper and the degree of collaboration was 0.986. There were 1066 (99%) multi-authored/collaborative papers and only 14 (1%) single authored publications. The most preferred journals for publication by the scientists were: Journal of Alloys and Compounds, Journal of the American Ceramic Society and Bio resource Technology

Lorna, Jesper and Larsen (2014) studied increasing demand for bibliometric assessment of individuals has led to a growth of new bibliometric indicators as well as new variants or combinations of established ones. The aim of this review is to contribute with objective facts about the usefulness of bibliometric indicators of the effects of publication activity at the individual level. This paper reviews 108 indicators that can potentially be used to measure performance on individual author-level, and examines the complexity of their calculations in relation to what they are supposed to reflect and ease of end-user application. As such we provide a schematic overview of author-level indicators, where the indicators are broadly categorized into indicators of publication count, indicators that qualify output (on the level of the researcher and journal), indicators of the effect of output (effect as citations, citations normalized to field or the researcher's body of work), indicators that rank the individual's work and indicators of impact over time. Supported by an extensive

appendix we present how the indicators are computed, the complexity of the mathematical calculation and demands to data-collection, their advantages and limitations as well as references to surrounding discussion in the bibliometric community. The Appendix supporting this study is available online as supplementary material.

Goswami and Hazarika (2014) studied the research publication trends of the Scientists of Tezpur University. The study covered the Bibliographic records of 847 items retrieved from Web of Science were studied and increasing publication trends were seen in Tezpur University (T.U.). The average output of the organization was 60 publications per year; the peak was 200 items in 2012 and the minimum was 4 items in the year 1999. Single authorship publication accounted for 6%, while multi authorship publication of articles accounted for 94 %. The top 22 institutions which collaborated with T.U accounted for about 26% share. It was seen that the publications of T.U received a total of 4763 citations during the period of 14 years. The average citation per item was 5.7.

Balasubramani and Parameswaran (2014) conducted a scientometric study titled "Mapping the research productivity of Banaras Hindu University .The study presented the growth and the contribution of research carried out by the scientists of Banaras Hindu University (BHU). The pattern of communication of authors and scattering of their research output in different journals, analysed and the strong and weak areas of university research noted. The data for the study was taken from the Web of Science online database published by Institute for Scientific information (ISI). The study shows that there was a gradual growth of publications during 2000 - 2011. The annual average research output of BHU was 578 records and the research output of the scientists is fairly collaborative. "Current Science" is one of the most preferred journals of the authors of BHU. The Institute of Technology leads in publications productivity with 1482 (21.3%) articles. The authors of BHU have been collaborated with the foreign authors for their research work.

Sudhier and Priyalekshmi (2013) conducted a Scientometric study in the research publication trend among the scientists of Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram. The study was based on the Bibliographic details of 1076 research articles obtained from the annual reports of Central Tuber Crops Research Institute (CTCRI) were studied and it was found that the highest number of 169 papers was published in the year 2006 and the average number of publications per year was 97.82. Most of the contributions were multi authored (87.68%). The degree of collaboration of scientists of CTCRI was 0.87 and most of the articles published by the scientists were in the foreign journals (51.89%). Journal of Root Crops published by Indian Society of Root Crops tops the list with the highest number of articles 125 (39.30%). Applicability of Bradford's Law in the journal distribution pattern of the CTCRI scientists does not fit the Bradford's distribution pattern.

Aswathy and Gopikuttan (2013) investigated publication pattern of faculty Members of three universities in Kerala viz., University of Kerala, Mahatma Gandhi University and University of Calicut. The study showed that Multi-authorship dominated among university teachers and there was no statistically significant difference between the experience and productivity. Designation-wise Degree of Collaboration showed that professors had a high Degree of Collaboration which indicated that increased in the age and experience resulted in more collaborative papers.

Sudhier (2013) conducted a bibliometric study analysed the research productivity of physicists at the Indian Institute of Science (IISc) and the University of Kerala (KU) during 2004-2008. The paper gave a summary and review of the various research evaluation studies of institutions and disciplines. The study concluded that the Phys. Rev. B tops the list of IISc physicists' choice of journals for publication with 16 publications (9.58%). The KU researchers prefer to publish their research results mostly in Indian journal of Radio and Space Physics with 10 articles 25.64%. Elsevier Science publisher is the most common publisher preferred by the Physicists of both institutions.

Asraf-Wani, Tahir-Pandit and Majeed (2013) examined the research productivity of Indian Institute of Technology. The study made an attempt to gauge the research output of IIT Delhi, one of the prime institutions of engineering and technology in India. The research output for the period of 1964-2010 as indexed by "Scopus" was collected and analyzed for set objectives. It was found that a total of 15476 research papers from the institute were published in journals and conference proceedings for the study period. The average citations count of the institution is 4.09. "Engineering" is the dominant discipline with 6,267 papers, whereas "Chemistry" is a highly cited subject field with a total of 14,264 citations. The institution has collaborated in 3057 and 1209 papers at national & international level respectively.

Baby and Kumaravel (2012) studied the research productivity of Periyar University faculties in India using the Scopus database for a period of thirteen years from 1998 to 2010. The study found that three-authored publications dominated the pattern of authorship and journal articles occupied the predominant place among other sources of publication.

Majhi and Maharana (2012) attempted to analyse quantitatively the growth and development of Physical Science Research in Sambalpur University in terms of publication output as reflected in Scopus Database. From its inception (1971) to till date (2010) a total of 417 papers were published by the Physical Science researchers of Sambalpur University in various subject domains: Physics, Chemistry, Mathematics, Statistics, Environmental Science, and Earth Science. The present study analyzed year-wise growth of publications, most preferred journals of the publications, Impact Factor (IF) of the publishing journals, authorship pattern of the papers, Subject wise distribution of papers, etc. Besides, the study explored intra-department, inter-department, intra-state, inter-state, and international research collaboration of the authors in Sambalpur University. The whole study will assess the intellectual output of the physical science researchers of the Sambalpur University and it may act as a catalyst for increasing their interest for further research. The findings of the research will be a matter of concern for various policy-making bodies

and funding agencies of Sambalpur University, such as, UGC, NAAC, Ministry of HRD, etc.

Maclean and Lewison (2012) estimated the financial resources going into malaria research. Garg estimated the quantum of malaria research output during 1990 and 2000 using PubMed and the Commonwealth Agricultural Bureaux International incorporating the Tropical Disease Bulletin. Lewison and Srivastava mapped the malaria research

Zafrunnisha (2012) has conducted a study on the application of Bradford's law. For the study 141 Ph.d theses were considered. An analysis was made to identify Bradford's Zones and productivity of journals cited in theses. The journals were divided into four equal groups in order to measure the productivity of journals. It is observed that the average rate of productivity of journals in the first group was 254 articles whereas it has come down to 10.73 articles in the fourth group. The journal distribution ratio in psychology has been worked out and dispersion of journal titles in psychology does not fit the Bradford's law of Scattering.

Balasubramani and Murugan (2011) have taken up the study of research performance of India in tapioca. The extent of study extends to the entire globe and the period chosen was 1997 -2010. The main focus of the study in research of tapioca is its growth, share and impact in global publication, the patterns of international and major collaborative partners, the publication productivity and the impact of leading institutions of India, the characteristics of most prolific authors and high-cited papers and patterns of research communication in the productivity journals. For the study SCI through Web of Science provided by Thomson Reuters was used. Totally 447 records were used and analyzed by using histcite software application in order to fulfill the objective of the study.

Vasishta (2011) investigated the contribution and impact of research output on PEC University of technology as reflected in its publications covered in Scopus international multidisciplinary database and described broad characteristics of

research publications of PEC during 1996-2009. She concludes that in all 177 research papers were published during 14 years by the nine departments of the PEC, showing an average of growth rate of 131.85%. Growth in the academic research output is seen after the PEC has attained a deemed university status. Contribution to engineering and technology literature from this institute is increasing steadily.

Park (2010) studied D-Lib Magazine was covering thirteen years and the data were collected by examining issues from July 1995 to May/June 2008. The findings showed that two and more authors' contribution was the highest with a ratio of 57%; most of the authors had a single contribution; the proportion of the male authors was much higher with a ratio of 74%; authors from the United States contributed 70% of the articles and the average number of references was 15. The literature review showed that many bibliometric studies on single journal literature in the field of LIS have been conducted but no such study of PJJIS has been conducted. Therefore, there is a need to analyze the literature published in PJJIS

Repanovici (2010) measured the visibility and the impact of the university's scientific production of the Transilvania University of Brasov using the scientific methods of scientometry. The methods provided a means for determining the international value of a university and the statistical evaluation of an individual's scientific research results. In this study, defined the scientific production and productivity, and presented the main indicators for the measurement of the scientific activity. The impact of the research measured and analyzed through citation analysis. The number of citations suggests the quality of the scientific information. Google Scholar, a freely available scientometric database, indexes academic papers from open access repositories and commercial sources, and also identifies referenced citations. The free Publish or Perish software can be used as an analysis instrument for the impact of the research. It was an exploratory study made at the Transilvania University of Brasov to evaluate the research output of the faculty and analyzed their 2008 research performances as documented in their annual evaluation that states the number of papers, books, and research contracts. Using Publish or Perish, calculated the H-index, G-index, HC-index and HI norm, of the 60 more productive

professors. The study presented the correlation indicators and discusses the importance of open access tools and repositories for increasing the impact of scientific research.

Bhatia (2010) analysed quantitatively research publications published by the scientists of National Institute of Occupational Health (ICMR) Ahmadabad, India, during 2000–2006. The result shows that more publications are observed in journals dealing in occupational health and occupational medicine, which is related to institutional research field. Multiple-author articles are more than single-author articles because research format in occupational health is multi-disciplinary. To carry out research in multiple disciplines/parameter one requires more scientists and core subject in occupational health and occupational medicine.

