SCHOLARLY COMMUNICATION BY WOMEN FACULTY OF INDIAN INSTITUTES OF TECHNOLOGY: A SCIENTOMETRIC STUDY

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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Submitted

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This is to certify that the Thesis entitled "**SCHOLARLY COMMUNICATION BY WOMEN FACULTY OF INDIAN INSTITUTES OF TECHNOLOGY: A SCIENTOMETRIC STUDY**" submitted by **Miss Bhagyashree Chetia** for the award of the Degree of **Doctor of Philosophy in Library and Information Science** is carried out under my guidance and incorporates the student's bona fide research. This is the candidate's original work and is worthy of examination**.**

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Date: Supervisor

DECLARATION

MIZORAM UNIVERSITY

APRIL, 2026

I **BHAGYASHREE CHETIA**, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to do the best of my knowledge to anybody else, and thatthe thesis has not been submitted by me for any research degree in any other University/Institute.

This is being submitted to the Mizoram University for the **Degree of Doctor of Philosophy in Library and Information Science.**

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Date: **BHAGYASHREE CHETIA**

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LIST OF ABBREVIATIONS

TERM	DESCRIPTION
IIT	Indian Institute of Technology
DST	Department of Science and Technology
ISRO	Indian Space Research Organisation
CSIR	Council of Scientific and Industrial Research
S &T	Science and Technology
R & D	Research and development
IF	Impact Factor
h-index	Hirsh-index
g-index	Egghe-index
SCI	Science Citation Index
SCCI	Social Science Citation Index
JCR	Journal Citation Reports
Wos	Web of Science
SJR	SCImago Journal Rank
SNIP	Source Normalized Impact per Paper
NIRF	National Institutional Ranking Framework
ETD	Electronic Theses and Dissertations
INFLIBNET	Information and Library Network
ICT	Information and Communication Technology
IITM	Indian Institute of Technology Madras
IITB	Indian Institute of Technology Bombay

IITD	Indian Institute of Technology Delhi
IITKGP	Indian Institute of Technology Kharagpur
IITK	Indian Institute of Technology Kanpur
JEE	Joint Entrance Examination
GATE	Graduate Aptitude Test in Engineering
CEED	Common Entrance Examination for Design
NGO	Non-Governmental Organizations
Moe	Ministry of Education
DC	Degree of Collaboration
CI	Collaborative Index
AGR	Annual Growth Rate
CAGR	Compound Annual Growth Rate
RGR	Relative Growth Rate
DT	Doubling Time
IRINS	Indian Research Information Network System

CHAPTER 1
INTRODUCTION

1.1 Introduction

The global research landscape is gradually changing. New research fields are emerging worldwide, which can help a country's development. Research is a key factor for developing countries. It allows these countries to reach new levels of progress. Science and technology are among the most influential drivers of growth and development for any nation. They can transform a country's socio-economic situation, benefiting individuals in their personal and professional lives. Science and technology can bring about significant changes to a country's economy, whether it is developed or developing. They are especially helpful for developing countries, as they support these nations in growing and reaching new milestones.

In a developing country like India, research plays a crucial role in improving the nation's social and political situation. India is known for its basic research efforts. Indian scientific research is recognized as a powerful tool for growth and development. Given recent developments and new demands on the science and technology system, we must undertake major science projects that address national needs. The Department of Science and Technology (DST) is essential in promoting science and technology across the country. The department's activities range from supporting advanced basic research and developing cutting-edge technologies to meeting the technological needs of ordinary people through appropriate skills and innovations. Science is fundamentally a global and collective effort. It is a competitive yet cooperative process where the free flow of knowledge is vital for progress. Scientific research produces information, and communication is its core. Science and technology are key drivers of economic growth, and science education forms the backbone of all scientific and technological efforts within a country. It is increasingly recognized that improving the nation’s competitiveness depends on a better-educated population. Within the scope of human capital, scientific manpower plays a critical role, and there is a strong link between human resources in science and technology and economic development.

1. Driven by research into advancements, new frontiers, and innovation in science and technology, the current global socio-economic scenario is witnessing an

economy known as the knowledge economy and a new society referred to as the knowledge society. Here, the phrase "knowledge is power" is being defined; a country or society dedicated to research that produces knowledge has an edge over others. In this context, knowledge or information has been economized or commoditized like never before. In other words, knowledge is being converted into a form of currency and measured by research output or productivity. Studies show that research output is directly linked to the economic performance of a nation (Solarin & Yen, 2016). It is also observed that academic research has a positive correlation with the innovation and economy of a nation (Merigóetal.,2016).

1.2 Science and technology research in India

Science and technology research in India is a dynamic and rapidly evolving field, supported by a combination of government initiatives, private sector investments, and academic excellence. India has made significant strides in science and technology research over the past few decades, establishing itself as a global hub for innovation and scientific advancement. With institutions like the Indian Space Research Organisation (ISRO), the Council of Scientific and Industrial Research (CSIR), and premier institutes such as the Indian Institutes of Technology (IITs), the country has developed strong capabilities in areas ranging from space exploration and nuclear energy to biotechnology and artificial intelligence. In developing countries, universities and research institutes must play a major role in transforming traditional societies into modern and developed ones. Research is a crucial component of any institution; its output is reflected in the institution's publications, which demonstrate the progress made in the field. In developing countries like India, there is a strong focus on enhancing science and technology (S&T) and advanced research to foster economic growth and knowledge creation. Globally, investment in S&T has gained renewed interest, providing a window of opportunity. Accordingly, research policy has adopted an essential role in each country’s broader economic landscape. S&T and advanced research will drive the pace of economic growth and yield greater prosperity. The primary focus of S&T policy is to increase the effectiveness and output of academic research. To this end, post-independence, the

Indian government has implemented numerous S&T policies. However, investment in S&T and research and development (R&D) projects in India has a history of less than a few decades, unlike in Western countries. Worldwide, investment in S&T has seen renewed interest as it opens up new opportunities. Educational institutions serve as centers for knowledge creation and innovation. The Government of India has undertaken several initiatives to promote and nurture S&T activities within academic institutions. This will foster research rigor in these institutions, thereby strengthening R&D capabilities. It is well-known that S&T institutions in India excel in producing high-quality graduates who contribute significantly to sustainable economic growth. India has made significant strides in science and technology research over the past few decades, establishing itself as a global hub for innovation and scientific advancement.

1.3 Concept of Scientometrics

An outcome of intellectual pursuits and inquiry is research output, or productivity. Research is a production process that involves human resources, tangible assets such as scientific instruments and materials, and intangible assets such as acquired knowledge and social networks. This process is required for research activities. Output, which includes new information, has a complex nature, comprising both tangible aspects (such as publications, patents, conference presentations, and databases) and intangible elements (including tacit knowledge and consulting services). The output is of a complex nature that includes new knowledge. The year 2014 for Abramo and D'Angelo. The output of research can be measured in terms of both its quantity and its impact. In order to facilitate the measurement of effectively performing scientists or researchers, a variety of indicators and approaches have been established by professionals in the information industry and subject matter specialists. These instruments are utilized by managers, administrators, and stakeholders in order to guarantee that participants receive fair recompense for the services they provide to society. The assessment of research activity has encouraged the formation of new fields, including bibliometrics, scientometrics, and informetrics, along with numerous indicators and methods such as citation analysis, content analysis, impact factor (IF), Hirsh-index (h-index), and Egghe-index (g-

index). When it comes to the procedures of recruiting, promotion, and grant distribution, the values that are obtained from these indicators serve as instruments for administrators, managers, stakeholders, and research funders. This is because openness and accountability are essential needs.

The topic of scientometrics has evolved from a fundamental quantitative approach of counting and observation into an interdisciplinary field that attracts the attention of professionals, researchers, policymakers, and academics in a variety of different ways, with differing degrees of engagement. Researchers and scientists have been substantially impacted by how scientometric methodologies have been implemented. Some see the field of scientometrics as controversial, while others find it to be advantageous. There have been numerous influential figures from a variety of fields who have contributed to the development of the field of scientometrics. Some of these figures include Eugene Garfield, a linguist and computer scientist; Derek de Solla Price, a physicist; and Robert Merton, a sociologist, amongst others who are recognized for their significant impact.

Evaluation of research output or productivity of scientists or researchers has become a special interest in the recent past because of much proliferation of so-called research output and literature masquerading as research output. The phenomenon of the white plague has been ignited or catalyzed by the inventions and transformations in the information and communication technologies, especially the internet. This has changed the entire landscape of scholarly or research communication in accessing and publishing research work. In a time such as when one can access a vast amount of information or knowledge and also publish their work very easily, it has become very crucial to identify who is doing real research and give due reward to them, and also to study the behavior of scientists.

Bibliometrics and scientometric methods and indices have become very important tools for gauging the quantity and quality of research output. Over the years, many such indices and methods have been developed to measure the output of scientists and researchers.

The modern science of science, or Scientometrics, traces its intellectual roots to SCI and bibliometrics, and therefore many of the terms and concepts are one and akin to what are applied in them, but just that it is applied to science. Scientometrics is concerned with the study of science as a communication or information process, and the application of quantitative methods and techniques to science, as Price (xv) described. Scientometrics is "turning the tools of science on science," as econometrics is to economics. Today, scientometrics has grown to great extent that it has given rise to many areas of study and drawn professionals from different disciplines. It is no longer just limited to information professionals.

1.3.1 Evolution of the subject Scientometrics

Scientometrics is a field of study that focuses on measuring and analyzing science, technology, and innovation. It employs quantitative methods, particularly bibliometrics (the analysis of scientific publications), to understand scientific research's structure, development, and impact.

The term "scientometrics" (Naukometriya in Russian) was first used in Eastern Russia by Nalimov and Mulchenko in 1969 to describe research on the quantitative study of scientific activities (Nalimov, V. V., & Mulchenko, B. M., 1969). The term gained popularity with the founding of the journal "Scientometrics" by Tibor Braun in Hungary in 1977. Paul Otlet introduced the term "bibliometrics," which was later further developed by Samuel C. Bradford, who proposed Bradford's Law of scattering in 1934 (regarding the distribution of articles across journals). Furthermore, bibliometrics became a key foundation for scientometrics. The subject of scientometrics gained legitimacy with the launch of the journal Scientometrics in 1978, founded by Tibor Braun in Hungary. Since then, it has become a global field with applications in science policy, research evaluation, and innovation studies.

Scientific productivity is frequently measured in terms of publication output, as data can easily be collected from various sources. A ratio between the output of scientific research and its inputs is a simple measure of scientific productivity. The other commonly used measures are the counting of publications and citations to

publications. The former is a gross indicator of quantity; the latter is a measure of the quality of the publications. Design and development of science indicators are now increasingly becoming popular. The number of papers, growth rates of articles, authors, patents, journals, institutions, impact factors, h-index, etc., are simple indicators. Computations of these indicators are not simple. It requires large amounts of data from several databases; it involves high cost and time; the other factors, such as reliability, validity, and availability of data, are equally important. Further, it is also difficult to identify and select reasonably good methodologies to analyze scientometric data. Scientific research and scientific communication are bound together so closely that the two always go hand in hand. There exists a cyclic relation between scientific research and literature production in a region. The higher the research output, the higher the publication of literature. The growth of scientific literature of a country or a region can, therefore, be used as a significant indicator to measure the progress of science and technology.

1.3.2 Definitions of scientometrics

Scientometrics plays a crucial role in information science by providing methodologies for tracking, evaluating, and analyzing information resources, as well as managing knowledge. Scientometric investigations are primarily conducted to assess the quantitative and qualitative advancements within the scientific profession. To effectively characterize information phenomena, it is essential to acquire quantitatively reliable data, develop appropriate methodologies, and apply relevant indicators. The utility of scientific information typically diminishes over time. This may be evident in the decreasing number of citations.
Braun and colleagues (1996) define scientometrics, focusing on the analysis of scientific data. Scientometrics is a field that investigates the quantitative aspects of the generation, transmission, and application of scientific information, thereby enhancing the understanding of the mechanisms underlying scientific research activities.
Scientometrics aims to identify the characteristics of phenomena and processes related to scientific research to enhance the management of scientific activities. Two

primary methodologies are employed in scientometrics: theoretical and empirical. The impact of scientific information is addressed in both theoretical and empirical studies. Sengupta (1992) defines scientometrics as a method that employs quantitative and qualitative measuring techniques for the evaluation and interpretation of science. This encompasses various activities, including the productivity, progress, organization, and management of science through mathematical and statistical calculations. This definition was provided by Sengupta. The most prevalent indicators utilized in scientometrics.
A range of scientometric indicators is employed to assess research and measure the performance of journals, institutions, countries, and collaborative research groups. This set of scientometric indicators primarily consists of citation-based metrics, typically sourced from citation databases including the Science Citation Index (SCI), the Social Science Citation Index (SSCI), and the Journal Citation Reports (JCR). Beginning in the early twenty-first century, web-based citation databases such as Scopus and Web of Science, along with citation search engines like Google Scholar, Microsoft Academic Search, and Cite Seer, have become widely used for generating citation-based indicators. The following graph presents a compilation of the most effective citation indicators.

Scientometrics involves the measurement and analysis of scientific activity. Scientometrics is typically conducted through bibliometrics, which involves the measurement of scientific publications. Scientometrics refers to the quantitative analysis of scientific literature and research outputs. In reality, it involves the application of statistical indicators (particularly bibliometric indicators) as a measure for the evaluation of scientific activity. Egghe and Rousseau (1990).

1.3.3 Features of Scientometrics

1. Briefly elucidate on the knowledge framework and the methods of information dissemination. Assesses all formal communication related to publication patterns.
2. Provides a quantitative assessment of publication trends
3. Indicates the rate of growth of literature at the pattern level.

4. Assess and quantify the research output of individual countries. Denotes the citation format employed in scholarly references

1.3.3.1 Most useful citation indicators

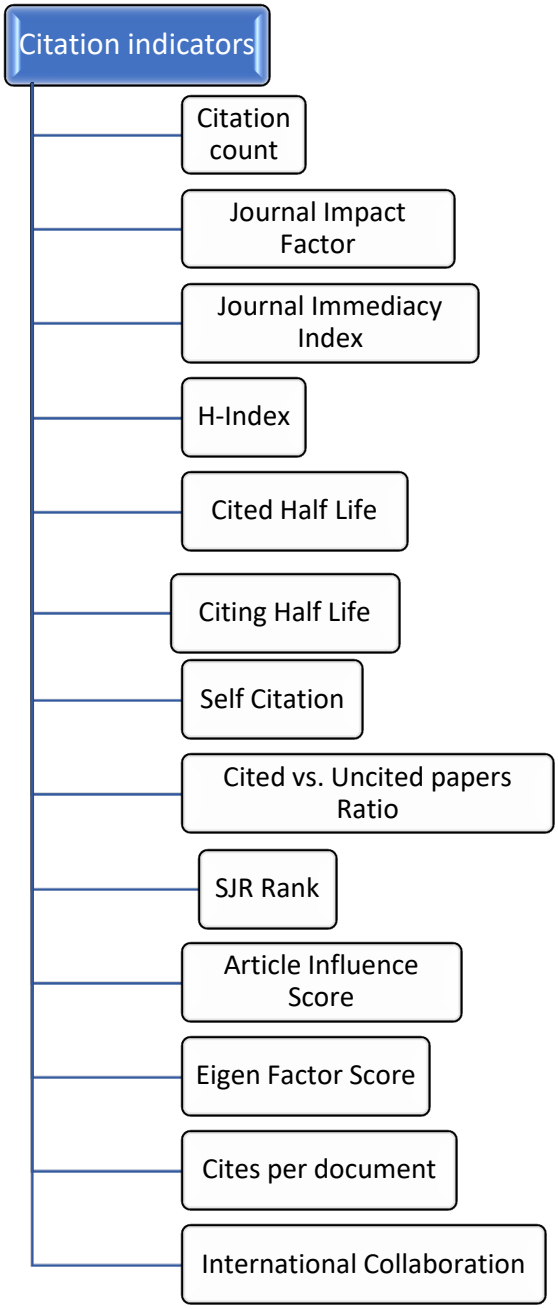

Figure 1.3.3.1: Citation indicators

1.3.4 Application of Scientometrics

The nature of scientometric studies is mostly empirical, and the research pertains to the scattering of articles over journals, growth of literature, obsolescence of documents, productivity and impact, research productivity of any country, language citation studies, etc. The scientometric analysis has received considerable attention in recent years and has been widely applied to evaluate the research performance of scientists and the growth of various scientific disciplines. Scientometrics techniques are now being used for a variety of purposes, like the determination of various scientific indicators, the evaluation of scientific output, the selection of journals for libraries, etc. The metrics studies mostly deal with the quantitative analysis of science to find relationships among various disciplines; evaluate scientific research by individuals, institutions, or countries; and analyze author and journal productivity, as well as the quantitative aspects of library and information studies. Obsolescence and growth of literature. Co-citation, bibliographic coupling, co-word analysis, rank distribution of words, etc.

a. Citation analysis: The purpose of citation analysis is to evaluate and interpret the citations that have been received by various forms of scientific activities, including papers, authors, institutions, and other aggregates. Within the field of sociology of science, it functions as a tool for evaluating the networks of communication that exist.
b. Obsolescence in Literature: “Obsolete” is a term that describes something that is no longer in use or that has become obsolete. The term "obsolescence" describes the process by which something becomes obsolete or is no longer utilized. In many circles, this phenomenon is referred to as the replacement phenomenon. Gross & Gross were the ones who initially presented the concept of "obsolescence" in the year 1927. A decrease of one-half over a period of fifteen years was discovered through an analysis of the references that were included in the volume of the Journal of Chemical Literature that was published in 1926. It is a characteristic that distinguishes scientific and technical literature from other types of writing. Between the years 1960 and 1970, Burton and Kebler were the first people to apply the term "half-life" to

papers. The duration of this period is defined as the time period during which fifty percent of the body of currently active literature is published. The amount of time that must pass before a collection of publications can qualify for fifty percent of the citations that they have received. Studies that are conducted in a diachronic fashion usually investigate the concept of half-life. The usage of literature looks to be declining swiftly, particularly when incorporating material of transient value, such as reports, theses, advanced communications, or preprints, within the framework of technological progress. When literature is descriptive, there is a possibility that its use will progressively decrease.

c. Hirsch Index (h-index): The number of papers (h) that have received citations that are equal to or more than h is the criterion that is used to determine the h-index. A scientist is said to have an index of h if it can be demonstrated that h of their N articles has a minimum of h citations apiece and that the remaining (N-h) papers have no more than h citations. In his study, Hirsch developed an index that would be referred to as the h-index in order to quantify the amount of scientific research that an individual completes. The h-index is a metric that measures the sum total of the influence that an individual's scholarly contributions produce. In addition to this, he has proposed that the value of h follows a linear progression over time for a particular individual. Egghe and Rousseau (2006) were the authors.
d. Author Output: Published output is frequently used as a means of quantifying scientific production. This is due to the fact that information regarding the number of publications authored by authors is easily accessible and typically reliable. On the other hand, quantitative metrics may on occasion act as markers of research outputs that are insufficient.

In addition to its theoretical underpinnings, the field of scientometrics possesses diverse practical applications within library and information science. The applications or laws are what matter most in the field of study and in making decisions about scientific policy. Among the most well-known laws in scientometrics

are Lotka's Law, Bradford's Law, and Zipf's Law. Information scientists use these laws a lot in their study to build theoretical frameworks and figure out how the body of literature has grown.

LOTKA'S LAW: Lotka's law says that the number of publications of each author is inversely proportional to the number of authors of scientific works. In accordance with this law, the number of authors who write two items is about a quarter of the number of authors who write one item, the number of authors who write three items is about a ninth of the number of authors who write one item, and about 60% of all authors write only one item. n2 = p(n), where p is the number of people who wrote n papers. k is a constant that is unique to a certain subject area. It is described as the "study of how to measure changes in science and technology." It helps us understand the framework of scientific activity, the fields being studied, the organizations involved, the strengths and weaknesses of the scientific groups, how they communicate, and the different levels of accumulation.

BRADFORD'S LAW: The scattering of scientific literature was observed by Samuel Clement Bradford, a chemist who became a librarian in 1934. He explored the issue of dispersed articles on a scientific topic in peer-reviewed publications. He put the journals on a certain topic in order of how productive they were, and then he divided the list into three equal-sized zones, each about $1:n:n^2$. This means that a small group of journals, called core journals, makes a lot of publications. It shows that the most important journals are at the bottom of the curve, called the "nuclear zone," and the least important journals are spread out among a lot of other journals at the top of the curve, called the "gross zone" or "peripheral zone." This law affects many things that happen in a library. For example, you can subscribe to journals based on their center or nuclear zone. It is a good idea to add the next zones to the buy list until the budget allows it. If the library has some extra money, it would be better to get copies of magazine articles when they are needed instead of paying for subscriptions.

ZIPF'S LAW: The Harvard linguistics professor George Kingsley Zipf came up with Zipf's law in early 1936 based on what he had seen and heard in real life. The law shows the order of the words in the text and how often they appear. If you put the

word list in order of how often it appears in the text, from most common to least common, the word rank times its frequency stays the same. From a mathematical perspective, Y = k/r is the rank of a word with y occurrences. Where k stays the same. There are now two main versions of Zipf's rule that look at high-frequency and low-frequency words in a text. It offers a gauge of an author's extensive vocabulary. You can use this method to figure out who really wrote a work that is being debated.

1.4 Scopus: An overview

Elsevier's Scopus is an online subscription-based bibliometric database that contains approximately 69 million entries of scientific literature from over 11,678 publishers. It began operations in 2004 to serve the academic community. It covers fields from around the globe, including life sciences, social sciences, physical sciences, and health sciences. In 2009, SCOPUS established an independent and worldwide Scopus Content Selection and Advisory Board to select publications for inclusion in the database (Elsevier).

Scopus represents the most comprehensive abstract and citation database of peer-reviewed literature, encompassing scientific journals, publications, and conference proceedings. It offers a thorough overview of research conducted globally across the disciplines of science, technology, medicine, social sciences, and arts and humanities. Scopus integrates advanced features that facilitate the monitoring, analysis, and visualization of research data. Furthermore, Scopus provides complimentary features to researchers without a subscription and is accessible via Scopus Preview. All journals included in the Scopus database undergo annual review to ensure they meet high-quality standards based on four key numerical metrics: h-Index, CiteScore, SJR (SCImago Journal Rank), and SNIP (Source Normalized Impact per Paper). Additionally, searches within Scopus include functionalities for searching patent databases.

1.5 Significance of the Study

Scientometrics has emerged as the most active area in library and information science. It is widely used to evaluate intellectual quality in terms of research literature growth, level of collaboration, other collaboration measures, authorship

patterns, citations, and their applications. One of the key topics of research in library and information science is tracing the breadth of ties among scholars and collaboration measures in a certain area, publication, or institute. It identifies the expansion of the literature in a specific area or discipline; citation analysis provides knowledge for publications impacted by other writers in the search for new inventions.

Moreover, the study findings will offer insights into the women faculty's research contributions and help them to decide how to optimize scholarly communications for future publications and their impact.

1.6 Scope of the Study

Women nowadays are far more confident, emancipated, visionary, and, most importantly, educated. In countries such as India, women's participation in all fields is low, but this is improving rapidly. Nowadays, there is no subject that has not been influenced by women; women are actively participating, demonstrating their talent, and contributing in every field, including education, research, sports, and politics. However, even though education has improved women's status and roles in society, women's participation and numbers in higher education and research institutes remain low. To understand their function in education and research, it is necessary to examine the position of women and analyze their role and perspectives on career advancement. The current study aims to identify and assess the performance trends of Indian women in science and technology.

Therefore, the study is limited to analyzing the women faculty's research contribution and investigates the Top five NIRF-ranked IITs in India who work in a variety of discipline. There are 23 IITs in India as of now, and based on NIIRF data (2022), the top five institutions are selected, which are IIT Madras, IIT Delhi, IIT Bombay, IIT Kharagpur, and IIT Kanpur. Thus, the scope is limited to the five IIT's as listed in Table 1. Institutional websites will be used to gather information about female faculty members. The bibliographic data for articles will be obtained only from the Scopus database. The objective of this study is to quantify and assess both qualitative and quantitative dimensions of publication, encompassing the volume of scientific

publications, the relevance of their citations, publication themes, and the most impactful authors and organizations among women faculty in the top 5 NIRF-ranked IITs across various disciplines. The faculty's output will be collected from the day they join the institute. This knowledge is crucial for monitoring and analyzing trends in the quality and quantity of research publications.

Table 1.6: List of IITs

Sl. No	Name of the IIT	Rank as per NIRF	Year of Establishment
1	Indian Institute of Technology Madras, Chennai, Tamil Nadu	2nd	1959
2	IIT Delhi, Delhi	3rd	1961
3	IIT Bombay, Maharashtra	4th	1958
4	IIT Kharagpur, West Bengal |	5th	1951
5	IIT Kanpur, Uttar Pradesh	6th	1959

(Source: NIRF website)

1.6 Research Design

A research design is a methodological approach developed by the researcher to offer reliable and unbiased solutions to the problems. It is a blueprint of strategies to carry out the research work. It is an arrangement of parameters for collecting and evaluating the data that attempts to strike a balance between operational effectiveness and relevance to study objectives. It emphasized the preparation of strategies to carry out numerous procedures and responsibilities essential to successfully conducting the study. And also, it validates that these methods are sufficient to generate authentic, truthful, and comprehensive responses to the research questions (Kumar, 2011).

1.6.1 Statement of the Problem

Scientific mapping is an important factor in the research process, enabling the identification of growth and development in a specific domain. It measures the growth of research using various scientific indicators. Women nowadays are much more confident, liberated, visionary, and, most importantly, educated. In a country like India, it is observed that the participation of women in every field is low, but

now the scenario is changing rapidly. Nowadays, there is no such area that is untouched by women; in every field, women are participating actively and showing their ability and contributing in every field, i.e., education, research, sports, politics, etc. Although education has changed the status and role of women in society, it is noticeable that women's participation and numbers are still lower in higher education and research institutes. In order to see their role in education and research, it is important to look at the situation of women scientists and discuss their role and perspective on career development. The present study is an effort to determine and analyze the performance trend of Indian women in the field of science and technology.

1.6.2 Objectives of the Study

The objectives of the research provide a direction and guide to carry out the investigation which are -

1. Study the overall research contribution of women faculty at the Indian Institute of Technology (IIT).

2. Find out the most productive authors, journals, and research areas.

3. Study the pattern of authorship collaborations between authors and impact by using different index measures.

4. Visualize the national and international collaborations of publication and its impact using scientific measures.

5. Analyze the trends of research themes over the years by analyzing keywords.

1.7 Research Methodology

Research methodology is the systematic procedure through which one can analyze the primary data and gather and organize them into meaningful information. It provides a comprehensive technique that assists in maintaining research focus and enables a basic, viable technique to culminate the study findings.

1.7.1 Type of Research

The present study examined and analyzed the research productivity of women faculty of the top five NIRF-ranked (Based on 2022) ranked IITs. The study's objective is to quantify and measure both qualitative and quantitative aspects of publication, including the number of scientific publications published, the significance of their citations, publication topics, and the most influential authors and organizations among the 393 women faculties of various disciplines. For the study, the Scientometric tools are used to evaluate the research growth and trends. Evaluation of scientific productivity is an important part of assessing research productivity. The scientometric study is a viable and relatively objective measure of a university and research institute's performance, particularly in science and technology.

1.7.2 Sample of the Study

The study examined and analyzed the research productivity of 393 women faculty of the top five NIRF (Based on 2022) ranked IITs. The primary data was collected from institutional websites and annual reports. And the faculty output was gathered with the help of the Scopus database, Google Scholar, ResearchGate, and IRINS. The study's objective is to quantify and measure both qualitative and quantitative aspects of publication, including the number of scientific publications published, the significance of their citations, publication topics, and the most influential authors and organizations. Starting on the day they joined the institute; the faculty's output was gathered. Having this knowledge is essential for tracking and examining trends in the quality and number of research publications. Additionally, the Scopus database from 2000 to 2024 served as the major source of data collection.

1.7.3 Data collection tools: For collecting the data, the following tools were used:

Scopus Database: Scopus is the greatest database of literature that has undergone peer review, including scientific journals, books, and conference proceedings. It offers a comprehensive examination of the research conducted globally in various areas of science, technology, health, social and behavioral sciences, and humanities and arts fields. The Scopus database was utilized to compile the publication statistics from the participating central universities.

Institution’s Website: An institution's website is the primary gateway and a functional tool of the organization. Irrespective of the institution, the website serves as an identity and information hub, provides the necessary services, and offers a secure infrastructure.

1.7.4 Data collection procedure: By using the Scopus database, the data required for the study were retrieved during September 2025 to December 2025 using the Scopus database up until the year 2024. The retrieved data were filtered, scrutinized, and arranged according to the study objectives by using Microsoft Excel. The total contribution of the faculties and their variations was identified manually using Biblioshiny (Bibliometrix R), an open-source tool for comprehensive scientific mapping and accessing scientific publications packages.

1.7.5 Data analysis and Interpretation: The collected data from the Scopus database were scrutinized, tabulated, and analyzed using suitable software packages, such as MS Excel, VOSViewer, and Biblioshiny (Bibliometrix R package). The number of publication and their pattern, as well as the growth of the publication of the faculty members was analyzed and arranged manually using MS Excel. While the analysis of authors, collaboration, country collaboration, trending topic, keywords was analyzed using the VOSviewer visualization platform. It is a platform to visualize the large-scale bibliometric networks. Developed by Nees Jan van Eck and Ludo Waltman at Leiden University. The platform takes the complex data from WoS, Scopus, PubMed, or Dimensions and turns it into intuitive colour-coded maps to see co-authorship, co-occurrence, citation, and co-citation and bibliographic coupling as well. Furthermore, the hypothesis testing was also done based on the study parameters. Later, the analyzed data were presented in the form of different tables, graphs, and figures for better interpretation of the results.

1.7.6 Hypothesis

H1: There is a correlation between the number of publications and the joining date.

H2: There is a significant citation variation between open-access publications and closed-access publications.

1.8 Organization of the study

Chapterization is the basic summary of the whole investigation report with logical structuring into sections and sub-sections. Chapterization helps to engage the reader's receptivity to fresh concepts and inferences with systemic enlightenments. This study is classified into six chapters, handing out all the logical details of the report along with bibliography and appendices. APA 7th reference style is used for both in-text citations and bibliographic references. The classified six chapters are arranged in the following particulars:

Chapter 1: Introduction

The chapter provides the introduction of the study and its relevance. The chapter also specifies the objectives and the scope of the study. It states the problem for undertaking the study and also explains the research methods and tools for the study. Furthermore, the chapter presents the entire research framework labelled as the organization of the study.

Chapter 2: Review of Literature

This chapter identified all the research publications that are relevant to validating this study. It also defines the current information related to the scope of the study. This chapter is divided into sub-sections pertinent to the topic, such as Scientometrics studies based on various topics, women's studies, etc. The review of the literature is arranged in descending chronological order for each sub-section.

Chapter 3: Scholarly Communications

The chapter provides a detailed concept of communication and its different channels, platforms, and its importance in research and academic activities. The chapter also provides how scholarly communication works and its importance in enhancing the quality and reliability of scholarly work. It also presents how assessing scholarly publications is one of the key concerns of information professionals.

Chapter 4: Indian Institute of Technology (IIT): An Overview

This chapter provides the detail institutions profile of the top five IITs. It also presents the illustration of their official website homepage, along with a table consisting of the list of all the IITs.

Chapter 5: Data Analysis and Interpretation

The chapter is referred to as the major part of the entire research work. It comprises the final evaluation of the results and findings after analysis of the data. This chapter pertains to the answers to the research questions with a systemic outlook by adopting tables, figures, and graphs. The comprehensively analyzed data are interpreted for a better understanding of the findings.

Chapter 6: Findings, Conclusion, and Suggestions

This chapter calls out the outline of the findings of the study based on the study parameters. It also reveals the suggestions and recommendations to the faculty members as well as institutions, as per the study findings.

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CHAPTER 2
LITERATURE REVIEW

2. Literature Review

2.1 Introduction

The in-depth assessment of research or publication on any subject area is considered a review of the literature. A review is a survey of academic outputs, such as books, journals, and conference proceedings, in a specific field of study, providing a concise overview and outline of the particular study. The main purpose of the literature review is to find out what has already been studied on a certain topic. To find different research methods and strategies for the collection of data to analyze the data that have not been successful earlier in the most productive way associated with the research area.

For this present study, the Scopus database, Web of Science, ResearchGate, Google Scholar, Shodhganga, etc database, were used as important tools or platforms to search and collect literature for the study. A total of sixty-eight literature was collected from various sources and reviewed. The review literature for the study was selected from 2003 to 2025. The literature was collected based on the topic of:

a. Overview of Scientometrics

b. Scientometric studies based on the Literature on women's studies

2..1.1 Overview of Scientometrics

Various bibliometrics and Scientometrics studies have been published in India and abroad, but studies that concentrate on the role and research output are found to be fewer. Another study conducted by **Rathika and Berlin (2025)** analyzed nuclear medical publishing in an article. The authors reviewed 30 years of literature (1991–2020) to identify the most significant journal publications, growth rate, research productivity, and—most importantly—author and institution contributions. They extracted a total of 12,632 data entries from the Web of Science database in text format and assessed them according to the study's objectives. The database provided primary data through the keyword search term (TOPIC (“Nuclear Medicine”)) and a timespan of 1991-2020. The authors used Histcite, Microsoft Excel, and VOS viewer software to analyze the data, which they presented in tables and graphs. Scientific

articles from 108 nations were found in nuclear medicine research. The United States led with 3,480 publications (27.55%), followed by Germany with 1,330 (10.53%), Italy with 1,145 (9.06%), the UK with 1,105 (8.75%), and France with 968 (7.66%). India ranked 20th worldwide with 211 publications (1.67%). The Journal of Nuclear Medicine, published by the US Society of Nuclear Medicine and Molecular Imaging, led with 1,146 publications (9.07%) and an H-Index of 85. Single-author contributions peaked in 1995 with 87 publications, while multi-author contributions peaked in 2020 with 706 articles. Multi-authorship papers dominated at 10,542 (83.45%).

Michael (2025) presents a full scientometric analysis of G-20 LIS research contributions from 2015 to 2024. The Web of Science Core Collection, a huge peer-reviewed academic literature database, provided this study's data. The search was limited to 2015–2024 Web of Science subject category "Library and Information Science" papers. The search query sought English-language articles, reviews, conference papers, book chapters, and more by G20 writers. Nationality was determined using publication metadata address data. Data analysis was conducted using Biblioshiny, a web-based interface for the R package Bibliometrix, enabling comprehensive bibliometric analysis. Publishing trends, citation impact, global collaboration networks, and new research ideas are examined using accurate bibliometric data. Major collaborations and thematic developments in LIS research over the past decade are examined. With large research production and influence differences, the data show that the US and China are the main G20 contributors. Most G-20 LIS articles are produced by the US and China (54.4%), reflecting their influence on international LIS research. Publishing in China has expanded the fastest over the past decade, at 12.3% annually. The US has the most manuscript citations (32.4), followed by the UK (29.7) and Australia (27.2). According to Mushtaq et al.'s (2024) assessment of Indian LIS research's global recognition and effect, India ranks eighth among the G20 countries in citation impact, with an average of 14.8 citations per publication. A lot of Indian LIS research is published in domestic journals like the DESIDOC Journal of Library and Information Technology and the Annals of Library and Information Studies, but experienced scholars prefer international

journals. European G20 members publish the most open access (42.3%), followed by North America (38.7%) and Asia (27.5%).

Daimary (2024). Provides a comprehensive bibliometric analysis of Tezpur University's research output and trends during 29 years, from 1995 to 2023, across four academic disciplines: management science, humanities and social science, engineering, and science. The survey reveals various development trends across disciplines, with Management Science seeing the most significant expansion, followed by Engineering. The essential data was gathered from the Web of Science database, which spans the years 1995 to 2023. The article accounts for four distinct academic subjects at a school throughout three time periods: 1995-2004, 2005-2014, and 2015-2023. It also lists the total number of publications in each discipline, as well as their % contribution to the overall total. The total number of data entries collected was 3655. Data was displayed as tables, graphs, and charts using MS Excel and Bib Excel. It analyzes research impact using citation number and Average Citation Per Paper (ACPP) metrics, as well as a relative specialization index that compares Tezpur University's worldwide and national contributions in each discipline. The study digs into collaborative research procedures and shows their ubiquity at the university. Prof Utpal Sharma, the most productive author, has 178 citations and 30 publications to his name, resulting in an average citation per paper (ACPP) of 5.93, putting him first. It is followed by Prof. Chandan Kumar Sharma, who has 32 citations and 36 publications and an ACPP of 0.89, ranking second.

Alireza, R. et al (2024) employed a cross-sectional descriptive method with a scientometric approach where the data were gathered from the Web of Science database in the year 2024 on the topic of scientific outcomes of MLIS from 1990 to 2022 to elucidate the underlying themes and contributions that were shaping the discipline. The analysis was done using Excel 2019 and VOSviewer 1.6 software. The result revealed that in the area of MLIS, united states in the leading producer of scientific output, followed by Iran. Tanya P. Barding and Danial Eric Burgard were the most prolific authors. The analysis also revealed a rapidly expanding and highly specialized field, with the greatest quantity of production occurring in 2008. The key research areas encompassed information science, Library Science, and Health Care

Sciences Services. Scientometric mapping revealed distinct clusters focusing on professional tasks, technology and Internet use, user-oriented services, organizational issues, and citation-related fields. These findings underscore the pivotal role of MLIS professionals in supporting healthcare. However, challenges persisted in methodological diversity, international collaboration, and research transparency. It was crucial to address these challenges to ensure that MLIS continued to wield significant influence in the future of healthcare. **Mondal, I. and Surendran, S. (2024)** conducted a study to analyze the global research trend on digital library during the year of 1991 to 2022. They have collected 6157 scholarly publications from the Scopus database and analyzed them using the BibliometrixR and Vosviewer software packages. The findings reveal that the research in the area of digital libraries has experienced exponential growth in the year 2022 (9.53%). The top prolific authors in this research area are Nelson ML from Old Dominion University (USA) with 54 publications, followed by Fox EA from Virginia Polytechnic (USA) with 50 publications. The USA ranks first in scientific production, followed by the UK and India. The top-most cited countries are the USA with 26535 citations and India with 635 citations. Keyword co-occurrence analysis reveals themes in digital library research, including digital libraries, information retrieval, systematic review, and artificial intelligence.