Sharma (2009) analysed a total of 2603 research articles published by the scientists of Central Potato Research Institute (CPRI) during 1991-2007 were collected by scanning of annual reports of CPRI and *Journal of the Indian Potato Association*. Analysis show that majority of the scientists preferred to publish research papers in joint authorship (82.67 %) having 0.82 degree of collaboration. Study further shows no uniform pattern of literature growth but factors like fund availability, scientists' recruitment and their availability, and years that had special occasions like conferences, seminars, etc., have impact over scientific productivity of the scientists during the period under review.

Bala and Gupta (2009) carried out the analysis of research activities of the Government Medical College and Hospital (GMCH) Chandigarh as reflected in its 16 years (1992-2007) of 754 publications output covered in Scopus. It focused on publication growth, characteristics, format and media of communication, research impact and quality, patterns of collection, broad and narrow areas of research focus and most cited papers. They concluded that GMCH stands at 9th rank in research output, 13th in average citation per paper and 12th in h-index among the top 15 medical colleges of the country. GMCH has recorded an annual publication growth of 19.79% and impact as measured by average citation per paper as 0.89. Although

55.97% of its total papers received one or more citations, only 14 of its papers received 16 and above citation and only 2-3% of its papers involved international collaboration.

Kumbar (2009) analyzed the strong and weak areas of university research, their growth rate and impact of research in terms of average citation received and also studied the output and impact of research under different existing subject departments of the university and the collaboration. They conclude that the research activity of university of Mysore in Science and Technology is growing with an average rate of 23% per annum. The analysis was based on publication data consisting of 1518 research papers published by the university from 1996-2006.

Kumar et. al (2008) carried out a scientometric study on web resources in INSPEC database. This study attempts to analyze the growth and development of web resources in INSPEC database during 1995 to 2005. A total of 18673 publications appeared in 171 web resources contributed by the scientists in various areas of research. Physics 11076, Computers and control technology 5524, Electrical and Electronics engineering 2050 and information technology 23. The highest numbers of publications in web resources in INSPEC database were from USA with 8364 (44.79) publications followed by Italy with 4342 (23.35%) publications and UK with 1967 (10.53%) publications. The publications in web resources have started appearing in the INSPEC database since 1995 with six publications. The highest numbers of publications in web resources published per year were 1698.

Zhou et. al. (2007) completed a scientometric analysis of Geo-statistics using multivariate methods taking data from the science citation index during 1967 to 2005. Hierarchical Cluster analysis was used in publication patterns based on different types of variables. A backward discriminate analysis with appropriate statistical tests was then conducted to confirm CA results and evaluate the variations of various patterns. For authorship pattern, the 50 most productive authors were classified by CA into 4 groups representing different levels and DA produced 92.0% correct assignment with high reliability. The discriminate parameters were mean

impact factor, annual citations per publications and the number of publications by the first author, for country pattern, CA divided the top most productive countries into 4 groups with 95.9% correct assignment and discriminate parameters were MIF, ACCP and independent publication. for institute pattern , 3 groups were identified from the top 50 most productive institutes with nearly 88.0% correct assignment. The top 50 most productive journals were classified into 3 groups with nearly 98.0% correct assignment. We also analyzed general pattern for publication document type, language and subject category and publication growth.

Rey-Rocha, Gazon-Gracia and Martin-Sempere (2007) explored the extent to which social integration plays a role in influencing scientists' research activity and performance, particularly their productivity, international visibility, collaboration patterns, participation in funded research projects and programme. A population of 357 tenured staff scientists working in biological and biomedical fields was evaluated. Those members who were "highly integrated" were found to perform better than their less integrated colleagues in some aspects of their research activity. The study also considered the effects of age, seniority and past organizational context on performance.

Sevukan, Nagarajan and Sharma (2007) explained research output in plant sciences of the faculties in central universities of India by analyzing a total 348 bibliographic records of plant sciences retrieved from ISI Science Citation Index-Extended (SCIE) for a period of 10 years from 1997-2006 by year, document type, authorship pattern and collaboration pattern at different levels viz., international, national, local.

Mahapatra and Padmanav (2006) described the growth of scientific research literature on Orissa published during 1985 to 2004, Includes 875 research papers from forty different journals. Analyses the data found that majority of authors prefer to publish their papers in collaboration with others. It was also found that research on agricultural science is more compared to other subjects. It was interesting to note that nearly 31% of the scientific literature is published in non-scientific journals. This

may result in the scientific papers going unnoticed by scientific works. More papers are published in Indian journals compared to foreign journals. It was found that majority of papers were six pages long.

Angadi et. al. (2006) scientometrically studied 358 publications published by the social scientists of Tata Institute of Social Sciences during 2001-2004 in various Departments and Research Units for authorship pattern and collaboration trend. The results indicated that 90.22 % of papers were single authored followed by two authored papers - 5.86 % and three authored papers - 3.35 %. Most prolific authors were Shalini Bharat (21), M. M. Koganuramath (18), Mallikarjun Angadi (13), R. N. Sharma (13), Chhaya Datar (12), Siva Raju (12), and Sarthi Acharya (10). The most preferred journals by the social scientists were: Economic and Political Weekly, Indian Journal of Social Work and Indian Journal of Labour Economics, with four papers each. Publication Density observed in the present study was 1.46.

Leahey (2006) suggested that the extent of research specialization can help explain the process by which gender affects research productivity. Using a probability sample of academics in two disciplines (sociology and linguistics), primary data collection, and simultaneous equation modeling, the author found that the extent of research specialization is a critical intervening variable: Women specialized less than men and thereby lose out on an important means of increasing their productivity. Jagsi et al. (2006) found a significant increase over the past 35 years in the proportion of women among 1st and senior authored research in academic medicine. Women still, however, comprise a minority of the authors of original research and guest editorials. The sharpest increase was in fields such as pediatrics and gynaecology where there is the greatest representation of women. Ding, Murray, and Stuart (2006) analysed of 4227 life scientists over a 30-year period for patenting rates. Regressions showed that women faculty members patent at about 40% of the rate of men. Gender gaps in patenting rates are declining, but the gap remains relatively large.

Kademani et al. (2005) attempted to highlight the scientific productivity, productivity age, collaboration trend, domains of contributions of eight Nobel laureates of past and present belonging to different domains of research in science. Also attempts to document the various factors that affect productivity of scientists. Nobel laureates cannot be compared with other Nobel laureates as they are an altogether different class of scientific elites and each piece of research is unique by itself.

Kademani et al. (2005) made study under the title "Publication productivity of the Bio-Organic Division at Bhabha Atomic Research Centre: A Scientometric Study". The chief objective of the present study were to quantitatively document the publication productivity behaviour of scientists during 1972-2002. Data for this study was collected from bibliography compiled by Subbaraman and Chattopadhyay and the publications included in BARC annual progress Reports (1998 to 2002). The division has produced 475 publications in various domains. The highest number of publications (38) was produced in 2001. The collaboration trend among the scientists towards multi authored papers. The most prolific authors identified in the study were / are holding important positions in BARC / Department of Atomic Energy. The publication behavior indicates that scientists were highly selective in publishing their research results in highly specialized journals.

Fieder, Iber and Wallner (2003) analysed the age profile of scientific employees and its relation to personnel costs and scientific productivity within eight faculties at the University of Vienna. The overall age demography was divided into two main categories: Category one faculties represent an increased number of younger aged researchers (Catholic-, Protestant Theology, Law, Economics, Information Sciences, and Medicine), category two faculties show an increased number of older aged researchers (Social Sciences, Humanities, and Science). In addition, it was demonstrated that the personnel costs for full professors are higher within four faculties (Catholic-, Protestant Theology, Law, and Economics and Information Sciences). Inevitably, this lead to savings for habilitated and non-habilitated researchers at these faculties. The faculty of Medicine represented a well-

balanced use of personnel costs. Three faculties (Social Sciences, Humanities, and Sciences) had to pay dramatically more for their older aged habilitated and non-habilitated personnel. For the entire university and two faculties, Medicine and Humanities, a positive and significant relationship between age and the average weekly teaching performance was shown. This study suggested that institutions with a high percentage of older researchers, mainly in the categories of habilitated and non-habilitated personnel, must change their policy to become more flexible and attractive for new talented young people. Due to the fact, that this cannot only be realized through the introduction of new laws, each faculty must establish a scientific plan combined with reorganizations of the personnel structure and personnel costs.

Williams and Winston (2003) carried out a statistical analysis on academic on research and publication towards decision making process. The research presented in the article addresses the original research published in frequently cited library and information science journals to consider the extent to which academic librarians and administrators conduct and publish original research and to evaluate the range of research methodologies used and the level of collaboration among academic librarians, LIS faculty members and others.

Osareh and Wilson (2003) analyzed international collaboration of Iranian scientific publications in Science Citation Index (SCI) during 1995 to 1999. The result discussed about two types. First one the science and technology increased dramatically in the citation index the study period. Another one authors with institutional affiliations in the American countries.

On the basis of the measured frequency distribution of China's interregional co-authored papers covered by the Chinese Science Citation Database, showed the pattern of China's interregional research collaboration (IRRC), and analysed how the collaborative pattern was formed. A new method was used to calculate the expected value matrix based on an observed value matrix of IRRC, which is asymmetric and has no diagonal elements. The results fall into three groups: regional scientific productivity affects both the collaborative preference and ranking of authors' names;

geographical proximity is an important factor determining the pattern of IRRC; and when using Salton's measure, regional mean collaborative strength increased as the regional productivity increased, and as the distance between two regions decreased (Liang and Zhu, 2002).

Barooah and Sharma(2001) explained the journal collection of the library of regional research laboratory Jorhat (RRCI) has been evaluated through a study of use of journals titles for publications of research by scientific community of the laboratory. Journals ranked on the basis of the use for individual groups and percentage of used journals

Granovsky (2001) devoted to his article to 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.

Glaser and Laudel (2001) discussed the methodological problems of integrating scientometrics methods into a qualitative study. They conducted that integrative attempts of the kind are poorly supported by the methodologies of both the sociology of science and scientometrics

Huber (2001) applied a new method for measuring scientific productivity to different disciplines to support its general applicability. The method yields the same results for modern physicists, biologists, psychologist's inventors and composers. That is, each individual's production is constant over time, and the time period fluctuations follow the Poisson distribution. However, the productivity varied widely across individuals and followed an exponential distribution with most authors producing at the lowest rate). The career duration of individuals also followed an exponential distribution with most having a very short career.

Sinha and Dhiman (2001) observed research articles published in Indian and foreign journals by Dr.R.C.Sinha. Out of 97 papers published in different journals and

as book chapters: 1 as Indian journal, 78 as Foreign journals and 18 as Book chapters. As a Single author, he published 30 articles and as joint author 67 articles.

Sinha and Dhiman (2001) attempted to illustrate the nature of the growth of literature in the developing branch of ethno botany during 1989-1999 and emphasised collaborative research work among various categories of authors, noting the correlation between the growth of such authorship and the impact of collaboration on the growth of regularly published literature. Parameswaran and Smitha (2001) reports results of a bibliometric study of Library and Information Science Abstracts (LISA) aimed at determining: the subjects covered by the articles; the total number of articles indexed in LISA during the period of study; the authorship pattern in the field of library and information science (LIS) as indicated by LISA; and the Indian authors making a significant contribution to LISA. All of the 60 issues of LISA published from January 1994 to 1998 were analyzed manually using a specially prepared data sheets. The subject headings listed in LISA were further grouped into 16 classes on the basis of their mutual relations. This helped to analyze the subject wise break up easily. The data collected manually using the data sheet was compared with the data available from the CD-ROM. The extent of collaborative authorship was measured using Subramanyam's formula and the results helped the investigators to prove the hypothesis that the research papers by single authors are greater in number than collaborative papers.

Amin and Mabe (2000) looked at the ISI Journal Citation Reports (JCR) impact factor, which has become the chief measure of journal quality, content, and the researchers who contributed and also discussed the limitations of citation analysis and outlined how it should and should not be used, While Cole (2000) provided a brief history of the development and critiques of citation analysis and the Science Citation Index (SCI) asserts that in the aggregate citation counts are strongly correlated with other independent measures of scientific quality.

Jayashree and Arunachalam (2000) have made studies on mapping of fish research in India by referring to six databases, covering 460 papers roughly 5.5% of

the world. Of them 82% are journal articles which have appeared in 113 Indian Journals. Less than 33% of articles have been published in journals indexed in SCI. Studies also include the contribution of papers from different Government laboratories and academic institutions. It is inferred that Kochi, Chennai, Mumbai and Mangalore are the cities and Tamil Nadu and Kerala are the states contributing large number of papers.

Noyons and Van Raan (1998) examined the mapping tools developed by CWTS are tested on our own research field (Scientometrics, Informetrics, and Bibliometrics: SIB). The main purpose of this study is to investigate the use and applicability of bibliometric mapping in general and the CWTS approach in particular.

Devarai et. al. (1998) analyzed M.N. Srinivas's publications by year, domain, authorship pattern, channels of communication used, etc. By the end of 1995, Srinivas had to his credit 144 papers which included 33 broad papers in sociology and anthropology; 18 papers in social change; 28 papers on village studies; 12 papers in religion; 17 papers on caste and 36 papers of general popular interest. Indian publishers published 119(82.64%) articles; foreign publishers published 22(15.28%) articles and 3(2.08%) articles by both.

Mitchell and Rebner (1995) tested the idea that time spent in non research roles, such as teaching or consulting, results in greater research productivity, using data from a 1980 sample of 5,605 faculty. Also attempted to determine the point at which non-research academic activities begin to negatively affect research productivity. Results indicate that up to 4 hours per week of consulting and up to 8 hours per week of teaching actually increase research productivity. Allison and Long (1990) used departmental prestige as a proxy for a suite of variables that affect research productivity, including physical resources, intellectual stimulation, and motivation. The study concludes that relocation to a more prestigious department or institution has a positive impact on research productivity. While Stewart (1983) studied the citation patterns among the sample of Geoscience articles. Found that article characteristics are a much stronger predictor of citation count than author

characteristics. Article length, as measured by number of pages, was the strongest determinant of the number of citations an article received.

Ramsden (1994) estimated the output (in terms of quantity of publications) of individual staff and academic departments across different subject areas and types of institution. Concerning research productivity, Australian academics resemble their colleagues in other countries: the average is low, while the range of variation is high. Most papers are produced by few academic staff. Several potential correlates of productivity, including level of research activity, subject area, institutional type, gender, age, early interest in research, and satisfaction with the promotions system, are examined. A model linking departmental context to personal research performance through departmental and personal research activity is developed and tested. The results support the view that structural factors (such as how academic departments are managed and led) combine with personal variables (such as intrinsic interest in the subject matter of one's discipline) to determine levels of productivity. There is also evidence that research and teaching do not form a single dimension of academic performance.

Long (1992) examined that the publication patterns of a sample of biochemists in terms of gender and provides a multi-dimensional, longitudinal description of how and where male and female scientists differ in productivity. Found that sex differences in publication and citation rates increased during the first decade of the career but are reversed later in the career. Among biochemists, sex discrepancies could not be explained by patterns of collaboration, which are nearly identical for males and females. Also determined that women biochemists' lower citation rates are caused by a lower quantity, not quality, of publications, as individual papers by women are ultimately cited more than those written by men. The article also showed the extent to which sample cohorts of women scientists from different decades cannot be viewed as a homogenous group. Kyvik (1991) studied scientists in Norway and found that women with young children published considerably less than their male counterparts.

Pierre and Herubel (1992) studied by authorship, gender and institutional affiliation were in the literature published in *Libraries and Culture*. The focus of the study was to examine gender of authorship and institutional affiliation. Twenty three years of *Libraries and Culture* were chosen as target volumes. The findings revealed that men published more than women in library history.

Shailendra Kumar (1992) investigated the collaborative pattern of authors in history of science in India from 1905 to 1986. He observed that single authors made more than 86% of contributions in the literature.

Rebrova and Komarov (1989) attempted Presents statistics on the time dynamics of the number of published papers during 1979-1985. The scientometric study of literature on electrical superconductivity divided into 10 areas (e.g. power lines, electrical energy converters, generators), the dynamics of the growth of the publishing rate during 1971-1985, the percentage of patent literature and of reports and the volume of literature references retrieved from individual data bases

Fox (1983) scrutinized the literature on correlates and determinants of publication productivity. It provides an overview of the gaps and shortcomings in the research. In the search among individual-level variables for explanation of productivity, investigators have also looked to the effect of demographic characteristics, particularly age.

2.3 Conclusion

The review of literature has been based on several grouping such as journals; country's output; Scientist's works; citation analysis; database; mapping the literature and bibliometric laws. The early research on scientometric studies were mostly by single authors. In the recent years there seems to be a collaborative study. The research contribution by Indian authors on scientometric is in increasing trend. The research analysis on scientometrics has been increasingly adopting advanced statistical tools and techniques as revealed by the review. Probably the use of software package for the analysis of data has facilitated such kind of analysis.

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CHAPTER 3

SREE CHITRA TIRUNAL INSTITUTE FOR MEDICAL SCIENCES AND TECHNOLOGY: AN OVERVIEW

3.1 Introduction

Sree Chitra Tirunal Institute for Medical Sciences and Technology (SCTIMST) is an institute of national importance under the Department of Science and Technology, Govt. of India. The joint culture of medicine and technology pioneered by its founders more than three decades ago, has come of age and gained unprecedented acceptance in India. The institute has the status of a university and offers excellent research and training facilities. It has three wings: a tertiary referral super specialty hospital, a biomedical technology wing and the Achutha Menon Centre for Health Science Studies.

The Institute focuses on high quality, advanced treatment of cardiac and neurological disorders, indigenous development of technologies for biomedical devices and materials and public health training and research. The institute offers advanced treatment using modern technologies in several specialized areas such as interventional radiology, cardiac electrophysiology, deep brain stimulation for movement disorders, epilepsy surgery, pediatric cardiac surgery, base of skull and vascular surgeries, to name a few. The institute has excellent facilities and teams of professionals dedicated to the development of innovative biomedical devices and products, evaluation of medical devices to global specifications, training in novel medical specialties and research in medical and public health areas of social relevance. The Institute is a Technical Research Centre for Biomedical devices and has a medical devices incubator (TIMed).

3.2 History

The origin of the Institute dates back to 1973 when the Royal Family of Travancore gifted a multistoried building for the people and Government of Kerala. Sri. P. N. Haskar, the then Deputy Chairman, Planning Commission, inaugurated the Sree Chitra Tirunal Medical Center in 1976, when patient services including inpatient treatment got underway. At the Satelmond Palace, Poojapura, nearly 11 km away from this Hospital Wing, the Biomedical Technology Wing followed soon, again a gift by the Royal Family.

The concept of amalgamating medical sciences and technology within a single institutional framework was regarded as sufficiently important by the Government of India to declare the center as an Institute of National Importance under the Department of Science and Technology by an Act of Parliament in 1980, and named it as Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram.