Basumatary, Yuvaraj, and Verma (2024). Use scientometric methods to analyze research trends and the performance of East Asian countries in the Internet of Things (IoT). They collected 1146 data points from Scopus over five years (2016–2020). The data was analyzed using various scientometric indicators with MS Excel, VOSviewer, and Biblioshiny. Cluster analysis and network visualization were used to evaluate the data, with results shown in tables and graphs. The study reveals that the field has grown rapidly recently, with China leading in IoT research rankings. The most prolific author produced the highest number of articles, and "Electronics (Switzerland)" was the most popular journal, followed by IEEE journals. Wang et al. (2016) authored the most cited paper, "Implementing Smart Factory of Industry 4.0: An Outlook," with 672 citations. Wang et al. (2019) published "Blockchain-Enabled Smart Contracts: Architecture, Applications, and Future Trends," which received 216

citations. Y Zhang topped the list with 24 publications, an H-Index of 11, a G-Index of 19, and a total of 374 citations. Y Li has written 21 papers, with an H-Index of 8, a G-Index of 19, and 373 citations in total. Many experts express concern about the rapid growth of intelligent environments, including "smart factories," "machine learning," "smart cities," "wireless sensor networks," and "blockchains," as shown in the study. Both Beijing University of Posts and Telecommunications and the University of Electronic Science and Technology of China, located in China, each published 61 papers. The trend analysis shows a significant rise in IoT research over the past five years (2016–2020). The annual publication count increased from 91 in 2016 to 369 in 2020, with a growth rate of 41.09%.

Rahimi, A. et al. (2024) conducted this study to examine the scientific outcomes of MLIS from 1990 to 2022 to better understand the underlying themes and contributions that shape the field. This study employed a cross-sectional descriptive method and a scientometric methodology. Data were obtained from the Web of Science in September 2024. The investigation was carried out with Excel 2019 and VOSviewer 1.6 software. According to the findings, Iran ranked sixth in terms of scientific output, while the United States was the major producer. Tanya P. Bardin and Daniel Eric Burgard were the most productive authors. A review of MLIS literature from 1990 to 2022 shows a rapidly expanding and highly specialized discipline, with the highest output in 2008. The primary research fields were information science, library science, and health care science services. Scientometric mapping revealed separate clusters centered on professional activities, technology and internet usage, user-oriented services, organizational challenges, and citation-related sectors.

Senthilkumar, P. et al. (2024). I conducted a study that looked at research on integrated learning published in Scopus from 2015 to 2023, and it showed a significant rise in both the number of publications and citations. The result of the analysis is a trend of increasing records, with a rise from 854 publications in 2015 to 22,344 in 2023. The results indicate that articles comprise the majority of publications (83.11%), with an impressive average of 10.49 citations per record. Significantly, the year 2020 witnessed a surge in the number of recordings (1,466)

and citations (22,455). The projections for 2030 and 2045 indicate that the output of integrated learning research will continue to grow positively, as indicated by time series and trend analysis. The results indicate that the global output for blended learning has increased annually, from 854 in 2015 to 22344 in 2023. The highest number of citations was 22455, with 1466 documents in 2020. A substantial increase in blended learning research output from 2015 to 2023 is also suggested by the study, which is indicative of the increasing interest among academicians in the field.

Basumatary, Verma, Khushwaha, and Verma (2023) evaluated the global research trends and assessed the performance of researchers, organizations, research institutions, countries, and funding agencies that were involved in BFT research over the past decade. The research was conducted using journal articles that were indexed in the Scopus database between 2013 and 2022. The digital object identifier (DOI) of the respective articles was employed to acquire altmetric data from Dimensions.ai. The researchers used MS Excel and Tableau to analyze the chronological development of publications, citations, AAS, and Mendeley readers. Performance measurement, scientific mapping, and network visualization were implemented using VOSviewer and Biblioshiny (Bibliometrix R package). The analysis demonstrated that BFT research has been consistently increasing, with a total of 911 documents published in the past decade. The three most productive countries in the field were Brazil, China, and India. The most prolific author in the discipline during the period was identified by the study as Wasielesky W. (Universidade Federal do Rio Grande, Brazil). Aquaculture, Aquaculture Research, and Aquaculture International were the most productive journals. The research topics that received the most attention in the documents were biofloc technology, followed by studies on Litopenaeus vannamei, water quality, growth performance, crustaceans, Nile tilapia, and Oreochromis niloticus. The co-authorship network analysis revealed that the most significant cohort was composed of researchers from Brazil, China, and India. **Yang, L., and Hailong, H. (2023)** carried out a study to investigate the research status of scientometrics based on 16,225 publications archived in the Web of Science Core Collection between 1992 and 2020. The result of the study shows that there has been a marked increase in publications on scientometric studies over the past decades,

with “Information Science Library Science” being the predominant discipline publishing scientometric studies, but scientometrics has been widely adopted in a variety of other disciplines (240 of 254 Web of Science categories). It was found that Web of Science, Vosviewer, and Scientometrics are the most utilized databases, software, and journals for scientometric studies, respectively. The most productive author (Lutz Bornmann from the Max Planck Society, Germany), organization (University of Granada, Spain), and country (USA) are also identified.

Orimi et al. (2023) examined the history of medical research books. Scientometric and altmetric factors dominated the investigation. Researchers used VOSviewer 1.6.18 and SPSS 16 to visualize bibliometric networks, perform statistical analysis, and detect patterns and trends in PubMed and Embase data. The study revealed a strong link between standard bibliometrics and social media metrics, such as the Altmetric Attention Score, in the history of medicine literature ($p < 0.05$). In two medical databases from 1900 to 2021, 107706 documents were indexed, demonstrating significant growth in the field of medical history over recent decades. WoS articles received more citations than Scopus, averaging 18.41 versus 8.81 per document. The study also found that collaborating with top international universities helps increase research output by leveraging their experience. In terms of volume, the US, UK, and Germany contributed the most to medical history. News outlets and Wikipedia ranked second and third, respectively, in promoting research in the history of medicine. However, the study noted that medical history scholars tend to overlook social media, which limits diversity.

Wodeyar and Mulla (2022) examined manuscripts indexed in the Web of Science and Scopus databases from 2002 to 2021. The primary aim of the paper was to analyze the development of scientometric research in the field of library and information science over time. It provides an overview of LIS in India, focusing on annual publication growth, prominent authors, preferred journals, and collaboration between countries and institutions. The search query used for data extraction was "Scientometric" OR "Bibliometric" OR "Webometric" OR "Librametric" AND Library and Information Science OR Library Science. Additionally, the search was filtered by country, specifically "India." To support quantitative scientometric

research, the data from Scopus and Web of Science were encoded in BibTeX format for analysis with R Bibliometrix, an open-source scientometric tool. The results show a total of 1025 authors and 618 publications. Prathap G is the leading author, with an h-index of 9, 415 citations, and 37 publications. Kumar S followed with 18 papers, 354 citations, and an h-index of 9. Notable authors include Garg K., Madhusudhan, Mergo, Patnaik D, Mukharjee B, and Singh H. The University of Delhi (26 publications) is the most productive, followed by APG Abdul Kalam Technological University (19) and Banaras Hindu University (13). The journal Library Philosophy and Practice has the highest publication count (173), followed by Scientometrics (38) and the DESIDOC Journal of Library and Information Studies (41). Observations from the investigation indicate an increasing trend in the number of publications over time.

Prasad (2022) analyzes research publishing trends in nanomedicine through scientometric analysis from 2005 to 2019. The data for this period were sourced from the SCOPUS database. A total of 30,625 entries were extracted using the search phrase "Nano Medicine," processed with MS Excel software in line with the study's objectives, and presented in both tabular and graphical formats. The study examines publication growth rates, citation patterns, author productivity and collaboration, the most productive journals, and the distribution of publications based on geographical and structural features. In 2016, the highest number of publications was recorded, totaling 2965 (7.29%), followed by 2012, with 2,907 records (7.15%). The peak of 72,377 citations occurred in 2000, while the lowest was 7,371 in 2019. The highest citations per paper value of 58.68 was recorded in 2003, and the lowest of 3.14 was noted in 2019. The findings indicate that the annual average publication output was 1626.76 papers. The investigation also identified a decline in publishing activity during the intermediate years. Nevertheless, the overall growth rate in Nano Medicine literature has been upward.

Kiss, A et al. (2022) conducted a study to investigate the gender-related trends in anti-doping sciences to explore the relational structure of gender aspects of authorial, topical, and methodological features, give recognition to women's contribution to anti-doping research, and identify unique “gendered” potentials for advancing anti-

doping research. Male authors are the majority (66.2%), and women are underrepresented in this field. The most important authorship position in academic articles is mainly occupied by men. The results of this study confirm the potential of the bibliometric approach in the identification of emerging research topics and quantifying gender differentiation in the field of anti-doping. Due to their higher information centrality, women are better positioned for problem-focused multidisciplinary research both within the anti-doping community and with researchers in cognate fields.

Serenko A, Marrone M, and Dumay J (2022) in Scientometric Portraits of recognized scientists: A Structured Literature Review Study present the results of a structured literature review of 110 publications that developed scientometric portraits of 91 recognized scientists. The findings of the study indicate that scientometric portraits are a growing topic in library & information science, Scientometric, and discipline-specific venues. Since 2010, the number of publications devoted to creating Scientometric portraits has been growing steadily, reaching approximately seven works per year by 2019. The study reveals a great interest among Indian scholars in promoting domestic research.

Mondal, D (2022). Research Emphasis of IISERs in Chemical Sciences from 2006 to 2020: A Scientometric Assessment Study. Focuses on the contribution of the faculty members of five IISERs in chemical sciences during the 15 years from 2006 to 2020 to identify the research trend, publication pattern, and scholarly impact. Chemistry was the most productive research area of the selected IISERs, and the faculty members contributed 3,973 articles, of which 18.52% were internationally collaborative articles. The articles were analyzed based on different parameters like chronological distribution, communication pattern, areas of research emphasis, the contribution of different institutes under IISERs, areas within Chemistry where they show strong presence, collaborating institutions and countries, leading authors, and their citation impact.

Nishavathi E., Jeyshankar R., and Oh, Dong-Geun (2022) in Evaluating Research Output Using Scientometric and Social Network Analysis: A Case of Alagappa

University, India, the study analyzed the research productivity of Alagappa University (AU), India, in terms of scientometric and social network analysis measures. The study revealed that AU produced 99.45 % of research articles in collaboration, particularly that 88.41% of the articles were the outcome of international scientific collaboration; the remaining 11.04% of them have collaborated domestically. It found that the main path of the most cited publications constituted the mainstream of development of the Department of Bio-Technology, AU.

Buragohain et al. (2021) analyzed publications related to augmented reality. The study explores global research on A.R. using various metrics that assess quality and quantity. This is achieved through relational indicators that describe the connections between research networks of individuals, institutions, and countries at micro, meso, and macro levels. The research examined the chronological development of publications, highly cited works, leading countries, prominent journals, prolific authors and institutions, co-authorship networks, and keyword analysis. Open-source tools such as Gephi, Biblioshiny, and VOSViewer were used to perform the analysis. The findings show that most publications on "Augmented Reality" are conference proceedings and articles. The most common keywords include A.R., Virtual Reality, and A.R. applications. A large number of publications originated in the USA, followed by Germany in 2020. This study will benefit researchers and stakeholders by providing comprehensive bibliographic information on relevant literature and guiding future research and development.

Buragohain, Verma, and Daud (2021). Assess the research output of SAARC countries in Fisheries Science quantitatively in this study. They utilize data from the Scopus database to perform a scientometric analysis of research in Fishery Science and Fish Biology among SAARC nations. The study covers the years 1994–2021, focusing on published material in English. Raw data exported as CSV files is analyzed and organized using software tools. Biblioshiny is employed to extract relevant information from the data, while MS-Excel is used for statistical analysis and creating graphical representations such as scatter plots. VOSviewer visualizes data networks. The dataset contains 1190 records from the Scopus database of

Fishery Science literature published between 1994 and 2021. Most documents are journal articles, followed by reviews, book chapters, conference papers, books, notes, errata, and short surveys. Of these, 1047 papers (87.98%) are journal articles, with reviews accounting for 8.74%. Khan, MA, has authored the most papers (35), while Harikrishnan, R, is the most influential author (g-index = 27), with 1100 total citations across 27 papers. Findings show an increase in fisheries research publications over the study period. India leads in publication volume among SAARC countries. Co-authorship analysis highlights the level of collaboration among authors, with the top contributors listed. The high degree of collaboration (DC = 0.99) suggests most papers have multiple authors. Overall, contributions steadily increased, averaging around 4 articles per year, reflecting continuous growth in the literature.

Narayan R, Pati P.K., and Sahoo, S (2021). In A Scientometrics Analysis on the growth of open access literature on library and information Science attempted to analyze the quantitative growth of open access publications on library and information science education research. The literature data obtained from the Scopus database and the scientometric methods were deployed to analyze the publications that originated during 2011 and 2020. The study shows that open-access papers on Library and Information Science education (LIS) have grown exponentially, and a significant amount of research papers have been published by both academics and working professionals. "Library Philosophy and Practice" is the favorite source for the researcher as it has published the highest number of papers, totaling 3151 and 3932 citations. Further, it has been found that information literacy, bibliometrics, academic libraries, scientometrics, open access, and citation analysis are the emerging areas of research in this domain.

Chattopadhyay, P., and Halder, B K (2021), in the article entitled "A Scientometric Sketch on the Paper Informetric & Scientometric of e-PG Pathshala Portal," enlightened that e-PG Pathshala is an authentic source of study of e-resources in different academic subjects, including the academic subject Library & Information Science. All the papers that are being taught in the courses of Library & Information Science are given here in detail. This article

regarding the paper “Informetrics & Scientometrics” of the Broad subject Library & Information Science covers all aspects depicted here for convenience and more awareness for students, teachers, LIS professionals, and other interested persons.

Srinivasaiah, R, Renuka, S. D., and Prasad, U K (2021) “Impact of DST-FIST Funding on Research Publications in India (2000-2020): A Bibliometric Investigation” investigates the impact of DST-FIST funding on research publications in India through bibliometric analysis using the R programming and VOS viewer. The research papers published during 2000-2020, acknowledging the DST-FIST funding from the Web of Science database, were considered for the study. The research collaboration worldwide is investigated with the help of explosion and growth patterns in scientific research outcomes. The most dominant document type is research articles, which accounted for 95.80% (6983). Research articles published under DST-FIST grants during 2000-2020 have received 76031 citations. The research publications in the field of Chemistry alone accounted for 47%, with 3437 articles. It implies that research in the chemistry domain (Crystallography, electrochemistry, polymer science, organic and inorganic, analytical, etc.) is the largest beneficiary of the DST-FIST funding scheme. The study results projected a significant impact of research grants on the quality and quantity of research publications, providing a wide-country collaboration network.

Kanaujia, A et. Al (2021). Discussed the quantum of research contribution of centrally funded institutions and institutional systems of India. The volume, proportionate share, and growth patterns of research publications from the major centrally funded institutions, organized into 16 groups, are analyzed in the study. The research output of the centrally funded institutions in India has increased steadily since 2001, with a good value for CAGR. The paper also presents noteworthy insights about scientific research production in India that may be useful to policymakers, researchers, and science practitioners in India. It presents a case for increased activity by the state governments and the private sector to further the cause of sustainable and inclusive research and development in the country.

P. P. H S, T. M., V and M, P (2021) in the paper entitled "Research Productivity of Indian Institute of Science (IISc), Bangalore during 2000-2019: A Scientometric Study" conducted a study to explore and develop the utility of Scientometrics as a research assessment tool to gain insight into the important aspects of research activities at the Indian Institute of Science (IISc), Bangalore. This study evaluates the research productivity of IISc, Bangalore, based on the data collected from the Web of Science for twenty years from 2000 to 2019. A total of 29580 data points were downloaded and analyzed using Biblioshiny and Excel software.

Shaikh, M K (2021). The study aims to highlight the global research output produced in the field of women's empowerment between 2011 and 2020. 4511 documents in total have been obtained from the Web of Science database. The study focuses on several areas of study on women's empowerment, including the rise in publications, the most useful sources, the most prolific writers, document formats, the countries that correlate to the authors, the authors' keywords, and the most useful affiliations. The year with the highest number of publications (763 records) is 2020, while the year with the fewest publications (231 records) is 2011. Yount KM 33 articles wrote the bulk of the publications. With 1563 papers, the USA was shown to be leading the research. **Veer, C D., and Kulkarni, J N. (2020).** "Publication Productivity Trend of Indian Institute of Technology, Delhi during 2015 to 2019: A Scientometric Study" reveals research productivity of scientists from the Indian Institute of Technology, Delhi (IITD) during 2015 to 2019. The required bibliographic information was collected from the Clarivate Analytics Web of Science database. It is found that international research collaboration of IITD faculties with the USA, Germany, England, France, and other countries. It is found that IITD's total average citation per paper is 8.24%. The majority of publications and citations were contributed by three collaborative authors.

Sudhier, K. G. and Kumar, D. V. (2020), in the article Scientometric Profile of Biochemistry Research in India: A Study based on Web of Science, " examine 25,132 biochemistry research contributions of Indian scientists covered in the Web of Science for a period of 10 years (2004-2013). It was found that the biochemistry research is gradually growing, and the average annual growth rate was 36.84 percent.

It was observed that the value of the co-authorship index was generally increasing and varied from 93 to 105 during the study period. Journal articles contribute 89.43 percent of the total output, followed by reviews (7.14 %). Indian researchers collaborate largely with the researchers of the USA (2.49 %). The geographical distribution shows that Tamil Nadu, Uttar Pradesh, and Delhi lead the list. 'Plos One' is the top-ranked journal, and it published 296 papers during the study period. Academic institutions contribute a greater number of papers (50.26 %), followed by research institutions (28.24 %).

Gireesh Kumar, T K et al (2020), in a study with a scientometric approach, present a systematic analysis of the publications in the C&RL News magazine during the years 1996 to 2019. The analysis provides an understanding of the features of highly cited publications. The publication data collected from the Scopus database have been utilized for analyses and interpretations. Authors have applied scientometric indicators such as collaboration coefficient, annual growth rate, and relative growth rate to recognize various dynamics of the magazine. Authors have also analyzed the characteristics of the highly cited publications and found that high-profile collaborative authorship and addressing the contemporary trending topics are consistent features of highly cited documents, even without having a formal peer-review process.

Waghmode S.S, Lathkar, R. A., and Kulkarni, J. N. (2020), in Research Publication Trends in Indian LIS Journals: A Scientometric Study, explore the Scientometric analysis of the three reputed and highly circulated Indian Library and Information Science (LIS) journals of five years. The total 673 articles published in the scoping period are analyzed by applying various parameters like year-wise distribution of articles, authorship pattern, and degree of collaboration, relative growth rate and doubling time, Productivity trends with Lotka's Law, and other parameters of Bibliographic Analysis. The study revealed that the Degree of Collaboration was quite high, i.e., 463 (0.69) in terms of collaborators' contribution. The study revealed that the value of the relative growth rates (RGR) has decreased from 2015 (0.67) to 2019 (0.19) in five years. The doubling time (DT) value has been found to increase from 1.03 to 3.64 in the respective years.

Garg & Kumar (2019) examined a total of 902 papers related to Scientometrics and bibliometrics that were published in select Indian and foreign journals by Indian authors between 1995 and 2014. The study aims to analyze the contributions made by Indian female and male writers in the fields of bibliometrics and scientometrics, as well as the pattern of domestic and international collaboration between women scholars and Indian organizations working in bibliometrics and science. It shows that out of 789 authors, 169 (21.4%) were female and the remaining 620 (78.6%) were male. Female scholars contributed to the production of 249 (27.6%) papers, both jointly and independently. The study also found that the number of publications with female authors increased from 73 in the first decade (1995-2004) to 176 in the second decade (2005-2014). The proportion of publications by female authors rose from 8% in 1995-2004 to 19.5% in 2005-2014. Consequently, the number of publications by female authors grew more than twofold (2.4 times) in the following decade. Women were the first authors on 67 of the joint-authored papers. Female professors produced slightly more individual papers than their male counterparts. Women scholars at GMCH, Chandigarh, contributed the most papers to CSIR-NISTADS.

Velmurugan, C (2019) conducted a study on the literature growth and development in Nanotechnology in Canada as reflected in a Web of Science data database. During the period between 1994 and 2014, a total of 576 scientific research papers, along with cited references, are 34955 were published in the field in Canada.

Saberi, M.K., and Ekhtiyari, F (2019) in "Characteristics of classic papers of Library and Information Science: A scientometric study this study" examine the characteristics of classic papers of Library and Information Science (LIS). The study data indicate that the Scientometrics journal covers most classic papers on LIS (5 papers). 60% of the papers are written by more than one author. The paper "Usage Pattern of Collaborating Tagging System" is a highly cited paper of LIS with 3051 and 1308 citations on Google Scholar and Scopus, respectively. Analysis of authors' affiliation shows that American universities and institutions play a considerable role in LIS classic papers. The data of statistical tests indicate that there is a significant

positive correlation between citations of classic papers in Google Scholar, Scopus, and Web of Science.

Gupta D.K., Gupta B.M., and Gupta, R. (2019) conducted a study with the aim of quantitatively and qualitatively analyzing library marketing research output using select bibliometric indicators with the aim of identifying top-performing countries, subject subthemes, organizations, authors, and journals in the area. The study has examined 520 publications in library marketing, as indexed in the Scopus database during 2006–2017. **Poornima, A., and Surulinathi, M. (2019)** investigated the research output of yoga in India using various scientometric approaches, including quantitative and qualitative methodologies. Bibliographic data for the study were acquired from Thomson Scientific's Web of Science Core Collection online database in the United States. The search strings 'Yoga and India' were used in the topic and address boxes to gather information. Researchers published 525 publications totaling 6683 Global Citations Scores (H-Index: 45), of which 525 were used for further data analysis. The current study covers the research output of yoga researchers in India from 1989 to 2018. It examines the growth rates of output in terms of research productivity across the study period. The authorship pattern and author productivity are investigated to determine the pattern of research contributions in the field of Yoga Research Output in India. In total, 525 articles were published. Furthermore, collaboration among authors and researchers in this domain has increased significantly. The study revealed that eight papers received 100 or more citations. The citations range from 1 to 246. According to the analysis, the h-index is 45, with 6683 citations. The number of papers and citations in Yoga Research has increased dramatically. The survey discovered that 232 articles were published in open-access journals. Additionally, the study showed an i10 index of 164. The investigation found 839 self-citations out of 6683.

Solanki T, et. al (2019) In the paper “Social Media Coverage of Research Output from 100 Most Productive Institutions in India” tries to analyze what proportion of research output from the 100 most productive Indian institutions gets social media coverage. It is found that, while average social media coverage for India is around 28.5%, the coverage varies between 5% to 60% for different institutions. It is also

observed that research output from institutions in some specific disciplines attracts more social media coverage than others. The findings present useful insight into social media coverage of research output of Indian institutions, which may be a proxy for the societal relevance of the research work, and also indicate that suitable mechanisms need to be designed to promote the dissemination of research results from Indian institutions in popular social media platforms.

Pattel, R and Verma, M K (2019) studied the publishing history of male and female scholars in the field of library and information science is compared in this study for the SRELS journal of information management. The study placed a strong emphasis on the role of women in research and the gender differences in research production. In this work, a bibliometric analysis of 464 research publications produced between 2011 and 2018 and contributed by 877 researchers is presented. The study focuses on the co-authorship pattern, the co-authorship pattern by gender, and the average co-authorship coefficient. The annual growth rate of female researchers in the SRELS journal at this time varies every year, reaching its highest level in 2015 (45.8).

Kumar, S. (2018), in a Scientometric study of Research productivity of ARIES, Nainital, evaluates the research performance of ARIES, Nainital. For this study, the data were collected from the Web of Science (WoS) bibliographical database for the period of 15 years, from 2001 to 2015, and analyzed. 574 research papers have been published over 15 years, of which 510 research publications are in refereed journals and 64 research publications are in conferences, symposiums, bulletins, etc. This paper identifies the scientists of ARIES who are active, the areas in which they are active, the journals in which they publish their research work, their productivity in terms of publications, citations, and H-Index, etc. The paper reveals the collaborating institutions, countries, and research funding agencies.

Mohanty R (2018), in the article entitled "Growth of LIS Research in India as Reflected in Scopus during 2010-2014 A Scientometric Analysis, "attempts to analyze the growth of research publications in the field of Library Information Science in India during the period 2010 to 2014. The analysis has been made by taking into account the publication output of India as

reflected in the Scopus Database. The study also analyses the year-wise growth of publications, most productive authors, preferred journals, major areas of research, and major productive organizations, and highlights India's contribution to the field of Library and Information Science Research that is available in the Scopus database.

Liao, C. H. and Chen, M. Y. (2018). Exploring knowledge patterns of library and information science journals within the field: a citation analysis from 2009 to 2016 aims to investigate library and information science (LIS) journal impact from a different perspective: the knowledge contribution to peer journals in the LIS field. The data are selected from the SSCI and SCI databases by Thomson Reuters from 2009 to 2016. This study not only uses social network analysis to investigate the citation patterns among the journals and rank the journals based on different structural characteristics in the network but also examines the formation of subfields through clustering analysis. The findings suggest research avenues for LIS scholars and journal editors, such as identifying research subgroups and formulating strategies for LIS journal development. **Pradhan and Ramesh (2018)** studied and analyzed the bibliographic data of six IITs (IIT Delhi, IIT Kharagpur, IIT Madras, IIT Bombay, IIT Kanpur, IIT Roorkee) in an article. A total of 72,940 bibliographic entries were collected from the Scopus database covering the period from 2006 to 2015. The analysis revealed that the citation impact of works by authors from IIT Kharagpur is greater than that of the other IITs. The authors from all six IITs prefer journals from the USA, which ranks first in scientific production, followed by the UK and India. The most cited countries are the USA with 26535 citations and India with 635 citations. Keyword co-occurrence analysis reveals themes in digital library research, including digital libraries, information retrieval, systematic review, and artificial intelligence. A study conducted by **Maurya, S.K., Ngurtinkhuma, R.K., and Shukla, A. (2018)** to analyze the research performance of faculty members of the Library and Information Science of Mizoram University, Aizawl. The study shows that a total of 394 faculty research publications were made during the study period. The study discussed the year-wise distribution of publications, forms of publications, authorship pattern, Degree of Collaboration, online research visibility through Google Scholar, research impact through Google Scholar, research supervision, and

research projects of LIS faculty members. Google Scholar has been used for citation-related data collection. The study found growth in terms of several research publications, journal articles, and conference/seminar papers as prevalent forms of research publications, as well as prevalent two-authored research publications. The overall Degree of Collaboration is 0.6. The status of research supervision and research projects is also good. Finally, concluded that faculty members of the Department tend to grow further in many directions.

Hussain, F. A. L.M (2017) conducted a study on gender variations in research productivity: insights from scholarly research, where the findings depict that, comparatively, males have a higher average productivity than females for all the performance indicators, especially research productivity, patent creation, funding, and collaboration across regions and disciplines; however, the gap is narrowing over time.

Kalita, D (2017) conducted a study entitled "Research Productivity and its Impact Analysis of the Central Universities of North East India," which evaluates about three primary fronts of research, viz., productivity, impact, and funding source of the nine central universities situated in North East India in the period from 2006 to 2015. During the period, the research productivity, as counted via publication output, has seen a Combined Annual Growth Rate (CAGR) of 23%, while the same for research impact is 52% in the citation time window from 2007 to 2016. Universities received funding from 56 Indian and 48 foreign agencies from 17 different countries. DST is the top funding Indian agency, while Korea is the top funding foreign country. "Chemistry" is found to be the most productive research area with the most no of publications (25% of total publications), followed by Physics.

Khan, I (2016) conducted a study to find out the quality, popularity, and impact of the international journal published by DESIDOC. The analysis of five volumes (from Volume No. 30 to 34) from the year 2010 to 2014 of DJLIT, covering 30 issues containing 307 contributions, was performed. The study shows a trend of gradual growth in contributions published during the period of study, with an average number of 61 contributions per volume of the journal. The study reveals that DJLIT gives

maximum importance to the original research papers for publishing, which attained the top position of publications with a total of 277 (90.23 percent). A maximum number of contributions during the period of study are from joint authors, with a total of 188 (61.24 percent). A maximum number of contributions are from India, with a total of 273 (88.93 percent).

Brown, C. M. and Eichmann D (2016) examine the effects of gender differences in collaboration on research outcomes. The network characteristics of seventeen medical research institutions that are Clinical and Translational Science Awardees (CTSA) to determine if network connectivity characteristics have the potential to help mitigate the performance gap between the sexes, as well as centrality to identify well-connected researchers. The results indicate that being well-connected is more highly correlated with success for women than men in most of the institutions studied. **Mary and Dorairajan (2016)** conducted a study to assess the research output of the University of Madras. The current study focuses on the publications of research scientists and faculty members, using indexed records in Web of Science from 1989 to 2014. The primary data for this study were research papers abstracted and indexed in Web of Science, used to evaluate the university's research performance. Between 1989 and 2014, a total of 7251 articles from the University of Madras were indexed in Web of Science; 155 were published in 1989, with numbers steadily increasing over time. The number of Web of Science-indexed publications rose to 457 (6.30%) in 2014, up from 189 (2.60%) in 2000, averaging 278 articles annually. During this period, Web of Science covered papers authored by 8477 researchers from the university. The average number of authors per article is 1.5. Among the authors, Prof. D. Velmurugan, with 387 publications, contributed 5.3 percent of the total, making him the top contributor, followed by Prof. R. Raghunathan with 291 publications. Acta Crystallographica Section E-Structure is considered the most sought-after journal.

Karpagam (2014) conducted a scientometric study on the global output of nanobiotechnology research. The study was based on the Scopus database, and data were collected for the period 2003-2012. The study examined various parameters, including growth, global publication shares, citation impact, the share of

international collaborative papers, and contributions from major collaborative partner countries. A total of 114,684 papers were published over 10 years, receiving 2,503,795 citations, with an average of 21.83 citations per paper. It was observed that during 2003-2012, the USA held the first position in the number of publications (34,736), h-index (349), g-index (541), hg-index (434.52), and p-index (326.47). Developing countries, such as India, China, South Korea, and Canada, exhibited increasing trends in their publications, and their activity index also showed upward trends. The top 10 institutions contributed 7.16% of total publications. The Massachusetts Institute of Technology, USA, received the highest h-index (120) among these institutions. Biomaterials (1631) was the leading journal in publication output; Nano Letters had the highest impact, with an average citation per paper of 73.86, while the American Chemical Society received the highest h-index (158) among the top 10 journals.

Another study by **Sotudeh and Khoshian (2014)** revealed that in nano-science, females perform equally to men in terms of scientific publications, but they are scarce in number. **Kumar K A (2014)** studied Digital Literacy in Online Library Information Science and Technology Abstracts (LISTA) during the years 1997 to 2011. The study attempts to examine the distribution of articles (age-wise, year-wise, and article-wise), authorship pattern, subject, language, and geographical distribution. Bradford's law was used to determine the scattering of journal articles in the publication pattern on the LISTA database. Results indicate that the majority of articles published during the years 2009-2011 focus mainly on academic education.

Sife, A. S., and Lwoga, E. T (2014) conducted a Scientometric study to analyze the research productivity and scholarly impact of academic librarians in Tanzania for a period of 30 years from 1984 to 2013. The study findings indicate that 434 publications were recorded for all librarians, giving an average of 14.5 publications per year. The top-ten ranked librarians contributed more than half (53.2 percent) of all publications, although they showed considerable variation among different metrics.

Kretschmer, H and Kretschmer, T (2013). The four gender performance myths are presented and explored in the study under discussion. In addition to the effects described in other explanation models, the persistence of these myths in various forms of evaluation is influencing women's discrimination in research careers, resulting in the existence of the invisible barrier (glass ceiling) that prevents women from ascending to the top rungs of the corporate ladder. Male scientists are more prolific and are referenced more frequently than female scientists, according to a study of the entire population. **Wani, Z. A., Pandit, M. T., and Majeed N (2013)** attempted to gauge the research output of IIT Delhi in their paper, " Research Productivity of Indian Institute of Technology. " They collected and analyzed research output for the period of 1964-2010, as indexed by "Scopus," for set objectives. It was found that a total of 15476 research papers from the institute were published in journals and conference proceedings during the study period. The average citation 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 on 3057 and 1209 papers at the national and international levels, respectively.

Kretschmer, H, Pudovkin, A., and Stegmann, J (2012) examined a German medical research institution's productivity and citation rate. The authors utilized the Web of Science database to gather the papers published by the DRFZ between 2004 and 2008. A total of 313 papers in the database were authored by 66 DRFZ scientists, both as authors and co-authors. In 96 domestic and foreign publications, these 313 papers were published. The productivity and citation rates of personnel at the German medical research centre were examined, which comprised 30 female faculty members and 32 male faculty the productivity and citedness of the personnel at a German medical research centre are examined. On average, only 30% of researchers in Europe are women. The study discovered that, overall, male scientists are more productive and are cited more frequently than female scientists. A study by **Hasan et al. (2012)** found no significant difference in the contributions made by male and female research scholars of CSIR. **Feeney M and Bernal M (2010)** investigated and compared how men and women scientists seek advice and support from women in

their networks. It was found that the field of science is the primary predictor of the presence of women in scientists' advice and support networks. Citizenship, rank, age, and friendship are significantly related to the proportion of women in women's networks, but are not consistently significantly related to the proportion of women in men's networks.

2.1.2 Scientometric studies based on the Literature on women studies

Sargsyan et al. (2025) investigate the contributions of Armenian women scientists to the field. The study utilizes biographical data (age, title, and academic position) and bibliometric data (number of publications and citations). In 2024, Web of Science was used to gather bibliometric data on publications and citations from 1991 to 2021. Armenia has 52% female researchers, compared to 30% worldwide. These women favor fields like the humanities, social sciences, chemistry, medicine, and biology. The analysis reveals that 51.8% of Armenian scientists are women, but only 32% of global science articles are authored by women. Women in science tend to publish less than their representation in various disciplines. Despite having a high Ph.D. rate in academia, women are underrepresented as scientists and hold fewer leadership roles, such as heads of departments, research groups, or laboratories.

Shi & Wu (2024). The purpose of this study is to collect a comprehensive dataset that will facilitate a panoramic analysis of the temporal trends in female representation across the entire spectrum of science. In order to examine the impact of gender disparities on research innovation and scientific impact, our research employed diverse and robust regression models that used multidimensional bibliometric indicators. In this work, the researchers used SciNet, a recently released large-scale dataset released by Lin et al. (2023) in May 2023. From 2001 to 2020, the analysis was conducted. A total of 56,800,185 articles and 265,716,439 author records, including their citation networks, were included in the study. Women's engagement in scientific areas is increasing significantly; in 2001, publications with at least one female author accounted for 42% of all articles, a proportion that has continuously increased and is expected to exceed 66% by 2020. Female participation in science is continuously increasing over time, yet gender disadvantages remain.

Basumatary, Yuvraj, Nordin, and Verma (2023) examined the growth, collaboration trends, and performance of researchers and identified issues in BRICS gender equality and women's empowerment research. They used scientometric tools to analyze research from 2012 to 2021. Scopus provided 1,558 bibliographic entries for analysis in Excel and Tableau. Open-source visualization tools VOSviewer and Biblioshiny were used to visualize networks and interpret scientific maps. The study found that BRICS countries produced 16.18% of global research on gender equality and women's empowerment over the past decade, with an annual growth rate of 20.45%. India contributed the most papers (n=683) and citations (TC=2,798), while South Africa collaborated most with other countries. Jewkes R was the most prolific author on topics such as sexual health, intimate partner violence, violence against women, domestic violence, gender-based violence, and sexual abuse. Barros AJD followed. The University of KwaZulu-Natal contributed the most papers (n=56, TC=267), followed by Witwatersrand (n=55, TC=547), and South Africa overall (n=37, TC=192). In the series, Woman in Russian Society published the most articles on gender equality, women's empowerment, movements, rights, and related topics. Agenda, a prominent publication, included papers on women's economic empowerment, nation-building, gender equality/inequality, violence against women, and more. Research on women's empowerment and gender equality increased with an annual growth rate of 20.45%.

Mukherjee, B (2022). The contributions that women scientists who work for various research organizations affiliated with India's Ministry of Science and Technology have made. It was possible to monitor their publishing output using the Scopus database. The 21810 papers that have been published up to December 2019—all of which were written by 901 women scientists working in 78 research organizations under the Ministry—have all been published between 2010 and 2019. This represents nearly 65 percent of all the papers that have been published. As more women from India pursue careers in research, the number of publications per scientist climbed from 6.85 articles per year before 2000 to 10.45 papers in the period from 2015 to 2019. Women scientists work predominantly in the biological sciences, but they are also increasingly choosing to study astronomy, materials sciences, and

nanotechnology as their chosen fields of study. Women scientists typically published their publications as part of a team of at most 10 authors; nevertheless, in multi-authored articles, they typically took the role of co-authors rather than the primary author. Maximum papers were created by women between the ages of 31 and 40, and over 98 percent of those publications were written in conjunction with other scientists. This study demonstrates that publication productivity does not decrease as people get older.

A study conducted by **Bebi and Kumar, S (2019)** where analyzed the research publications of 24 women faculty members in selected institutions of Delhi during 2011-2015. These 24 women faculty members published 230 research papers collected from various sources. The methodology relies on Scientometrics techniques. The analysis undertaken here focuses on the role, year-wise, and institution-wise number of publications, h-index, i10-index, authorship pattern, research interest areas, preferred journals, etc. It has been found that comparatively, females are fewer in number than male faculties

Kumar, A., and Ps, V (2019) in the study use scientometric methods to examine how the field of women's empowerment has changed between 1985 and 2018. The results of the empirical investigation show that women's empowerment is present in numerous domains of development. Additionally, it identifies 15 subject clusters: 4 clusters based on co-citations from authors, 4 clusters based on co-citations from journals, 5 clusters based on hot issues, and an additional 5 groups based on new topics in the study of WE. The analyses overall demonstrated trends of convergence and divergence as well as the diversity of themes, specialization, and interdisciplinary engagement in Women Empowerment research, providing the most recent insights into the area.

Bebi and Kumar (2018) conducted a study on the research output of women faculty in physics at 10 central universities in India. Data was collected for 5 years (2011-2015), revealing that a total of 36 women physics faculty published 282 papers. The primary focus of the study was on research output, citations, h-index, i10-index, the position of women authors in articles, the number of women authors per paper, and

the central university with the highest number of women authors and papers. The results showed that women authors served as corresponding authors more frequently than as first authors or as both (first and corresponding). The University of Delhi ranked highest in terms of the number of women contributors and papers. The ratio of women authors per article was found to be 0.3. The Journal of Applied Physics emerged as the most preferred journal among women authors in physics.