Dr. Manmohan Singh, the then Honorable Finance Minister of Government of India, laid the foundation stone of the third dimension of the Institute, Achutha Menon Center for Health Science Studies (AMCHSS) on June 15, 1992. Dr. Murali Manohar Joshi, the then Honorable Minister of Science and Technology and Human Resource Development, Government of India, dedicated the AMCHSS to the nation on January 30, 2000.

3.3 Organization

The Institute has three wings - the Hospital, Biomedical Technology Wing and the Achutha Menon Centre for Health Science Studies. Excellent research and teaching facilities are available at these centres. This uniquely poised Institute has a dedicated team of clinicians, scientists and engineers devoted to high quality biomedical research and developing technologies in health care with emphasis on cardiovascular and neurological diseases

3.3.1 Hospital Wing

The hospital has 253 beds and serves as tertiary referral center for cardiovascular, thoracic and neurologic diseases. With a number of highly qualified personnel including doctors, nurses and other para-medical staff, various departments of the hospital have updated state-of-the-art facilities for diagnosis and treatment with highly advanced and sophisticated equipments.

Mission

- Improve patient health outcomes
- Increase patient satisfaction
- Decrease Medical errors, costs and waste
- Serve the underserved

Vision

Be a Global Leader in High Quality Patient Care and in post-graduate training programs in cardiovascular, thoracic and neurological diseases by 2020.

Services

The hospital has 253 beds and serves as tertiary referral center for cardiovascular, thoracic and neurologic diseases. With a number of highly qualified personnel including doctors, nurses and other para-medical staff, various departments of the hospital have updated state-of-the-art facilities for diagnosis and treatment with highly advanced and sophisticated equipments.

3.3.2 Biomedical Technology Wing

The Biomedical Technology Wing (BMT Wing) located at the Satelmond Palace at Poojappura, Trivandrum consists of culturally diverse and pluralistic team committed to medical device development, research & teaching. The broad areas of activities of the wing include

- Medical devices
- Biomaterials

- Biocompatibility
- Tissue Engineering
- Product incubation and commercialization

BMT Wing has been instrumental in establishing a medical device industry base in India by successfully developing and commercializing technologies of a number of devices and implants. Some of the commercialized technologies include blood bag, membrane oxygenator, hydrocephalus shunt, artificial heart valve, dental materials, hydroxyapatite based materials and implants. The Biomedical Technology wing has implemented a quality system meeting international standard ISO/IEC 1

Mission

- To develop and translate innovative healthcare technologies.
- To undertake research on frontier areas of biomedical science & engineering.
- To generate competent biomedical professionals through education & training.
- To offer internationally accepted medical device testing & evaluation.

Vision

- To become a global leader in developing and translating affordable healthcare technologies through innovative research, education & training by 2020.

Services

The available services of BMT Wing of SCTIMST described on the following heads:-

➤ **Testing Services**

The Biomedical Technology Wing of the Institute, located at Poojappura Campus offers selected testing services to external customers - primarily intended for the medical device industry in the areas of Physico-chemical characterization as well as biological evaluation of materials. The testing services are coordinated by the Customer Service Cell (CSC), which is the point of all contact and communication for the external customers with the Institute.

The CSC will extend you with all support such as providing information on the testing services, testing timelines, limitations, test methods, test charges, payments etc. If required, interaction with testing laboratory will be facilitated by the CSC. Please feel free to contact the CSC for all your queries regarding testing services.

➤ **Preclinical Functional and Safety Evaluation of Medical Devices**

Preclinical studies: Safety and functional performance evaluations in large animals are also offered as part of the testing service and the Institute possess excellent facility and expertise for the evaluation. These studies are carried out on a study mode based on a study plan/protocol which is prepared based on the requirement of the customer. Budget for the study is made and is to be paid by the sponsor. These animal studies are conducted subject to approval by the CPCSEA.

➤ **Accelerated Ageing Studies**

The manufacturer must ensure the product and package system combine to create a total product that performs efficiently, safely and effectively in the hands of the user. Accelerated Aging is the storing of packages at elevated temperature and / or other intensified environmental conditions in order to simulate real time aging in a smaller duration of time. Environmental chambers are used for accelerated aging test. The principle behind the concept of accelerated ageing is that the ageing of medical device packaging can be accelerated to two time space by increasing the storage temperature by 10oC, by what is known as Q10 analysis.

➤ **Calibration Services offered:**

Volumetric apparatus as per the national / international standards ASTM E 542/ ISO 8655. Thermal calibrations as per the national / international standards: ASTM E77/ASTM E 145.

3.3.3 Achutha Menon Centre for Health Science Studies

The Achutha Menon Centre for Health Science Studies (AMCHSS) is recognized as a centre of excellence for public health training by the Ministry of Health and Family Welfare Government of India. The centre continuously doing training and research in different areas of public health. In addition to two years MPH programmes, it also offers both regular and part time PhD programme. On research activities recently there are collaborations with major universities such as the University of Arizona in the United States of America, Melbourne and Monash Universities of Australia, University of Edinburgh in the UK and University of Heidelberg, Germany.

Routine Activities

In addition to the MPH training program at the Achutha Menon Centre, the MPH program is also offered through the National Institute of Epidemiology, Chennai, and the Christian Medical College, Vellore. The research activities were continued in collaboration with several international universities such as the University of Arizona in the USA, Melbourne and Monash Universities in Australia and the University of Edinburgh, UK. There are new research initiatives on health equity and Non Communicable Diseases.

As of today there were 9 PhDs graduated from this centre and 196 MPH students and 68 DPH students completed their respective programs.

In addition to regular programmes centre also offers short term courses in the areas of Public Health. That includes courses such as short course on Ethics in Health Research.

3.4 Research Programs and collaborative programs

One of the major research projects was on building capacity for tobacco cessation in India and Indonesia supported by the Fogarty International Centre of the US National Institutes of Health. The major objective of this project was to develop and implement tobacco cessation modules for undergraduate medical education in

India. We developed and implemented 15 modules on tobacco cessation related to different departments of five medical colleges in south India. We also produced 14 clinical videos to support the teaching of tobacco cessation to the medical students. The professionally made videos were uploaded along with teaching modules in a website. Another important project was the community interventions for health project supported by the Oxford Health Alliance UK. This was a pilot project implemented in three countries: Calicut Medical College, Trivandrum, India and Mexico. The interventions were implemented in schools, worksites, health centers and the neighborhood groups. The first publication using data from all the three sites came out this year. Now, this has led to implementation of NCD intervention in the state of Kerala. As per the current project there will be NCD interventions in all 14 districts of Kerala.

Controlling hypertension in rural India is another project supported by the global alliance for chronic diseases and the National Health and Medical Research Council of Australia. This project was implemented in three sites in India: Kerala, East Godavari in Andhra Pradesh and Rishy Valley in Andhra Pradesh.

The project titled “Research Initiative on factors influencing women’s reproductive choices” is supported by the Ford Foundation. The project consists of three inter-related activities: Multi-centered prospective research study on factors influencing postpartum reproductive choices in Jharkhand and Kerala.

Keeping the importance of Public Health education a meeting on Public Health Challenges in India was organized during 14 October-16 October 2014. Senior faculty members from All India Institute of Medical Sciences New Delhi, Indian Institute of Public Health New Delhi, Centre for Social Medicine Jawaharlal Nehru University new Delhi, Post Graduate Institute Medical Education and Research Chandigarh, Tata Institute of Social Sciences Mumbai, National Institute of Mental Health and Neurosciences Bangalore, National Institute of Epidemiology Chennai and Christian medical College Vellore participated in the meeting.

3.4.1 Research Areas

Achutha Menon Centre for Health Science Studies

- Community Research
- Epidemiology and Biostatistics
- Ethics
- Gender and Health
- Health Policy and Management
- Technology

Biomedical Technology Wing (BMT Wing)

- Biomaterials Research
- Biological Research
- Biomedical engineering
- Product development

Hospital Wing

- Department of Anesthesiology
- Division of Biochemistry
- Experimental and clinical oncology
- Department of Cardiology
- Department of Cardiovascular and Thoracic Surgery
- Division of Cellular and Molecular Cardiology
- Department of Imaging Sciences and Interventional Radiology
- Division of Microbiology
- Department of Neurology
- Department of Neurosurgery

- Department of Pathology
- Department of Transfusion Medicine

In the late 70s, healthcare was becoming increasingly dependent on technology with most medical equipments being imported. And, no initiatives were being taken to promote indigenous development of technology and the industry was either unwilling or incapable of investing in research. So, it was decided that the government should take the initiative. By then, Sree Chitra had established its credibility as a tertiary care center for cardiology and neurology. So, they were given the task of establishing a medical device industry base in India by developing technologies for a number of devices and implants. Their concern is that technologies should reach the patients and for this require the industry to manufacture and market our technologies. Today, Sree Chitra has more than a dozen tie-ups with industries who have licensed their technologies. The industries who had taken up their technologies in the past are now investing in research, because they know that technologies are commercially viable. For instance, the latest model of Sree Chitra heart valve is fully sponsored by TTK healthcare. However, to promote indigenous manufacturing of medical devices need to have more and more industry collaborations. Today, majority of the research work in India is funded by the Ministry of Science and Technology and other government funding agencies. A good regulatory mechanism in place will assess the quality of medical devices manufactured in India as well as of imported devices. Also, it will help the industry in gaining credibility in the international market.

3.5 Conclusion

Sree Chitra Tirunal Institute for Medical Sciences and Technology, an Institute of national importance under the department of Science and technology, Government of India. This Institute is unique in that it blends medical, engineering and public health sciences under a single institutional framework. In a world that is increasingly competitive, demanding and fast-paced, the institute can retain its position of pre-eminence only through perseverance and an abiding sense of direction that is in tune with its vision. Scientometric study refers to a general set of techniques useful for analyzing and understanding the outcome of any of the leading research institutions. High quality research in India is grossly inadequate and requires strategic planning, investment and resource support. There is also a need to improve the existing medical research system, which should foster research culture.

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CHAPTER 4

DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

The process of evaluating data by using analytical and logical reasoning to examine each component of the data provided. This form of analysis is just one of the many steps that must be completed when conducting a research experiment. Data from desired sources is gathered, reviewed, and then analyzed to form some sort of finding or conclusion. The main objective of the present study is to ascertain the research productivity of Sree Chitra Tirunal Institute for Medical sciences and Technology, Thiruvananthapuram by analyzing the publications produced from the said institute. For this the bibliographical details of publications were recorded on spreadsheets designed for this purpose. The data collected has been subjected to analysis and interpretation.

This chapter caters to the analysis and interpretation of collected data. The results of quantitative analysis of publications of the SCTIMT, Thiruvananthapuram are discussed under the following heads.

4.2 Year-Wise Distribution of Publications

Year-Wise distribution of publication is an important indicator of publication productivity of an Institution. The total productivity of SCTIMST for the five year period (2011-2015) studied and is given chronologically in the Table 4.1.

Table 4.1: Year-Wise Distribution of Publications

Sl. No.	Year	No. of Articles	Percentage
1	2011	121	28.81
2	2012	55	13.10
3	2013	85	20.24
4	2014	87	20.71
5	2015	72	17.14
Total		420	100.00

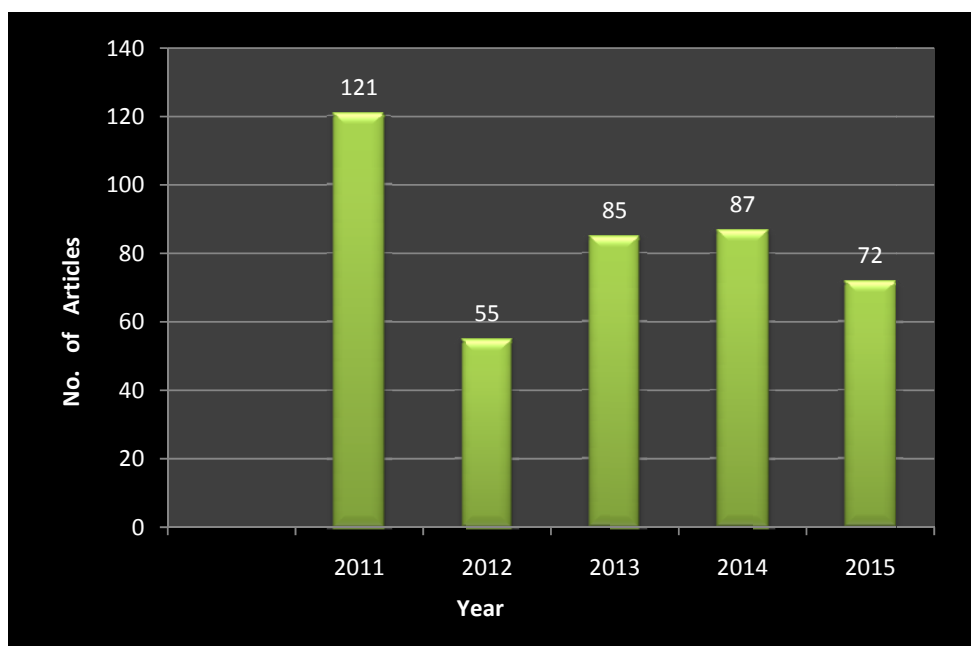


Figure 4.1: Year-Wise distribution of Publications

It can be observed that the total published literature of scientists of the SCTIMST for the five year period amounts to 420. It includes journal articles, books, book chapters and other publications. The study indicates that, 2011 is the most productive year with 121 publications (28.81%) followed by 2014 with 87 publications (20.71 %) and 2013 with 85 publications (20.24%).The analysis shows that there is a no regular pattern is visible in the case of number of publications during the period of study.

4.3 Publication Channels

The productivity of scientists of SCTIMST are spread over variety of publication media like journal articles, books/book chapters and other forms like conferences, seminar proceedings etc. The details of publication channels adopted by scientists of SCTIMST are given in the Table 4.2

Table 4.2: Publication Channels

Sl. No.	Forms	No. of Publications	Percentage
1	Journals	403	95.95
2	Books/Book Chapters	9	2.14
3	Others	8	1.90
Total		420	100.00

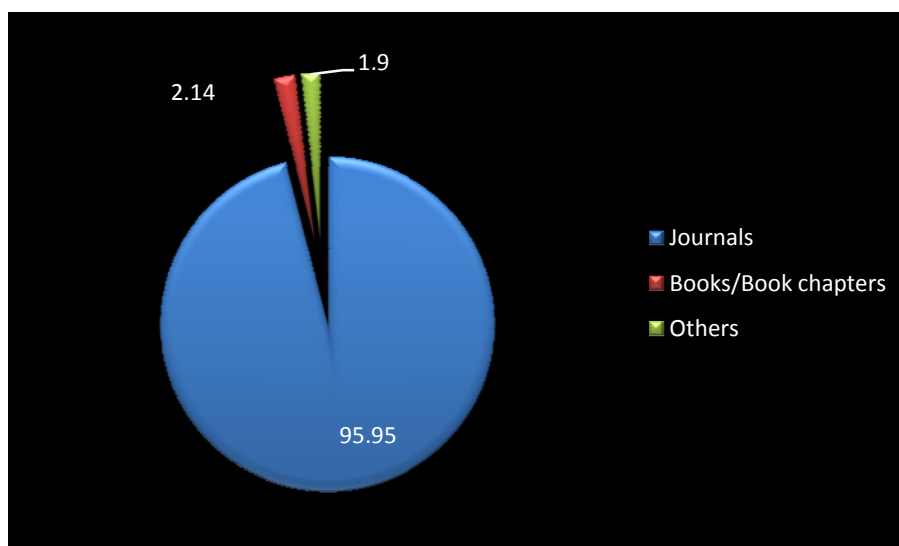


Figure 4.2: Publication Channels

Most of the scientists tend to prefer to publish their ideas on journal articles (95.95%).

4.4 Author Productivity

An attempt was made to identify most productive authors. There are a total of 420 publications and 278 principle and collaborative authors in the publication list of SCTIMST, Trivandrum over the period 2011-2015. Details shown in Table 4.3.

Table 4.3: Rank list of most Productive Authors

Sl. No.	Authors	Rank	No. of Publications	Percentage
1	Sarma,P S	1	43	10.24
2	Thankappan,K R	1	43	10.24
3	Mohanan,P V	2	36	8.57
4	Varma, H K	3	34	8.10
5	Radhakrishnan, K	4	32	7.62
6	Sreenivasan, K	5	31	7.38
7	Jayasree, R S	6	26	6.19
8	Kesavadas, P	7	22	5.24
9	Nair, P D	7	22	5.24
10	Sharma, P	8	21	5.00
11	Mini,G K	9	19	4.52
12	Nazeer,S S	10	15	3.57
13	Krishnan,L K	11	14	3.33
14	Ramesh, P	11	14	3.33
15	Ravindran, TKS	11	14	3.33
16	Thomas,B	11	14	3.33
17	Radhakrishnan,A	12	13	3.10
18	Rekha,M R	12	13	3.10
19	Nichter,M	13	12	2.86
20	Syama,S	13	12	2.86

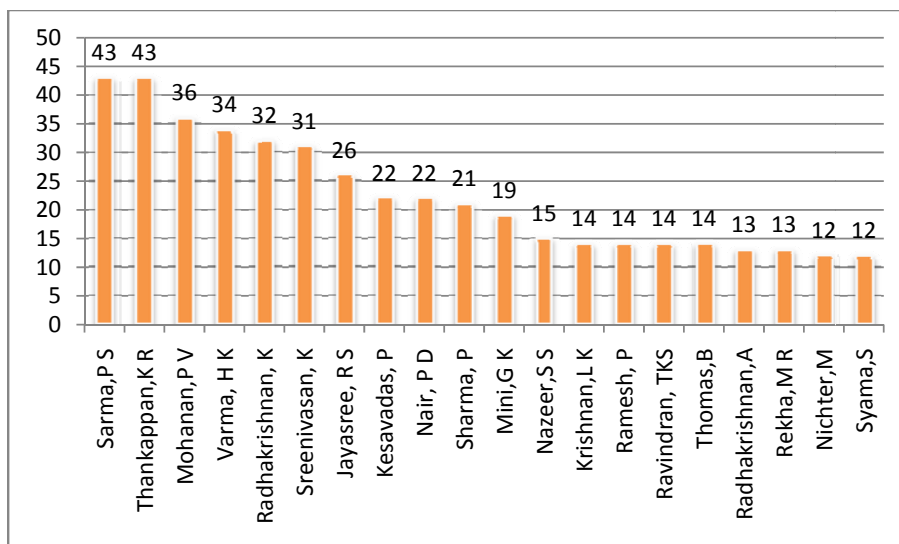


Figure 4.3: Rank List of Most Productive Authors

Table 4.3 shows the list of most productive authors. It revealed that out of 278 authors, the most productive authors are Sarma, P. S. and Thankappan, K. R. They are contributing 43 articles each and ranked into first place. Second rank goes to Mohanan, P.V. with 36 articles and followed by Varma, H. K. with 34 articles.

4.5 Authorship Pattern of Publications

It is a common trend that collaborative research is a characteristic feature in most of the Science and Technology research fields including Medical Sciences and allied subjects. To test this, the collected data are explicitly examined on the basis of authorship pattern.