Dabas, B., and Kumar, S (2018), in the paper entitled "Research Output of Indian Women Scientists in the Field of Physics and Astronomy: A Scientometrics Study," analyzed a period from 2011 to 2015. There are only 73 female scientists out of a total of 583 employees, which means that their strength is lower than that of men (12.35%), who make up the majority of scientists. The current analysis exposes the individual contributions made by each of the seventy-three female scientists who have published a total of 713 research articles. The National Physical Laboratory published the most papers (144), however, the Indian Institute of Astrophysics received the most citations for fewer works (129 articles in 2018). The majority of these articles were released in association with other institutions at the national and international levels.

Bebi and Kumar (2017) examined the contributions of female physics faculty members at institutions in Delhi. The research includes 802 papers from 44 female academics, sourced from various sources between 2011 and 2015. The report conducts a scientometric analysis of 463 journal publications. The study explores authorship trends, research interests, the most productive writers, the most cited journals, and more. The findings reveal that 44 (14.7%) of the 300 faculty members are female scientists. CSIR-National Physical Laboratory has the highest number of female staff, while Jamia Millia Islamia has the fewest. Journal articles are the most common form of literature. Publishing of journal articles and conference papers peaked in 2015 with 144 (24.3%), and in 2014 with 132 (22.3%), respectively. An institutional survey shows that the University of Delhi leads with 168 (28.3%) publications, followed by the CSIR-National Physical Laboratory with 158 (26.6%). Ratnamala Chatterjee is the most productive author with 54 journal papers, followed by S. Annapoorni with 33, and Ranjana Mehrotra with 27.

Garg, K. C., and Kumar, S (2014) conducted a Scientometric study on women scientists in India based on the WoS database. They analyzed 9,957 papers published by Indian scientists and indexed by WoS in 12 sub-disciplines of life sciences during 2008–2009, indicating that academic institutions produced the highest number of papers. It has been found that 340 (3.4 %) were contributed by female scientists exclusively, and 4,671 (47 %) were written jointly by male and female scientists. Women scientists produced about 0.36 papers per author, while their male counterparts produced 0.50 papers per author. The study supports that female contribution is less compared to male scientists.

Bal, V (2005) examined 669 publications indexed by PubMed from January 1994 to April 2004 to study the scientific productivity of female biologists and found that women contributed 15% of all publications. **Leta, J, and Lewison, G. (2003)** carried out a case study on the contributions made by women to science, primarily in astronomy, immunology, and oceanography. Through their publication in the Science Citation Index from 1997 to 2001, Brazilian male and female scientists' accomplishments were accessible. According to the findings, women contributed most in immunology, only slightly in oceanography, and least in astronomy. Additionally, it was discovered that both male and female professors had an equal number of publications and a comparable potential impact.

2.2 Research Gap

Based on the review of the literature, it has been observed that several studies that are dealing with the Scientometric assessment of Indian science have been conducted by many researchers. All the literatures have been divided into two main categories, i.e., Overview of Scientometrics and Scientometric studies based on the Literature on women studies. However, as it is seen from the reviewed literature the very least number of studies have been conducted on the routes or approach of women faculty's research output.

Yet to date, no study has examined the contributions of Indian female scientists and their productivity at the national level. Therefore, this study is an attempt to fulfil the

research gap of scientometrics analysis of the research output of Women faculties of IITs in India.

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CHAPTER 3
SCHOLARLY COMMUNICATION

3. Scholarly Communications

3.1 Introduction

In the context of academia and research, scholarly communication is the central process of disseminating information. It is carried out by the academicians and researchers through various media and channels. Mostly, scholarly communication is carried out by journal articles, conference proceedings, dissertations, etc. With the invention of various technologies, the modes of communication have become much easier and have proven themselves as a boon for the present-day information dissemination scenario. However, this landscape has evolved significantly with the advent of the digital age, expanding the avenues through which scholarly work can be shared and accessed. The rise of digital repositories, online journals, preprint archives, academic social networks, and open-access platforms has democratized scholarly content, making it more inclusive and accessible to a broader audience.

A research paper is a standard way of presenting the research findings of any area and subject that is based on some scientific experiments and observations. So, a research paper that goes through various peer review processes before it gets published is one of the key documents in academia and a major part of scholarly communication.

Scholarly communication is the process by which researchers, academics, and scholars develop, evaluate, share, and preserve information within and across disciplines. Ensuring that discoveries, hypotheses, and critical insights are accessible to the broader scholarly community and society forms the foundation of academic growth and intellectual exchange. Traditionally, journals, publications, and conferences have been the main methods of scholarly communication; however, today, many digital platforms, open access repositories, and collaborative networks have become viable alternatives.

The primary goal of scholarly communication is to share research results to enhance knowledge and understanding. This process allows scholars to build on previous work, verify findings, and participate in important discussions. Peer review functions as a quality check, ensuring research is credible and trustworthy. Additionally,

scholarly communication extends beyond academics to influence policymakers, industries, and the public.

3.2 The channels of scholarly communication:

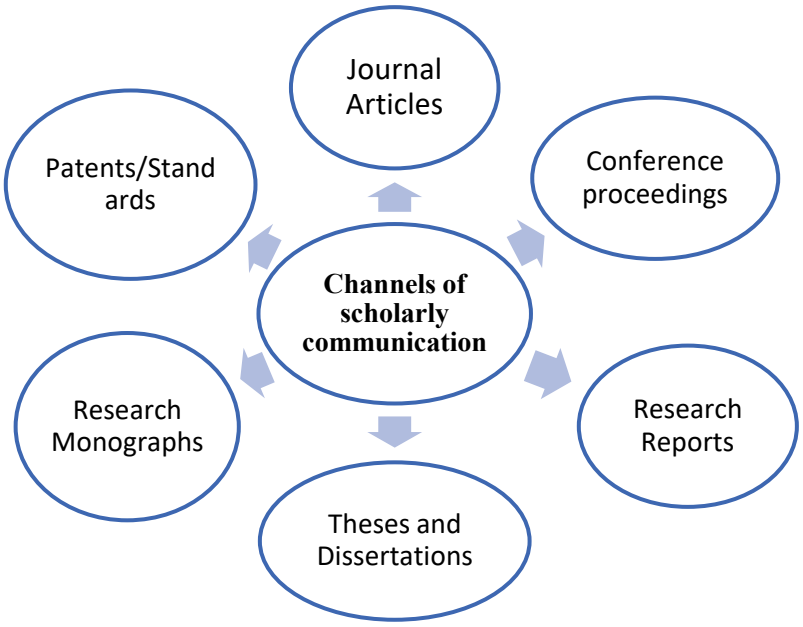

Figure 3.2: Channels of scholarly communication

Because of their importance in the process of scholarly communication, these are acknowledged as the foundational sources of literature. Within the academic community, there are numerous avenues for scholarly discourse. Conference papers that are published before or after the conference are a great way to encourage communication between specialists from different fields. It is regarded as having high standards, respectable credentials, considerable scholarly influence, and promising outreach potential. However, a research monograph is thought to be a powerful tool for sharing a study's results. Within the academic community, books and monographs are considered to be timeless artifacts that have a lasting impact. Research reports and project reports are considered to be efficient ways to formally record and communicate research findings, which helps scholars communicate with one another. A highly structured form of communication within research communities is represented by theses and dissertations. Analyzing and disseminating the results of master's and doctoral research carried out in academic institutions and research centers is the goal. The fact that doctoral theses and dissertations, also

known as ETDs (electronic theses and dissertations), are available in electronic format through national and institutional repositories in some countries is very beneficial. All Indian universities and research institutions use the Shodhganga project of the INFLIBNET Centre as their electronic thesis and dissertation system. One type of scholarly document intended to communicate the findings of ongoing research projects is the working paper. It helps researchers get timely, qualitative feedback so they can make the necessary changes to their research design or data analysis. In relation to scientific endeavours or discoveries, the patents protect the proprietary rights of their holders. Scientific research produces a new product, method, or technique with particular uses meant to improve human life. However, the Association for College and Research Libraries (ACRL) offers a comprehensive viewpoint:

Scholarly communication is the process of producing research and other scholarly writings, evaluating their quality, disseminating them to the academic community, and archiving them for future use. The system includes both formal channels, such as peer-reviewed journal publication, and informal channels, such as electronic mailing lists (ACRL Scholarly Communications Committee, 2003). As technology and ideologies have evolved, so too have formal protocols for academic communication. These changes have led to a more dynamic and accessible landscape for sharing knowledge, enabling researchers to reach wider audiences and engage in collaborative efforts across disciplines. Consequently, the ongoing evolution of scholarly communication continues to reshape how academic work is valued and utilized in society. This transformation enhances the visibility of research and encourages a more inclusive dialogue among scholars, practitioners, and the public. As a result, the barriers that once hindered the dissemination of knowledge are gradually diminishing, paving the way for innovative approaches to learning and collaboration. These changes have led to a more dynamic and accessible landscape for sharing knowledge, enabling researchers to reach wider audiences and engage in collaborative efforts across disciplines. This evolution enhances the dissemination of research findings and encourages interdisciplinary dialogue, fostering innovation and new ideas. As a result, academics are increasingly able to leverage diverse

perspectives, ultimately enriching the quality and impact of their work. Consequently, the ongoing evolution of scholarly communication continues to reshape how academic work is valued and utilized in society. This transformation not only enhances the visibility of research but also encourages a more inclusive dialogue among scholars, practitioners, and the public. As a result, the barriers that once hindered the dissemination of knowledge are gradually diminishing, paving the way for innovative approaches to learning and collaboration. Industries and associations have emerged as a result of facilitating scholarly communication, whether through journals, conferences, and related proceedings, or through monographic treatments of research topics. New attitudes and technological advancements are challenging established systems for the publication and dissemination of scholarly work. It is impossible to overestimate the role that information and communication technologies (ICTs) play in helping researchers overcome time and distance constraints. In the past, communication was limited to the fastest modes of transportation. Last but not least, ICTs have made communication nearly instantaneous, enabling experts from various nations to collaborate and exchange ideas without being constrained by distance.

In a similar vein, technology that records academic discourse and gathers and preserves research evidence allows for the exploration of themes on a scale that was unthinkable just a few decades ago. Large interdisciplinary teams of academics working in centralized or decentralized groups toward a common goal are now required for big data and big science projects. For academics, the organizations where they work, and the funding agencies that assist them, the resources needed to carry out such projects pose special challenges. The system of scholarship is still largely focused on human-centered activities, despite the crucial role that technology plays in the preservation and distribution of scholarly output. Technology only provides the tools required to make collaboration, communication, storage, and distribution easier. The setting in which scholarship takes place, as well as the ethical standards and cultural norms of the academic community, all have an impact on the process.

The way we present our findings and interact with colleagues is more crucial than ever for accountability and transparency. All scholarly endeavours should be transparent, according to the open science movement (de la Fuente, 2018). Open access publishing, in which authors or publishing houses make scholarly works freely accessible to a global audience, has been the most prominent manifestation of this movement. Open science is expanding to include open software, open researcher notes, open datasets, and open peer review for scholarly publications. Transparency, accountability, reuse, repeatability, and accessibility are all facilitated by openness. This, in turn, encourages further learning and exploration. Nonetheless, there are advantages and disadvantages to the desire for openness. The need for privacy and confidentiality of personal and societal information must be balanced against the need for transparency in some disciplinary fields, especially those that involve social research. Because of the potential for information discovery, big data poses ethical challenges.

Scholarly communication is greatly impacted by ethical questions, which are at the center of the scholarly endeavor. The goal of research is to learn more about the world they live in. An environment of "publish or perish," which is exacerbated by increasing pressure on researchers to "produce," increases the risk of unethical behaviour or scientific misconduct. The spread of poor research, a focus on the least publishable unit, unnecessary authorship, data manipulation, plagiarism, and selective reporting of findings are a few ways that the pressure to create may appear. Since reputation and impact are assessed, at least in part, by citation and other usage indicators, journal editors and publishers are subject to the same pressures as academic institutions. There are a number of difficulties in making a journal more visible in order to attract the best submissions.
In every academic field, academic communication is unquestionably essential. Without this framework, distribution channels and scholarly networks would be eliminated, and readers would not have access to the abundance of documented research. To put it simply, the advancement of modern knowledge depends on intellectual communication. Despite the long history of formal communication

systems, research on academic communication and its various aspects is more important than ever.

3.3 Conclusion

Besides ensuring research quality, peer review is a vital part of scholarly communication, serving purposes such as encouraging academic innovation, upholding ethical standards, and providing constructive feedback. Its importance in enhancing the quality and reliability of scholarly work is hard to overstate. While the academic world keeps evolving, the peer review process remains essential because it sustains scholarly rigor, trust, and the ongoing pursuit of knowledge. Scholarly communication is fundamental to academic progress, fostering collaboration, ensuring quality, and promoting accessibility and transparency. Its various roles are key to advancing knowledge and innovation, ultimately creating a more informed and prosperous society. Embracing and improving scholarly communication methods is crucial for a thriving academic ecosystem and a brighter future for all.

In the contemporary era, assessing scholarly publications is one of the key concerns of information professionals. Evaluating published scholarly communication makes us understand the research trends and social and intellectual structures of a particular subject domain and predict the future research direction. The performances of scholars and scholarly communication can be evaluated through impact factors that enable the performance and value of the contribution to academia. The impact of scholarly activity can be estimated by citation counts, journal impact factors, and other citation-based impact values.

Over the years, library and information science have employed many metric fields as measurement applications. Examples include Librametrics, Bibliometrics, Scientometrics, Informetrics, and Webometrics. Significantly, Bibliometrics and Scientometrics were the primary tools most widely used for measuring author and journal impacts and evolved as computational measurement and scientific mapping.

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CHAPTER 4
INDIAN INSTITUTE OF TECHNOLOGY: AN OVERVIEW

4. Indian Institute of Technology (IIT): An Overview

4.1 An Overview of IITs

A network of independent, top-tier public technical and research universities throughout India is known as the Indian Institutes of Technology (IITs). These Institutes of Technology (IITs) are institutions of national importance established to promote innovation, research, and leadership in technical fields. They are internationally recognized for their expertise in engineering, science, and technology education, among other disciplines.

The Institutes of Technology Act of 1961 is the main law governing them. After the first Indian Institute of Technology (IIT) was founded in Kharagpur in 1951, subsequent IITs were established in Bombay in 1958, Madras in 1959, Kanpur in 1959, and Delhi in 1961. Today, there are 23 IITs across India, strategically distributed to ensure access to technical education for everyone in the country. These institutions offer undergraduate, graduate, and doctoral degree programs in engineering, technology, management, and sciences. The Bachelor of Technology program is globally renowned, highly competitive, and the flagship offering of these institutes. Admission is primarily through the Joint Entrance Examination (JEE Advanced), which is considered one of the most challenging entrance exams in the world.

IITs conduct cutting-edge research in fields such as artificial intelligence, nanotechnology, renewable energy, biotechnology, aerospace, and materials science. They collaborate with some of the most prestigious colleges, companies, and government agencies worldwide. In global rankings, IITs consistently rank among the best engineering universities in the world. Each IIT functions independently, but they are connected through the IIT Council, which oversees national policies. Graduates of IITs have made significant contributions across science, technology, business, and leadership in India and internationally. Numerous alumni hold positions as CEOs of multinational corporations, distinguished scientists, entrepreneurs, and government officials, significantly contributing to India's scientific advancement, industrial growth, and innovation landscape. The IITs are

recognized for cultivating an environment conducive to innovation and the development of start-up ideas.

Despite their financial independence, IITs receive support and policy guidance from the Government of India, which helps preserve their academic autonomy. Alumni worldwide make significant contributions to academia, research, industry, entrepreneurship, and public policy. IIT research parks and incubation centers promote startups, entrepreneurial ventures, and innovative ideas. Higher education in India is exemplified by the IITs, which symbolize excellence, innovation, and global competitiveness. These institutions are not only among the best engineering schools globally but also centers of research, innovation, and leadership. Graduates from IITs continue to influence India's technological and economic future, shaping regional and global advancements in the process.

4.1.1 The Contribution to the Development of the Nation

1. Industry growth is fueled by a highly qualified workforce of engineers, scientists, and managers.

2. Impact of Research: Taking on national issues, including sustainable energy research, digital infrastructure, and rural development.

3. Developing India's innovation environment and assisting startups with incubation centers are instances of entrepreneurial endeavours.

4. To achieve international recognition, India must enhance its standing as a center for top-notch higher education.

The IITs offer undergraduate engineering and technology programs, specialized postgraduate programs, and Ph.D. programs across diverse engineering, science, and interdisciplinary fields. Their emphasis on research and innovation is significant. Undergraduate admissions are determined by merit in the Joint Entrance Examination (JEE) Advanced, contingent upon successful completion of the JEE Main. Postgraduate and doctoral programs in engineering, technology, architecture, science, and the humanities require the Graduate Aptitude Test in Engineering (GATE). Admission to postgraduate and doctoral programs in science is facilitated through the Joint Admission Test for M.Sc. (JAM), while

postgraduate design programs are accessed via the Common Entrance Examination for Design (CEED).

4.2 Profile of the institutions

4.2.1 Indian Institute of Technology (IIT) Madras

The Indian Institute of Technology Madras is recognized nationally and internationally for its excellence in technical education, research (both basic and applied), innovation, entrepreneurship, and industrial consultancy. The esteemed faculty, a highly motivated and exceptional student body, outstanding technical and support staff, along with efficient administration, have collectively established IIT Madras's prominent status. The Institute is honored to hold the distinction of being the top engineering university in India. IIT Madras has recently been designated as an Institute of Eminence. In 1956, the German Government provided technical assistance to establish a higher education institute in engineering in India. The inaugural Indo-German agreement for the establishment of the Indian Institute of Technology in Madras was signed in Bonn, West Germany, in 1959. The Institute was officially established in 1959 by Professor Humayun Kabir, who served as the Union Minister for Scientific Research and Cultural Affairs. IIT Madras is a residential institution comprising approximately 550 faculty members, 8000 students, and 1250 administrative and support staff. It is situated on a self-contained campus that spans around 250 hectares of wooded land. The campus is situated in Chennai, formerly referred to as Madras. Chennai serves as the capital of Tamil Nadu; a state located in southern India. The Institute comprises sixteen academic departments and several advanced research centers across various engineering and pure science disciplines, featuring nearly 100 laboratories arranged in a distinctive configuration. IIT Madras has maintained its position as the top-ranked engineering institute in India for four consecutive years and was recognized as the 'Best Educational Institution' in the Overall Category in the NIRF Rankings of 2019, published by the Ministry of Human Resource Development.

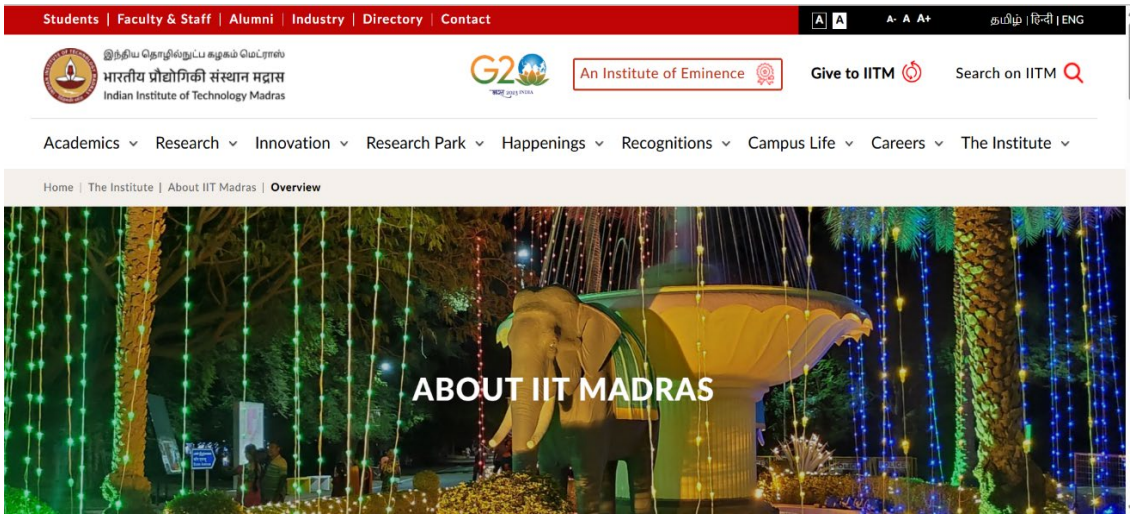

Figure 4.2.1: Homepage Of IIT Madras

The IIT Madras comprises 18 academic departments, which include Aerospace Engineering, Civil Engineering, Humanities and Social Sciences, Mathematics, Applied Mechanics, Computer Science and Engineering, Management Studies, Ocean Engineering, Biotechnology, Data Science & Artificial Intelligence, Mechanical Engineering, Physics, Chemical Engineering, Engineering, Medical Science and Technology, Chemistry, Engineering Design, Metallurgical and Materials Engineering.

4.2.2 Indian Institute of Technology (IIT) Delhi

The Indian Institute of Technology Delhi is a Center of Excellence for scientific, engineering, and technology education, research, and development in India. The Institute was founded in 1961 as the College of Engineering. It was later known as the "Indian Institute of Technology Delhi." It was then promoted to the status of a Deemed University, with the ability to establish its own academic policies, administer its own examinations, and grant degrees. Several alumni have left their primary fields to engage in administrative services, active politics, and non-governmental organizations (NGOs). As a result, they have made significant contributions to both national and global development. The Institute's objective is to benefit India and the globe by delivering outstanding scientific and technical education and research; to serve as a useful resource for industry and society; and to be a source of pride for all Indians. In December 2017, IIT Delhi was designated as

an institute of eminence, meaning both financial aid and the goal of upgrading IIT D to a higher level of prominence.

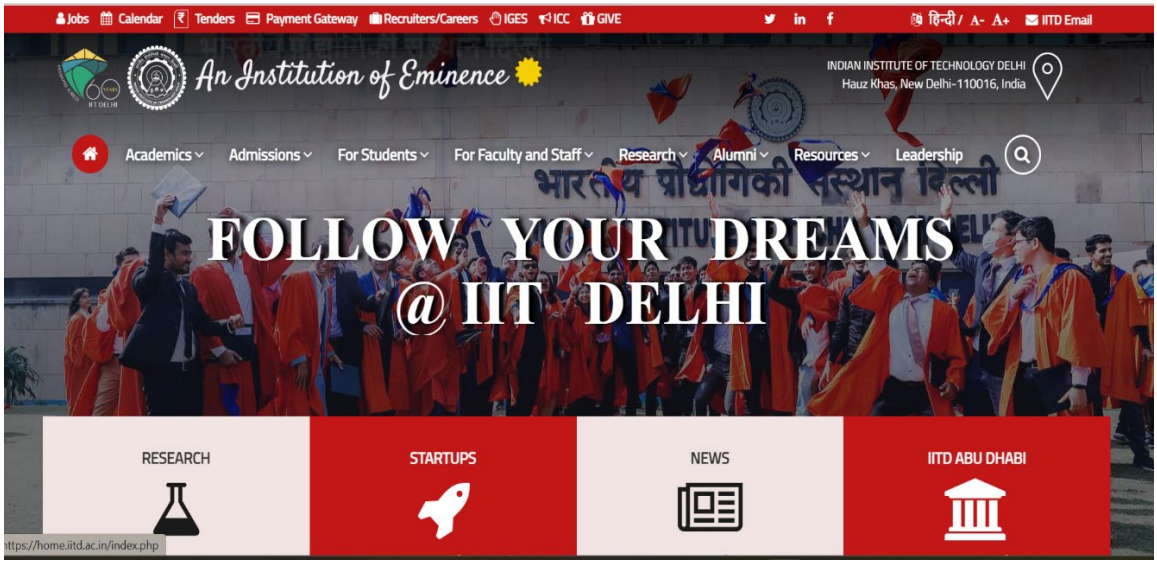

Figure 4.2.2: Homepage of IIT Delhi

4.2.3 Indian Institute of Technology (IIT) Bombay

IIT Bombay was established in 1958. It attracts highly qualified candidates. IIT Bombay is an autonomous institute and declared university, with a board of governors chaired by India's president. It is overseen by the IIT Council, which was created by India's Ministry of Education (MoE), formerly known as the Human Resource Development. The director, nominated by the Ministry of Education, oversees the institute for five years, managing academic concerns and working on other committees. The Senate, which is made up of professors and nominated members, oversees academic standards. In 1961, an Act of Parliament designated it as a national institution, allowing it to bestow its own degrees and diplomas.

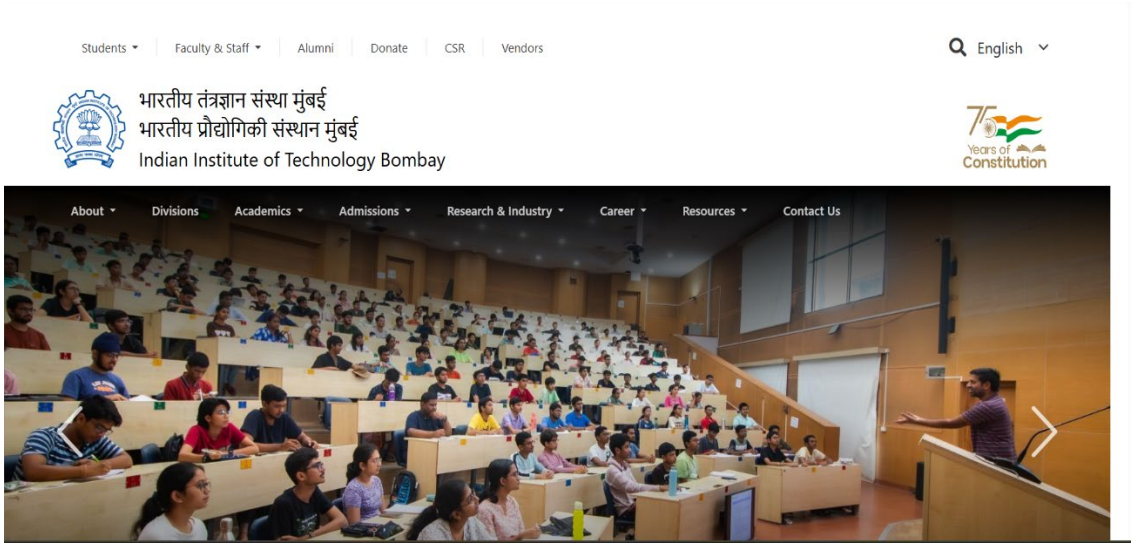

Figure 4.2.3: Homepage of IIT Bombay

4.2.4 Indian Institute of Technology (IIT) Kharagpur

In 1946, Hon'ble Sir Jogendra Singh, a member of the Viceroy's Executive Council and the Department of Education, Health, and Agriculture, established a committee to explore the possibility of creating Higher Technical Institutions in India to support the country's industrial growth after World War II. This marked the beginning of the IIT system. IIT Kharagpur started in the old Hijli Detention Camp, where some of our bravest freedom fighters worked and died for our country's independence. The school was established to train engineers after India became independent in 1947. The institute has a main campus in Kharagpur and an extension center in Kolkata that offers continuing education programs, remote learning courses, and guesthouse accommodations. The Kolkata extension center in Rajarhat offers full-time undergraduate and graduate programs. The Rajarhat campus spans 4 hectares (10 acres) and houses about 2,500 students. The Institute's plan for a similar branch campus measuring 0.81 square kilometers (200 acres) in Bhubaneswar was rejected by the Union Ministry of Human Resource Development. On September 5, 2019, IIT Kharagpur and four other Indian public institutions were granted 'Institute of Eminence' status by the Ministry of Human Resource Development. This designation

provided the institutes with autonomous control over their affairs and additional benefits.

Figure 4.2.4: Homepage of IIT Kharagpur

4.2.5 Indian Institute of Technology (IIT) Kanpur

The Indian Institute of Technology Kanpur, which was established in 1959 by the Indian government, is an elite institution. IIT Kanpur is one of the first-generation IITs and continues to make unique contributions to teaching, research, and innovation. IIT Kanpur encourages innovation and problem-solving to address challenges in the modern world. The campus is a center for cutting-edge discoveries, where research in basic and applied sciences leads to important breakthroughs. Student loans are easy to get at IIT Kanpur; therefore, education finance is meant to be easy to get. The Institute also gives money to students who deserve it. At IIT Kanpur, the search for knowledge and education goes beyond the walls of classrooms and labs. Campus life shows a culture of respect for information and a strong desire to learn more. The Institute actively supports the Student Gymkhana and many other clubs, which get students involved in a wide range of activities. These programs promote sports, the arts, and activities relating to science and technology. The main goal of the financial aid program is to make sure that eligible students can still attend IIT Kanpur even if they can't afford it.

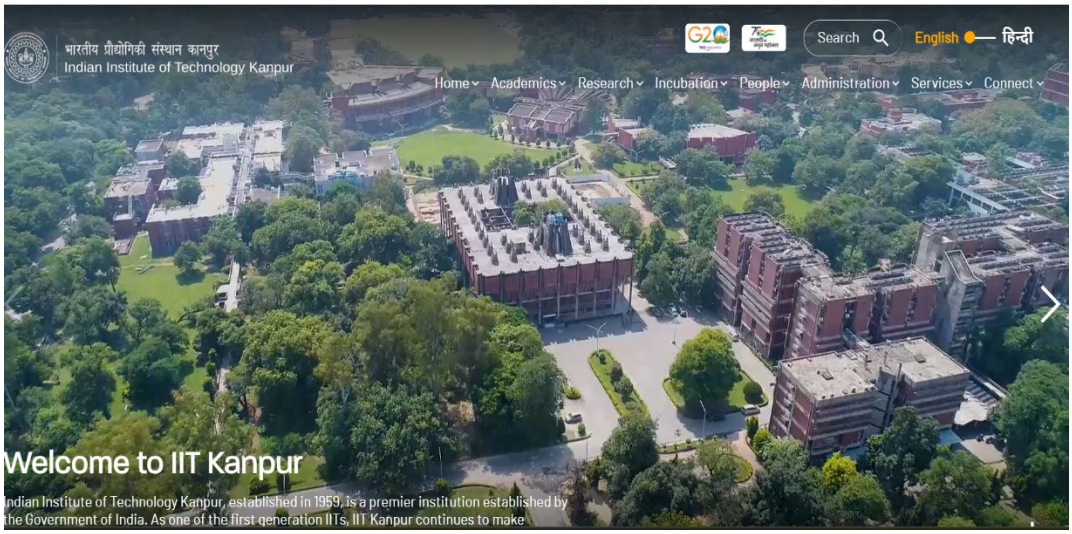

Figure 4.2.5: Homepage of IIT Kanpur

4.3 List of IITS

Table 4.3: List of all IIT's

Sl. No	Name	Address	Establishment year
1	IIT Madras	Chennai, Tamil Nadu	1959
2	IIT Delhi	New Delhi, India	1961
3	IIT Bombay (IITB)	Powai, Mumbai, Maharashtra – 400076	1958
4	IIT Kanpur	Kalyanpur, Kanpur -208 016	1959
5	IIT Kharagpur (IIT KGP)	Kharagpur, West Bengal	1951
6	IIT Roorkee	Roorkee - 247667, Uttarakhand	2001
7	IIT Hyderabad	Sangareddy district, Telangana, 502285	2008
8	IIT Guwahati	Guwahati - 781039, Assam	1994
9	IIT Bhubaneswar (IITBBS)	Kansapada village, Khordha district, Odisha	2008
10	IIT Indore	Indore, Madhya Pradesh	2009
11	IIT (ISM) Dhanbad	Jharkhand, Dhanbad	2016
12	IIT Patna	Patna, Bihar	2008
13	IIT Gandhinagar (IITGN)	Gandhinagar, Gujarat	2008
14	IIT Ropar	Rupnagar, Punjab	2008
15	IIT Jodhpur	Jodhpur, Rajasthan	2008
16	IIT Mandi	Kamand Valley, Mandi, Himachal Pradesh	2009
17	IIT BHU Varanasi	Varanasi, Uttar Pradesh	2012
18	IIT Tirupati	Tirupati, Andhra Pradesh	2015
19	IIT Jammu	Jammu city, Jammu and Kashmir	2016
20	IIT Palakkad	Kerala, India	2015
21	IIT Bhilai	Kutelabhata, Bhilai, Chhattisgarh	2016
22	IIT Dharwad	Chikkamalligawad, Dharwad, Karnataka - 580011	2016
23	IIT Goa	Ponda, Goa	2014

(Source: https://en.wikipedia.org/wiki/Indian_Institutes_of_Technology)

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CHAPTER 5
DATA ANALYSIS AND INTERPRETATION

5. Data Analysis and Interpretation

5.1 Introduction

The present study was conducted to examine the research productivity of women faculty at the top five NIRF-ranked IITs, which are the Indian Institute of Technology Madras, IIT Delhi, IIT Bombay, IIT Kharagpur, and IIT Kanpur. The study also focuses on their roles in education and research. It is important to consider the situation of women scientists and discuss their roles and perspectives on career development. Having this knowledge is essential for tracking and analyzing trends in the quality and quantity of research publications. The Scopus database from 2000 to 2024 will serve as the primary source of data collection. Statistical tools will be used to analyze the bibliographic information according to the study's needs. Hypothesis testing will be performed as needed using these tools. To prevent duplication, all collected data were cross-checked by comparing the article titles, document titles, document types, author names, years, and other relevant details.

A total of 18030 documents were found during the study period of 2000 to 2024. And based on the objectives of the study, the data were arranged and analyzed with MS Excel. The results were presented in the form of tables, graphs, and figures by using bar charts, pie charts, and line charts as per the study parameters, along with the interpretation. The analysis of data is the most important part of the research process. This chapter portrays the analysis and interpretation of collected data.

5.1.1 Research Productivity of Women Faculties

The accompanying figure depicts year-by-year faculty growth from 1983 to 2024. The distribution of women faculty at the top five IITs was based on their respective departments. All selected IIT websites were thoroughly examined to identify female faculty members in each department across these institutions. Only regular faculty members were included, excluding canters and schools. To ensure consistent and uniform data collection, extreme care was taken during the process. The accompanying graph shows a clear long-term upward trend. Growth was slow in the early years, with faster expansion in recent years. The peak in 2024 indicates the highest faculty strength of women, reflecting strong academic capacity. The graph

depicts year-by-year faculty growth from 1983 to 2024. From 1983 to 1995, faculty numbers remained very low (0–2), indicating a formative stage. Steady growth began in the late 1990s, with moderate fluctuations until 2005. After 2006, faculty numbers increased significantly, suggesting institutional expansion, despite some temporary declines around 2011–2015. From 2016 to 2024, growth was consistent, reaching a peak of 30 faculty members in 2024. Overall, the trend demonstrates long-term growth with minor fluctuations.

Year-wise growth of faculty members

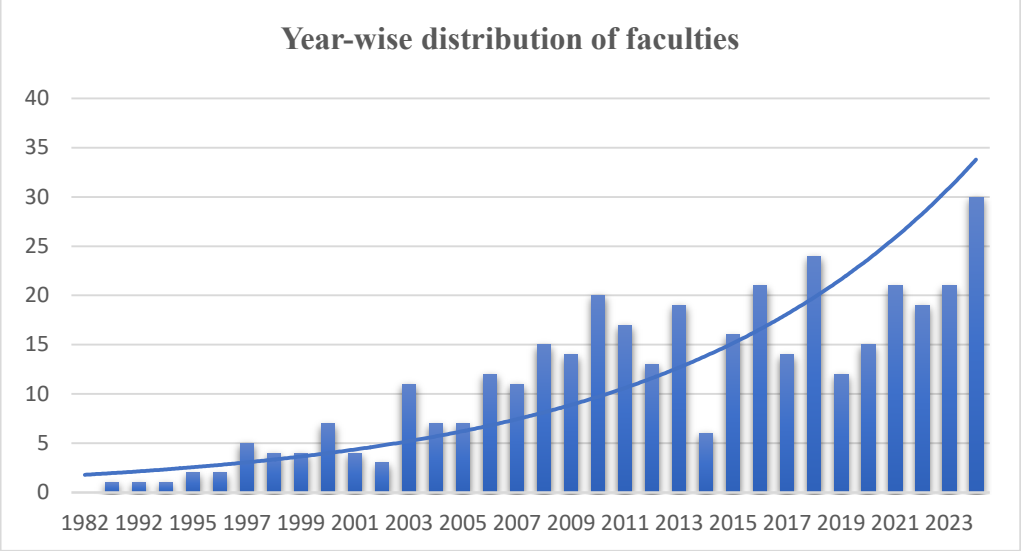

Figure 5.1.1: Year-Wise Growth of Faculty Members

5.2 Designation-Wise Distribution of Faculties

The accompanying table and figure (5.2) show the distribution of faculty by designation. The distribution highlights noticeable variation in faculty strength across career stages.

Professors constitute the largest group, followed by assistant professors, while associate professors are comparatively fewer. This indicates a faculty structure dominated by senior and entry-level positions, with a smaller proportion at the mid-career level. Professors form the largest group, with approximately 170–175 faculty

members. This indicates a strong presence of senior and experienced academicians. Assistant professors constitute the second-largest group, numbering around 130–135. Associate professors are the smallest group, with roughly 90–95 faculty members.

Table 5.2: Designation-wise distribution of faculties

Faculty Designation	Total
Assistant Professor	131
Associate Professor	95
Professor	167
Total	393

(Source: Survey Data)

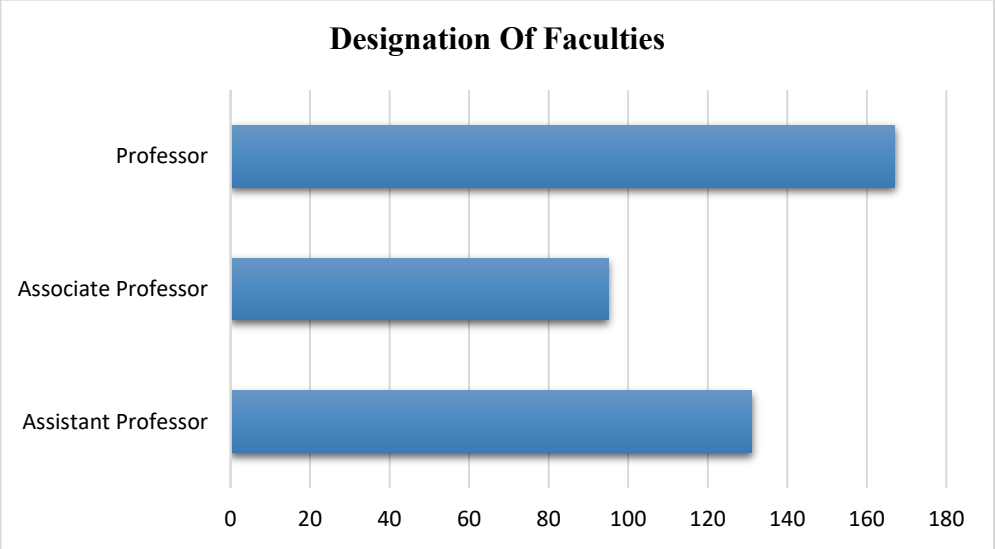

Figure 5.2: Designation-Wise Distribution of Faculties

5.3 Institute-Wise Distribution of Faculty Members

5.3.1 Indian Institute of Technology Madras, Chennai, Tamil Nadu

The table below (5.3.1) shows the distribution of faculty members. The IIT Madras has a total of 728 faculty members, of whom 88.19% are male and 11.81% are female. Departments such as electrical engineering, civil engineering, and mechanical engineering have the highest faculty strength. Whereas Medical Sciences

& Technology (13) and Data Science and AI (18) have relatively smaller faculty sizes. Female representation is highest in management studies (11) and biotechnology (10), showing relatively better gender inclusivity in interdisciplinary and life science domains. Departments such as Data Science and AI (0 female), Mechanical Engineering (2 female), and Aerospace Engineering (2 female) show very low female participation, highlighting areas where gender diversity initiatives may be required.

Table 5.3.1: Distribution of Faculty Members of IIT Madras

Sl. No	Department	Faculty		Total
		Male	Female	
1	Aerospace Engineering	40	2	41
2	Applied Mechanics & Biomedical Engineering	34	5	39
3	Biotechnology	27	10	37
4	Chemical Engineering	40	6	46
5	Chemistry	34	1	35
6	Civil Engineering	60	7	67
7	Computer Science and Engineering	33	5	38
8	Data Science and AI	18	-	18
9	Electrical Engineering	70	7	74
10	Engineering Design	20	1	21
11	Humanities and Social Sciences (HSS)	35	10	45
12	Management Studies	15	11	26
13	Mathematics	41	7	48
14	Mechanical engineering	63	2	65
15	Medical Sciences & Technology	10	3	13
16	Metallurgical and Materials Engineering	30	2	32
17	Ocean Engineering (DOE)	25	1	26
18	Physics	47	6	53

(Source: Survey Data)

5.3.2 Indian Institute of Technology Delhi

The table (5.3.2) presents the distribution of faculty members of IIT Delhi. It indicates that IIT Delhi has 567 faculty members, with 478 (84.30%) being male and 89 (15.70%) females. Electrical Engineering (59) and Mechanical Engineering (53) are the largest departments, followed by Physics (49) and Civil & Environmental Engineering (48), highlighting the prominence of core engineering disciplines.

Humanities and Social Sciences (46) and Management Studies (25) show relatively higher female participation, with 19 and 11 female faculty members, respectively.

Table 5.3.2: Distribution of Faculty Members of IIT Delhi

Sl. No	Department	Faculty		Total
		Male	Female	
1	Applied Mechanics	36	1	37
2	Biochemical Engineering & Biotechnology	14	6	20
3	Chemical Engineering	27	3	30
4	Chemistry	34	3	37
5	Civil & Environmental Engineering	42	6	48
6	Comp. Sc and Engineering	39	5	44
7	Design	12	3	15
8	Electrical Engineering	57	2	59
9	Energy Science and Engineering	23	2	25
10	Humanities and Social Science	27	19	46
11	Management Studies	14	11	25
12	Materials Science and Engineering	17	5	22
13	Mathematics	25	9	34
14	Mechanical Engineering	49	4	53
15	Physics	42	7	49
16	Textile and Fiber Engineering	20	3	23

(Source: Survey Data)

5.3.3 Indian Institute of Technology, Bombay

The Table below (5.3.3) shows the distribution of faculty members of IIT Bombay. The total faculty strength of IIT Bombay across all departments is 610, comprising 522 male (85.57%) and 88 female (14.43%) faculty members. The highest number of faculty members is found in Electrical Engineering (69), followed by Mechanical Engineering (53) and Civil Engineering (49). Humanities and Social Sciences stand out as the most gender-balanced department, with 22 male and 18 female faculty, where female representation (45%) is significantly higher compared to technical disciplines.

Table 5.3.3: Distribution of Faculty Members of IIT Bombay

Sl. No	Department	Faculty		Total
		Male	Female	
1	Aerospace Engineering	22	1	23
2	Biosciences and bioengineering	20	7	27
3	Chemical Engineering	34	7	41
4	Civil Engineering	44	5	49
5	Computer Science and Engineering	38	8	46
6	Electrical Engineering	65	4	69
7	Energy Science and Engineering	27	2	29
8	Earth sciences	24	2	26
9	Environmental science and engineering	14	3	17
10	Mechanical Engineering	51	2	53
11	Metallurgical Engineering and Materials Science	35	7	42
12	Physics	38	8	46
13	Chemistry	35	5	40
14	Mathematics	39	8	47
15	Humanities and Social Sciences	22	18	40
16	Industrial Engineering and Operations Research	14	1	15

(Source: Survey data)

5.3.4 Indian Institute of Technology Kharagpur, West Bengal

The table below presents the distribution of faculties of IIT Kharagpur. The institute has a total of 527 faculty members, including 460 males (87.29%) and 67 females (12.71%), indicating a significant gender imbalance. Mechanical Engineering (48) is the largest department, followed by Computer Science and Engineering (42) and Electrical Engineering (42), reflecting the dominance of core engineering fields. Female representation is highest in Humanities and Social Sciences (10) and the School of Management (9), whereas Bioscience and Biotechnology, Electronics and Electrical Communication Engineering, and Ocean Engineering report no female faculty, highlighting critical areas of gender disparity.

Table 5.3.4: Distribution of Faculty Members of IIT KGP

Sl. No	Department	Faculty		Total
		Male	Female	
1	Aerospace Engineering	18	3	21
2	Agricultural and Food Engineering	31	6	37
3	Architecture and Regional Planning	12	3	15
4	Bioscience and Biotechnology	19	-	19
5	Chemical Engineering	25	7	32
6	Chemistry	33	3	36
7	Civil Engineering	30	4	34
8	Computer Science and Engineering	37	5	42
9	Electrical Engineering	39	3	42
10	Electronics and Electrical Communication Engineering	31	-	31
11	Industrial and Systems Engineering	14	1	15
12	Mechanical Engineering	45	3	48
13	Metallurgical and Materials Engineering	22	4	26
14	Mining Engineering	15	1	16
15	Ocean Engineering and Naval Architecture	12	-	12
16	Physics	34	2	36
17	School of Management	13	9	22
18	Humanities And Social Sciences	24	10	34
19	Education	6	3	9

(Source: Survey data)

5.3.5 Indian Institute of Technology Kanpur, Uttar Pradesh

The table shows that IIT Kanpur has a total faculty strength of 593, comprising 526 males (88.70%) and 67 females (11.30%), indicating a high gender disparity. Electrical Engineering (67) is the largest department, followed by Mathematics & Statistics (54) and Aerospace Engineering / Physics (49 each). Female representation is highest in Humanities & social sciences (10) and mathematics & statistics (10), followed by management sciences (8) and economic sciences (7). Core engineering fields such as aerospace engineering, mechanical engineering, and chemical engineering show very low female participation (1 each), indicating a persistent gender gap in traditional engineering disciplines.

Table 5.3.5: Distribution of Faculty Members of IIT Kanpur

Sl. No	Department	Faculty		Total
		Male	Female	
1	Aerospace Engineering	48	1	49
2	Biological Sciences & Bioengineering	26	3	29
3	Chemical Engineering	29	1	30
4	Civil Engineering	43	3	46
5	Computer Science & Engineering	33	4	37
6	Electrical Engineering	61	6	67
7	Materials Science & Engineering	26	2	28
8	Mechanical Engineering	45	1	46
9	Management Sciences	20	8	28
10	Sustainable Energy Engineering	15	1	16
11	Humanities & Social Sciences	22	10	32
12	Chemistry	37	3	40
13	Mathematics & Statistics	44	10	54
14	Physics	43	6	49
15	Earth Sciences	16	1	17
16	Economic Sciences	18	7	25

(Source: Survey data)

5.4 Institution-Wise Productivity of Research Publications

The table below (5.4.1) demonstrates that IIT Madras exhibits robust, diverse, and high-impact research productivity. The institution shows a strong balance between high-volume publication departments and high-impact citation-driven disciplines, reinforcing its reputation as a premier research university. The analysis of research publications reveals that IIT Madras has made a substantial contribution to scholarly output, with 3,914 publications totalling 64,274 citations. This indicates not only a high volume of research activity but also a strong overall citation impact, reflecting the institution's academic visibility and influence at national and international levels. Among all departments, the Electrical Engineering Department emerges as the most prolific, contributing 872 publications, thereby accounting for the largest share of institutional output. The Civil Engineering Department follows this with 533 publications and the Mathematics Department with 418 publications, indicating sustained and consistent research activity in these core engineering and science disciplines. In the case of the citation, the Civil Engineering Department records the highest citation count (15,388 citations), indicating the production of highly

influential research, likely driven by applied, policy-oriented, and interdisciplinary studies. The Biotechnology Department, with 10,108 citations from 251 publications, demonstrates exceptional citation performance, suggesting high research quality and global relevance in life sciences and biomedical research. IIT Madras exhibits a robust and diversified research ecosystem, dominated by engineering and applied science disciplines, while maintaining a balanced representation of basic sciences and humanities. The variation in publication output and citation impact across departments highlights both high-volume research domains and high-impact specialized fields. This multidimensional research profile underscores IIT Madras's position as a leading research-intensive institution, with significant contributions to scientific advancement and societal development.

5.4.1 Department-Wise Research Productivity (IIT Madras)

Table 5.4.1: Department-Wise Productivity and Impact of the Research Publication of IIT Madras

Sl. No	Name Of the Department	Total publications	Total Citations
1	Aerospace Engineering	145	1411
2	Biotechnology	251	10108
3	Chemical Engineering	189	3854
4	Engineering Design	152	1285
5	Mechanical Engineering	74	1546
6	Applied Mechanics & Biomedical Engineering	248	1671
7	Chemistry	31	377
8	Civil Engineering	533	15388
9	Computer Science and Engineering	220	3920
10	Humanities And Social Science	130	927
11	Management Studies	316	6384
12	Mathematics	418	4838
13	Metallurgical And Material Engineering	44	720
14	Physics	291	3341
15	Electrical Engineering	872	8504
Total		3914	64274

(Source: Survey data)

5.4.2 Department-Wise Research Productivity (IIT DELHI)

The table below demonstrates substantial scholarly productivity and citation impact across a wide spectrum of disciplines at IIT Delhi. Among all departments, the Department of Physics emerges as the most prolific contributor, producing 775 publications, thereby accounting for the largest share of the institutional research output. This highlights the strong emphasis on fundamental scientific research at IIT Delhi. The Department of Physics, with 12,154 citations, records the highest citation count, underscoring its global research influence and the quality of its scholarly contributions. Similarly, Textile and Fibre Engineering (9,635 citations) and Biochemical Engineering and Biotechnology (9,385 citations) demonstrate exceptional citation performance, highlighting the applied and industry-relevant nature of research in these areas. The Civil and Environmental Engineering Department also exhibits high research impact with 9,129 citations, indicating strong engagement in infrastructure, environmental sustainability, and policy-related research. IIT Delhi possesses a strong and diversified research ecosystem, with particular strengths in physics, biotechnology, textile engineering, civil engineering, and chemistry. The substantial contribution of the humanities and social sciences further highlights the institution's interdisciplinary orientation. The variation in publication output and citation impact across departments underscores the coexistence of high-volume research areas and high-impact specialized disciplines, collectively reinforcing IIT Delhi's status as a leading research-intensive institution.

Table 5.4.2: Department-Wise Productivity and Impact of the Research Publication of IIT Delhi

Sl. No	Name Of the Department	Total publication	Total Citations
1	Applied Mechanics	25	207
2	Civil & Environmental Engineering	323	9129
3	Computer Science and Engineering	133	1672
4	Biochemical Engineering and Biotechnology	326	9385
5	Chemical Engineering	210	3534
6	Chemistry	223	7552
7	Design	24	131
8	Electrical Engineering	16	144

9	Energy Science and Engineering	271	3844
10	Humanities & Social Sciences	364	4724
11	Department Of Management Studies	308	4576
12	Materials Science and Engineering	262	4007
13	Mathematics	353	3221
14	Mechanical Engineering	94	2553
15	Physics	775	12154
16	Textile And Fibre Engineering	325	9635
Total		4032	76010

(Source: Survey data)

5.4.3 Department-Wise Research Productivity (IIT BOMBAY)

The table shows that IIT Bombay demonstrates exceptionally high research productivity and citation impact, underscoring its position as one of India's foremost research-intensive institutions. The distribution of publications and citations across departments reflects a strong emphasis on fundamental sciences, engineering, and interdisciplinary research, with pronounced variations in both output and impact. Among all departments, the Department of Physics stands out as the most prolific contributor, with an outstanding 1,293 publications, representing the largest share of institutional research output. This is followed by the Department of Mathematics, which has produced 845 publications, indicating a strong foundation in theoretical and applied mathematical research. Citation performance reveals extraordinarily high research impact in fundamental science disciplines. The Department of Physics records an exceptional 131,431 citations. IIT Bombay possesses a highly robust and globally competitive research ecosystem, with physics, mathematics, chemical engineering, and computer science emerging as dominant disciplines in terms of both productivity and citation impact. The pronounced citation concentration in fundamental sciences reflects the institution's strong orientation toward theoretical depth and high-impact research. At the same time, the presence of applied sciences, engineering, and humanities underscores the multidisciplinary character of IIT Bombay's research landscape.

Table 5.4.3: Department-Wise Productivity and Impact of the Research Publication of IIT Bombay

Sl. No	Name Of the Department	Total Publications	Total Citations
1	Biosciences & Bioengineering	233	7128
2	Chemistry	247	6461
3	Chemical Engineering	326	20483
4	Civil Engineering	262	4866
5	Computer Science & Engineering	411	11242
6	Mechanical Engineering	106	1222
7	Earth Sciences	22	811
8	Electrical Engineering	626	6644
9	Energy Science and Engineering	143	3140
10	Environmental Science and Engineering	156	9128
11	Humanities And Social Sciences (HSS)	286	5376
12	Industrial Engineering and Operations Research (IEOR)	93	329
13	Mathematics	183	31344
14	Metallurgical Engg and Materials Science	666	28364
15	Physics	1293	131431
16	Aerospace Engineering	67	1326
Total		5120	269295

(Source: Survey data)

5.4.4 Department-Wise Research Productivity (IIT Kharagpur)

IIT Kharagpur demonstrates a broad-based, multidisciplinary research profile, with substantial contributions across engineering, the sciences, the humanities, and emerging technological domains. The distribution of publications and citations across departments highlights both high-volume research areas and high-impact specialized disciplines, reflecting the institution's long-standing academic legacy and research capacity. Agricultural and Food Engineering emerges as the most productive, contributing 568 publications, underscoring IIT Kharagpur's unique strength in agricultural engineering and food technology research. This is closely followed by metallurgical and materials engineering (543 publications) and mathematics (544 publications), indicating strong research activity in both applied engineering and fundamental sciences. Agricultural and Food Engineering records the highest citation impact, accumulating 19,895 citations, indicating high relevance and application of

research outputs in agriculture, sustainability, and food systems. Metallurgical and Materials Engineering also demonstrates substantial research influence with 13,415 citations, reflecting strong industrial and technological linkages. IIT Kharagpur maintains a strong and diversified research ecosystem, with notable strengths in agricultural and food engineering, metallurgical and materials engineering, chemical sciences, and mathematics. The coexistence of high-volume research departments and high-impact applied disciplines reflects the institution's comprehensive academic structure and research depth. The variation in publication output and citation impact across departments underscores the dynamic nature of research activity at IIT Kharagpur, reinforcing its position as a premier multidisciplinary research institution in India.

Table 5.4.4: Department-Wise Productivity and Impact of the Research Publication of IIT Kharagpur

Sl. No.	Department	Total publications	Total Citations
1	Agricultural And Food Engineering	568	19895
2	Artificial Intelligence	9	98
3	Chemical Engineering	336	8756
4	Chemistry	309	7952
5	Civil Engineering	186	5020
6	Computer Science & Engineering	389	3373
7	Aerospace Engineering	145	3116
8	Education	83	1400
9	Electrical Engineering	156	3056
10	Geology And Geophysics	139	2389
12	Humanities And Social Sciences	201	1427
13	Industrial And Systems Engineering	134	1810
14	Mathematics	544	6700
15	Mechanical Engineering	44	1002
16	Metallurgical And Materials Engineering	543	13415
17	Mining Engineering	29	395
18	Physics	189	2421
19	Architecture And Regional Planning	62	257
Total		4066	82482

(Source: Survey data)

5.4.5 Department-Wise Research Productivity (IIT Kanpur)

IIT Kanpur exhibits a highly concentrated yet impactful research profile, with pronounced strengths in fundamental sciences and selective engineering disciplines. Among all departments, the Department of Physics emerges as the dominant contributor, with an exceptionally high output of 1,426 publications, accounting for a substantial proportion of the institution's total research productivity. This underscores IIT Kanpur's long-standing emphasis on advanced research in fundamental physical sciences. The Department of Physics records an impressive 63,966 citations, indicating exceptional global visibility and strong scholarly influence. The Biological Sciences and Bioengineering Department also demonstrates substantial citation influence, accumulating 9,254 citations from 126 publications, suggesting high citation density and strong interdisciplinary relevance in life sciences and bioengineering research. The analysis demonstrates that IIT Kanpur's research ecosystem is strongly anchored in the fundamental sciences, particularly physics, which serves as the institution's flagship discipline in both productivity and impact. The presence of moderately productive engineering, life science, and management departments reflects a selective yet high-quality research orientation. The variation in publication output and citation impact across departments underscores the institution's focus on depth and excellence in core disciplines, reinforcing IIT Kanpur's reputation as a leading centre for fundamental and interdisciplinary research in India.

Table 5.4.5: Department-Wise Productivity and Impact of the Research Publication of IIT Kanpur

Sl. No	Name Of the Department	Total publications	Total Citations
1	Economic Sciences	48	414
2	Earth Sciences	4	149
3	Physics	1426	63966
4	Mathematics & Statistics	194	2211
5	Chemistry	52	568
6	Humanities & Social Sciences	114	598
7	Sustainable Energy Engineering	13	172
8	Management Sciences	123	2058
9	Mechanical Engineering	11	234

10	Materials Science & Engineering	77	1108
11	Electrical Engineering	189	1663
12	Computer Science & Engineering	124	1508
13	Civil Engineering	112	1639
14	Biological Sciences & Bioengineering	126	9254
Total		2613	85542

(Source: Survey data)

5.5 Year-wise productivity of research publications by women faculty for the years 2000-2024

5.5.1 Year-Wise Growth Trend of Publications by Female Faculties

The graph depicts the year-wise growth trend of publications by female faculty members across the top five NIRF-ranked IITs from 2000 to 2024.

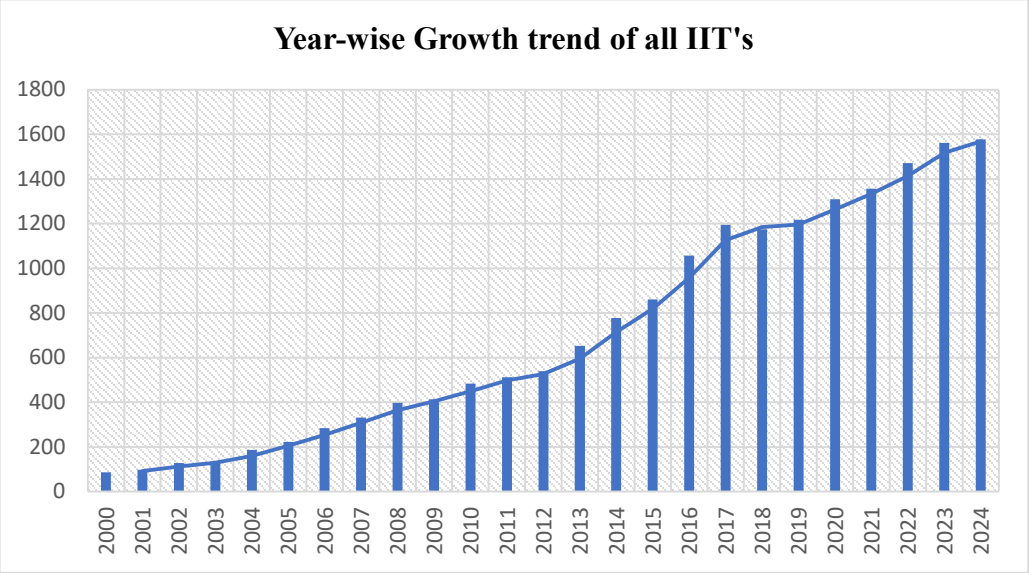

Figure 5.5.1: Year-Wise Growth Trend of Publications by Female Faculties

The figure shows a clear trend of growth and a steady upward trajectory in research output over the 25 years. During the initial years (2000-2005), growth was relatively moderate, but it started to increase and remained steady from 2006 onward. From 2013, a notable surge occurred as publications began to rise sharply, indicating an expansion in research productivity. Although there was a slight decline around 2017-2019, growth accelerated again from 2020, reaching its peak in 2024. The graph

clearly demonstrates that all the IITs have significantly increased their research output over the years.

5.6 Institution-wise productivity of research publications by women faculty for the years 2000-2024

5.6.1 Research productivity of women faculty of IIT Madras for the years 2000-2024

The figure below shows a long-term upward trend in IIT Madras publications, emphasizing higher research output over time despite slight variations. It displays the annual growth in publications between 2000 and 2024. Publications were low in the early years (2000–2004), but they gradually increased. Despite slight variations, there was a consistent increase from 2005 to 2010. Publications increased somewhat between 2011 and 2015, indicating an increase in research activity. After 2016, there is a noticeable increase in publication output. There were only minor fluctuations in the number of publications between 2018 and 2021

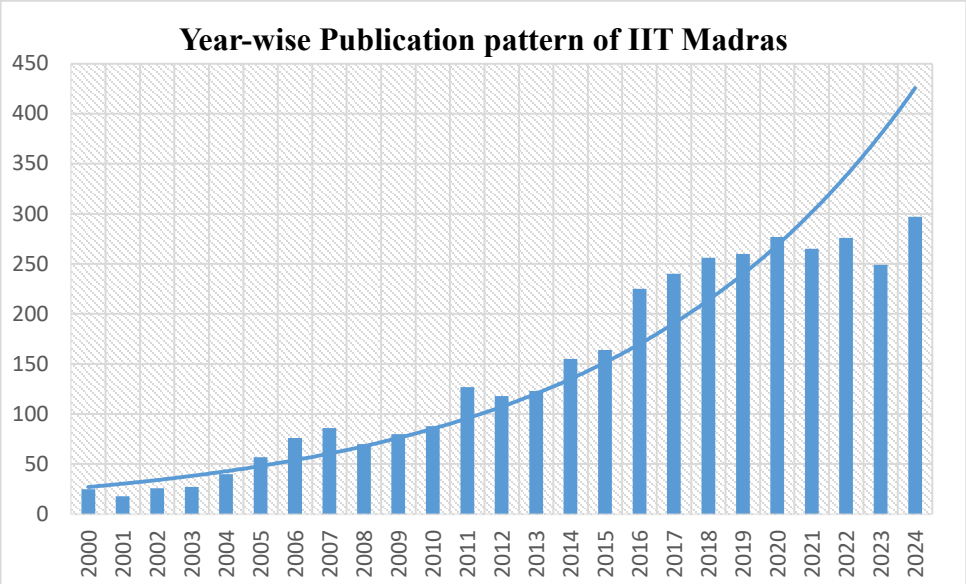

Figure 5.6.1.1: Year-wise Publication Pattern of IIT Madras

5.6.1.2 The year-wise citation pattern of women faculty of IIT Madras

The figure below represents the year-wise citation pattern of women faculty of IIT Madras from 2000 to 2024.

During 2000–2004, citations were relatively low, indicating limited research visibility. From 2005 onwards, citations increased sharply, reflecting improved research impact. Noticeable peaks occur around 2008, 2010, and especially between 2015 and 2018, with the highest citation count around 2018. After 2019, citations show a declining trend, though minor recoveries are seen in some years. By 2022–2024, citation counts decrease substantially compared to the peak period. The graph highlights a period of strong research impact during the mid to late 2010s, followed by a recent decline in citations, suggesting either reduced citation accumulation for newer publications or a shift in research dynamics.

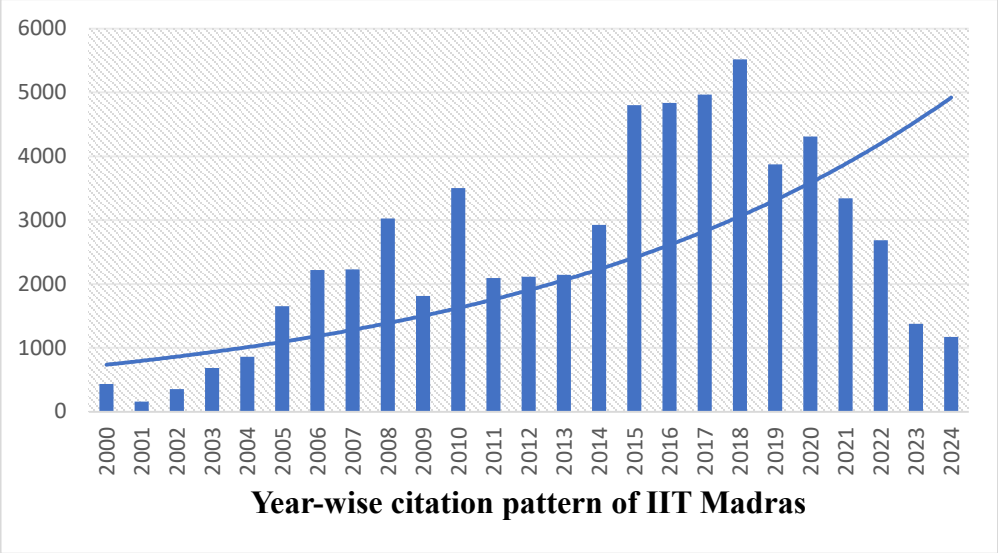

Figure 5.6.1.2: Year-wise citation pattern of IIT Madras

5.6.2 Research productivity of women faculty of IIT Delhi for the years 2000-2024

The graph 5.6.3 depicts the year-wise growth of total publications of IIT Delhi from 2000 to 2024.

The graph shows that in the initial phase (2000–2004), publication output is low with minor fluctuations, indicating a developing research phase. From 2005 to 2010, there was a steady and consistent increase, reflecting the gradual strengthening of research activity. During 2011–2014, slight fluctuations appear, but the overall growth momentum is maintained. A sharp rise is observed after 2015, indicating a significant expansion in research productivity. The highest publication counts occur around 2022–2023, marking the peak research output period. The graph clearly illustrates a substantial increase in total publications over time, highlighting continuous improvement in research output with minor year-to-year variations.

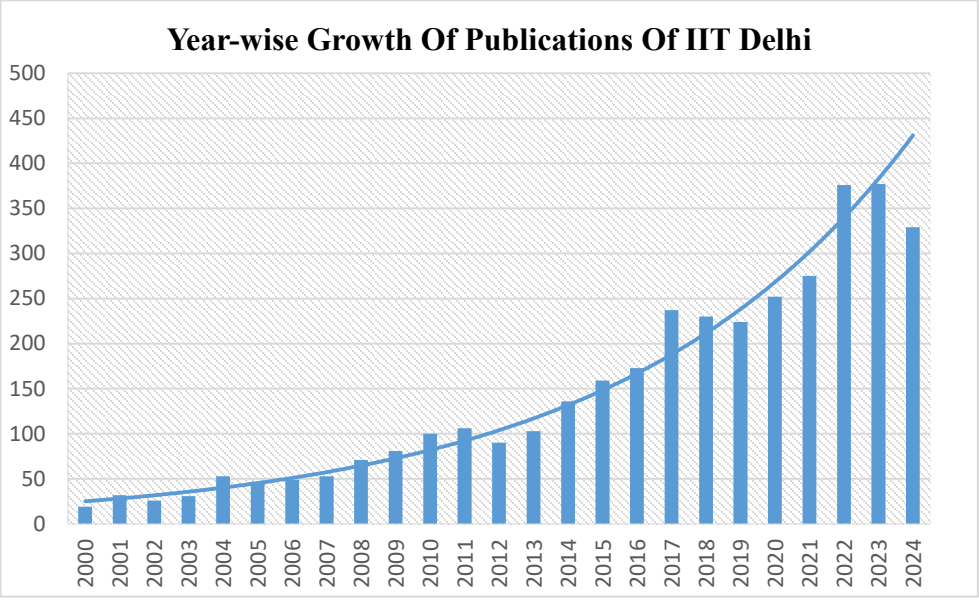

Figure 5.6.2.1: Year-wise Growth of Publications of IIT Delhi

5.6.2 The year-wise citation pattern of women faculty of IIT Delhi

The figure illustrates the year-wise distribution of total citations from 2000 to 2024.

In the early period (2000–2003), citation counts remained low, indicating limited visibility of publications. A sharp increase in 2004 marks the beginning of a phase of enhanced research recognition. Between 2005 and 2011, citations fluctuated but remained consistently high, suggesting steady scholarly influence. A noticeable decline occurred in 2012, followed by a strong recovery from 2013 onwards. The period 2016–2018 reflects a substantial rise in citations, demonstrating peak research impact. Although minor fluctuations are observed during 2019–2021, citation counts remain relatively high. The highest citation levels are recorded around 2021–2022. In the most recent years (2023–2024), a sharp decline in citations is evident, which may be attributed to the shorter citation window for recent publications.

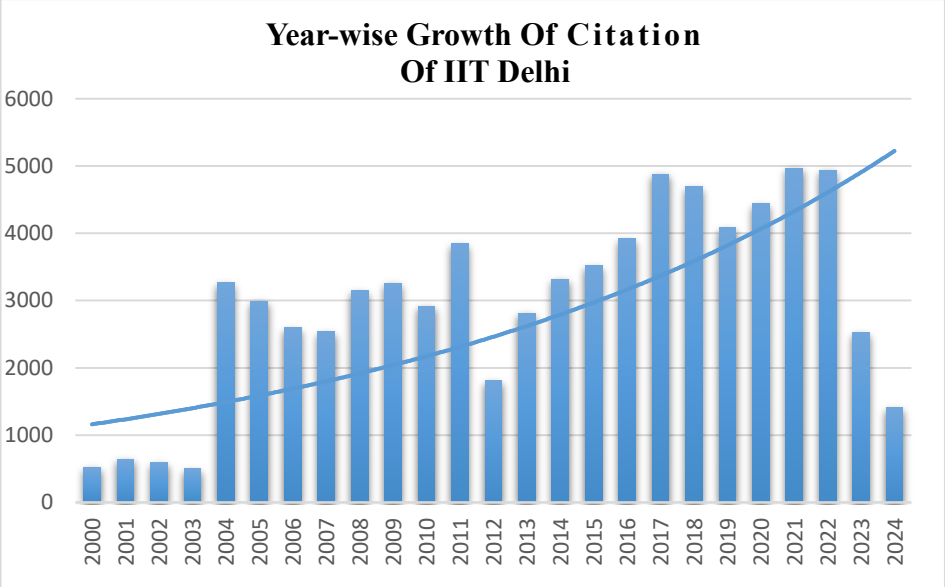

Figure 5.6.2.2: Year-wise Growth of Citation of IIT Delhi

5.6.3 Research productivity of women faculty of IIT Bombay for the years 2000-2024

Figure 5.6.3 presents the year-wise growth of total publications from 2000 to 2024, demonstrating a clear and sustained increase in research output over the study period.

During the initial phase (2000–2005), the number of publications is relatively low, increasing gradually from 18 to about 48, which reflects the formative stage of research activity. From 2006 to 2010, publication output rose steadily, reaching approximately 168 publications, indicating consolidation and expansion of scholarly work. Between 2011 and 2015, growth continued at a moderate pace, with total publications increasing from 136 to around 216. A marked acceleration is observed after 2016, where publication counts rise sharply, crossing 300 publications by 2019. The period 2020–2022 shows sustained high productivity, with totals exceeding 350 publications. The peak publication output is recorded in 2023–2024, reaching above 400 publications, which signifies the most productive phase of the study period.

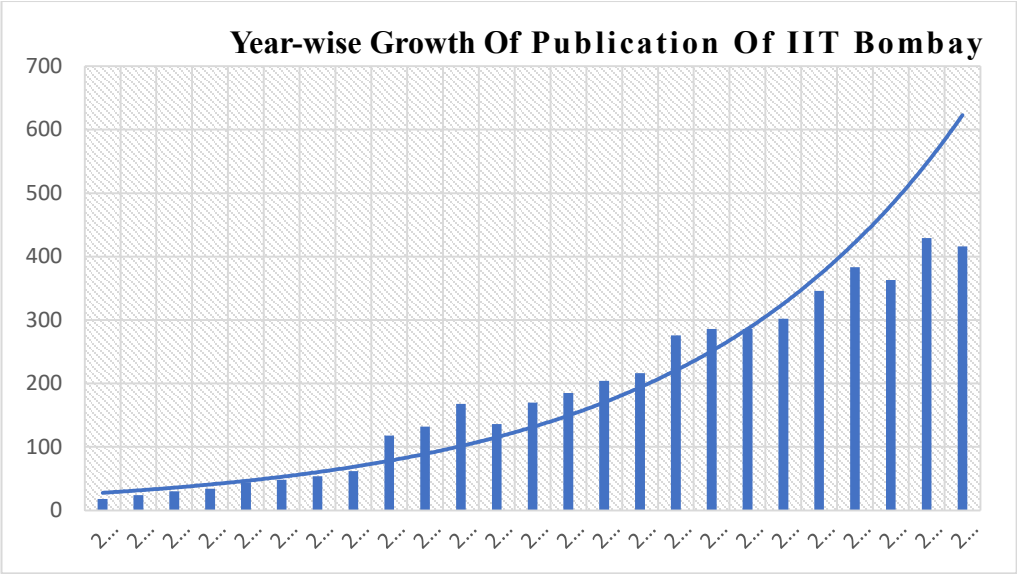

Figure 5.6.3.1: Year-wise Growth of Publication of IIT Bombay

5.6.3 The year-wise citation pattern of women faculty of IIT Bombay

The figure below depicts the year-wise trend of total citations from 2000 to 2024, reflecting the evolving research impact over the study period.

In the initial years (2000–2004), citation counts remained very low, indicating limited visibility and early stages of research activity. From 2005 to 2009, citations show a gradual increase, suggesting an improvement in the recognition of published work. A notable rise is observed during 2010–2012, marking a phase of enhanced scholarly influence. Between 2013 and 2017, citations increased sharply, reaching a

pronounced peak around 2016–2017, which represents the period of maximum research impact. This peak indicates high citation accumulation for publications produced during earlier years. After 2018, citation counts exhibit noticeable fluctuations with an overall declining tendency.

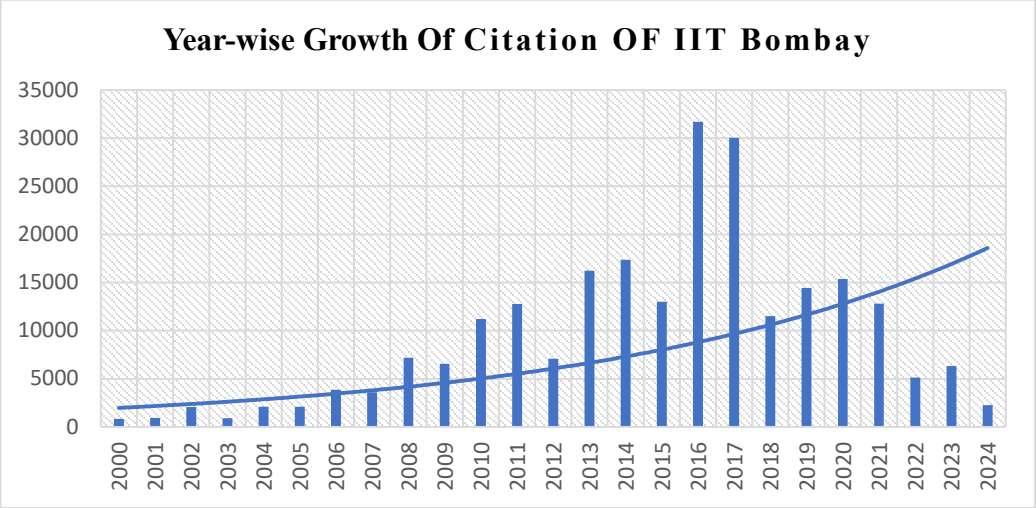

Figure 5.6.3.2: Year-wise Growth of Citations of IIT Bombay

5.6.4 Research productivity of women faculty of IIT Kharagpur for the years 2000-2024

The figure illustrates the year-wise trend in total publications from 2000 to 2024.

In the initial period (2000–2004), publication output remains low and increases gradually, reflecting the early stage of research activity. From 2005 to 2007, a noticeable rise was observed, indicating an expansion phase. During 2008–2011, growth slowed slightly with minor fluctuations, but the overall upward movement was maintained. A steady and stronger increase begins after 2012, with publication output rising consistently through 2016–2017, marking a phase of consolidation and enhanced productivity. Although a brief dip is visible around 2018, the trend recovers quickly. From 2019 onwards, publications increased sharply, indicating accelerated research output. The highest level of publications is recorded in 2024 (342 publications), representing the peak of research productivity during the study period.