Table 4.4: Year-Wise Author Collaboration

Year	Single	Two	Three	Four	Five or more
2011	5	26	27	26	37
2012	2	8	7	18	20
2013	3	21	11	16	34
2014	10	14	22	12	29
2015	1	16	17	13	25
Total	21	85	84	85	145

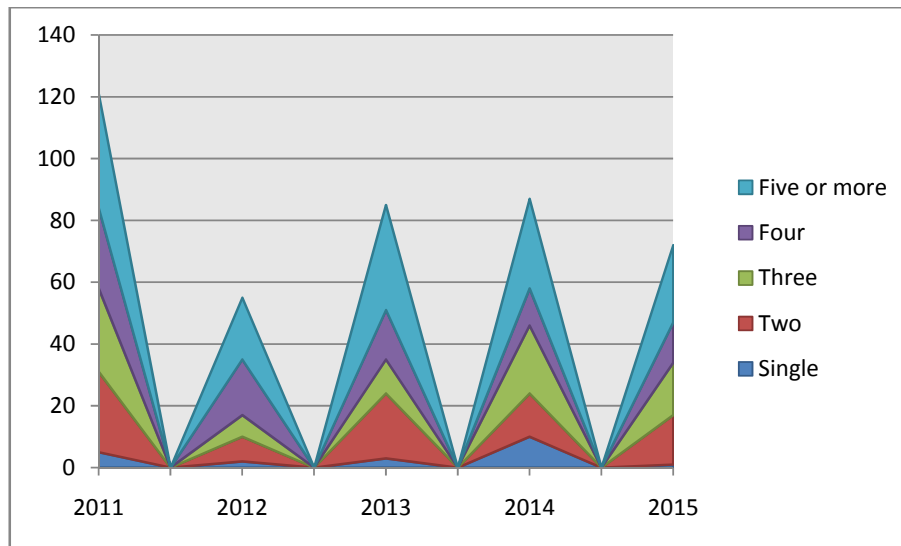


Figure 4.4: Year-Wise Author Collaboration

Table 4.5: Authorship Pattern

No. of Authors	No. of Articles	Percentage
Single	21	5.00
Two	85	20.24
Three	84	20.00
Four	85	20.24
Five or more	145	34.52
Total	420	100.00

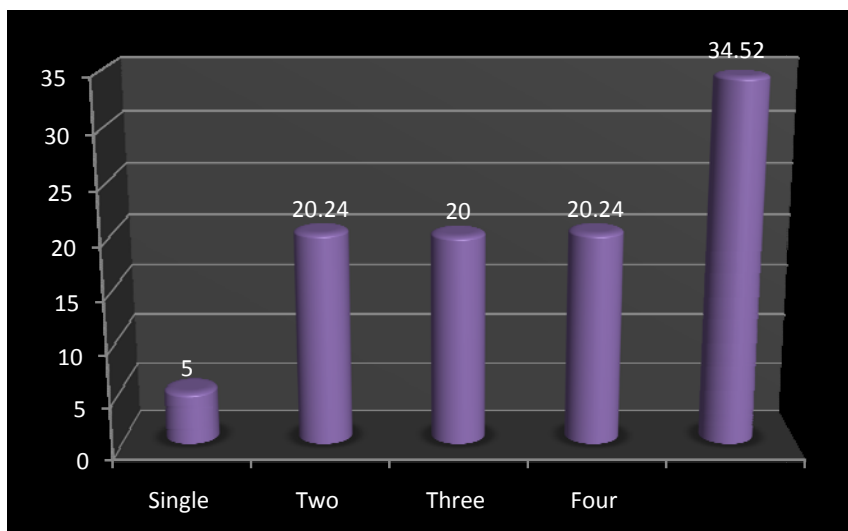


Figure 4.5: Authorship Pattern

Here, out of 420 publications, 21 were written by the single author (5%) and 85 of them were written by two (20.24%) authors. About 20% were written by three. Almost 20.24% were written by four authors. Remaining 34.52% were collaborative authorship with five or more authors each.

4.6 Degree of Collaboration

Extend of collaboration can be measured with the help of multi- authored papers. To measure the collaborative research pattern a simple indicator called collaboration coefficient is used. Collaboration co-efficient is the ratio of the number of collaborative research papers during a certain period of time. As per the formula given by K. Subramanyam (1983), for determining the degree of collaboration in a discipline, the value of collaboration will be between 0 and 1.

According to him,

$$\text{Degree of collaboration (C)} = \frac{C_m}{(C_m + C_s)}$$

Where,

C_m = Number of Multi-authored articles published

C_s = Number of Single authored articles published

Table 4.6: Degree of Collaboration

Year	Single-authored articles	Multi-authored articles	Degree of Collaboration	Average
2011	5	116	0.96	0.95
2012	2	53	0.96	
2013	3	82	0.96	
2014	10	77	0.89	
2015	1	71	0.99	

The table 4.6 shows the degree of collaboration of each year. It is observed that the degree of collaboration is high (0.99) in 2015 and low (0.89) in 2014. The analysis indicates that the average of degree of collaboration in the period 2011-2015 is 0.95.

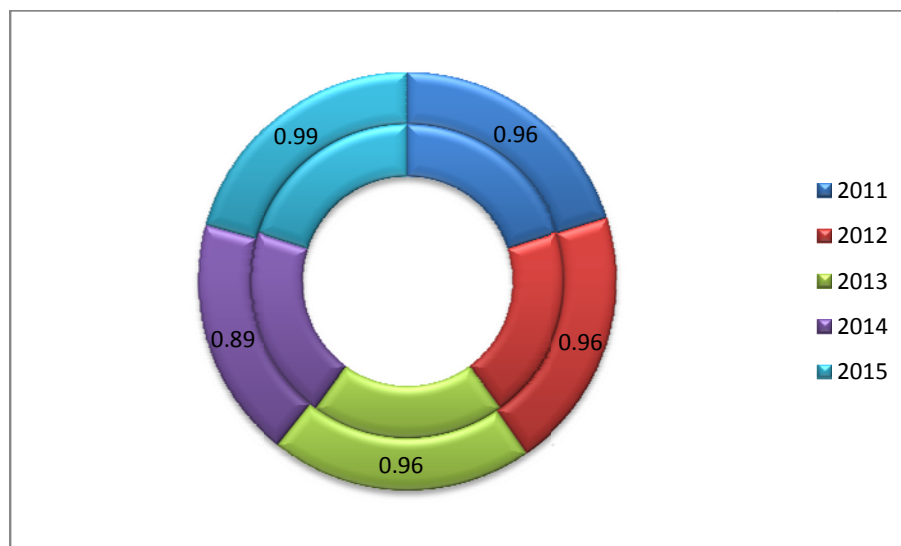


Figure 4.6: Degree of Collaboration

4.7 Analysis of Journal Articles

The journal articles are analyzed by the following measures:-

4.7.1 Year –Wise Distribution of Articles in Foreign and Indian Journals

The analysis of distribution of articles reveals that out of 403 journal articles, 359 (89.08%) were published in foreign journals and 44 (10.92%) were published in Indian journals. The year 2011 is the most productive year in the case of journal articles. Out of the 112 total articles published in the year 2011, one hundred and one (101) are in the foreign journals and 11 are published in Indian journals.

Table 4.7: Year –Wise Distribution of articles in Foreign and Indian journal

Year	foreign Journals	Indian Journal	Total
2011	101	11	112
2012	46	6	52
2013	72	11	83
2014	71	13	84
2015	69	3	72
Total	359	44	403

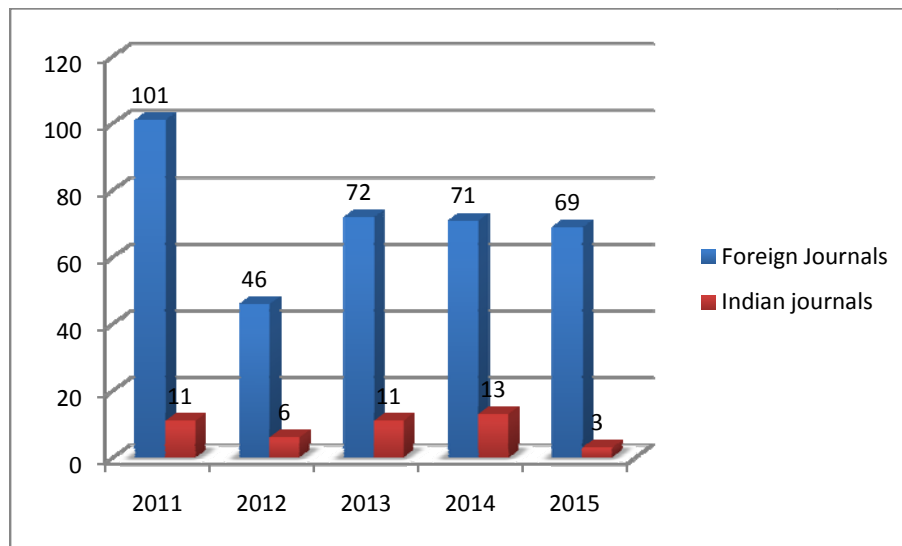


Figure 4.7: Year –Wise Distribution of Foreign and Indian Journals

4.7.2 Authorship pattern of Journal Articles

It is seen from the Table 4.8 that most of the journal articles are by five or more authors. One hundred and forty five (35.98%) articles written by five or more authors and 83 are by four authors

Table 4.8: Authorship Pattern of Journal Articles

Sl. No.	Number of authors	Number of articles	Percentage
1	Single	16	3.97
2	Two	79	19.60
3	Three	80	19.85
4	Four	83	20.60
5	Five or more	145	35.98
Total		403	100.00