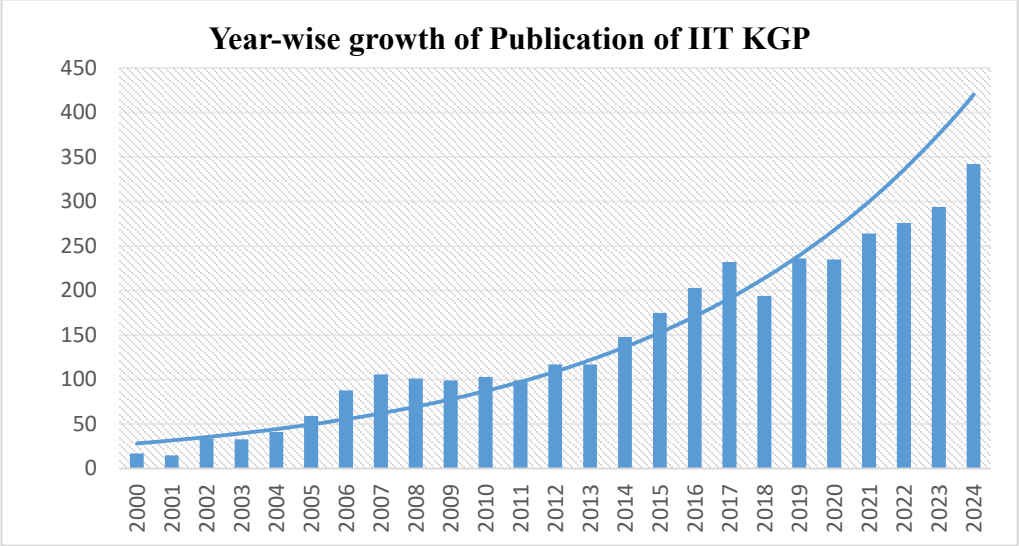

Figure 5.6.4.1: Year-wise growth of publications of IIT KGP

The year-wise citation pattern of women faculty of IIT Kharagpur

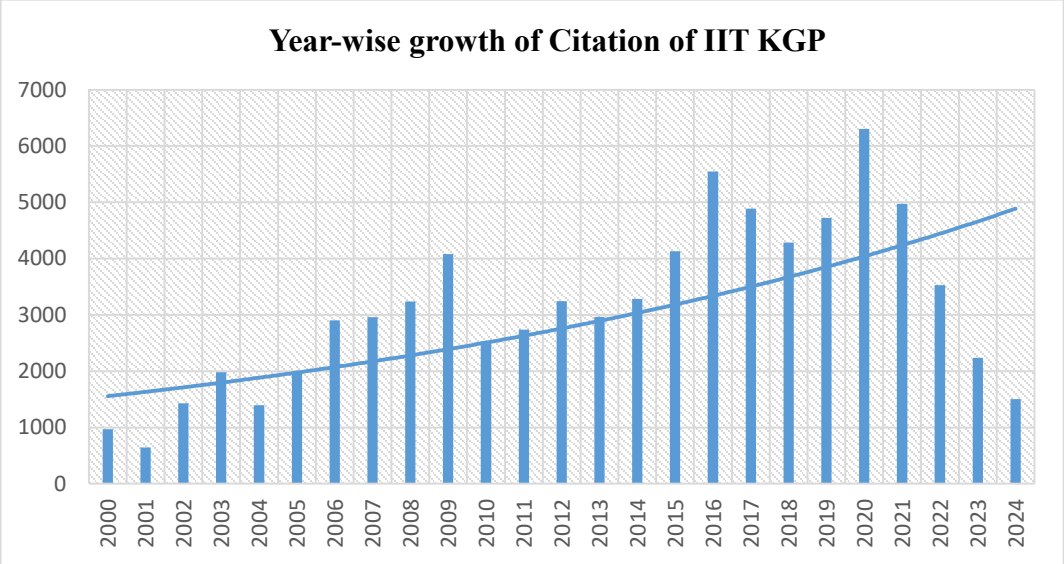

Figure 5.6.4.2: Year-wise growth of citations of IIT KGP

5.6.5 Research productivity of women faculty of IIT Kanpur for the years 2000-2024

The figure shows the year-by-year growth of total publications from 2000 to 2024. In the early years (2000–2007), publication output was relatively low, with gradual and modest growth. The number of publications increased steadily but without any sharp

jumps, reflecting a formative stage of research development. During the next phase (2008–2012), moderate growth is seen, with minor fluctuations along the way. A significant turning point occurred in 2013, marked by a sharp rise in the number of publications. This increase suggests a substantial boost in research productivity, possibly due to increased funding, expansion of academic programs, collaborative efforts, or policy changes at institutions. From 2014 to 2018, the growth trend continued steadily, with publications nearing and surpassing 200 by 2018. This period can be viewed as a phase of consolidation and growth in research output. The trend line further confirms a strong positive growth pattern throughout the entire timeframe. Overall, the graph indicates a long-term upward trend in research output, with a notable acceleration after 2013, reflecting ongoing institutional growth and increased scholarly contributions.

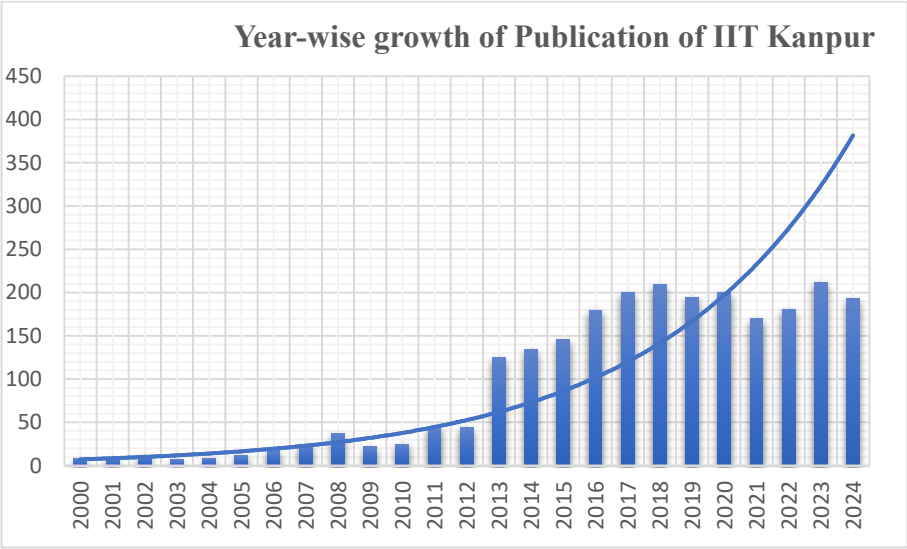

Figure 5.6.5.1: Year-wise growth of publications of IIT Kanpur

5.6.5.2 The year-wise citation pattern of women faculty of IIT Kanpur

The figure illustrates the year-wise distribution of total citations received during the period 2000–2024. In the initial phase (2000–2004), citation counts were minimal, indicating limited research visibility or fewer publications during these early years. A gradual increase is observed from 2005 to 2008, suggesting growing academic recognition and improved dissemination of research findings. Between 2009 and 2012, citations continued to rise steadily, crossing the 3,000–4,000 mark. This period

marks a transition toward greater research influence and enhanced scholarly engagement. A significant surge in citations is evident from 2013 onwards. The year 2013 records a sharp peak exceeding 10,000 citations, representing a breakthrough in research impact. Although slight fluctuations are observed in the subsequent years (2014–2017), citation counts remained consistently high, reflecting sustained research quality and influence. The highest citation peak appears around 2018, surpassing 10,000 citations once again. This suggests that publications from preceding years gained considerable academic attention and recognition during this period. The graph demonstrates a marked improvement in research impact over the study period, with a pronounced acceleration after 2012. The upward-sloping trend line confirms the long-term growth in citation performance, highlighting enhanced scholarly visibility, research quality, and academic influence over time.

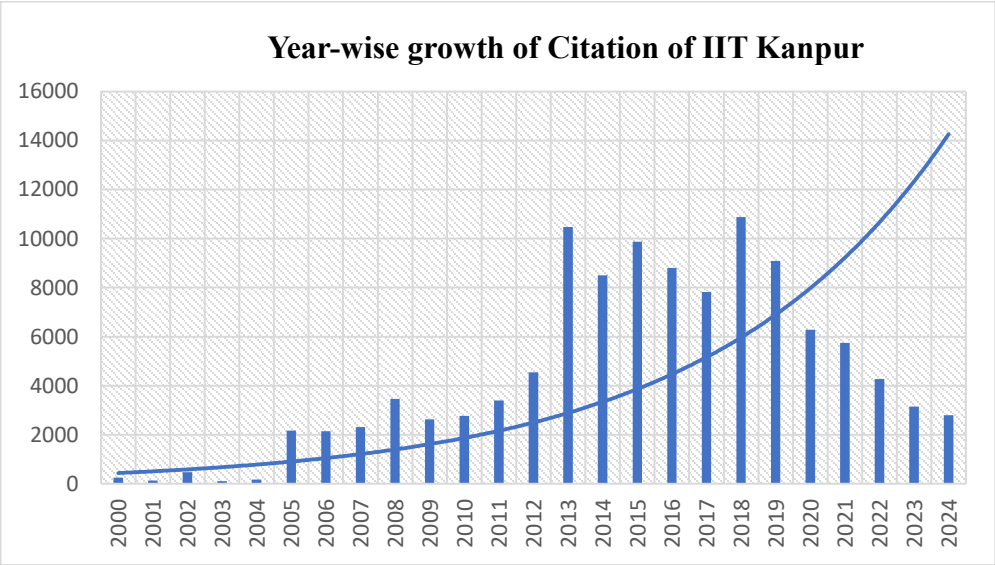

Figure 5.6.5.2: Year-wise growth of citations of IIT Kanpur

5.7 Form-wise Productivity of Research Publications

5.7.1 Form-wise Productivity of Research Publications (IIT Madras)

The following table and pie chart illustrate the distribution of various publication types. The data clearly shows that most documents are concentrated in a few dominant categories. Articles make up the largest share, accounting for 60% of all documents. This indicates that journal articles are the main form of scholarly

communication in the dataset. The high percentage suggests a strong focus on publishing in peer-reviewed journals, which are generally seen as the most reputable and influential form of academic output. Conference papers are the second-largest category, making up 32% of the total documents. This significant portion highlights active participation in academic conferences. Both books and editorials show 0%, indicating either no publications or an extremely small number in these categories during the study period. This suggests that standalone book publications and editorial contributions are not major parts of the overall research output. The publication pattern is heavily skewed toward journal articles and conference papers, which together make up 92% of all documents. This reflects a strong tendency toward quickly publishing research findings through journals and conferences rather than through books or editorials. In conclusion, the data reveal a research culture that emphasizes peer-reviewed articles and conference presentations as the main channels of scholarly communication, with limited focus on books, editorials, or other types of publications.

Table 5.7.1: Form-wise Productivity of Research Publications (IIT Madras)

Sl. No.	Form/Type of document	Frequency/No. of documents	Percentage %
1	Article	2170	60
2	Book	14	0
3	Book Chapter	137	4
4	Conference Paper	1163	32
5	Review	89	3
6	Editorial	14	0
7	Others	38	1
Total		3625	100

(Source: Survey data)

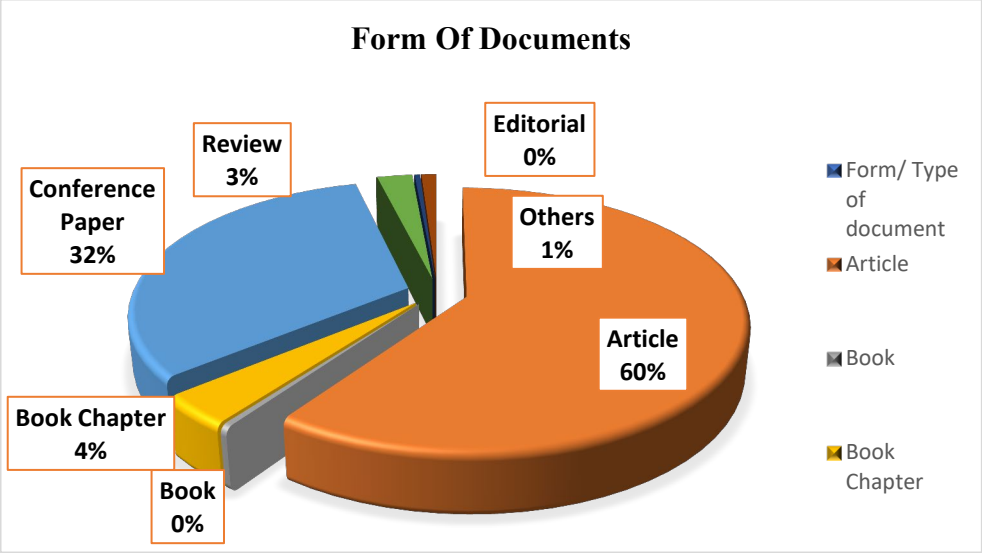

Figure 5.7.1: Form-wise Distribution of Research Publications (IIT Madras)

5.7.2 Form-wise Productivity of Research Publications (IIT Delhi)

The pie chart shows how different sorts of publications are spread out. The data shows that articles are by far the most common sort of document, making up 72% of the total. Other types of papers follow. This large percentage shows that journal articles are the main way that scholars talk to each other. It shows that peer-reviewed journal publishing is very important, which is frequently thought to be the most respected and influential way to share knowledge. 14% of the total materials are conference papers. Conference papers, while much less common than publications, are nonetheless an important way to share fresh research findings and connect with other academics. The entire publication pattern is significantly biased toward journal papers, which make up around three-fourths of the total output. These two groups, along with conference papers, make up 86% of all publications. This shows that researchers prefer to share their work through journals and conferences. Other types of scholarly work, like book chapters, reviews, editorials, and books, are not as important as articles. The data shows that the research profile focuses on publishing in journals and does not branch out much into other types of academic writing.

Table 5.7.2: Form-wise Productivity of Research Publications (IIT Delhi)

Sl. No	Form/ Type of document	Frequency/ No of documents	Percentage %
1	Article	2610	72
2	Book	22	0
3	Book Chapter	243	7
4	Conference Paper	501	14
5	Review	161	4
6	Editorial	31	1
7	Others	61	2
Total		3629	100

(Source: Survey data)

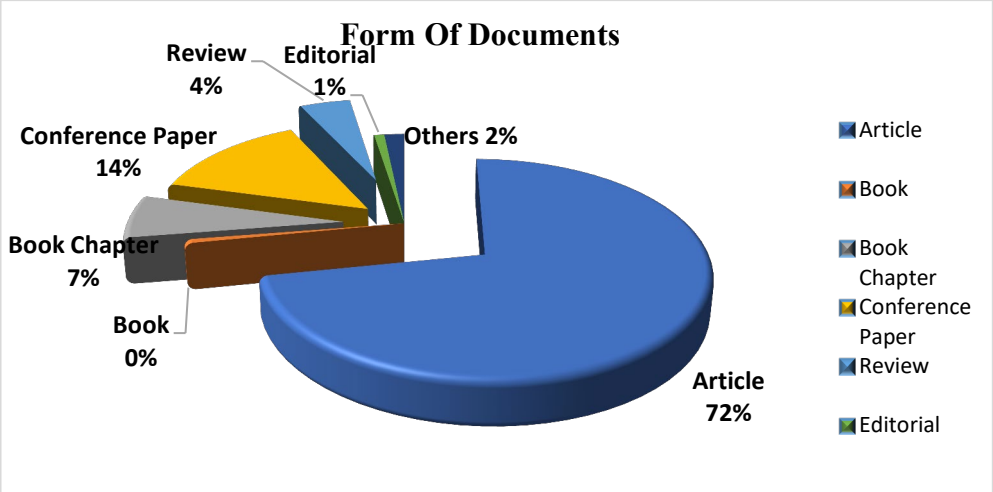

Figure 5.7.2: Form-wise Distribution of Research Publications (IIT Delhi)

5.7.3 Form-wise Productivity of Research Publications (IIT Bombay)

The pie chart illustrates that articles account for 69% of all publications, making them the most common document type. This, followed by conference papers, makes up 24% of the entire production. Review papers account for 3% of the publications. Although limited in quantity, reviews are critical for summarizing previous research, identifying trends, and exposing research shortages in certain disciplines. Articles and conference papers account for 93% of total publications, indicating a significant preference for research dissemination through journals and conferences. Other types, such as book chapters, reviews, editorials, and books, make only a marginal contribution. Journal articles dominate the publication pattern, with conference

papers contributing significantly, while other document formats play a limited role in overall scientific production.

Table 5.7.3: Form-wise Distribution of Research Publications (IIT Bombay)

Sl. No	Form/ Type of document	Frequency/ No of documents	Percentage %
1	Article	3272	69
2	Book	9	0
3	Book Chapter	114	2
4	Conference Paper	1137	24
5	Review	116	3
6	Editorial	20	1
7	Others	62	1
Total		4730	100

(Source: Survey data)

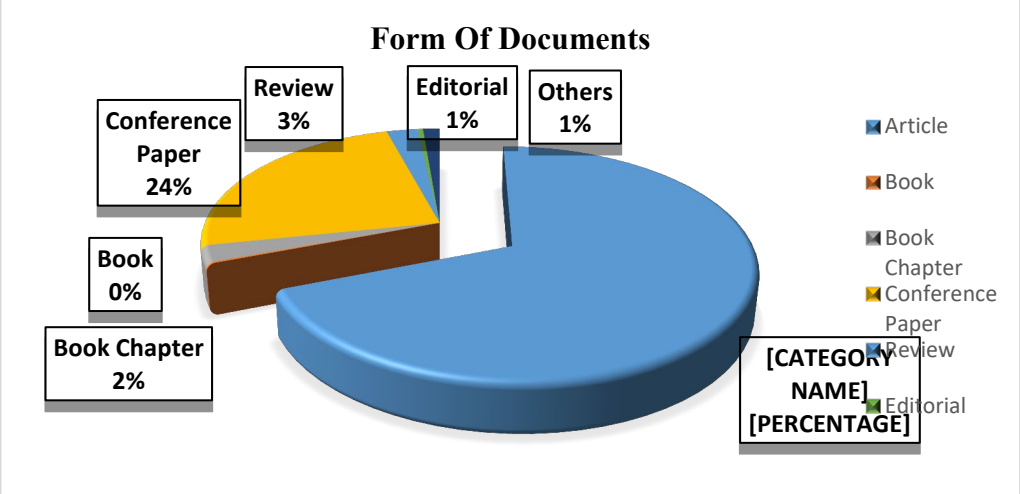

Figure 5.7.3: Form-wise Distribution of Research Publications (IIT Bombay)

5.7.4 Form-wise Productivity of Research Publications (IIT Kharagpur)

The accompanying table and pie chart show the proportional distribution of various types of publications. Articles account for 71% of all publications, making them the most significant category. It is followed by conference papers, which make up 19% of the total output. Book chapters account for 5% of the publications. This indicates some contribution to edited volumes and scholarly books, but it is still significantly lower than journal articles and conference papers. The findings show that the publication profile is heavily focused on journal articles, with a moderate share of

conference papers, while traditional book publishing and editorial contributions are minimal.

Table 5.7.4: Form-wise Distribution of Research Publications (IIT Kharagpur)

Sl. No	Form/ Type of document	Frequency/ No of documents	Percentage %
1	Article	2561	71
2	Book	13	0
3	Book Chapter	201	5
4	Conference Paper	684	19
5	Review	109	3
6	Editorial	28	1
7	Others	32	1
Total		3628	100

(Source: Survey Data)

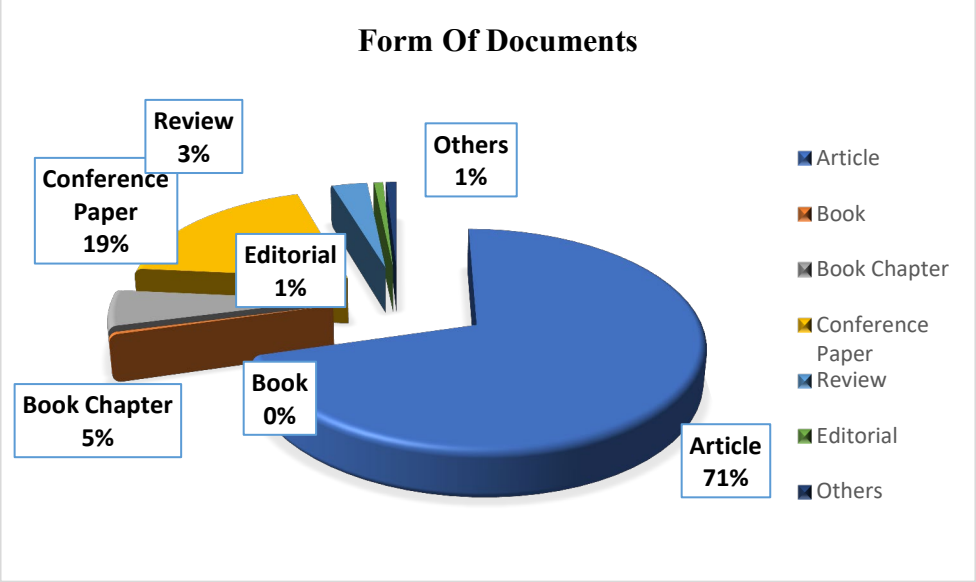

Figure 5.7.4: Table: Form-wise Distribution of Research Publications (IIT Kharagpur)

5.7.5 Form-wise Productivity of Research Publications (IIT Kanpur)

The table and pie chart show a strong dominance of journal articles, with other forms contributing in smaller proportions. Articles account for 77% of total documents, or more than three-quarters of the total publication output. Conference papers account for 17% of total publications. Journal articles and conference papers account for 94% of total publications, indicating that scholarly output is highly concentrated in these

two forms. Other document types, such as book chapters, reviews, editorials, and other publications, play a minor role. The publication pattern reflects a strong research orientation toward journal-based dissemination, which is supplemented by conference presentations, while traditional book publishing and other forms of documentation are minimal.

Table 5.7.5: Form-wise Distribution of Research Publications (IIT Kanpur)

Sl. No	Form/ Type of document	Frequency/ No of documents	Percentage %
1	Article	1874	77.50%
2	Book	4	0.17%
3	Book Chapter	38	1.57%
4	Conference Paper	410	16.96%
5	Review	37	1.53%
6	Editorial	13	0.54%
7	Others	42	1.74%
Total		2418	100.00%

(Source: Survey Data)

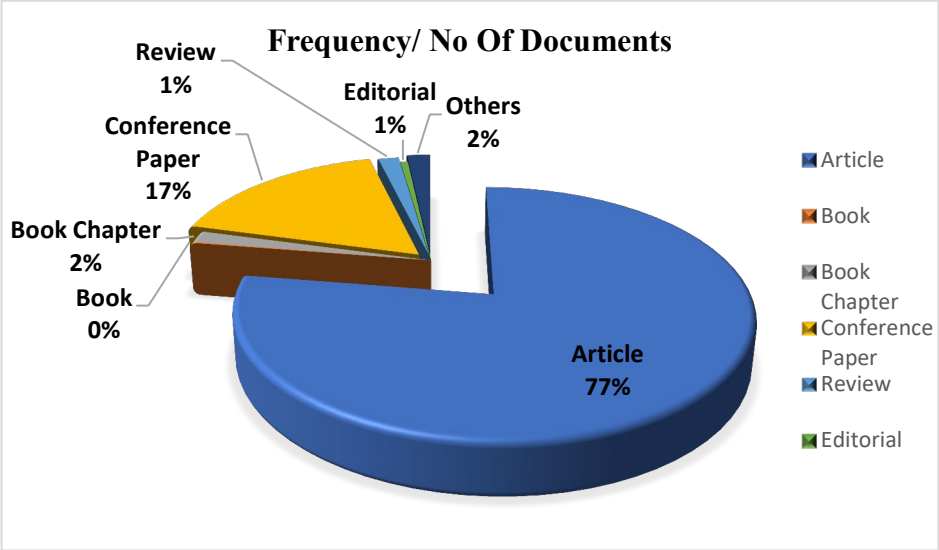

Figure 5.7.5: Form-wise Distribution of Research Publications (IIT Kanpur)

5.8 Year-wise productivity of research publications

5.8.1 Year-wise productivity of research publications (IIT MADRAS)

The table presents the annual distribution of publications of IIT Madras from 2000 to 2024, showing total publications, percentage contribution, cumulative frequency, and cumulative percentage. A total of 3,625 publications were produced during the study period.

Table 5.8.1: Year-wise productivity of research publications of IIT MADRAS

Year	Total publication	Percentage	Cumulative Frequency	Cumulative %
2000	25	0.69%	25	1%
2001	18	0.50%	43	1%
2002	26	0.72%	69	2%
2003	27	0.74%	96	3%
2004	40	1.10%	136	4%
2005	57	1.57%	193	5%
2006	76	2.10%	269	7%
2007	86	2.37%	355	10%
2008	70	1.93%	425	12%
2009	80	2.21%	505	14%
2010	88	2.43%	593	16%
2011	127	3.50%	720	20%
2012	118	3.26%	838	23%
2013	123	3.39%	961	27%
2014	155	4.28%	1116	31%
2015	164	4.52%	1280	35%
2016	225	6.21%	1505	42%
2017	240	6.62%	1745	48%
2018	256	7.06%	2001	55%
2019	260	7.17%	2261	62%
2020	277	7.64%	2538	70%
2021	265	7.31%	2803	77%
2022	276	7.61%	3079	85%
2023	249	6.87%	3328	92%
2024	297	8.19%	3625	100%
Total	3625	100.00%		

(Source: Survey Data)

The table shows that, in the beginning, the number of publications was still pretty low. In 2000, only 25 publications (0.69%) were reported. By 2005, the number had risen to 57 publications (1.57%). By 2005, the cumulative percentage had risen to only 5%, indicating that research activity was limited in the early stages. Since 2006, there has been a consistent upward trend, with publications increasing from 76 (2.10%) in 2006 to 123 (3.39%) by 2013. A significant increase is observed in 2011 (127 publications; 3.50%). The highest levels of research productivity were recorded in the most recent years: 2020: 277 publications (7.64%); 2022: 276 publications (7.61%); and 2024: 297 publications (8.19%), which were the highest over the entire period. The data show a clear upward trend over the last 25 years. The early decade (2000-2009) accounted for only 14% of all publications. The majority of the contribution (more than 70%) came after 2014, demonstrating recent increases in research productivity. The year-by-year analysis shows a progressive and accelerating growth pattern in research publications between 2000 and 2024. While the early years are slow, the period after 2014 sees significant growth, culminating in the highest productivity in 2024. This pattern suggests improved research capacity, increased academic engagement, and consistent improvement in scholarly output over time.

5.8.2 Year-wise productivity of research publications (IIT DELHI)

The table presents the annual distribution of publications of IIT Delhi from 2000 to 2024, including total publications, percentage contribution, cumulative frequency, and cumulative percentage. The dataset records a total of 3,629 publications (100%) over the 25 years.

Table 5.8.2: Year-wise productivity of research publications of IIT DELHI

Year	Total publication	Percentage	Cumulative Frequency/Total	Cumulative %
2000	19	0.52%	19	1%
2001	32	0.88%	51	1%
2002	26	0.72%	77	2%
2003	31	0.85%	108	3%
2004	53	1.46%	161	4%
2005	47	1.30%	208	6%

2006	49	1.35%	257	7%
2007	53	1.46%	310	9%
2008	71	1.96%	381	10%
2009	81	2.23%	462	13%
2010	100	2.76%	562	15%
2011	106	2.92%	668	18%
2012	90	2.48%	758	21%
2013	103	2.84%	861	24%
2014	136	3.75%	997	27%
2015	159	4.38%	1156	32%
2016	173	4.77%	1329	37%
2017	237	6.53%	1566	43%
2018	230	6.34%	1796	49%
2019	224	6.17%	2020	56%
2020	252	6.94%	2272	63%
2021	275	7.58%	2547	70%
2022	376	10.36%	2923	81%
2023	377	10.39%	3300	91%
2024	329	9.07%	3629	100%
Total	3629	100%		

(Source: Survey data)

The table depicts the annual distribution of publications from 2000 to 2024, including total publications, percentage contribution, cumulative frequency, and cumulative percentage. Over the course of the 25 years, 3,629 publications (100%) are recorded in the dataset. Research output was modest in the beginning and increased gradually, reaching 19 publications (0.52%) in 2000, 53 publications (1.46%) in 2004, and 49 publications (1.35%) in 2006. After 2014, there is a discernible increase in productivity: 136 publications (3.75%), 159 publications (4.38%), 173 publications (4.77%), and 237 publications (6.53%) in 2015, 2016, and 2017. Even though 2018 (230) and 2019 (224) saw some minor variations, the total output was still much higher than in previous years. A significant breakthrough occurs in 2022 and 2023, when each year accounts for more than 10% of the overall output. Total publications reached 3,629 (100%) by 2024. By 2019, the cumulative frequency had increased to 2,020 publications (56%), indicating that the second half of the study period produced more than half of the total research output. From slow initial growth (2000–2006) to steady development (2007–2013), rapid expansion

(2014–2019), and finally a high-productivity peak phase (2020–2024), the year-by-year analysis shows a shift.

5.8.3 Year-Wise Productivity of Research Publications (IIT BOMBAY)

The table presents the annual distribution of publications from 2000 to 2024, including total publications, percentage contribution, cumulative frequency, and cumulative percentage. A total of 4,730 publications (100%) were produced during the 25-year study period.

Table 5.8.3: Year-Wise Productivity of Research Publications of IIT Bombay

Year	Total publication	Percentage	Cumulative Frequency/Total	Cumulative %
2000	18	0.38%	18	0%
2001	24	0.51%	42	1%
2002	30	0.63%	72	2%
2003	34	0.72%	106	2%
2004	44	0.93%	150	3%
2005	48	1.01%	198	4%
2006	54	1.14%	252	5%
2007	62	1.31%	314	7%
2008	118	2.49%	432	9%
2009	132	2.79%	564	12%
2010	168	3.55%	732	15%
2011	136	2.88%	868	18%
2012	170	3.59%	1038	22%
2013	185	3.91%	1223	26%
2014	204	4.31%	1427	30%
2015	216	4.57%	1643	35%
2016	276	5.84%	1919	41%
2017	286	6.05%	2205	47%
2018	286	6.05%	2491	53%
2019	302	6.38%	2793	59%
2020	346	7.32%	3139	66%
2021	383	8.10%	3522	74%
2022	363	7.67%	3885	82%
2023	429	9.07%	4314	91%
2024	416	8.79%	4730	100%
Total	4730	100.00%		

(Source: Survey data)

The table shows that, during the initial phase (2000-2007), the number of publications was relatively low. 2008 saw a significant uptick, nearly doubling the previous year with 118 publications (2.49%). The output rose gradually to 204 publications (4.31%) in 2014. After 2015, the number of publications produced rose dramatically. The number of publications rose from 216 (4.57%) to 346 (7.32%) between 2015 and 2020. Over this period, research productivity has grown dramatically. The highest annual output was recorded in 2023, with 429 publications (9.07%). With 383 (8.10%) and 416 (8.79%) publications in 2021 and 2024, respectively, extremely high productivity was also shown. The publications trend shows a consistent upward trajectory, with particularly strong growth after 2015. The data show that research productivity has significantly increased over the last decade, especially during 2020–2024, the most productive period of the entire study period.

5.8.4 Year-wise productivity of research publications (IIT Kharagpur)

The dataset in the table 5.8.4 presents the annual distribution of 3,628 total publications over 25 years at IIT Kharagpur. The trend clearly shows a steady and progressive rise in research productivity.

Table 5.8.4: Year-wise productivity of research publications of IIT Kharagpur

Year	Total publication	Percentage	Cumulative Frequency/Total	Cumulative %
2000	17	0.47	17	0%
2001	15	0.42	32	1%
2002	34	0.94	66	2%
2003	33	0.9	99	3%
2004	41	1.14	140	4%
2005	59	1.63	199	5%
2006	88	2.43	287	8%
2007	106	2.93	393	11%
2008	101	2.79	494	14%
2009	99	2.73	593	16%
2010	103	2.84	696	19%
2011	99	2.73	795	22%
2012	117	3.23	912	25%
2013	117	3.23	1029	28%
2014	148	4.07	1177	32%
2015	175	4.82	1352	37%

2016	203	5.6	1555	43%
2017	232	6.39	1787	49%
2018	194	5.35	1981	55%
2019	236	6.5	2217	61%
2020	235	6.47	2452	68%
2021	264	7.27	2716	75%
2022	276	7.6	2992	82%
2023	294	8.1	3286	91%
2024	342	9.42	3628	100%
Total	3628	100	-	-

(Source: Survey Data)

The table above shows that, during the initial years, the number of publications was fairly low. 2001 had the lowest output (15 publications; 0.42%). Output rose to 59 publications (1.63%) by 2005. With 88 publications (2.43%) in 2006, there was a discernible uptick. By 2013, the total output was 28%, and there were 117 publications (3.23%). Beginning in 2014, productivity rose sharply. Between 2014 and 2019, the publications increased from 148 (4.07%) to 236 (6.50%). While productivity is modest in the early years, it rapidly expands after 2014. The fact that 2024 saw the highest output suggests that research productivity is at its highest point right now. The data unequivocally point to increased collaboration, better infrastructure, improved research engagement, and higher academic output in recent years.

5.8.5 Year-wise productivity of research publications (IIT Kanpur)

The table presents the year-wise distribution of 2,418 publications of IIT Kanpur for over 25 years, from 2000 to 2024. The trend clearly indicates three distinct phases of research productivity.

Table 5.8.5: Year-wise productivity of research publications of IIT Kanpur

Year	Total publication	Percentage	Cumulative Frequency	Cumulative %
2000	8	0.33%	8	0%
2001	9	0.37%	17	1%
2002	12	0.50%	29	1%
2003	7	0.29%	36	1%
2004	9	0.37%	45	2%

2005	12	0.50%	57	2%
2006	18	0.74%	75	3%
2007	25	1.03%	100	4%
2008	37	1.53%	137	6%
2009	22	0.91%	159	7%
2010	25	1.03%	184	8%
2011	45	1.86%	229	9%
2012	44	1.82%	273	11%
2013	125	5.17%	398	16%
2014	134	5.54%	532	22%
2015	146	6.04%	678	28%
2016	180	7.44%	858	35%
2017	200	8.27%	1058	44%
2018	209	8.64%	1267	52%
2019	195	8.06%	1462	60%
2020	200	8.27%	1662	69%
2021	170	7.03%	1832	76%
2022	181	7.49%	2013	83%
2023	212	8.77%	2225	92%
2024	193	7.98%	2418	100%
Total	2418	100.00%	-	-

(Source: Survey Data)

The table shows that the publication output stayed very low in the early years. From 2000 to 2005, annual publications varied between 7 and 12, each contributing less than 1% annually. By 2008, output rose marginally to 37 publications (1.53%), with cumulative output totaling merely 6%. Between 2009 and 2012, publication output exhibited consistent improvement. A notable increase has been observed since 2013. Publications surged to 125 (5.17%) in 2013 and continued to rise. By 2018, cumulative output exceeded 50%, indicating that over half of the total publications were generated within the preceding seven years. From 2017 to 2024, approximately 56% of total publications were produced, indicating a mature and highly productive research period. The general trend indicates exponential growth in research productivity, particularly post-2013. Over 80% of publications were generated in the last decade (2013–2024), indicating substantial growth, improved research infrastructure, heightened collaborations, or augmented funding support during this timeframe.

5.9 Year-wise productivity of journal articles

The table presents the distribution of 12,537 publications of journal articles over 25 years from 2000 to 2024. The trend demonstrates steady growth in the early years.

The data table shows that, in the early years, the publication output of journal articles was relatively modest but showed steady growth. There were 74 publications (0.59%) in 2000, increasing to 223 publications (1.78%) in 2007. The cumulative percentage rose from 1% to 8%. This phase reflects an evolving research foundation with moderate annual expansion. Starting in 2008, output began to increase more consistently, with 280 publications that year (2.23%). A significant jump is seen from 2013 onward, with 475 publications (3.79%), and in 2024, the number reached 1082 publications (8.63%) – the highest annual output. The overall trend indicates exponential and sustained growth in research productivity, especially in the last decade (2013–2024). The steady rise from 74 publications in 2000 to 1082 in 2024 clearly shows that the institution or field has achieved a peak in productivity recently, with 2024 marking the highest yearly total.

Table 5.9: Year-wise productivity of journal articles

Year	Total publication	Percentage	Cumulative Frequency	Cumulative %
2000	74	0.59%	74	1%
2001	81	0.65%	155	1%
2002	91	0.73%	246	2%
2003	91	0.73%	337	3%
2004	131	1.04%	468	4%
2005	152	1.21%	620	5%
2006	200	1.60%	820	7%
2007	223	1.78%	1043	8%
2008	280	2.23%	1323	11%
2009	268	2.14%	1591	13%
2010	316	2.52%	1907	15%
2011	325	2.59%	2232	18%
2012	350	2.79%	2582	21%
2013	475	3.79%	3057	24%
2014	534	4.26%	3591	29%
2015	608	4.85%	4199	33%
2016	740	5.90%	4939	39%

2017	812	6.48%	5751	46%
2018	896	7.15%	6647	53%
2019	867	6.92%	7514	60%
2020	945	7.54%	8459	67%
2021	959	7.65%	9418	75%
2022	1019	8.13%	10437	83%
2023	1018	8.12%	11455	91%
2024	1082	8.63%	12537	100%
Total	12537	100.00%	-	-

(Source: Survey Data)

The figure below illustrates the publication trend of journal articles from 2000 to 2024. It plainly shows that, initially, publication numbers were quite low, but they gradually increased and peaked in 2024 with 1,082 articles.

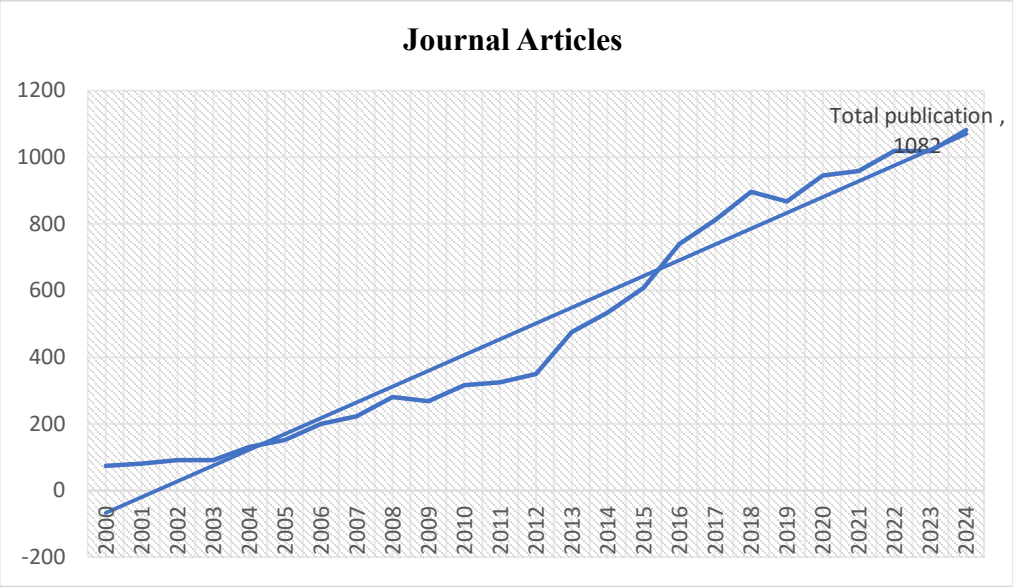

Figure 5.9: Year-wise productivity of journal articles

5.10 Year-wise productivity of conference papers

The table and figure below present the annual distribution of publications from 2000 to 2024. It shows a distinct, progressive growth trend, culminating in a notably productive period in recent years. A total of 3,846 publications were produced throughout the study period.