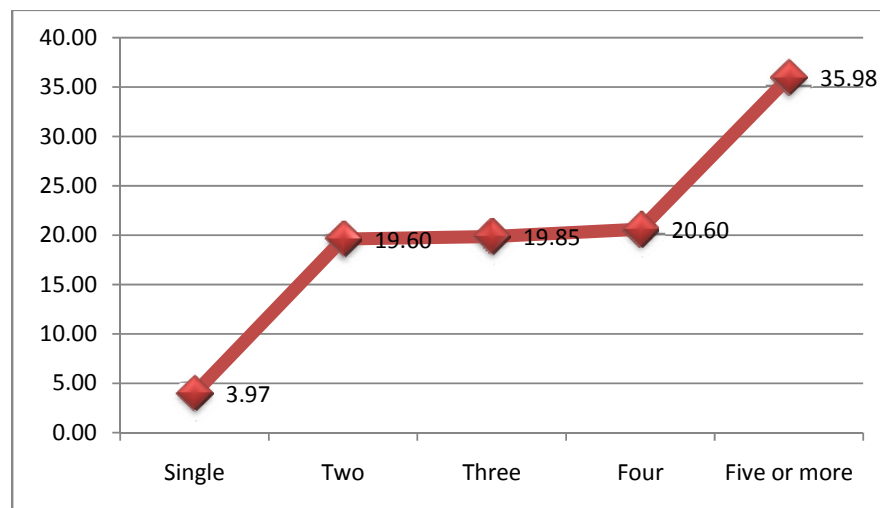


Figure 4.8: Authorship Pattern of Journal Articles

4.7.3 Ranked Authors of Journal Articles

Table 4.9: Ranked Authors of Journal Articles

Sl. No.	Author	Rank	No. of Publications	Percentage
1	Sarma,P S	1	41	10.17
2	Thankappan,K R	1	41	10.17
3	Mohanam,P V	2	36	8.93
4	Varma, H K	3	34	8.44
5	Radhakrishnan, K	4	30	7.44
6	Sreenivasan, K	5	31	7.69
7	Jayasree, R S	6	26	6.45
8	Kesavadas, P	7	22	5.46
9	Nair, P D	8	21	5.21
10	Sharma, P	8	21	5.21

The study reveals that Sarma,P.S. and Thankappan,K.R. are the most productive authors contributing 41 contributions each, followed by Mohanam,P V with 36 articles and Varma,H K with 34 articles (Table 4.9).

4.7.4 Geographical Distribution of Journals

The journals are analysed according to their country of origin (Table 4.10).

Table 4.10: Geographical Distribution of Journals

Sl. No.	Country	No. of Journals	Percentage
1	U.K.	59	26.34
2	U.S.A	56	25.00
3	Netherlands	29	12.95
4	India	26	11.61
5	Germany	10	4.46
6	France	8	3.57
7	Ireland	7	3.13
8	Canada	6	2.68
9	Egypt	6	2.68
10	Switzerland	5	2.23
11	Sweden	4	1.79
12	Australia	2	0.89
13	Russia	2	0.89
14	Iran	1	0.45
15	Singapore	1	0.45
16	South Korea	1	0.45
17	Thailand	1	0.45
Total		224	100.00

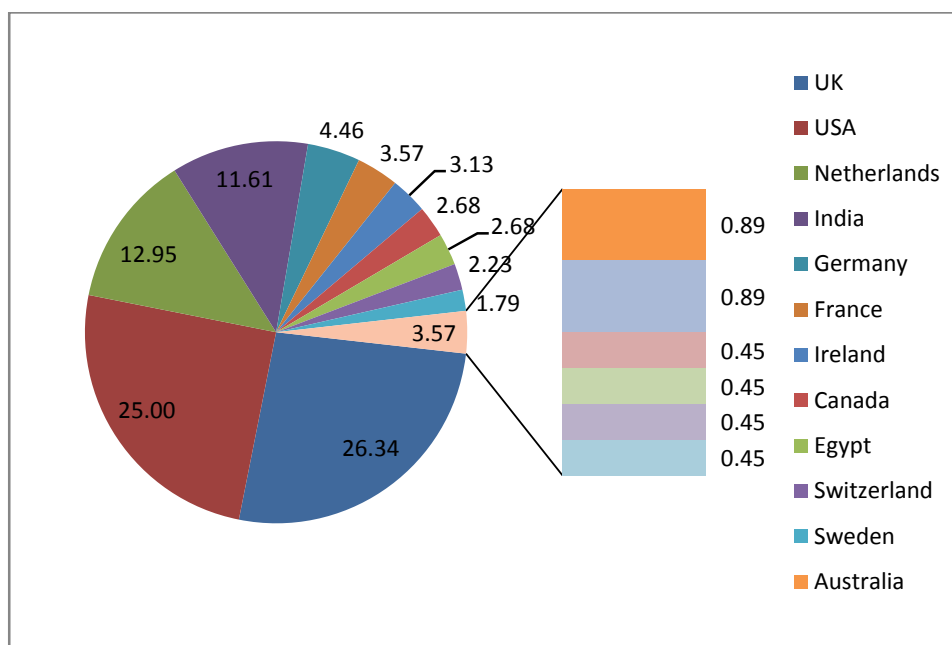


Figure 4.9: Geographical Distribution of journals

The list of countries is quite long as 17 countries published 224 journals. Out of the 17 countries India ranks Fourth (Table 4.10). It has been observed that U.K. is the leading country with 59 journals (26.34 %). USA is in the second position with 56 journals.

4.7.5 Rank list of Journals

The rank list of top 10 journals is listed in the Table 4.11. It gives the rank list of most productive journals with a minimum of 6 articles. From the Table 4.11, it is seen that *Colloids and Surfaces B: Biointerfaces* an international journal published by Elsevier coming to top of the list with the highest number of articles 11 (2.73%). It is followed by *Annals of Indian Academy of Neurology* with a share of 10(2.48%) and *Carbohydrate Polymers* occupy the third position with 9(2.83 %) publications.

Table 4.11: Rank list of First Ten Journals

Sl. No.	Name of Journal	Publisher	Country	No. of articles	Rank	Percentage
1	Colloids and Surfaces B: Biointerfaces	Elsevier	Netherlands	11	1	2.73
2	Annals of Indian Academy of Neurology	Indian Academy of Neurology	India	10	2	2.48
3	Carbohydrate Polymers	Pergamon Press Ltd	U.K.	10	2	2.48
4	Asia Pacific Journal of Public Health	SAGE	U.S.A.	7	3	1.74
5	Epilepsy Research	Elsevier	Netherlands	7	3	1.74
6	Advances in Polymer Technology	John Wiley and Sons Inc.	U.S.A	6	4	1.49
7	Asian Pacific Journal of Cancer Prevention	Asian Pacific Organization for Cancer Prevention	Thailand	6	4	1.49
8	Neurology	Lippincott Williams and Wilkins Ltd.	U.S.A	6	4	1.49
9	Journal of Applied Polymer Science	John Wiley and Sons Inc	U.S.A	6	4	1.49
10	Seizure	The British Epilepsy Association	U.K.	6	4	1.49

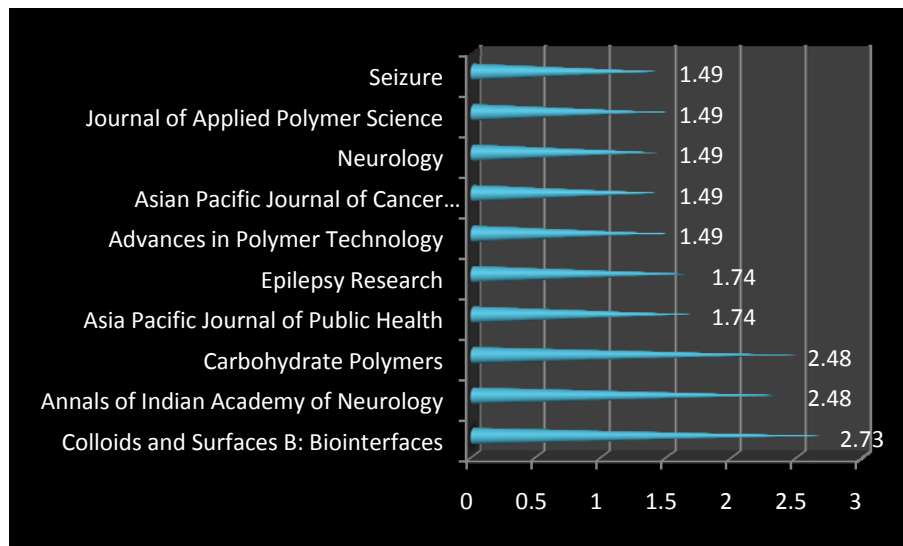


Figure 4.10: Rank list of first ten Journals

4.7.6 h-index of Journals

It quantifies both country scientific productivity and scientific impact and it is also applicable to scientists, journals, etc. The index can also be applied to the productivity and impact of a scholarly journal. In this study, h-index is measured on the basis of scimago database. Out of 224 journals, 33 journals are not covered in the database. The analysis is shown in the Table 4.12.