In the initial phase (2000–2006), research productivity was very low, with annual publications rising incrementally from 12 (0.31%) in 2000 to 68 (1.77%) in 2006.

The cumulative contribution during this period constituted merely 7% of the total output, signifying a nascent phase of research development. The following phase (2007–2013) signifies a period of consistent consolidation and growth. The annual output rose from 92 publications (2.39%) in 2007 to 155 publications (4.03%) in both 2011 and 2012. Despite minor fluctuations, the overall trend persisted in an upward direction. The period from 2017 to 2024 constitutes the most prolific phase, accounting for nearly fifty percent of the total publications. The peak annual output occurred in 2023 with 331 publications (8.61%), closely followed by 299 publications (7.77%) in 2024. By the conclusion of 2024, cumulative production attained 100%, validating consistent and elevated research productivity. The table illustrates a progression from an embryonic research phase to a developed and high-yield research ecosystem. The significant increase in publications over the past decade highlights improved research infrastructure, greater collaboration, and enhanced academic performance, signifying a strong and established scholarly environment.

Table 5.10: Year-wise productivity of conference papers

Year	Total publication	Percentage	Cumulative Frequency	Cumulative %
2000	12	0.31%	12	0%
2001	13	0.34%	25	1%
2002	34	0.88%	59	2%
2003	32	0.83%	91	2%
2004	44	1.14%	135	4%
2005	55	1.43%	190	5%
2006	68	1.77%	258	7%
2007	92	2.39%	350	9%
2008	89	2.31%	439	11%
2009	70	1.82%	509	13%
2010	138	3.59%	647	17%
2011	155	4.03%	802	21%
2012	155	4.03%	957	25%
2013	137	3.56%	1094	28%
2014	198	5.15%	1292	34%
2015	174	4.52%	1466	38%
2016	237	6.16%	1703	44%
2017	257	6.68%	1960	51%

2018	223	5.80%	2183	57%
2019	241	6.27%	2424	63%
2020	248	6.45%	2672	69%
2021	256	6.66%	2928	76%
2022	288	7.49%	3216	84%
2023	331	8.61%	3547	92%
2024	299	7.77%	3846	100%
Total	3846	100.00%	-	-

(Source: Survey data)

The figure below shows the trend of publication of conference papers published by all the IITs during the years 2000 to 2024. In the earlier years, the publication was recorded as low, but it increased steadily.

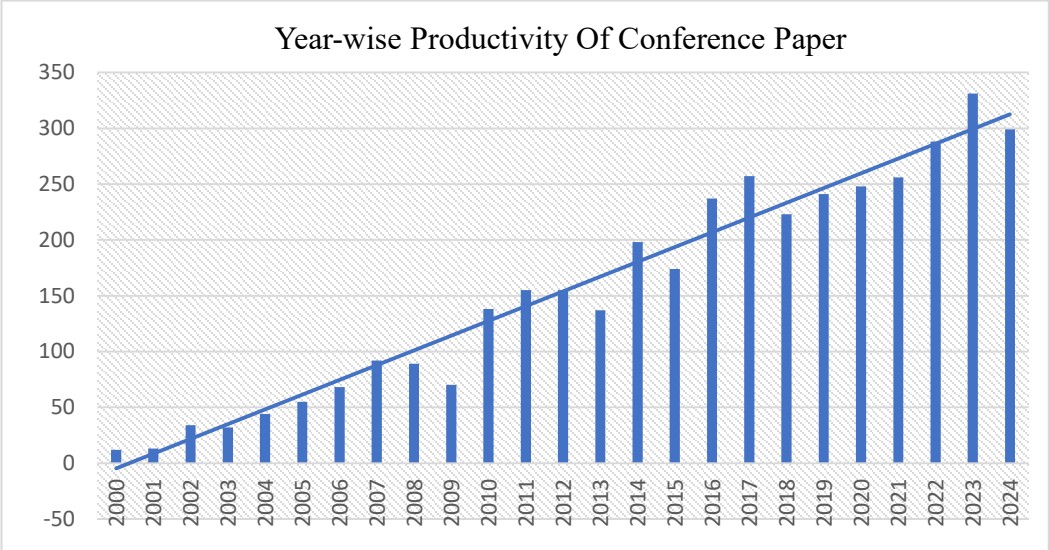

Figure 5.10: Year-wise productivity of conference papers

5.11 Year-wise productivity of book chapters

The table shows the year-wise distribution of book chapter publications from 2000 to 2024. A total of 733 book chapters were published during the study period, reflecting a significant rise in scholarly contributions to edited volumes and academic compilations.

During the first phase (2000-2005), no book chapters were published until 2003. Between 2003 and 2005, productivity was low, with only six chapters published in total, contributing less than 1% cumulatively. During the period 2006–2013, there

was steady but moderate growth. Publications rose from 7 chapters (0.96%) in 2006 to 16 chapters (2.19%) in 2012. By 2013, the cumulative output had reached 8%, indicating a gradual shift toward book-based scholarly dissemination. Since 2014, there has been a significant acceleration. The number of book chapters increased steadily, rising from 17 (2.32%) in 2014 to 38 (5.19%) in 2016. The upward trend persisted, with significant contributions in 2022 (74 chapters; 10.10%), 2023 (110 chapters; 15.01%), and 2024 (85 chapters; 11.60%). The year 2023 saw the highest annual output and the largest single-year contribution. By 2021, more than half (57%) of all book chapters had been published, with the period 2017-2024 accounting for roughly 77% of total output. The data clearly show a shift from negligible output in the early years to a mature and highly productive period in recent years. The significant increase since 2016 suggests increased academic collaboration, greater participation in edited volumes, and increased scholarly visibility through book publication.

Table 5.11: Year-wise productivity of book chapter

Year	Total publication	Percentage	Cumulative Frequency	Cumulative %
2000	0	0	0	0%
2001	0	0	0	0%
2002	0	0	0	0%
2003	2	0.28	2	0%
2004	1	0.14	3	0%
2005	3	0.41	6	0%
2006	7	0.96	13	1%
2007	4	0.55	17	1%
2008	13	1.78	30	2%
2009	7	0.96	37	2%
2010	9	1.23	46	3%
2011	10	1.37	56	5%
2012	16	2.19	72	6%
2013	13	1.78	85	8%
2014	17	2.32	102	11%
2015	29	3.96	131	13%
2016	38	5.19	169	17%
2017	71	9.69	240	23%
2018	63	8.60	303	29%
2019	57	7.78	360	37%

2020	51	6.96	411	47%
2021	53	7.24	464	57%
2022	74	10.10	538	69%
2023	110	15.01	648	84%
2024	85	11.60	733	100%
Total	733	100	-	-

(Source: Survey data)

Below is the graphical representation of book chapter productivity from 2000 to 2024.

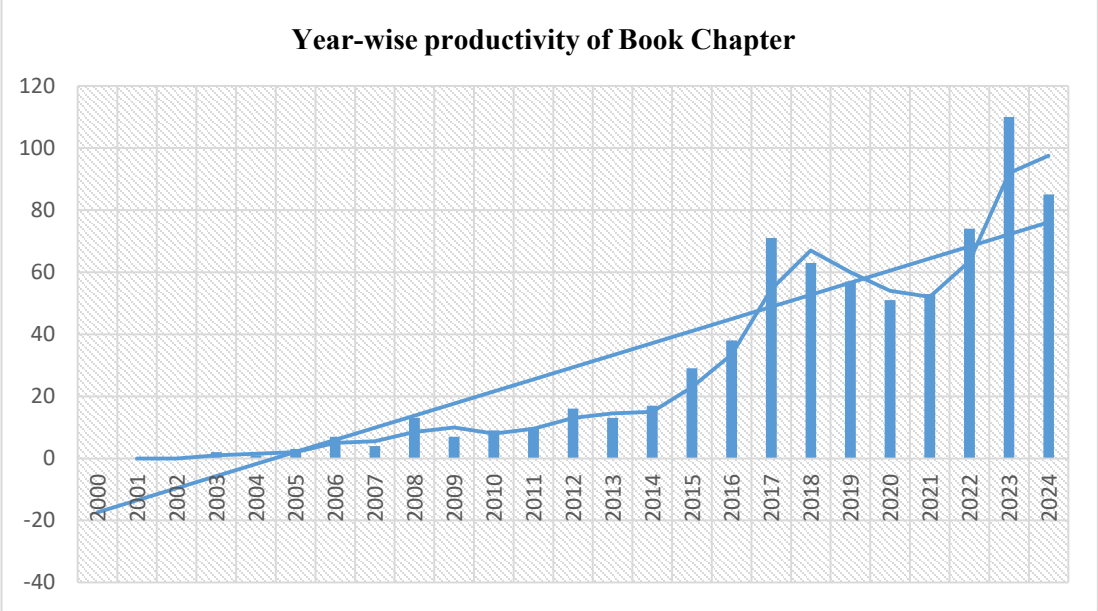

Figure 5.11: Year-wise productivity of book chapter

5.12 Growth of research publication

The study analyses the research output of women faculty of the top five NIRF-ranked IITs for the years 2000 to 2024. And in order to assess the growth and rate of literature, the following scientometric indicators were used.

1. Annual Growth Rate
2. Compound growth rate
3. Relative growth rate
4. Doubling time

5.12.1 Annual Growth Rate of All IITS

The table presents the Annual Growth Rate (AGR) of publications for all IITs from 2000 to 2024, highlighting both actual yearly growth and cumulative growth patterns. The data reveals fluctuating annual growth rates alongside a steady expansion in cumulative research output. Starting in 2000, the output of publications increased from 87 to 187 in 2004. Significant increases were observed in 2002 (30.62%) and 2004 (41.67%), indicating strong early expansion. The cumulative AGR remained high throughout the period, indicating rapid institutional development. Despite moderate fluctuations, growth remained stable between 2005 and 2012. The annual AGR varied from 4.29% (2009) to 27.81% (2006). The cumulative AGR decreased gradually, from 35.29% in 2005 to 16.44% in 2012. This declining cumulative rate does not imply decreased productivity; rather, it reflects the mathematical effect of an expanding publication base, in which maintaining very high percentage growth becomes more difficult. The year 2016 saw a significant growth rate of 22.91%, which was followed by 13.06% in 2017. This period coincides with a significant increase in IIT research productivity. However, 2018's growth rate is marginally negative (-1.68%), indicating a brief dip before a recovery in subsequent years. Since 2019, growth has become more consistent and moderate. Despite annual AGR fluctuations, the consistent increase in cumulative publication frequency confirms the ongoing strengthening of research output at all IITs, indicating long-term institutional stability and sustained scholarly productivity.

Table 5.12.1: Annual Growth Rate of All IITS

Sl. No.	Year	Actual		Cumulative	
		Frequency	AGR	Frequency	AGR
1	2000	87	-	87	-
2	2001	98	12.65	185	112.65
3	2002	128	30.62	313	69.19
4	2003	132	3.13	445	42.18
5	2004	187	41.67	632	42.03
6	2005	223	19.26	855	35.29
7	2006	285	27.81	1140	33.34
8	2007	332	16.50	1472	29.13
9	2008	397	19.58	1869	26.99

10	2009	414	4.29	2283	22.16
11	2010	484	16.91	2767	21.21
12	2011	513	5.99	3280	18.54
13	2012	539	5.07	3819	16.44
14	2013	653	21.16	4472	17.10
15	2014	777	18.99	5249	17.38
16	2015	860	10.69	6109	16.39
17	2016	1057	22.91	7166	17.31
18	2017	1195	13.06	8361	16.68
19	2018	1175	-1.68	9536	14.06
20	2019	1217	3.58	10753	12.77
21	2020	1310	7.65	12063	12.13
22	2021	1357	3.59	13420	11.25
23	2022	1472	8.48	14892	10.97
24	2023	1561	6.05	16453	10.49
25	2024	1577	1.03	18030	9.59

(Source: Survey data)

Below is the graphical representation of the Annual Growth Rate (AGR) of publications across all IITs from 2000 to 2024, demonstrating a clear and sustained trajectory in research productivity upward. The vertical bars indicate yearly publication output, while the trend line reflects the overall growth direction across the study period.

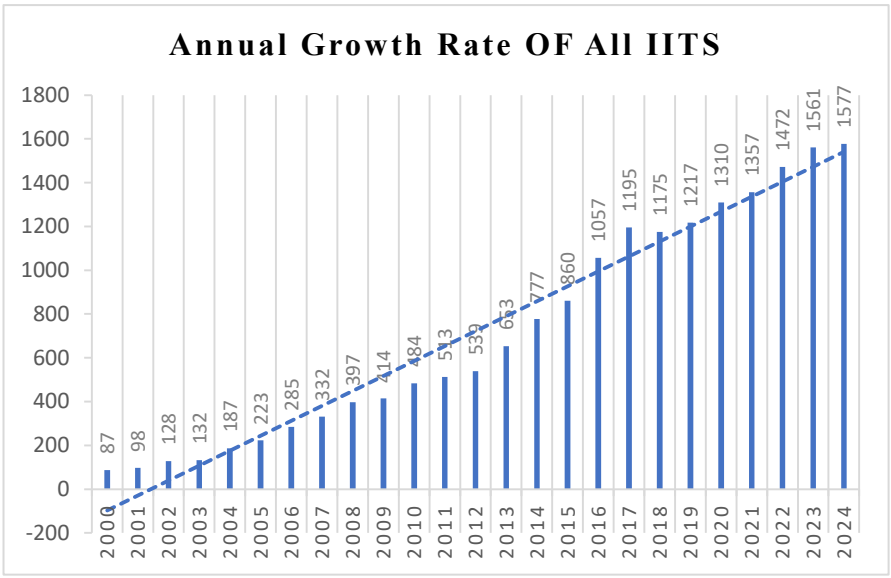

Figure 5.12.1: Annual Growth Rate of All IITS

5.12.2 Compound Annual Growth Rate

The Compound Annual Growth Rate (CAGR) data from 2000 to 2024 shows a clear pattern of long-term growth with a gradual decline in the annual growth rate over time. The table presents the year-wise growth in total frequency, along with cumulative frequency and CAGR values.

The initial years of 2000 to 2005 saw a relatively high growth rate, with CAGR falling from 12.3% in 2000 to 8.1% in 2005. This indicates a strong expansion phase, during which total output increased dramatically. Although cumulative frequency increased consistently, the CAGR fell steadily from 7.1% to 4.4% between 2006 and 2012. Since 2013, the growth rate has declined significantly, falling below 3% after 2014 and approaching 0% by 2023 and 2024. The overall trend shows a decreasing CAGR with an increasing cumulative frequency, indicating that the field has matured and grown steadily. Although annual growth rates have slowed, the total number of publications/outputs has steadily increased over the last 25 years, indicating sustained productivity. Despite this, the cumulative frequency has risen from 4,472 in 2013 to 18,030 in 2024, indicating steady but mature growth. The overall compound annual growth rate (CAGR) from 2000 to 2024 is around 12.3%, indicating a strong long-term growth trend despite a gradual decline in annual growth percentages in later years.

To calculate the overall CAGR (2000–2024):

$$CAGR = (Ending\ Value / Beginning\ Value)^{1/n} - 1$$

Where:

Beginning Value (2000) = 87

Ending Value (2024) = 1577

Number of years (n) = 2024 − 2000 = 24 years

Table 5.12.2: Compound Annual Growth Rate of IITs

Sl. No.	Year	Frequency/ Total	Cumulative Frequency	CAGR
1	2000	87	87	12.3%
2	2001	98	185	11.8%
3	2002	128	313	10.6%
4	2003	132	445	10.4%
5	2004	187	632	8.9%
6	2005	223	855	8.1%
7	2006	285	1140	7.1%
8	2007	332	1472	6.4%
9	2008	397	1869	5.7%
10	2009	414	2283	5.5%
11	2010	484	2767	4.8%
12	2011	513	3280	4.6%
13	2012	539	3819	4.4%
14	2013	653	4472	3.6%
15	2014	777	5249	2.9%
16	2015	860	6109	2.5%
17	2016	1057	7166	1.6%
18	2017	1195	8361	1.1%
19	2018	1175	9536	1.2%
20	2019	1217	10753	1.0%
21	2020	1310	12063	0.7%
22	2021	1357	13420	0.6%
23	2022	1472	14892	0.3%
24	2023	1561	16453	0.0%
25	2024	1577	18030	0.0%

(Source: Survey data)

5.13 Relative Growth Rate and Doubling Time of Research Publications

The Relative Growth Rate (RGR) and Doubling Time (DT) are important scientometric indicators used to measure the growth pattern of research publications over time. RGR indicates the increase in cumulative publications per unit of time, while DT represents the time required for the publications to double. Table (5.13) below shows the RGR and DT of research publications for the years 2000 to 2024.

Table 5.13: Relative Growth Rate and Doubling Time of Research Publications

Sl. No	Year	No of Publication		Relative Growth Rate			Doubling Time	
		Frequency	Cumulative	Log	RGR	Mean	DT	Mean
1	2000	87	87	4.47				
2	2001	98	185	5.23	0.76	0.222245	0.92	4.127668
3	2002	128	313	5.75	0.53		1.32	
4	2003	132	445	6.10	0.36		1.97	
5	2004	187	632	6.45	0.36		1.98	
6	2005	223	855	6.76	0.31		2.30	
7	2006	285	1140	7.04	0.29		2.41	
8	2007	332	1472	7.30	0.26		2.72	
9	2008	397	1869	7.54	0.24		2.91	
10	2009	414	2283	7.74	0.21		3.47	
11	2010	484	2767	7.93	0.20		3.61	
12	2011	513	3280	8.10	0.18		4.08	
13	2012	539	3819	8.25	0.16		4.56	
14	2013	653	4472	8.41	0.16		4.40	
15	2014	777	5249	8.57	0.17		4.33	
16	2015	860	6109	8.72	0.16		4.57	
17	2016	1057	7166	8.88	0.16		4.35	
18	2017	1195	8361	9.04	0.16		4.50	
19	2018	1175	9536	9.17	0.14		5.28	
20	2019	1217	10753	9.29	0.13		5.77	
21	2020	1310	12063	9.40	0.12		6.03	
22	2021	1357	13420	9.51	0.12		6.51	
23	2022	1472	14892	9.61	0.11		6.66	
24	2023	1561	16453	9.71	0.10		6.96	
25	2024	1577	18030	9.80	0.10		7.58	

(Source: Survey data)

The analysis of the Relative Growth Rate (RGR) and Doubling Time (DT) from 2000 to 2024 demonstrates a distinct growth pattern in research publications. The initial rapid growth stage was indicated by an RGR of 0.76 in 2001. The RGR declined from 0.53 to 0.24 between 2002 and 2008, indicating a stabilization in publication growth. By 2023 and 2024, the RGR had decreased steadily from 2009 onward, reaching 0.10. Although the total number of publications increased annually, the rate of exponential growth slowed over time, as indicated by this consistent decline. This pattern is typical of a research field that is transitioning from an expansion phase to a maturity phase. Indicating moderate long-term growth, the mean RGR for the entire

period is approximately 0.22. RGR is inversely related to Doubling Time (DT), which exhibits an increasing trend. The DT was 0.92 years in 2001, indicating that the number of publications doubled in less than one year. DT experienced a consistent increase from approximately 2.30 to 4.56 years during the middle phase (2005–2012). DT experienced a substantial increase in the subsequent years (2018–2024), culminating in a value of 7.58 years in 2024. The publication output, on average, doubled every four years during the study period, as indicated by the mean doubling time of approximately 4.12 years. The analysis unambiguously illustrates a negative correlation between doubling time and relative growth rate. DT increased in tandem with the decrease in RGR over the years. This suggests that the rate of exponential growth decreased, despite the fact that the number of research publications continued to increase in absolute terms. This transition from a rapid expansion to a more mature and stabilized research environment is reflected in the data. The data suggest a transition from a rapid expansion in the early years to a mature and stabilized growth phase in recent years.

To calculate the Relative Growth Rate (RGR)

$$RGR = \frac{\ln W_2 - \ln W_1}{T_2 - T_1}$$

Where:

- W_1= Cumulative publications in the initial year
- W_2= Cumulative publications in the succeeding year
- $T_2 - T_1$= Time interval (usually 1 year)
- ln= Natural logarithm

To calculate Doubling Time (DT),

$$DT = \frac{0.693}{RGR}$$

(0.693 is the natural log of 2.)

5.13.1 Relative Growth Rate and Doubling Time of Journal Articles

The table below provides significant insight into the Relative Growth Rate (RGR) and Doubling Time (DT) in the growth of journal article publications over the 25 years from 2000 to 2024.

The RGR reveals a decreasing trend over time, suggesting that publication growth is gradually stabilizing. During the initial years of 2000 to 2005. The RGR was at its highest in 2001 (0.74), which was indicative of the rapid expansion of journal article output. The cumulative publications continued to increase steadily, despite the fact that the RGR decreased from 0.47 to 0.29 between 2002 and 2005. RGR varied between 0.28 and 0.17. The growth rate gradually slowed, despite the fact that annual publication numbers increased significantly (particularly in 2013 and 2014). This suggests a transition from rapid growth to moderate stabilization. The RGR experienced an additional decline from 0.16 in 2015 to 0.10 in 2024. The rate of exponential growth decreased, despite the high annual output of 1082 articles in 2024. The consistent decrease in RGR suggests that, despite an increase in productivity in absolute terms, the rate of growth has decreased over time, suggesting a transition from expansion to consolidation. RGR is inversely related to Doubling Time (DT), which exhibits an increasing trend. In 2001, the DT was at its lowest point (0.94 years), indicating that publications doubled in less than one year. DT increased from 1.51 to 2.47 years between 2002 and 2005, indicating a decrease in the rate of doubling. DT experienced a substantial increase from 2018 to 2024, culminating in a value of 7.68 years. This confirms that the growth of journal articles has reached a plateau and necessitates additional time to double. The transition from an early high-growth phase to a mature and stabilized research environment is evident in the RGR and DT for journal articles. The field has reached a stage of structural consolidation and steady progression, as evidenced by the declining RGR and increasing DT, despite the fact that annual publication output remains robust.

Table 5.13.1: Relative Growth Rate and Doubling Time of Journal Articles

Sl. No.	Year	No of Publication		Relative Growth Rate			Doubling Time	
		Frequency	Cumulative	Log	RGR	Mean	DT	Mean
1	2000	74	74	4.31				
2	2001	81	155	5.05	0.74		0.94	
3	2002	91	246	5.51	0.47		1.51	
4	2003	91	337	5.83	0.32		2.21	
5	2004	131	468	6.15	0.33		2.12	
6	2005	152	620	6.43	0.29		2.47	
7	2006	200	820	6.71	0.28		2.48	
8	2007	223	1043	6.95	0.25		2.89	
9	2008	280	1323	7.19	0.24		2.92	
10	2009	268	1591	7.38	0.19		3.76	
11	2010	316	1907	7.56	0.19		3.83	
12	2011	325	2232	7.72	0.16		4.41	
13	2012	350	2582	7.86	0.15	8.191633	4.76	0.122076
14	2013	475	3057	8.03	0.17		4.11	
15	2014	534	3591	8.19	0.17		4.31	
16	2015	608	4199	8.35	0.16		4.44	
17	2016	740	4939	8.51	0.17		4.27	
18	2017	812	5751	8.66	0.16		4.56	
19	2018	896	6647	8.81	0.15		4.79	
20	2019	867	7514	8.93	0.13		5.66	
21	2020	945	8459	9.05	0.12		5.85	
22	2021	959	9418	9.16	0.11		6.46	
23	2022	1019	10437	9.26	0.11		6.75	
24	2023	1018	11455	9.35	0.10		7.45	
25	2024	1082	12537	9.44	0.10		7.68	

(Source: Survey data)

5.14 Year-wise Authorship pattern of research publications

The table presents the detailed interpretation of the Year-wise Authorship Pattern of Research Publications 2000–2024.

The year-wise authorship trend of research publications (2000–2024) distinctly demonstrates the prevalence of collaborative research. Among 18,030 total publications, multiple-authored papers constitute the largest proportion (48.21%),

followed by triple-authored papers (24.22%) and double-authored papers (24.04%). Single-authored publications represent merely a minor fraction (3.52%). In the initial years, collaboration was moderate; however, post-2010, there was a substantial increase in double, triple, and multiple-authored publications. The number of papers with multiple authorship rose significantly from 557 in 2016 to 808 in 2024. Single-authored contributions remained relatively low during the entire period. Of the 18,030 total publications: Single Author: 635 (3.52%), Double Author: 4,334 (24.04%), Triple Author: 4,367 (24.22%), Multiple Authors (more than 3): 8,691 (48.21%). It clearly indicates that publications with multiple authors comprise nearly half (48.21%) of the total output, illustrating a robust collaborative research culture. The prevalence of co-authored publications indicates the increasing complexity of research issues, interdisciplinary methodologies, and a collaborative academic environment. The consistent increase in co-authored publications indicates that collaboration has emerged as the primary characteristic of research productivity during the analyzed timeframe.

Table 5.14: Year-wise Authorship pattern of research publications

Year	Single Author (N)	(%)	Double Author(N)	(%)	Triple Author (N)	(%)	Multiple Author(N)	(%)	Total	%
2000	10	1.58	26	0.60	21	0.49	30	0.35	87	0.49
2001	12	1.89	30	0.70	26	0.60	30	0.35	98	0.55
2002	7	1.11	36	0.84	32	0.74	53	0.61	128	0.71
2003	9	1.42	38	0.88	39	0.90	46	0.53	132	0.74
2004	11	1.74	66	1.53	52	1.20	57	0.66	187	1.04
2005	12	1.89	52	1.20	78	1.79	80	0.93	223	1.24
2006	15	2.37	78	1.80	76	1.75	116	1.34	285	1.59
2007	20	3.15	94	2.17	105	2.41	113	1.31	332	1.85
2008	29	4.57	107	2.47	99	2.27	161	1.86	397	2.21
2009	15	2.37	109	2.52	111	2.55	179	2.06	414	2.30
2010	24	3.78	118	2.73	125	2.87	217	2.50	484	2.69
2011	38	5.99	128	2.96	135	3.10	212	2.44	513	2.85
2012	19	2.99	131	3.03	141	3.23	248	2.86	539	2.99
2013	26	4.10	165	3.81	143	3.28	319	3.68	653	3.63
2014	28	4.41	198	4.57	183	4.20	368	4.24	777	4.31
2015	27	4.26	236	5.45	201	4.61	396	4.56	860	4.77
2016	41	6.46	229	5.29	230	5.27	557	6.41	1057	5.87
2017	32	5.04	289	6.67	296	6.78	578	6.66	1195	6.63

2018	49	7.72	248	5.73	297	6.81	581	6.69	1175	6.52
2019	37	5.83	262	6.05	284	6.51	634	7.30	1217	6.75
2020	39	6.15	315	7.27	284	6.51	672	7.74	1310	7.27
2021	32	5.04	301	6.95	333	7.63	691	7.96	1357	7.53
2022	33	5.20	315	7.27	379	8.68	745	8.58	1472	8.17
2023	33	5.20	379	8.75	349	7.99	800	9.21	1561	8.66
2024	37	5.83	384	8.87	348	7.97	808	9.30	1577	8.75
Total	635	100	4334	100	4367	100	8691	100	18030	100

(Source: Survey data)

5.14.1 Institute-wise Authorship pattern of research publications

The table below portrays the institute-wise analysis of authorship patterns. It reveals the dominance of collaborative research at all selected IITs. The data set includes single, double, triple, and multiple-authored publications, as well as the Degree of Collaboration (DC) and the Collaborative Index.

The analysis on authorship patterns reveals a strong bias toward collaborative research across all IITs. There were 635 single-author publications, 4,334 double-author publications, 4,367 triple-author publications, and 8,691 multiple-author publications. Collaborative research (double, triple, and multiple authorship) dominates the total research output. IIT Bombay had the most overall publications (4,727), followed by IIT Delhi (3,629), IIT KGP (3,628), IIT Madras (3,625), and IIT Kanpur (2,418). In all institutes, multiple-authored papers account for the majority of publications. The Degree of Collaboration (DC) varies greatly across institutes, ranging from 0.95 to 0.98, implying that more than 95% of publications are collaborative. IIT Kanpur and IIT Madras have the highest collaboration level (DC = 0.98). The Collaborative Index (CI) ranges from 2.99 to 3.40, with IIT Kanpur having the highest CI (3.40), indicating a larger average number of authors per paper. Overall, the findings support a strong collaborative research culture at all selected IITs. The high Degree of Collaboration and Collaborative Index values indicate a strong culture of teamwork, interdisciplinary engagement, and institutional collaboration. The findings confirm that research productivity at IITs is primarily driven by collaborative scholarly efforts rather than individual authors.

Table 5.14.1: Institute-wise Authorship pattern of research publications

Institute	Single Author	Double Author	Triple Author	Multiple Author	Total	Dc	CI
IIT Bombay	143	853	1010	2721	4730	0.97	3.34
IIT Delhi	214	889	1055	1471	3629	0.95	3.05
IIT Kanpur	62	488	301	1567	2418	0.98	3.40
IIT Kharagpur	133	1115	1008	1372	3628	0.97	2.99
IIT Madras	83	989	993	1560	3625	0.98	3.12
Total	635	4334	4367	8691	18030		

(Source: Survey data)

5.15 Degree of Collaboration and Collaborative Index of Research Publications

The Degree of Collaboration (DC) and Collaborative Index (CI) are important indicators used to measure the extent and intensity of collaborative research. DC indicates the proportion of multi-authored publications, while CI represents the average number of authors per paper.

The table below presents the DC and CI in research publications of all the faculties.

Table 5.15: Degree of Collaboration and Collaborative Index of Research Publications

Year	Single Author (n)	Double Author(n)	Triple Author (n)	Multiple Author(n)	Total	DC	CI
2000	10	26	21	30	87	0.35	2.82
2001	12	30	26	30	98	0.31	2.76
2002	7	36	32	53	128	0.42	3.03
2003	9	38	39	46	132	0.35	2.93
2004	11	66	52	58	187	0.32	2.84
2005	12	52	78	81	223	0.37	3.03
2006	15	78	76	116	285	0.41	3.03
2007	20	94	105	113	332	0.36	2.94
2008	29	107	99	162	397	0.41	2.99
2009	15	109	111	179	414	0.44	3.10
2010	24	118	125	217	484	0.44	3.11

2011	38	128	135	212	513	0.42	3.02
2012	19	131	141	248	539	0.47	3.15
2013	26	165	143	319	653	0.49	3.16
2014	28	198	183	368	777	0.48	3.15
2015	27	236	201	396	860	0.47	3.13
2016	41	229	230	557	1057	0.53	3.24
2017	32	289	296	578	1195	0.49	3.19
2018	49	248	297	581	1175	0.50	3.2
2019	37	262	284	634	1217	0.53	3.25
2020	39	315	284	672	1310	0.52	3.22
2021	32	301	333	691	1357	0.51	3.25
2022	33	315	379	745	1472	0.51	3.25
2023	33	379	349	800	1561	0.52	3.23
2024	37	384	348	808	1577	0.52	3.23
Total	635	4334	4367	8694	18030	-	-

(Source: Survey Data)

The analysis of authorship patterns over the period 2000–2024 reveals a significant shift from individual research to collaborative scientific production. The total number of publications increased remarkably from 87 in 2000 to 1577 in 2024, indicating a substantial growth in research output and scholarly communication. The authorship distribution shows that single-author publications account for only 3.52% (635 out of 18,030) of the total output. Conversely, collaborative authorship dominates the dataset. Double-authored (24.04%) and triple-authored (24.21%) publications together contribute nearly half of the total output, while multiple-authored papers (48.23%) constitute the largest share. The sharp rise in multi-authored publications—from 30 in 2000 to 808 in 2024 indicates the increasing importance of team-based and interdisciplinary research.

The Degree of Collaboration (DC) has been calculated using Subramanyam's formula:

$$DC = \frac{N_m}{N_m + N_s}$$

where:

- N_m= Number of multi-authored publications
- N_s= Number of single-authored publications

The Degree of Collaboration consistently remained elevated throughout the study period from 2000 to 2024. The DC has increased from 0.35 in 2000 to 0.52 in 2024, with values consistently exceeding 0.50 in recent years. This consistent rise indicates a significant transition from solo-authored research to collaborative research. The data indicate that collaborative publications predominate in research output.

Further, the Collaboration Index (CI) has risen steadily from 2.82 in 2000 to 3.23 in 2024, indicating an increase in the average number of authors per paper. A CI value above 3 suggests that most publications involve three or more contributors. The consistently elevated Degree of Collaboration and rising Collaborative Index affirm a robust culture of teamwork and collective research. The results demonstrate that contemporary research endeavors are progressively reliant on contributions from multiple authors, highlighting interdisciplinary methodologies and institutional cooperation.

5.15.1 Institute-wise Degree of Collaboration of Research Publications

5.15.1.1 Institute-wise degree of collaboration of research publications of IIT Bombay

The table presents the Degree of Collaboration (DC) and Collaborative Index (CI) for IIT Bombay for the study period 2000 to 2024. The table shows that, from the year 2000 to 2024, IIT Bombay produced 4,730 publications, with 143 single authors, 853 double authors, 1,010 triple authors, and 2,721 multiple authors. The majority of publications have multiple authors, indicating a strong collaborative research culture.

DC ranged between 0.12 and 0.29, and the Collaboration Index (CI) of around 2.3–2.8 (2000-2005), indicating a relatively low level of collaboration. During the middle phase (2006–2015), both DC and CI show a steady increase. DC rises to around **0.50–0.61**, while CI crosses **3.0**, indicating a transition toward multi-authored publications.

From 2016 to 2024, DC remained consistently high, ranging between 0.53 and 0.66. The highest DC (0.65) was measured in 2023, indicating the strongest collaborative

tendency. This gradual increase in DC indicates a shift from individual research to team-based research. The highest CI (3.48) was recorded in 2023, indicating an average of nearly 3.8 authors per paper. The institute-specific analysis clearly shows that IIT Bombay has seen a significant increase in collaborative research during the study period. The increasing DC and CI values indicate a significant shift toward multi-authored publications. The prevalence of double, triple, and multiple-authored papers at IIT Bombay demonstrates the increasing importance of teamwork, interdisciplinary research, and institutional collaboration in research productivity.

Table:5.15.1.1 Degree of Collaboration of Research Publications of IIT Bombay

Year	Single Author	Double Author	Triple Author	Multiple Author	Total	DC	CI
2000	5	5	4	4	18	0.23	2.39
2001	6	7	8	3	24	0.13	2.34
2002	1	12	11	6	30	0.2	2.74
2003	3	6	11	14	34	0.42	3.06
2004	2	15	13	13	44	0.30	2.80
2005	3	13	19	12	47	0.26	2.86
2006	3	13	16	22	54	0.41	3.06
2007	5	21	10	26	63	0.42	2.88
2008	6	18	38	55	117	0.48	3.22
2009	3	20	32	77	132	0.59	3.39
2010	6	25	34	103	168	0.62	3.40
2011	11	28	23	74	136	5	3.18
2012	6	28	35	101	170	0.60	3.36
2013	7	46	39	93	186	0.5	3.17
2014	7	36	39	122	204	0.60	3.36
2015	3	46	51	116	216	0.54	3.30
2016	6	47	48	175	276	0.64	3.43
2017	6	47	61	172	286	0.61	3.40
2018	13	45	78	150	286	0.53	3.28
2019	12	54	64	172	302	0.57	3.32
2020	8	53	65	220	346	0.64	3.44
2021	5	63	85	230	383	0.61	3.41
2022	5	62	76	220	363	0.61	3.41
2023	4	67	76	282	429	0.66	3.49
2024	7	76	74	259	416	0.63	3.41
Total	143	853	1010	2721	4730	-	-

(Source: Survey Data)

5.15.1.2 Institute-wise degree of collaboration of research publications of IIT Delhi

The table presents year-wise analysis of Degree of Collaboration (DC) and Collaborative Index (CI) for IIT Delhi during 2000- 2024.

The table shows a strong presence of collaborative research throughout the study period, despite moderate fluctuations. From 2000 to 2024, IIT Delhi published 3,629 papers, with 214 single authors, 889 double authors, 1,055 triple authors, and 1,471 multiple authors. The majority of publications are co-authored, demonstrating the importance of collaborative research. The DC values range from 0.25 to 0.58, indicating moderate to strong collaboration. DC ranged from 0.25 (2001) to 0.58 (2002), indicating a range of collaborative intensity. DC has improved slightly since 2016, reaching 0.47 in 2022, indicating increased teamwork. The highest DC (0.58) was recorded in 2002, while recent years have shown stable collaboration between 0.40 and 0.47. The CI values range from 2.68 to 3.24, implying an average of nearly three authors per paper. In the early phase, the CI ranged between 2.79 and 3.24, indicating a moderate team size. From 2016 to 2024, CI remained mostly above 3.0, indicating increased collaborative intensity. The highest CI (3.24) was recorded in 2002, and recent years (2022-2024) show CIs ranging from 2.95 to 3.20, indicating stable research teams. The analysis shows that IIT Delhi has a strong collaborative research culture, with the majority of publications being co-authored. Although the Degree of Collaboration fluctuates moderately, the consistently high CI values indicate ongoing teamwork and institutional collaboration. The findings confirm that research productivity at IIT Delhi is primarily driven by collaborative scholarly efforts.