Table 4.12: h-index of Journals

Sl. No.	h-index	No. of Journals	No. of Articles
1	Below 50	85	160
2	51-100	53	103
3	101-150	34	56
4	151-200	9	22
5	201-250	5	14
6	251-300	4	4
7	301-350	0	0
8	351-400	0	0
9	401-450	0	0
10	451-500	0	0
11	501-550	0	0
12	551-600	1	2
13	Not mentioned	33	42
Total		224	403

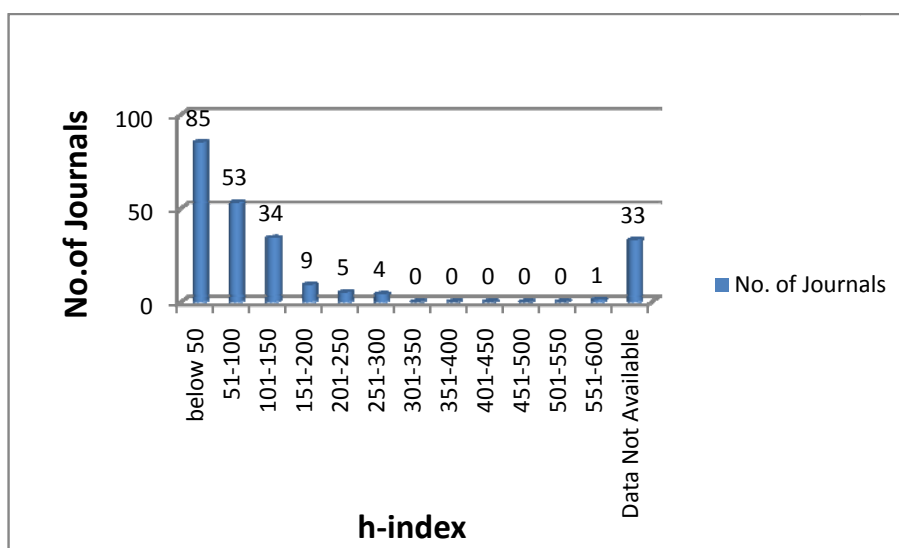


Figure 4.11: h-index of Journals

It has been observed that h- index of more number of journals are comes below the value of 50. It is observed the there is only one journal, *Lancet* published by the Lancet publishing group, U.K has having h-index 600. It is also revealed that, there are two articles published in this journal.

4.8 Conclusion

The current study was carried out to analyze the scientific productivity of SCTIMST, Thiruvananthapuram. In this chapter the collected data was subjected to detailed examination to ascertain characteristics like year-wise distribution of publications, publication channels, author productivity, authorship pattern, degree of collaboration, year-wise distribution of articles in journals, authorship pattern of journal articles, Ranking of authors of journal articles, geographical distribution of journals, ranking of journals and h-index. The major findings and suggestions are discussed in Chapter 5.

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CHAPTER 5

FINDINGS AND CONCLUSION

5.1 Introduction

The present study aimed to analyse the publication trend of SCTIMST scientists and doctors during period 2011-15. The list of publications was collected from the website of the institute. The scientometric analysis of the data is presented in the previous chapter. The data collected were analyzed to fulfill following objectives

1. To ascertain year-wise growth of publications of research productivity.
2. To examine the communication channel preferred for research publication.
3. To make a rank list of most productive authors.
4. To ascertain authorship pattern and degree of collaboration of publications.
5. To find out the year-wise distribution of articles in foreign and Indian journals
6. To examine the authorship pattern of journal articles
7. To find out the geographical distribution of journals
8. To analyse the ranking of journals
9. To calculate the h-index of journals

This chapter deals with the major findings and conclusions obtained from the analysis. It also provides the suggestions given by the investigator.

5.2 Findings

This study fulfilled identified objectives. The findings drawn from the analysis of data collected for the study are summed up below.

5.2.1 Year-Wise Distribution of Articles

- i. It is found that a total published literature of SCTIMST for the five year (2011-2015) period amounts to 420.
- ii. The majority of articles were published in the year 2011, i.e. 121 (28.81).
- iii. Less productive year was 2012, in which only 13.10% of the total articles published.
- iv. No regular pattern in publishing articles is visible per year.
- v. It is observed a sudden decrease in the growth of articles from 2011 to 2012 and then a gradual increase in 2013 and 2014, further decrease in 2015.

5.2.2 Publication Channels

- i. The productivity of scientists of SCTIMST are spread over variety of publication media like journal articles, books/book chapters and other forms like conferences, seminar proceedings etc.
- ii. Most of the scientists tend to prefer to publish their ideas on journal articles, i.e. 403 (95.95%).
- iii. About 2.14% are in the form of Book/Book Chapters and remaining 1.90% are in other forms of publications like conferences, seminar proceedings etc.

5.2.3 Author Productivity

- i. There are a total of 278 principle and collaborative authors in the publication list of Sree Citra Tirunal Institute for Medical Sciences and Technology, Trivandrum over the period 2011-2015.
- ii. It revealed that out of 278 authors the most productive authors are Sarma, P.S. and Thankappan, K.R. They are contributing 43 articles each and ranked into first place.

- iii. Second most productive author is Mohanan, P.V. with 36 articles and followed by Varma, H. K. with 34 articles.

5.2.4 Authorship pattern of Publications

- i. It is found that out of 420 publications, 21 articles are contributed by single authors (5%).
- i. Two authored articles were 85, which constitutes 20.24% of total articles.
- ii. About 20% of the articles were written by three authors.
- iii. Almost 20.24% were written by four authors.
- iv. The highest contribution of articles, 145 (34.52%) by collaborative authorship with five or more authors each.
- v. It is found that 95% of total publications have multi-authorship pattern.
- vi. It reveals that collaborative research is prominent in the field of medical sciences and technology.

5.2.5 Degree of Collaboration

- i. The degree of collaboration was highest in 2015 (i.e. 0.99).
- ii. The lowest degree of collaboration (0.89) was recorded in the year 2014.
- iii. Degree of collaboration which is 0.96 can be seen first three years i.e. 2011,2012 and 2013
- iv. The average degree of collaboration during the period 2011-2015 is 0.95.

5.2.6 Year –Wise Distribution of Articles in Foreign and Indian journals

- i. The analysis of distribution of articles reveals that a total of 403 journal articles were published during the year 2011-2015.
- ii. There are 359 articles (89.08%) were published in foreign journals and 44 (10.92%) were published in Indian journals.
- iii. The most productive year was 2011 (112 articles) in the case of journal articles too.

- iv. The study reveals that great number of articles was published in foreign journals so it envisages that the research output of the SCTIMST was internationally standardized.

5.2.7 Authorship Pattern of Journal Articles

- i. It is found that out of 403 publications, 16 articles only were written by single author (3.97%).
- ii. Two authored articles were 79, which constitutes 19.60% of total articles.
- iii. About 19.85% of the articles were written by three authors.
- iv. Almost 20.60% were written by four authors.
- v. The highest contribution of articles, 145 (35.98%) by five or more authors.
- vi. It is found that 96.03% of total articles have multi-authorship pattern.

5.2.8 Ranked Authors of Journal Articles

- i. It is found that out of 403 journal articles were published during the year 2011-2015.
- ii. Sarma, P.S. and Thankappan, K.R. are the most productive authors contributing 41 journals each.
- iii. Second rank goes to Mohanan, P V with 36 articles and followed by Varma, H K with 34 articles.
- iv. While analyzing the ranking of authors either in the case of whole publications or journal articles, the position of the authors are more or less similar.

5.2.9 Geographical Distribution of Journals

- i. It has been observed that UK is the leading country with 59 journals (26.34 %). USA is in the second position with 56 journals.
- ii. Netherlands is in the third position with 29 articles (12.95%)
- iii. Out of the 17 countries India ranks Fourth position.

5.2.10 Rank List of Journals

- I. The rank list of top ten journals prepared on the basis of number of articles published by the scientists of SCTIMST.
- II. It gives the rank list of most productive journals with a minimum of 6 and maximum 11 articles during the period 2011-2015.
- III. It is seen that “Colloids and Surfaces B: Biointerfaces” an International journal published by Elsevier coming to top of the list with the highest number of articles 11 (2.73%).
- IV. It is followed by Annals of Indian Academy of Neurology with a share of 10 (2.48%) and Carbohydrate Polymers occupy the third position with 9 (2.83%) articles.

5.2.11 h-index of Journals

- I. On the basis of scimago database, it has been analysed that out of 224 journals, 33 journals are not covered in the scimago database.
- II. There are 85 journals comes under the h-index below 50.
- III. 53 journals are in the h-index range of 51-100.
- IV. There are no journals in the h index range between 301 and 550.
- V. 600 is the highest noted h-index range and it goes to the foreign journal entitled ‘Lancet’ published by the Lancet publishing group, U.K...There are two articles published in this journal.

5.3 Areas of Further Research

The present study is related to a single institute and further studies can be done by comparing with other similar institutes.

A comprehensive study can be conducted by applying all the scientometric techniques and bibliometric laws, so that more comprehensive results can be evolved.

Such institutional productivity studies can also be conducted in other institutes of national importance, universities and its departments in the state.

5.4 Conclusion

The present study aims to assess the research productivity of Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram. It is a scientometric study based on the publication list available on the institution's website. This study provides an understanding of characteristics such as authorship pattern, collaboration trend, growth of research output etc. Scientometric analysis and studies of such kind, namely, bibliometrics, informetrics, and webometrics have gained much importance in the field of Library and Information Science. These techniques can be used to identify the emerging research areas in any branch of knowledge to evaluate the research performance of scientists, research groups and countries, to map the cognitive or intellectual structure of a research area and to study the relation between authors, institutions and journal articles. Measurement of research productivity of an institution is an acceptable one.

The most fundamental social process of science is the communication and exchange of research inferences. It is mainly through the journals, conference proceedings and other sources. The articles /research papers published commonly termed as research productivity. Research productivity of R and D institution is very important in all field of knowledge. Basic research in India has generally followed

global models during the last three decades. Indian systems for supporting basic research has so far not adopted adequate measures for promoting joint research with active schools in the global scene in frontier areas of science. The challenge however is how to spot, attract, nurture, and encourage sparks and talent in scientific research and identify areas of national interest and gaps for promotion of basic research and improving the quality of education.

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