Table 5.15.1.2: Degree of Collaboration of Research Publications of IIT Delhi

Year	Single Author	Double Author	Triple Author	Multiple Author	Total	DC	CI
2000	1	5	4	9	19	0.48	3.11
2001	2	11	11	8	32	0.25	2.79
2002	2	5	4	15	26	0.58	3.24
2003	3	9	8	11	31	0.36	2.88
2004	1	12	14	26	53	0.50	3.23

2005	1	12	11	23	47	0.49	3.20
2006	5	11	9	24	49	0.49	3.07
2007	7	14	14	18	53	0.34	2.82
2008	16	18	10	27	71	0.39	2.68
2009	7	22	19	33	81	0.41	2.97
2010	8	30	29	33	100	0.33	2.87
2011	11	29	29	37	106	0.35	2.87
2012	3	16	38	33	90	0.37	3.13
2013	13	26	25	39	103	0.38	2.88
2014	11	30	46	49	136	0.37	2.98
2015	7	36	59	57	159	0.36	3.05
2016	14	34	46	79	173	0.46	3.10
2017	10	49	83	95	237	0.41	3.11
2018	22	46	68	94	230	0.41	3.02
2019	8	56	63	97	224	0.44	3.12
2020	9	78	75	90	252	0.36	2.98
2021	10	68	79	118	275	0.43	3.11
2022	14	72	115	175	376	0.47	3.20
2023	20	118	102	137	377	0.37	2.95
2024	9	82	94	144	329	0.44	3.14
Total	214	889	1055	1471	3629	-	-

(Source: Survey Data)

5.15.1.3 Institute-wise degree of collaboration of research publications, IIT Kanpur

The Table shows the Degree of Collaboration (DC) and Collaborative Index (CI) of Research Publications – IIT Kanpur during 2000–2024.

The data presented in the table shows that IIT Kanpur produced 2,418 publications from 2000 to 2024, comprising 62 single authors, 488 double authors, 301 triple authors, and 1,567 multiple authors. The DC values exhibit a notable upward trajectory over time. During the initial decade (2000-2010), DC was comparatively low, fluctuating between 0.10 and 0.50, signifying moderate collaboration. From 2014 to 2019, DC consistently exhibited elevated values, fluctuating between 0.66 and 0.81, signifying robust collaborative dominance. The maximum DC (0.81) was documented in 2018, signifying a zenith in collaborative intensity. The Collaborative Index also considers the growth of team size over time. During the initial period (2000-2010), CI fluctuated between 2.23 and 2.84, signifying modest research teams.

Beginning in 2013, the CI consistently surpassed 3.40, signifying a substantial rise in the average number of authors per paper. The peak CI (3.68) was documented in 2018, signifying extensive collaborative research teams. The substantial rise in DC and CI values indicates a robust culture of collaboration and multi-author research. The frequency of multi-authored publications indicates that the research output of IIT Kanpur is predominantly fueled by collaborative academic endeavors.

Table 5.15.1.3: Degree of Collaboration of Research Publications of IIT Kanpur

Year	Single Author	Double Author	Triple Author	Multiple Author	Total	DC	CI
2000	0	5	0	3	8	0.38	2.75
2001	0	5	1	3	9	0.34	2.78
2002	0	3	3	6	12	0.5	3.25
2003	1	1	2	3	7	0.43	3
2004	2	4	2	1	9	0.12	2.23
2005	2	2	4	4	12	0.34	2.84
2006	4	4	5	5	18	0.28	2.62
2007	0	11	8	6	25	0.24	2.8
2008	2	22	7	6	37	0.17	2.46
2009	3	11	6	2	22	0.10	2.32
2010	3	9	4	9	25	0.36	2.76
2011	4	16	9	16	45	0.36	2.83
2012	5	14	4	21	44	0.48	2.94
2013	1	20	4	100	125	0.8	3.63
2014	4	19	17	94	134	0.71	3.5
2015	4	31	15	96	146	0.66	3.40
2016	5	23	23	129	180	0.72	3.54
2017	5	34	17	144	200	0.72	3.5
2018	3	20	18	168	209	0.81	3.68
2019	4	22	18	151	195	0.78	3.63
2020	1	34	27	138	200	0.69	3.51
2021	2	42	29	97	170	0.58	3.3
2022	2	51	18	110	181	0.61	3.31
2023	2	44	28	138	212	0.66	3.43
2024	3	41	32	117	193	0.61	3.37
Total	62	488	301	1567	2418		

(Source: Survey Data)

5.15.1.4 Institute-wise degree of collaboration of research publications of IIT Kharagpur

The table presents the Degree of Collaboration (DC) and Collaborative Index (CI) of Research Publications, IIT Kharagpur, during the study period of 2000–2024.

The table shows that, from 2000 to 2024, IIT Kharagpur generated 3,628 publications, including 133 single-author, 1,115 double-author, 1,008 triple-author, and 1,372 multiple-author works. During the initial years (2000–2002), the DC varied between 0.74 and 0.89, signifying robust collaboration. Since 2003, DC has predominantly exceeded 0.94, indicating a highly collaborative research milieu. The peak DC values (0.99) were recorded in 2009, 2012, 2013, 2019, and 2023, signifying nearly total prevalence of co-authored publications. The CI values span from 2.53 to 3.19, indicating a moderate to strong team size. During the initial years, the citation index fluctuated between 2.53 and 2.89, signifying an average of approximately 2 to 3 authors per publication.
The peak CI (3.19) was observed in 2023, signifying marginally larger collaborative groups in recent years. The prevalence of co-authored publications and consistent CI values near 3.0 affirm a robust culture of collaboration and teamwork within the institution. The results show that consistent and established collaborative research practices are a major factor in IIT Kharagpur's research productivity.

Table 5.15.1.4: Degree of Collaboration of Research Publications of IIT Kharagpur

Year	Single Author	Double Author	Triple Author	Multiple Author	Total	DC	CI
2000	4	3	7	3	17	0.77	2.53
2001	4	3	2	6	15	0.74	2.67
2002	4	12	7	11	34	0.89	2.74
2003	1	14	11	7	33	0.97	2.73
2004	1	15	15	10	41	0.98	2.83
2005	4	12	30	13	59	0.94	2.89
2006	3	24	27	34	88	0.97	3.05
2007	6	24	42	34	106	0.95	2.99
2008	4	29	23	45	101	0.97	3.08
2009	1	40	31	27	99	0.99	2.85

2010	5	30	38	30	103	0.96	2.91
2011	6	22	41	30	99	0.94	2.96
2012	2	42	33	40	117	0.99	2.95
2013	1	43	37	36	117	0.99	2.93
2014	3	61	34	50	148	0.98	2.89
2015	11	71	33	60	175	0.94	2.82
2016	8	67	48	80	203	0.97	2.99
2017	6	82	72	72	232	0.98	2.91
2018	9	67	54	64	194	0.96	2.90
2019	6	71	69	90	236	0.99	3.03
2020	17	74	48	96	235	0.93	2.95
2021	10	68	67	119	264	0.97	3.12
2022	7	61	84	124	276	0.98	3.18
2023	2	80	73	139	294	0.99	3.19
2024	8	100	82	152	342	0.98	3.11
Total	133	1115	1008	1372	3628	-	-

(Source: Survey Data)

5.15.1.5 Institute-wise degree of collaboration of research publications of IIT Madras

The table presents the year-wise authorship pattern of research publications from IIT Madras during 2000–2024, along with Degree of Collaboration (DC) and Collaboration Index (CI).

During the study period, the women faculty at IIT Madras produced a total of 3,625 publications. Single-authored papers account for only 83 publications (2.29%), while multi-authored papers (3,542 publications; 97.71%) dominate, indicating that IIT Madras has a strong collaborative research culture. The Degree of Collaboration (DC) ranges from 0.88 to 1.00 and is consistently high throughout the period. In several years (2000, 2001, 2002, 2006), DC equals 1.00, indicating that all publications were collaborative. This reflects the institution's emphasis on collaborative and interdisciplinary research. The Collaboration Index (CI) ranges between 2.43 and 3.43, indicating that on average, each paper has three authors. The highest CI (3.43) was recorded in 2002, indicating an increase in team size that year. Total publications have increased steadily over time, from 25 in 2000 to 297 in 2024. The number of multiple-authored papers (four or more authors) has increased significantly, particularly since 2015, indicating an expansion of large research teams and collaborative projects. The steady rise in double, triple, and multiple-authored

papers suggests increased national and international collaboration, research networking, and interdisciplinary integration. Overall, the data show that IIT Madras has a highly collaborative and rapidly expanding research environment, with few single-author contributions and a strong dominance of multi-author contributions throughout the study period.

Table 5.15.1.5: Degree of Collaboration of Research Publications of IIT Madras

Year	Single Author	Double Author	Triple Author	Multiple Author	Total	DC	CI
2000	0	8	6	11	25	1	3.12
2001	0	4	4	10	18	1	3.34
2002	0	4	7	15	26	1	3.43
2003	1	8	7	11	27	0.97	3.04
2004	5	20	8	7	40	0.88	2.43
2005	2	13	14	28	57	0.97	3.20
2006	0	26	19	31	76	1	3.07
2007	2	24	31	29	86	0.98	3.02
2008	1	20	21	28	70	0.99	3.09
2009	1	16	23	40	80	0.99	3.28
2010	2	24	20	42	88	0.98	3.16
2011	6	33	33	55	127	0.96	3.08
2012	3	31	31	53	118	0.98	3.14
2013	4	30	38	51	123	0.97	3.11
2014	3	52	47	53	155	0.99	2.97
2015	2	52	43	67	164	0.99	3.07
2016	8	58	65	94	225	0.97	3.09
2017	5	77	63	95	240	0.98	3.04
2018	2	70	79	105	256	0.99	3.13
2019	7	59	70	124	260	0.98	3.20
2020	4	76	69	128	277	0.99	3.16
2021	5	60	73	127	265	0.99	3.22
2022	5	69	86	116	276	0.99	3.14
2023	5	70	70	104	249	0.98	3.10
2024	10	85	66	136	297	0.97	3.11
Total	83	989	993	1560	3625	-	-

(Source: Survey Data)

5.16 Most prolific women faculty during the study period 2000-2024

The table presents the comprehensive assessment of research productivity and impact of the top 15 most prolific authors using bibliometric indicators such as total

publications, total citations, h-index, i10 index, i20 index, and g-index. These indicators collectively provide an understanding of research performance.

The table shows a detailed analysis of the top contributing authors based on productivity and citation impact. A significant variation was observed among the faculties, where Swagata Mukherjee (IIT Kanpur) leads all authors with 1104 publications, an impressive h-index of 112, and 60,723 citations along with a 937 i10 index and 782 i20 index which indicates both high productivity and significant research impact. The list followed by Dash, Sadhana (IIT Bombay), with 608 publications, an h-index of 110, and a g-index of 182, and 42,979 citations, despite having fewer publications, indicates significant scholarly influence.

Pai, Archana (IIT Bombay), is ranked eighth in productivity (208 publications), with the highest citation count (81,077) and a high h-index of 86, indicating exceptional research impact relative to output. Rintu Banerjee, Jyotsna Dutta-Majumdar, and Swagata Dasgupta are among the IIT Kharagpur faculty members who have made significant contributions in terms of publication counts and citations. Similarly, IIT Madras researchers such as Venkitesh, Deepa, Ligy Philip, and Nandita Dasgupta demonstrate consistent research productivity and moderate citation impact.

Table 5.16: List of most prolific authors

Sl. No	Name of author	Institution Name	Total publications	H-index	i10 index	i20 index	g-index	Total Citation	Rank
1	Swagata Mukherjee	IIT Kanpur	1104	112	937	782	180	60723	1
2	Dash, Sadhana	IIT Bombay	608	110	466	387	182	42979	2
3	Das, Amita R.	IIT Delhi	342	41	195	111	53	6855	3
4	Shojaei Baghini, Maryam	IIT Bombay	323	29	110	53	53	4285	4
5	Venkitesh, Deepa	IIT Madras	273	14	22	13	25	999	5
6	Banerjee, Rintu	IIT Kharagpur	229	51	163	119	78	8713	6

7	Dutta-Majumdar, Jyotsna	IIT Kharagpur	216	43	127	82	72	6813	7
8	Pai, Archana	IIT Bombay	208	86	180	167	208	81077	8
9	Philip, Ligy	IIT Madras	194	49	136	110	78	7744	9
10	Dasgupta, Swagata	IIT Kharagpur	181	40	113	82	58	5012	10
11	Das, Karabi	IIT Kharagpur	178	37	129	88	57	4847	11
12	Verma, Ashu Kumar	IIT Delhi	174	27	61	34	45	2590	12
13	Shukla, Shobha	IIT Bombay	161	28	52	34	48	2539	13
14	Vijaya, Ramarao	IIT Kanpur	159	15	25	8	28	1166	14
15	Dasgupta, Nandita	IIT Madras	156	28	51	34	48	2878	15

(Source: Survey Data)

Below is the graphical representation of prolific authors along with the number of publications and their i10-index and g-index.

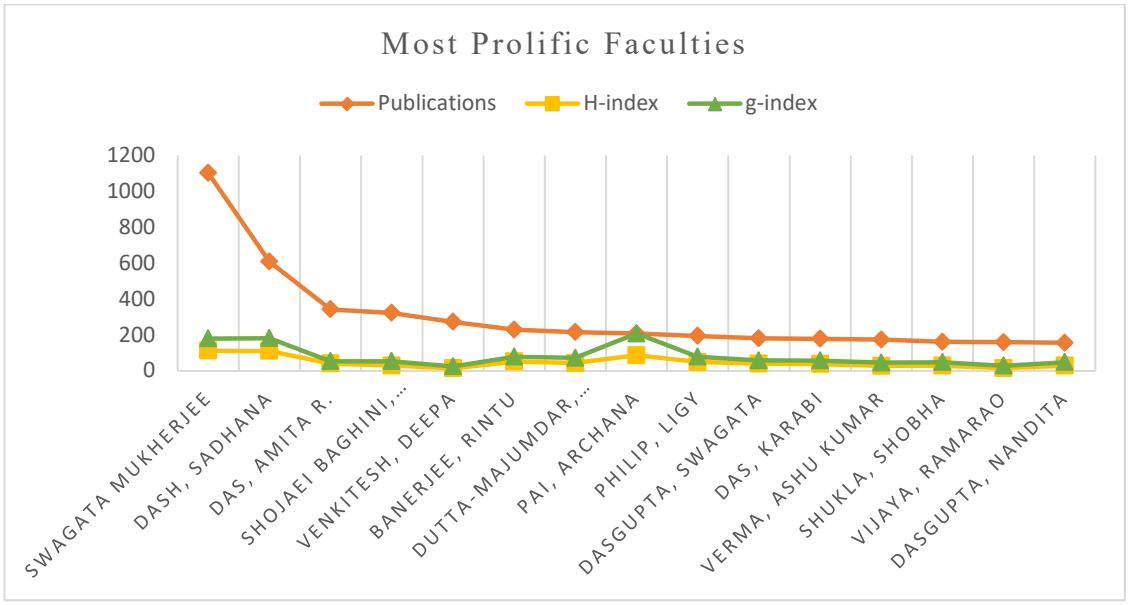

Figure 5.16: List of most prolific faculties

The overall analysis shows that scholarly impact is the product of productivity and citation among the authors. The number of publications does not always correspond to high citation impact. In publication output, the dominance of IIT Kharagpur is significantly noticeable, whereas faculties from IIT Bombay show citation intensity and research quality. The comparison between i10 and i20 index values across faculties reveals important insights into citation distribution, whereas the g-index further enhances the analysis by emphasizing highly cited publications.

5.16.1 Institute-wise list of the most contributing faculty

5.16.1.1 Most prolific faculties of IIT Bombay

The table highlights the top 10 most prolific authors of IIT Bombay based on total articles, citations, and h-index during 2000–2024.

The table shows that Dash, Sadhana is first with 608 publications, 42,979 citations, and an impressive h-index of 110, indicating both high productivity and strong scholarly impact. Although ranked third in publication count, Pai, Archana has the highest citation impact (81,077 citations) and an h-index of 86, indicating exceptional research influence relative to output. Shojaei Baghini, Maryam Shojaei, ranks second with 323 publications and a moderate citation impact (4,285 citations; h-index 29). Overall, the data show a distinction between research productivity (number of articles) and research impact (citations, h-index). While Dash, Sadhana lead in productivity, Pai, Archana lead in citation influence, demonstrating the diverse patterns of academic excellence at IIT Bombay.

Table 5.16.1.1: List of the most prolific faculties of IIT Bombay

Rank	Name	Citations	H-Index	Articles 2000-2024
1	Dash, Sadhana	42979	110	608
2	Shojaei Baghini, Maryam	4285	29	323
3	Pai, Archana	81077	86	208
4	Shukla, Shobha	2539	28	161
5	Mukherjee, Asmita K.	2511	31	139
6	Venkataraman, Chandra	13764	47	135
7	Mukherji, Suparna	8620	40	127
8	Rao, Preeti	906	13	115
9	Sarawagi, Sunita	6834	38	111

10	Pratibha, Sharma	2694	29	101

(Source: Survey Data)

5.16.1.2 Most prolific faculties of IIT Delhi

The table presents the top 10 most prolific authors of IIT Delhi based on total publications, citations, and h-index during 2000–2024.

The table shows that Das, Amita R., is the most productive faculty with 342 publications, 6,855 citations, and an h-index of 41. Followed by Ashu Kumar Verma with 174 publications, and citation impact (2,590 citations; h-index 27) is not as strong as that of others. Joshi, Mangala have had a big impact on research. She has received 5,763 citations and a high h-index of 40, even though she has published fewer papers (148) than the top-ranked author. The table shows that Amita R. Das is the most productive, but citation impact is spread out among several scholars. This shows that IIT Delhi is a competitive and research-heavy place to study.

Table 5.16.1.2: List of the most prolific faculties of IIT Delhi

Rank	Name	Citations	H-index	Articles 2000-2024
1	Das, Amita R.	6855	41	342
2	Verma, Ashu Kumar	2590	27	174
3	Upadhyayula, Sreedevi	2736	30	151
4	Joshi, Mangala	5763	40	148
5	Sharma, Shilpi S.	3339	30	134
6	Chakraborty, Tanushree	2517	30	128
7	Gupta, Deepti Bahl	3239	30	122
8	Sinha, Aloka	1658	20	107
9	Jain, Nidhi	3501	26	89
10	Mehra, Mani	1110	19	89

(Source: Survey Data)

5.16.1.3 Most prolific faculties of IIT Kanpur

The table presents the top 10 most prolific authors of IIT Kanpur based on total publications, citations, and h-index during 2000–2024.

Table 5.16.1.3: List of the Most prolific faculties of IITK

Rank	Name	Citations	H-Index	Articles 2000-2024
1	Swagata Mukherjee	60723	112	1104
2	Vijaya, Ramarao	1166	15	159
3	Gupta, Nandini	945	16	87
4	Katiyar, Monica	1108	19	75
5	Ateeq, Bushra	7558	31	69
6	Banerjee, Mohua	1217	15	63
7	Raychowdhury, Prishati	832	17	52
8	Malakar, Preeti	337	9	43
9	Nayak, Jayita	844	16	37
10	Chatterjee, Urbi	718	12	37

(Source: Survey Data)

5.16.1.4 Most prolific faculties of IIT Kharagpur

The table shows the list of the top 10 most contributing faculties of IIT Kharagpur during 2000-2024.

The list shows that Swagata Mukherjee is the most prolific author with an outstanding 1104 publications, 60,723 citations, and a very high h-index of 112, clearly dominating in both productivity and research impact. Vijaya Ramarao is in second place with 159 publications, but the citation impact (1,166 citations; h-index 15) is not as strong as that of the first place. Ateeq, Bushra is the most impactful author, with 7,558 citations and an h-index of 31, even though she has only published 69 papers. This shows that her research is of high quality and has had a big impact. Overall, the data show that Swagata Mukherjee has a lot of research output and impact, while other authors contribute steadily. This shows that productivity and citation influence are mixed at IIT Kanpur.

Table 5.16.1.4: List of the Most prolific faculty of IIT Kharagpur

Rank	Name	Citations	H-index	Articles 2000-2024
1	Banerjee, Rintu	8713	51	229
2	Dutta-Majumdar, Jyotsna	6813	43	216
3	Dasgupta, Swagata	5012	40	181
4	Das, Karabi	4847	37	178

5	Dutta, Ratna	1493	19	131
6	Chowdhury, Dipanwita Roy	1010	16	128
7	Jenamani, Mamata	1810	21	126
8	Sarkar, Sudeshna	1655	23	120
9	Chakraborty, Debjani	2397	25	108
10	Biswas, Karabi	2569	27	106

(Source: Survey Data)

The table indicates that Banerjee, Rintu, holds the top position with 229 publications, 8,713 citations, and a notable h-index of 51, reflecting substantial productivity and significant research impact. Dutta-Majumdar, Jyotsna, ranks next with 216 publications, 6,813 citations, and an h-index of 43, indicating a significant academic impact. Dasgupta, Swagata, and Das, Karabi exhibit robust performance with over 175 publications each and commendable citation metrics, indicating sustained research involvement. The data reveal a balanced distribution of productivity and citation impact among prominent scholars at IIT Kharagpur, with Banerjee, Rintu identified as the most significant contributors during the study period.

5.16.1.5 Most prolific faculties of IIT Madras

The table presents the top 10 most prolific authors of IIT Madras based on total publications, citations, and h-index during 2000–2024.

Table 5.16.1.5: List of the most prolific faculties of IIT Madras

Rank	Name	Citations	H-index	Articles 2000-2024
1	Venkitesh, Deepa	999	14	273
2	Philip, Ligy	7744	49	194
3	Dasgupta, Nandita	2878	28	156
4	Arunachalam, Kavitha Ac In	1285	19	148
5	Vanajakshi, Lelitha Devi	2828	24	134
6	Nambi, Indumathi Manivannan	4145	35	120
7	Sarkar, Sunetra	1325	21	115
8	Lakshminarasamma, N.	2065	19	111
9	Bhattacharya, Shanti	736	15	109
10	Rama, Raghavan Rao	1422	20	107

(Source: Survey Data)

The table shows that Venkitesh highlights Deepa as the most prolific researcher with 273 publications, though her citation impact is about average with 999 citations (h-

index 14). Philip Ligy, however, stands out for his significant research influence, boasting 7,744 citations and an impressive h-index of 49, despite having fewer papers (194). This indicates that his work is of high quality and makes a substantial impact. Other notable researchers include Nandita Dasgupta (156 publications; h-index 28) and Indumathi Manivannan Nambi (120 publications; 4,145 citations; h-index 35), whose productivity and influence are quite comparable. Overall, the data reveal an interesting distinction at IIT Madras between research output and research impact. While Venkitesh and Deepa lead in publication numbers, Philip Ligy and Nambi are recognized for their higher citation counts and scholarly influence during the study period.

5.17 Most productive Journals of faculty members

The table shows the most productive journals that women faculties that published most of their research studies.

The data show that the most publications (341 articles) were in Lecture Notes in Computer Science (including subseries), which is published by Springer Verlag. This shows that the research made a big impact in computer science and related conference proceedings. Journals in the field of physics, like Journal of High Energy Physics (182 articles), Physical Review D (171), Physics of Plasmas (168 articles), and Physical Review Letters (149 articles), publish a lot of work. This shows that they are important for high-energy and theoretical physics research. More contributions to nuclear and particle physics can be seen in Physics Letters B (163) and European Physical Journal C (82). Sources that focus on conferences, such as Optics InfoBase Conference Papers (166), AIP Conference Proceedings (85), and Proceedings of SPIE (73), show that people are actively taking part in international scientific conferences. The Economic and Political Weekly's (112 articles) work in the social and interdisciplinary sciences stands out from other science and engineering journals. Overall, the data show that most of the faculty's research is published in journals in physics, computer science, and engineering. The journals are mostly put out by large international publishers like Springer, Elsevier, the American Physical Society, and AIP.

Table 5.17: List Of the Most Productive Journals

Sl. No	Sources	No of Articles	Publisher
1	Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics)	341	Springer Verlag
2	Journal of High Energy Physics	182	Springer Science and Business Media Deutschland GmbH
3	Physical Review D	171	American Physical Society
4	Physics of plasmas	168	American Institute of Physics Inc.
5	Optics InfoBase conference papers	166	Optica Publishing Group (formerly OSA)
6	Physics Letters, Section B: nuclear, elementary particle and high-energy physics	163	Elsevier B.V.
7	Physical Review Letters	149	American Physical Society
8	Economic and Political Weekly	112	Economic and Political Weekly
9	Leibniz international proceedings in informatics, lipics	94	Schloss Dagstuhl-Leibniz-Zentrum für Informatik GmbH, Dagstuhl Publishing
10	Journal of magnetism and magnetic materials	93	Elsevier B.V.
11	Journal of Applied Physics	88	American Institute of Physics Inc.
12	AIP conference proceedings	85	American Institute of Physics Inc.
13	European Physical Journal C	82	Institute for Ionics
14	Physical review c - nuclear physics	76	American Physical Society
15	Proceedings of SPIE - the international society for optical engineering	73	SPIE

(Source: Survey Data)

5.18 Most Cited Documents

5.18.1 Most Cited Articles of the female faculty members of the top five IITs

The table highlights the top 20 most cited research articles contributed by women faculty members across all IITs.

The data clearly indicate that the most cited article, “Observation of gravitational waves from a binary black hole merger,” published in Physical Review Letters (2016), has garnered 12,274 citations, establishing it as the highest-impact contribution. Likewise, “GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral” (2017) has received 8,382 citations, indicating international scientific acknowledgment. Numerous other extensively cited papers, including GW151226, GW170104, GW170814, and GWTC-1, have been published in Physical Review Letters and Physical Review X, underscoring the significance of high-energy physics and astrophysics research. In addition to physics, significant contributions are evident in energy research and materials science, with publications in Science, Nature Chemistry, and Acta Biomaterialia, especially regarding solar cell efficiency and nanoparticle investigations. Environmental and interdisciplinary studies, including “Bounding the Role of Black Carbon in the Climate System” and “The IPBES Conceptual Framework,” exhibit significant citation impact. The data indicate that physics and astrophysics lead in citation impact, particularly in gravitational-wave research, followed by significant contributions in renewable energy, materials science, environmental science, and biomedical research. The existence of esteemed journals like Physical Review Letters, Nature, Science, and Astrophysical Journal Letters signifies the international prominence and research superiority of IIT faculty members.

Table 5.18.1: List Of the Most Cited Research Articles

Sl. No	Title	Journal Name	Year	Publisher	Total Citation
1	Observation of gravitational waves from a binary black hole merger	Physical Review Letters	2016	American Physical Society	12274
2	GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral	Physical Review Letters	2017	American Physical Society	8382
3	Porphyrin-sensitized solar cells with cobalt (II/III)-based redox electrolyte exceed 12 percent efficiency	Science	2011	American Association for the Advancement of Science	5830
4	Bounding the role of black carbon in the climate system: A scientific assessment	Journal of Geophysical Research Atmospheres	2013	Blackwell Publishing Ltd	4999
5	Dye-sensitized solar cells with 13% efficiency achieved through the molecular engineering of porphyrin sensitizers	Nature Chemistry	2014	N	4271
6	Multi-messenger observations of a binary neutron star merger	Astrophysical Journal Letters	2017	American Astronomical Society	3482
7	GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence	Physical Review Letters	2016	American Physical Society	3238
8	Advanced LIGO	Classical and Quantum Gravity	2015	Institute of Physics Publishing	3159
9	GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs	Physical Review X	2019	American Physical Society	3127
10	Gravitational Waves and Gamma-Rays from a Binary Neutron Star Merger: GW170817 and GRB 170817A	Astrophysical Journal Letters	2017	Institute of Physics Publishing	2898
11	GW170104: Observation of a 50-Solar-Mass	Physical Review Letters	2017	American Physical Society	2255

	Binary Black Hole Coalescence at Redshift 0.2				
12	The mutational landscape of lethal castration-resistant prostate cancer	Nature	2012	Springer Nature	2159
13	GW170817: Measurements of Neutron Star Radii and Equation of State	Physical Review Letters	2018	American Physical Society	2028
14	The IPBES Conceptual Framework - connecting nature and people	Current Opinion in Environmental Sustainability	2015	Elsevier B.V.	1982
15	GW170814: A Three-Detector Observation of Gravitational Waves from a Binary Black Hole Coalescence	Physical Review Letters	2017	American Physical Society	1926
16	GWTC-2: Compact Binary Coalescences Observed by LIGO and Virgo during the First Half of the Third Observing Run	Physical Review X	2021	American Physical Society	1901
17	Response surface methodology	Wiley Interdisciplinary Reviews: Computational Statistics	2010	Association for Computing Machinery	1746
18	Strain specificity in antimicrobial activity of silver and copper nanoparticles	Acta Biomaterialia	2008	Elsevier BV	1740
19	Size-controlled silver nanoparticles synthesized over the range 5-100 nm using the same protocol, and their antibacterial efficacy	RSC Advances	2014	Royal Society of Chemistry	1675
20	Tests of General Relativity with GW150914	Physical Review Letters	2016	American Physical Society	1496

(Source: Survey Data)

5.18.2 Most Cited Articles of IIT Bombay

The table indicates that the article titled “Observation of Gravitational Waves from a Binary Black Hole Merger” (2016), published in Physical Review Letters, has

garnered 12,274 citations, establishing it as a seminal contribution to contemporary physics. This paper contributes to the groundbreaking LIGO discovery, which markedly propelled global astrophysical research. Likewise, "GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral" (2017), which has garnered 8,382 citations, along with various other GW-series publications such as GW151226, GW170104, GW170814, and GWTC-1 & 2, exemplify IIT Bombay's vigorous involvement in substantial international scientific collaborations. The frequent publication in journals such as Physical Review Letters, Physical Review X, and Astrophysical Journal Letters underscores significant contributions to high-impact physics literature. The article on porphyrin-sensitized solar cells published in Science (5,830 citations) and the study in Nature Chemistry (4,271 citations) exemplify outstanding contributions to energy research and the improvement of solar cell efficiency from IIT Bombay. The environmental research is significant, especially the paper on black carbon and climate system assessment (4,999 citations), reflecting interdisciplinary involvement in climate science and sustainability studies. Moreover, research in nanotechnology and biomaterials, including studies on silver nanoparticles published in Acta Biomaterialia and RSC Advances, demonstrates practical scientific significance. The citation distribution indicates that although gravitational wave research leads in citation volume, IIT Bombay exhibits a robust multidisciplinary research impact in energy, environmental science, nanotechnology, and applied statistics. The existence of internationally esteemed journals validates the significant visibility and global acknowledgment of IIT Bombay's research contributions.

Table 5.18.2: Most Cited Articles of IIT BOMBAY

Sl. No	Title	Journal Name	Year	Publisher	Citation
1	Observation of gravitational waves from a binary black hole merger	Physical Review Letters	2016	American Physical Society	12274
2	GW170817: Observation of Gravitational Waves from a Binary Neutron Star Inspiral	Physical Review Letters	2017	American Physical Society	8382
3	Porphyrin-sensitized solar cells with cobalt (II/III)-based redox electrolyte	Science	2011	American Association for the	5830

	exceed 12 percent efficiency			Advancement of Science	
4	Bounding the role of black carbon in the climate system: A scientific assessment	Journal of Geophysical Research Atmospheres	2013	Blackwell Publishing Ltd	4999
5	Dye-sensitized solar cells with 13% efficiency achieved through the molecular engineering of porphyrin sensitizers	Nature Chemistry	2014	SpringerNature	4271
6	Multi-messenger observations of a binary neutron star merger	Astrophysical Journal Letters	2017	American Astronomical Society	3482
7	GW151226: Observation of Gravitational Waves from a 22-Solar-Mass Binary Black Hole Coalescence	Physical Review Letters	2016	American Physical Society	3238
8	Advanced LIGO	Classical and Quantum Gravity	2015	Institute of Physics Publishing	3159
9	GWTC-1: A Gravitational-Wave Transient Catalog of Compact Binary Mergers Observed by LIGO and Virgo during the First and Second Observing Runs	Physical Review X	2019	American Physical Society	3127
10	Gravitational Waves and Gamma-Rays from a Binary Neutron Star Merger: GW170817 and GRB 170817A	Astrophysical Journal Letters	2017	Institute of Physics Publishing	2898
11	GW170104: Observation of a 50-Solar-Mass Binary Black Hole Coalescence at Redshift 0.2	Physical Review Letters	2017	American Physical Society	2255
12	GW170817: Measurements of Neutron Star Radii and Equation of State	Physical Review Letters	2018	American Physical Society	2028
13	The IPBES Conceptual Framework - connecting nature and people	Current Opinion in Environmental Sustainability	2015	Elsevier B.V.	1982
14	GW170814: A Three-Detector Observation of Gravitational Waves from a Binary Black Hole Coalescence	Physical Review Letters	2017	American Physical Society	1926
15	GWTC-2: Compact Binary Coalescences Observed by LIGO and Virgo during the	Physical Review X	2021	American Physical Society	1901

	First Half of the Third Observing Run				
16	Response surface methodology	Wiley Interdisciplinary Reviews: Computational Statistics	2010	John Wiley & Sons, Inc.	1746
17	Strain specificity in antimicrobial activity of silver and copper nanoparticles	Acta Biomaterialia	2008	Elsevier BV	1740
18	Size-controlled silver nanoparticles synthesized over the range 5-100 nm using the same protocol and their antibacterial efficacy	RSC Advances	2014	Royal Society of Chemistry	1675
19	Tests of General Relativity with GW150914	Physical Review Letters	2016	American Physical Society	1496
20	GW190814: Gravitational Waves from the Coalescence of a 23 Solar Mass Black Hole with a 2.6 Solar Mass Compact Object	Astrophysical Journal Letters	2020	IOP Publishing Ltd	1489

(Source: Survey Data)

5.18.3 Most Cited Articles of IIT Delhi

The table presents the top 20 most cited research articles, reflecting diverse research domains of IIT Delhi for the study period of 2000 to 2024.

The most cited article, "A microRNA signature of hypoxia," published in Molecular and Cellular Biology (2007), has 972 citations, indicating a significant impact on molecular biology and cancer research. The list is followed by the article "Chemical and biochemical transformations in ionic liquids," published in the journal "Tetrahedron," which has 795 citations. High-impact interdisciplinary research is evident in publications such as "Residential biofuels in South Asia," which was published in science (562 citations) and addresses climate change and aerosol emission concerns. Environmental and atmospheric studies, including those published in the Journal of Geophysical Research Atmospheres and Global Biogeochemical Cycles, make significant contributions to climate science. The presence of reputable publishers such as Elsevier, ACS, Wiley, AAAS, and the Royal

Society of Chemistry demonstrates the research output's global visibility and scholarly influence.

Table 5.18.3: Most Cited Articles of IIT DELHI

Sl. No	Title	Journal Name	Year	Publisher	Citation
1	A microRNA signature of hypoxia	Molecular and Cellular Biology	2007	Taylor & Francis Group	972
2	Chemical and biochemical transformations in ionic liquids	Tetrahedron	2005	Elsevier	795
3	Enhancement of biogas production from solid substrates using different techniques - A review	Bioresource Technology	2004	Elsevier	795
4	Curcumin nanoparticles: Preparation, characterization, and antimicrobial study	Journal of Agricultural and Food Chemistry	2011	American Chemical Society	771
5	Residential biofuels in South Asia: Carbonaceous aerosol emissions and climate impacts	Science	2005	American Association for the Advancement of Science	562
6	Limitations in the enhancement of visible light absorption due to mixing state	Journal of Geophysical Research Atmospheres	2006	Blackwell Publishing Ltd	504
7	Synthesis and characterization of chitosan and silver-loaded chitosan nanoparticles for bioactive polyester	Carbohydrate Polymers	2011	Elsevier	414
8	MicroRNA regulation of DNA repair gene expression in hypoxic stress	Cancer Research	2009	American Association for Cancer Research	396
9	Antimicrobial activity of some natural dyes	Dyes and Pigments	2005	Elsevier	358
10	Increasing probability of mortality during Indian heat waves	Science Advances	2017	American Association for the Advancement of Science	336
11	Emissions from open biomass burning in India: Integrating the inventory approach with high-resolution Moderate Resolution Imaging Spectroradiometer (MODIS) active-fire and land cover data	Global Biogeochemical Cycles	2006	John Wiley & Sons, Inc	318

12	Functionalized mesoporous SBA-15 silica: Recent trends and catalytic applications	Nanoscale	2020	Royal Society of Chemistry	316
13	Ecofriendly antimicrobial finishing of textiles using bioactive agents based on natural products	Indian Journal of Fibre and Textile Research	2009	CSIR-NIScPR	287
14	Influence of freeze-thaw stress on the structure and function of microbial communities and denitrifying populations in soil	Applied and Environmental Microbiology	2006	American Society for Microbiology	285
15	Dynamics and functional relevance of ammonia-oxidizing archaea in two agricultural soils	Environmental Microbiology	2009	John Wiley & Sons, Inc	277
16	Rheological and viscoelastic behavior of HDPE/Octamethyl-POSS nanocomposites	Macromolecules	2006	ACS Publications	269
17	An integrated approach for experimental target identification of hypoxia-induced miR-210	Journal of Biological Chemistry	2009	Elsevier	263
18	Greenhouse implications of household stoves: An analysis for India	Annual Review of Energy and the Environment	2000	Annual Reviews Inc	258
19	The Indian National Initiative for Advanced Biomass Cookstoves: The benefits of clean combustion	Energy for Sustainable Development	2010	Elsevier	257
20	Recent developments in antimicrobial finishing of textiles - A review	AATCC Review	2004	Elsevier	250

(Source: Survey Data)

5.18.4 Most cited articles of IIT Madras

The table highlights the top 20 most cited articles of IIT Madras, reflecting strong multidisciplinary research impact during the years 2000-2024.

From the table below, it is clearly noticeable that the paper "Efficient lattice (H)IBE in the standard model" (2010), published in Lecture Notes in Computer Science, has 843 citations, indicating that it made a significant contribution to cryptography and information security. The second most cited work in traffic engineering, "Short-term

traffic flow prediction using seasonal ARIMA model" (2015), has 746 citations and demonstrates the impact of applied research in transportation systems. "Supply chain coordination" (2008), published in the International Journal of Production Economics, has received 699 citations, indicating a significant influence in operations and supply chain research. IEEE Transactions on Sustainable Energy contains numerous highly cited papers on energy and sustainability, with a focus on DC microgrids, battery-supercapacitor systems, and power management strategies. The findings show that IIT Madras has achieved balanced research excellence in computer science, energy systems, environmental engineering, biotechnology, and management sciences, with publications in prestigious international journals increasing global research visibility and impact.

Table 5.18.4: Most cited articles of IIT MADRAS

Sl. No	Title	Journal Name	Year	Publisher	Citation
1	Efficient lattice (H)IBE in the standard model	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	2010	Springer Nature	843
2	Short-term traffic flow prediction using a seasonal ARIMA model with limited input data	European Transport Research Review	2015	Springer Verlag	746
3	Supply chain coordination: Perspectives, empirical studies and research directions	International Journal of Production Economics	2008	Elsevier	699
4	Adaptive droop control strategy for load sharing and circulating current minimization in low-voltage standalone DC microgrid	IEEE Transactions on Sustainable Energy	2015	Institute of Electrical and Electronics Engineers Inc.	476
5	Limited Mitochondrial Permeabilization Causes DNA Damage and Genomic Instability in the Absence of Cell Death	Molecular Cell	2015	Cell Press	373

6	Lattice basis delegation in fixed dimension and shorter-ciphertext hierarchical IBE	Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	2010	Springer Nature	373
7	Manganese-oxide-coated alumina: A promising sorbent for defluoridation of water	Water Research	2006	Elsevier Ltd	369
8	Design and analysis of novel control strategy for battery and supercapacitor storage system	IEEE Transactions on Sustainable Energy	2014	Institute of Electrical and Electronics Engineers Inc.	368
9	Hairy root culture for mass-production of high-value secondary metabolites	Critical Reviews in Biotechnology	2007	Taylor & Francis	358
10	A consistent chemical mechanism for the oxidation of substituted aromatic species	Combustion and Flame	2010	Elsevier	348
11	A micro-convection model for thermal conductivity of nanofluids	Pramana - Journal of Physics	2005	Springer	341
12	Biological valorization of low molecular weight lignin	Biotechnology Advances	2016	Elsevier Inc.	336
13	Unraveling the mechanistic effects of electric field stimulation towards directing stem cell fate and function: A tissue engineering perspective	Biomaterials	2018	Elsevier Ltd	322
14	Enhanced fluoride removal from drinking water by magnesia-amended activated alumina granules	Chemical Engineering Journal	2008	Elsevier	305
15	Role of polyphenols and other phytochemicals on molecular signaling	Oxidative Medicine and Cellular Longevity	2015	Hindawi Publishing Corporation	304
16	Toward a Comprehensive Strategy to Mitigate Dissemination of Environmental Sources of Antibiotic Resistance	Environmental Science and Technology	2017	American Chemical Society	304
17	Elicitation: a stimulation	Phytochemistry	2017	Springer Netherlands	292

	of stress in in vitro plant cell/tissue cultures for enhancement of secondary metabolite production	Reviews			
18	The 2016 oxide electronic materials and oxide interfaces roadmap	Journal of Physics D: Applied Physics	2016	Institute of Physics Publishing	283
19	Modeling the causes of food wastage in Indian perishable food supply chain	Resources, Conservation and Recycling	2016	Elsevier B.V.	281
20	Role of PECAM-1 in the shear-stress-induced activation of Akt and the endothelial nitric oxide synthase (eNOS) in endothelial cells	Journal of Cell Science	2005	The Company of Biologists	275

(Source: Survey Data)

5.18.5 Most cited articles of IIT KGP

The table below presents the top 25 most cited articles of IIT KGP. The most cited article is "Guided wave-based structural health monitoring: A review" (2016), published in Smart Materials and Structures, with 1,005 citations, followed by "Core-shell structured catalysts for thermocatalytic, photocatalytic, and electrocatalytic conversion of CO2" with 715 citations. Articles on solid waste management and plastic waste management during COVID-19 (606 and 561 citations, respectively) represent timely and socially relevant research contributions. Highly cited works on microalgae for biodiesel production, immobilized algae for wastewater treatment, and green solvent technologies have been published in reputable journals such as Renewable and Sustainable Energy Reviews and Science of the Total Environment, highlighting biotechnology and bioenergy research. The citation distribution shows that IIT Kharagpur excels in sustainable technologies, catalysis, materials engineering, environmental management, and biotechnology, with a focus on green and renewable research themes.

Table 5.18.5: Most cited articles of IIT KGP

Sl. No	Title	Journal Name	Year	Publisher	Citation
1	Guided wave-based structural health monitoring: A review	Smart Materials and Structures	2016	Institute of Physics Publishing	1005
2	Core-shell structured catalysts for thermocatalytic, photocatalytic, and electrocatalytic conversion of CO2	Chemical Society Reviews	2020	Royal Society of Chemistry	715
3	Challenges, opportunities, and innovations for effective solid waste management during and post-COVID-19 pandemic	Chemistry Central Journal	2020	Elsevier B.V.	606
4	Challenges and strategies for effective plastic waste management during and post-COVID-19 pandemic	Annals of Botany	2021	Elsevier B.V.	561
5	Biotechnological potential of immobilized algae for wastewater N, P and metal removal: A review	Renewable and Sustainable Energy Reviews	2002	Springer	502
6	Microalga Scenedesmus obliquus as a potential source for biodiesel production	Plant Physiology and Biochemistry	2009	Springer	499
7	Silica–Ceria sandwiched Ni core–shell catalyst for low temperature dry reforming of biogas: Coke resistance and mechanistic insights	Applied Microbiology and Biotechnology	2018	Elsevier B.V.	458
8	Laser processing of materials	BioMetals	2003	Indian Academy of Sciences	372
9	Reactive oxygen species: Response of algal cells	Ecotoxicology and Environmental Safety	2000	Elsevier GmbH	370
10	Effect of laser surface melting on corrosion and wear resistance of a commercial magnesium alloy	Journal of Plant Physiology	2003	Elsevier BV	343
11	Laser material processing	Chemical Society Reviews	2011	Maney Publishing	321

12	A review of aspects of additive engineering in perovskite solar cells	Applied Catalysis B: Environmental	2020	Royal Society of Chemistry	312
13	Seed birth to death: Dual functions of reactive oxygen species in seed physiology	Journal of Materials Chemistry A	2015	Oxford University Press	294
14	Use of chlorophyll fluorescence in metal-stress research: A case study with the green microalga Scenedesmus	Biomaterials	2003	Academic Press	290
15	Transfer learning-based classification of optical coherence tomography images with diabetic macular edema and dry age-related macular degeneration	Resources, Conservation and Recycling	2017	OSA - The Optical Society	282
16	A comprehensive review on harvesting of microalgae for biodiesel - Key challenges and future directions	Science of the Total Environment	2018	Elsevier Ltd	278
17	Sustainable green solvents and techniques for lipid extraction from microalgae: A review	Biomedical Optics Express	2017	Elsevier B.V.	263
18	Interpretation of inequality constraints involving interval coefficients and a solution to interval linear programming	Fuzzy Sets and Systems	2001	Elsevier Science Publishers B.V.	263
19	Green solvents and technologies for oil extraction from oilseeds	Journal of Materials Science	2017	BioMed Central Ltd.	258
20	Salicylic acid-induced resistance to Fusarium oxysporum f. sp. lycopersici in tomato	International Materials Reviews	2009	Elsevier	255

(Source: Survey Data)

5.18.6 Most cited articles of IIT Kanpur

The table below shows that the article "The mutational landscape of lethal castration-resistant prostate cancer," published in Nature (2012), received the most citations, with 2,159. The majority of highly cited papers are from experimental high-energy physics, particularly from large international collaborations such as the CMS and

LHC experiments. Articles in Physical Review Letters, Journal of High Energy Physics, European Physical Journal C, and Physics Letters B discuss Higgs boson measurements, top-quark mass, supersymmetry searches, W-boson production, and proton-proton collision analyses. These works have citation counts ranging from 400 to over 1,100, indicating a high global visibility. The overall analysis of citation patterns reveals that IIT Kanpur's research impact is concentrated in particle physics and cancer genomics, with publications in prestigious journals such as Nature, Science, Physical Review Letters, and Journal of High Energy Physics.

Table 5.18.6: Top cited articles of IIT KANPUR

Sl. No	Title	Journal Name	Year	Publisher	Citation
1	The mutational landscape of lethal castration-resistant prostate cancer	Nature	2012	Springer Nature	2159
2	Measurement of prompt J/ψ pair production in pp collisions at s = 7 Tev	Physical Review Letters	2015	American Physical Society	1180
3	Genomic loss of microRNA-101 leads to overexpression of histone methyltransferase EZH2 in cancer	Science	2008	American Association for the Advancement of Science	955
4	Measurement of the inclusive t t ¯ cross section in pp collisions at √s=5.02 TeV using final states with at least one charged lepton	Journal of High Energy Physics	2016	Springer Science and Business Media Deutschland GmbH	796
5	Identification of targetable FGFR gene fusions in diverse cancers	Cancer Discovery	2013	American Association for Cancer Research	641
6	Measurement of the top quark mass using events with a single reconstructed top quark in pp collisions at √s = 13 TeV	European Physical Journal C	2016	Institute for Ionics	588
7	Data scouting and data parking with the CMS high level trigger	Journal of High Energy Physics	2013	Springer Verlag	550
8	Measurement of differential and integrated fiducial cross sections for Higgs boson production	Journal of High Energy Physics	2013	Springer Verlag	550

	in the four-lepton decay channel in pp collisions at √s = 7 and 8 TeV				
9	Measurement of prompt and nonprompt charmonium suppression in PbPb collisions at 5.02 TeV	European Physical Journal C	2015	Springer Nature	549
10	Observation of electroweak W+W− pair production in association with two jets in proton-proton collisions at s=13TeV	Journal of Instrumentation	2017	Institute of Physics	538
11	Observation of a new boson with mass near 125 GeV in pp collisions at √=7 and 8 TeV	Journal of Instrumentation	2017	Institute of Physics Publishing helen.craven@iop.org	502
12	Search for a heavy right-handed W boson and a heavy neutrino in events with two same-flavor leptons and two jets at √s=13 TeV	Journal of Instrumentation	2018	Institute of Physics	487
13	Search for disappearing tracks as a signature of new long-lived particles in proton-proton collisions at √s=13 TeV	European Physical Journal C	2019	Springer Nature	441
14	Combined search for supersymmetry with photons in proton-proton collisions at s=13 TeV	Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics	2013	Elsevier B.V.	436
15	KS 0 and Λ(Λ¯) two-particle femtoscopic correlations in PbPb collisions at sNN=5.02TeV	Physics Letters, Section B: Nuclear, Elementary Particle and High-Energy Physics	2013	Elsevier B.V.	436
16	Rearrangements of the RAF kinase pathway in prostate cancer, gastric cancer, and melanoma	Nature Medicine	2010	Springer Nature	427
17	First measurement of the forward rapidity gap distribution in (Formula presented) collisions at	Journal of Instrumentation	2014	Institute of Physics	413

	(Formula presented)				
18	Measurement of normalized differential t t ¯ cross sections in the dilepton channel from pp collisions at √s=13 TeV	Journal of Instrumentation	2015	Institute of Physics	409
19	Measurement of multijet azimuthal correlations and determination of the strong coupling in proton-proton collisions at s=13TeV	Nature	2015	Nature Research	381
20	Mechanistic Rationale for Inhibition of Poly (ADP-Ribose) Polymerase in ETS Gene Fusion-Positive Prostate Cancer	Cancer Cell	2011	Cell Press	378

(Source: Survey Data)

5.19 Analysis of Co-Authorship of Research Publications of Women Faculties

The opportunities for discovering novel information and the specialization of the subject areas are enhanced by the collaboration. Co-authorship network analysis reveals the collaboration and communication among the authors in the publications. Co-authorship is the practice of two authors publishing a study together (Lu & Wolfram, 2012; Koseoglu, 2016). The social structure of research publications by female faculty members at the top five IITs—IITM, IITB, IITD, IITKGP, and IITK—was the main focus of the co-authorship analysis. The analysis will show the network of collaboration that exists among the faculty members by examining the co-authorship pattern and the degree of cross-country collaborations. The study's findings will highlight the faculty's geographic contributions, collaboration, and interconnectedness in their research publications.

To analyze the co-authorship, the VOSviewer has been used with a simple algorithm by ignoring the documents' co-authors by a larger group of people. And to analyze the social structure and collaboration pattern of women faculty, Biblioshiny by the R visualization tool has been used. The analysis of collaboration is completed by a simple algorithm by ignoring the documents co-authored by a large number of countries. Out of the countries that participated in the research collaboration, the minimum number of documents by a country was 2, and the minimum number of

documents by an author was 2. And ignoring the documents with a large number of authors by setting 10 as the number of authors per document. For each country, the link strength of the co-authorship links with other countries was calculated. And countries with the greatest link strength are selected. Based on the number of documents, the collaboration network is visualized. The countries and authors are divided into clusters, and each of the clusters is differentiated based on a different colour. The countries in the common cluster with the same colour depict that these countries have a good collaboration network and have published papers.

5.19.1 Co-Authorship of Countries and Authors of IIT Madras

The analysis of co-authorship is done by using the VOS viewer tools with the algorithm which is to ignore the documents co-authored by large groups of countries. Out of the 79 Countries that have been found contributing, taking the minimum number of documents by a country as 2, it was found that 53 countries meet the threshold. For each of the 53 countries, the link strength of the co-authorship links with other countries is calculated on the basis of the greatest total link strength. Based on the weights of the number of documents, the collaboration of india with other countries is visualized. The 53 countries are divided into 12 clusters and differentiated by various colours. The countries in a common cluster with the same colour depict the fact that these countries have worked in cooperation and published papers. Cluster 1(Red) has 9 countries, which consist of Greece, Jordan, Malaysia, Portugal, Saudi Arabia, South Africa, South Korea, etc. Cluster 2 (Green) has Australia, Chile, Japan, Nepal, Spain, Thailand, etc. Cluster 3 (Blue) consists of countries Belgium, Denmark, Singapore, Norway, Hungary, and Israel. The cluster 4 (yellow) includes countries like Brazil, Canada, China, Finland, Russian Federation. Cluster 5 (Purple) has countries such as France, Italy, the Netherlands, Romania, and Taiwan. Cluster 6 has countries like Hong Kong, Ireland, Sweden, and Switzerland. Cluster 7 has 4 countries: India, New Zealand, Serbia, and Trinidad and Tobago. Cluster 8 has US and USA. Whereas cluster 9 is made of Algeria, Germany, and Lebanon. Cluster 10 has Bulgaria and Slovenia; cluster 11 consists of Austria and the Czech Republic, and cluster 12 has 1 country, Ethiopia.

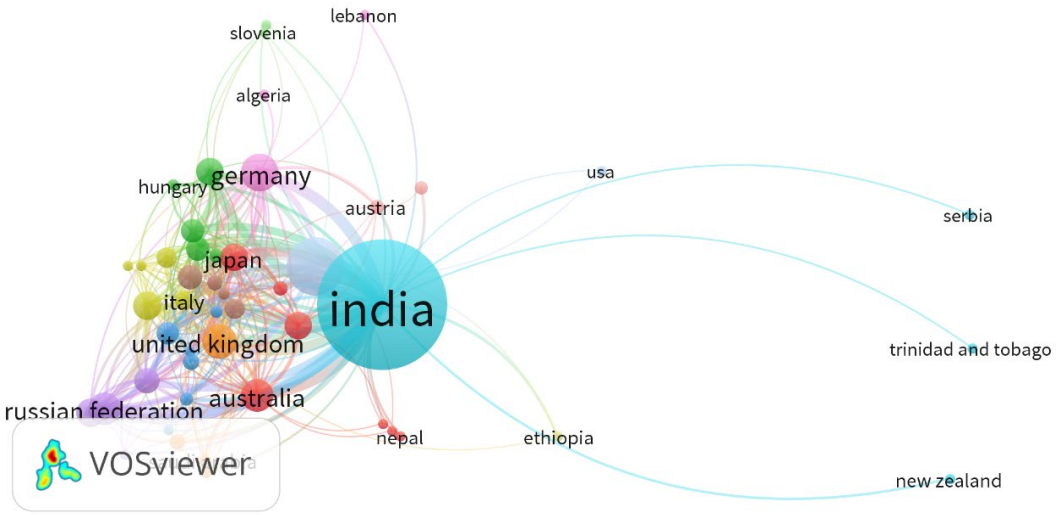

Figure 5.19.1(a): Co-Authorship Of Countries of IIT Madras

The analysis of co-authorship of authors has been visualized by ignoring documents with a large number of authors, which is set as the maximum number of authors per document, at 10. Out of 4212 total authors, 512 authors meet the threshold. And for the 512 authors with the greatest link strength turned out to be between 291 authors, the total strength of the co-authorship is calculated. All the authors are divided into 24 clusters. Where the cluster 1 has 26 authors consists of Agrawal, Govind p, David Koil Pillai r, Lakshmi Narayan v, Venkatesh Deepa, Vijay Anirudh etc. cluster 2 has authors such as Chadha Anju, dixit Madhulika, Chandel Shivam, Janakiraman Vani, Kavitha telikepalli, etc. cluster 3 are made of 30 authors, such as Bhattacharya Enakshi, Bhattacharya shanti, paramita v, Ramakrishna m, Sridharan Gayathri m etc. cluster 4 has 19 authors, out of them some are Anada s, arshinder k, Banu jasmine, Baral Rupa Shree, Datta Anindya, etc. cluster 5 has 18 authors, Ambika Selvaraj, deva Sena m, Nambi Indhumathi, sivagami krishna, Samy, Srinivasan Ramya, etc. cluster 6 made of 17 items, Augustine sijo, chitpadi Nagesh, lakshminarasamma n, Ravi, Vaishnavi, etc. cluster 7 (17) authors has Dasgupta a, DasGupta Nandita, pialy Roy, sarkar Sujan, Sruthi m p, etc. cluster 8 is made of 17 items, some of which are bhallamudi s Murthy, Choudhary, Vaishali, Delhi raja Vaishali, Mukherjee sritama, etc. Philip Ligy, etc., cluster 9 has Arunachalam Kavitha, Baskaran Divya, Krishnamurthy c v, Ramanujam Sarathi, etc. Cluster 10 has 15 authors (Anusha S P,

Banik Sharmili, Thankappan, Ajitha, Vanajakshi Lelitha, etc.). cluster 11 (Dixit Awakash, Ghosh Aditi, Hanif Shahna M, Venkatesh D, Vijaya R, etc). Cluster 12 has 14 authors (Aswathy M.S., Bose Chandan, Gupta Sayan, Sarkar, Sunetra, etc.). Cluster 13 is made up of 12 authors (Datta Amitabha, Siridhar K, Gopi Sarath, Sheetal Kalyani, Kumar Suman, etc.). Cluster 14 has 12 items (Aghalayam Preeti, Ganesh Anuradha, Samdani Ganesh, etc). Cluster 15 has 10 authors (Jayanthy A.K., John Pauline, Rao Suresh R, Unni Sujatha Narayan, etc). Cluster 16 has 9 authors (Arora b m, Bhattacharya Jayeeta, Dutta Saumya, Ghosh Sandip, etc.). cluster 17 (9 authors), cluster 18 (7 authors), cluster 19 (6 authors), cluster 20 (5 items), cluster 21 (3 authors, cluster 22 (2 authors, and clusters 23 and 24 have 1 author each.

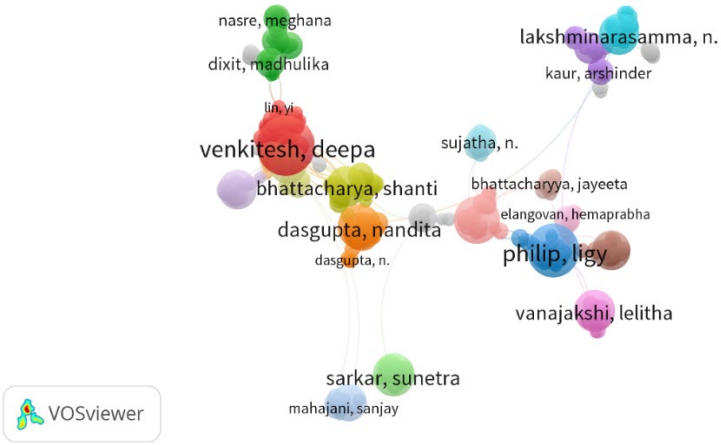

Figure 5.19.1(b): Co-Authorship Of Authors, IIT Madras

5.19.2 Co-Authorship of Countries and Authors of IIT Bombay

The visualization shows that IIT Bombay has collaborations with 113 countries. Out of that, the link strength of only 62 countries is found to be too strong and greatest. The 62 countries are divided into 5 clusters of different colours. Where cluster 1has a total of 28 countries, such as Argentina, Austria, Chile, Cyprus, Denmark, Egypt, etc., cluster 2 is made of 13 items or countries, which are Australia, Belgium, Canada, Greece, Israel, etc. Cluster 3 has countries like Brazil, China, Croatia, France, South Korea, etc. Cluster 4 made of 6 items, Bulgaria, Germany, Ukraine, US, etc., and cluster 5 has a total of 6 countries, India, Tunisia, UAE, etc.

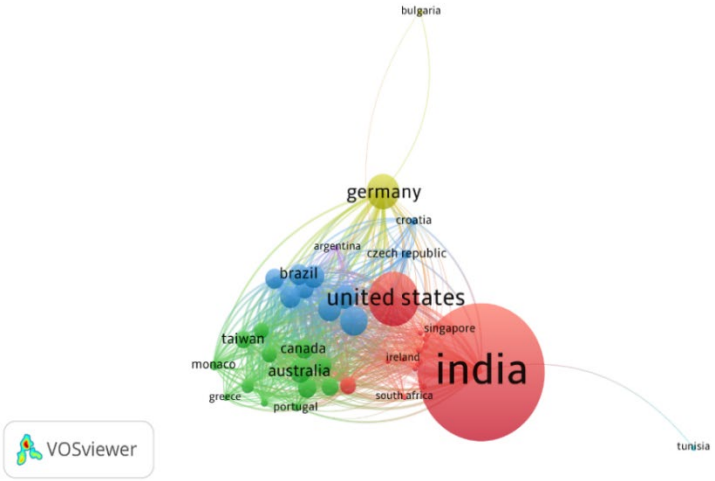

Figure 5.19.2(a): Co-Authorship of Countries of IIT Bombay

Co-authorship of the authors of IIT Bombay

The co-authorship of authors is developed using the VOSViewer visualization, and it shows that 5279 authors were recorded, but only the authors with the link strength among them show to be 581. Only 418 authors showed to having the stronger link strength. All the 418 authors are divided into 31 clusters of different colours. Cluster 1 was formed by 40 authors, some of them are Amaravati Anvesha, Arratia Mahima, Baghini, m Shojai, Das Devarsi, Dave Marshnil, Gilda Neena, Goel, Mayank, etc. Cluster 2 has a total of 30 items (Ayyub Pushan, Cerullo Giulio, Dhamadhikari, Jayashree A., Vasa Parinda, etc.). cluster 6 has 21 authors, some are Bishnoi Ankita, Dalai Sridhar, gangal Aneesh c, gupta nanalal, Patro Bharati, Sharma Pratibha, Shrivastava Pragya, etc. cluster 7 has 20 authors, Mukherjee Asmita, Mishra Anuradha, Chakrabarti Dipankar, Kishore raj, Harindra Nath a, Saha Sudeep, etc.). cluster made of 18 items, consists of Anand Ramasamy Vijaya, Bhattacharjee dipanwita, Bhattacharya amrita, Bhattacharya Apurba, Raghuvanshi Parul r, etc. cluster 9 has 17 authors, Kulkarni Purushottam, Chabrol Kameswari, Paul debjani, Priyanka naik, etc. cluster 10 has 16 authors, Banerjee Swagata, Ghosh subimal, Indu j , mandal Arpita, Pradhan Ankita, etc. likewise, cluster 11 (15 items), cluster 12 (15 items), cluster 13 (15 items), cluster 14 has (14 items), cluster 15, 13 items. Cluster 16, 13 items, cluster 17, 12 items, cluster 18, 11 items, cluster 19, 11 items, cluster 20, 10 items, cluster 21, 10 items, cluster 22, 10 items, cluster 23, 10 items, cluster

24, 6 items, cluster 25, 5 items, cluster 26 and 27 has 4 items each, cluster 28 and 29 has 3 items, and cluster 30 and 31 has 2 items each.

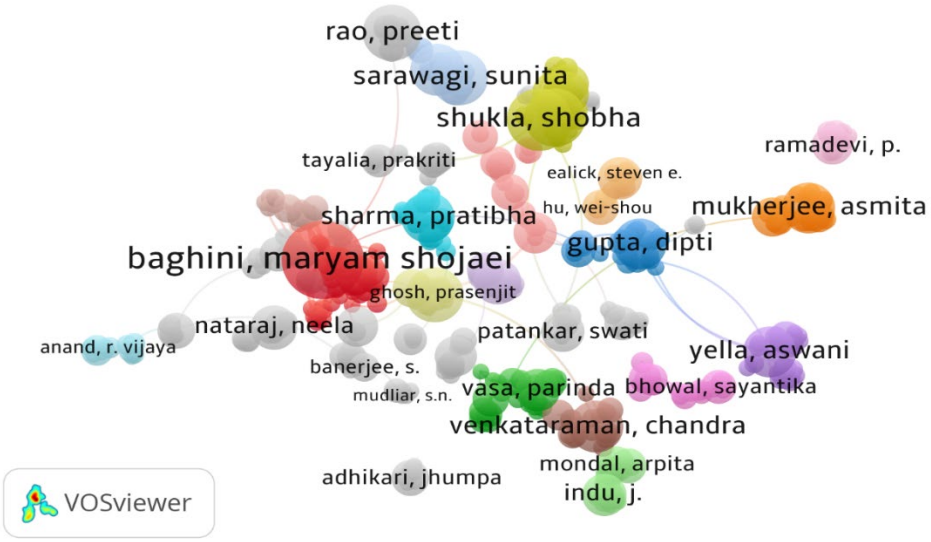

Figure 5.19.2.(b): Co-authorship of authors of IIT Bombay

5.19.3 Co-Authorship of Countries and Authors of IIT Delhi

The visualization shows that 84 countries have a collaboration with IIT Delhi, and while setting the threshold at the minimum number of documents of a country as 2, 61 countries meet the threshold and are found to have the greatest link strength. The countries are divided into 7 clusters, cluster 1 has 16 authors consists of Colombia, Egypt, Greece, Indonesia, Japan, Lebanon, etc. cluster 2 is made of 15 countries, Argentina, Brazil, Chile, Croatia, Czech Republic, Italy, etc. cluster 3 has 11 countries and has countries like Austria, Belgium, Finland, France, Spain, etc. cluster 4 has 7 items, China, Cyprus, Denmark, Ethiopia, Netherlands, etc. cluster 5 is made of Canada, india, Ireland, Israel, united states, etc, cluster 6 and 7 has 3 ans 2 countries each.

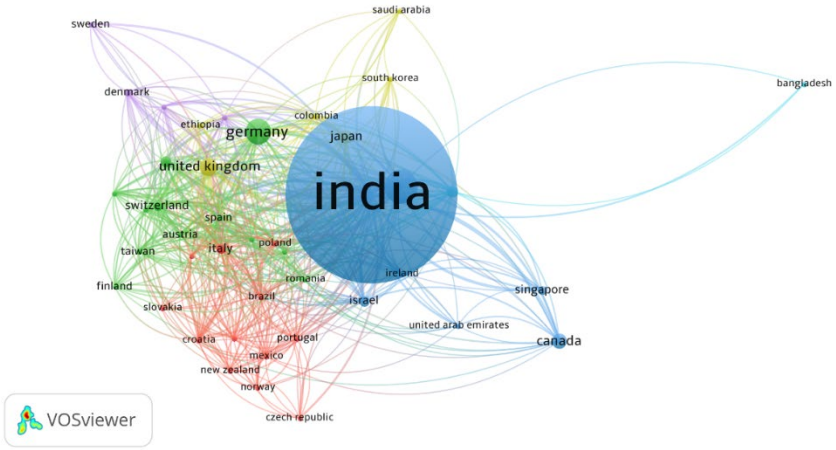

Figure 5.19.3.(a): Co-authorship of countries of IIT Delhi

Co-authorship of the authors of IIT Delhi

The authorship network shows that IIT Delhi had a total of 3831 authors. And while ignoring the document with a large number of authors and putting the maximum number of authors per document as 10, a total of 1536 authors meet the threshold. And out of that, only 893 authors seem to have the greatest link strength. And all the authors are divided into different clusters, where authors who come under the same colour or circle seem to have collaboration among them. In total, 43 clusters, the 893 authors are divided into different colours. Cluster 1 have the 54 authors, Agarwal Ashish, Sanghi Sujata, rangi Manisha, Sharma neetika, Singh prajyoti, Dhiman Indu, kumari Poonam, Sanghi Sujata, etc. cluster 2 has 43 authors, Chakraborty Swati, Dhamija anandite, gaur Snehhraj, gupta Nikita, etc. cluster 3 has 42 items, some are Upadhyula Shridevi, Afreen gul, Patra Tanmoy, Parveen Firdaus, Kumar Komal, ray nirat, etc. cluster 4 is made of 39 authors, Habib Gazala, arub Zainab, Bhandari Sahil, Hildebrandt Ruiz lea, Apte Joshua, Baig Nisar, Bansal Mahak, etc. cluster 5 made of 38 authors, such as das amrita, Verma Deepa, amrita, Sengupta Sudip, Kew predhiman, Deshpande Shishir, deshwal Priya, etc. cluster 6 has 37 items, sarkar Jayati, Sharma Ashutosh, Biswas Gautam, ray bahni, thaokar rochich m, etc. cluster 7 has 36 authors and, Anand Gautam, Bhattacharjee Annapurna, Tyagi Rashi, Dubey Shubham, Sharma Shilpi, Srivastava sonal, etc. cluster 8 made of 34 items, Banerjee Arundhati, Bhartiya Priyanka, Basu dipanjan, Chakraborty Tanushree, Mishra Sunita,

etc. cluster 9 has 34 authors, kulshreshtha Ritu, sarkar Chitra, Sharma Vikas, Mondal Indranil, Nagpal Neha, Ghosh Sourabh, etc. cluster 10 has 32 authors, Singh shveta, kashiramka Smita, Jain p k, gupta juhi, gupta Vikas, Chaudhury Neeru, Jain Sonali, etc. cluster 11 has 32 authors, Verma Ashu, Sharma Sumedha, Sharma Shivani, Panigrahi b k, Bhatti t s, Pathak Nikhil, etc. likewise, cluster 12 and 13 has 31 items each, cluster 14 has 30 authors, cluster 15, 28 authors, cluster 16 has 27 authors, cluster 17, 25 authors, cluster 18, 24 authors, cluster 18, 23 authors, cluster 20 and 21 both has 22 authors, cluster 22 has 21 authors, cluster 23, 20 authors, cluster 24 has 18 authors, cluster 25 and 26 has 16 authors, cluster 27 and 28 has 14 items, cluster 29 has 12 authors, cluster 30 has 10 authors, cluster 31,32 and 33 made of 9 authors, cluster 34 has 8 authors, cluster 35 has 6 items, cluster 36 and 37 has 5 authors, cluster 38 and 39 has 4 authors, cluster 40 has 3 items, and cluster 41, 42 and 43 has 2 authors each.

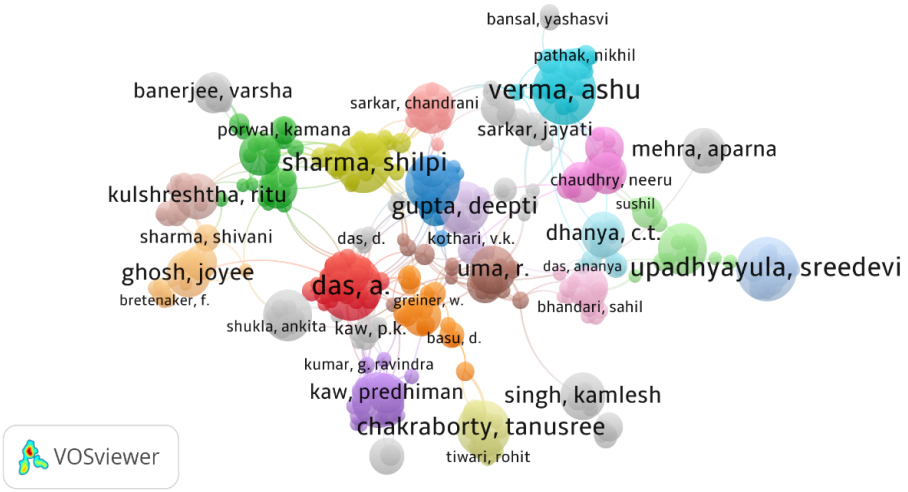

Figure 5.19.3.(b): Co-authorship of authors of IIT Delhi

5.19.4 Co-Authorship of Countries and Authors of IIT Kharagpur

Co-authorship of countries

The visualization shows that IIT KGP has collaborations with 71 countries. Out of that, 35 countries meet the threshold. And those countries are found to have the greatest link strengths among them. The 35 countries are divided into 9 clusters. Cluster 1 has 6 countries, united states, Iran, Poland, South Korea, etc. Cluster 2 has

Japan, south Africa, Bangladesh, Nigeria and cluster 3 has Brazil, Italy, Portugal, Spain, United Kingdom, cluster 4 consists of, india, Ireland, Israel, Netherlands, Norway, cluster 5 and 6 has 4 countries each, cluster 7 has Belgium, Qatar, Switzerland, cluster 2 has Germany and Russian federation lastly the cluster have turkey.

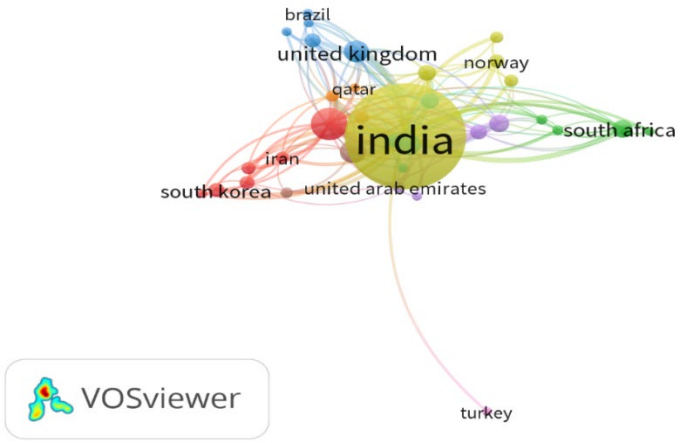

Figure 5.19.4.(a): Co-authorship of countries of IIT KGP

Co-authorship of the authors of IIT KGP

The visualization presented in the graph shows that IIT KGP has a total of 1528 authors for collaborating where only 870 authors are found to have the greatest link strength. All the authors are divided into 36 clusters and differentiated by separate colours. Cluster 1 has 61 authors, Dasgupta Swagata, Ghosh Sudeshna, Banerji Heimanti, Pathak Tanmaya, de Saumya, etc. Cluster 2 is made of 56 authors, Banerjee Rintu, Das Mohan, Dutta Swagata, Mukherjee Gargi, Bose Debalina, etc. cluster 3 has 43 authors, such as Roy Anushree, Paul Bernita, Chatterjee swastika, etc. cluster 4 has 40 authors, Majumdar j Dutta, manna I, Mukherjee s, Majumdar Jyotsna Dutta, etc. cluster 5 has 39 authors, das Karabi, Banthia swastika, das Karabi, das saptarshi, Jena sambedan, etc. cluster 6 has 37 authors, which are das Gargi, Hota shikha, Bhattacharya paramita, ray subhabratam, Sengupta Sonali, Mitra jayeeta, etc. cluster 7 is made of 36 authors, Majumdar j Dutta, manna I, Mukherjee s, Chatterjee Satyajit, etc. cluster 8 has 35 authors, some are jenamani Mamata, rout ray Aurobindo, Gayen r, Mondal Arpita, sarmah sarada prasad, etc. cluster 9 has 33

authors, Mallick Nirupama, Dutta Ratna, Mukhopadhyay Sourav, Mitra sarbari, Bagchi Sourav Kumar, etc. cluster 10 has 33 authors, aich s, Chakraborty m, Das k, Adhikari t, etc. likewise, cluster 11 has 32 authors, cluster 12 has 32 authors, cluster 13 has 31 authors, cluster 14 and 15 has 28 authors, cluster 16 has 27 authors, cluster 17 has 24 authors, cluster 18 has 22 authors, cluster 19 and 20 has 21 authors, cluster 21 has 20 authors, cluster 22 has 18 items, cluster 23 and 24 has 18 authors, cluster 25 has 17 items, cluster 26 has 15 items, cluster 27 and 28 has 13 authors, cluster 29 is made of 12 authors, cluster 30 made of 10 authors, cluster 31 has 9 authors, 32 cluster has 8 authors, cluster 33 and 34 has 6 items each, cluster 35 has 5 authors, and 3 authors in cluster 36.

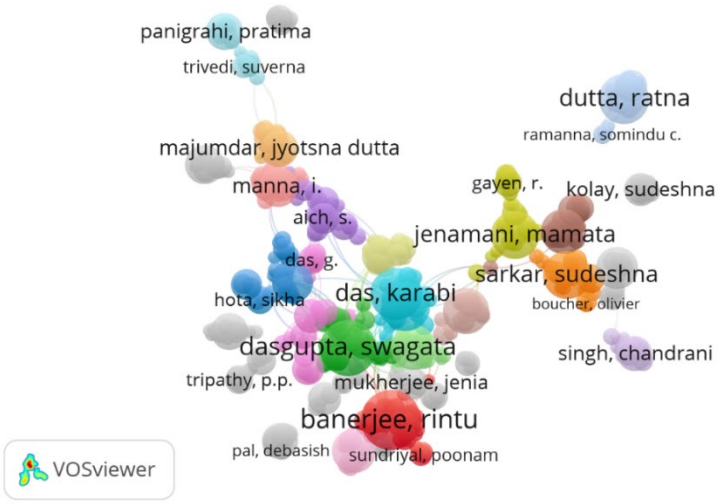

Figure 5.19.4.(b): Co-authorship of countries of IIT KGP

5.19.5 Co-Authorship of Countries and Authors of IIT Kanpur

Co-Authorship Of Countries of IIT Kanpur

The visualization shows that there is a record of 340 countries, where the strongest link is shown in 127 countries that come under the threshold. So, these countries are divided into 49 clusters and shown in various colours. Cluster 1 consists of countries such as india, Poland, Ireland, the United Kingdom, Italy, Japan, etc. Cluster 2 has 11 countries: Armenia, Austria, Brazil, China, Belarus, etc. Cluster 3 also has 11

countries, including South Korea. Turkey, Chile, Germany, etc., cluster 4 has 10 countries: New Zealand, Portugal, the Russian Federation, Saudi Arabia, etc. Cluster 5 has 9 countries: Cyprus, Czech Republic, Egypt, Estonia, Finland, etc.

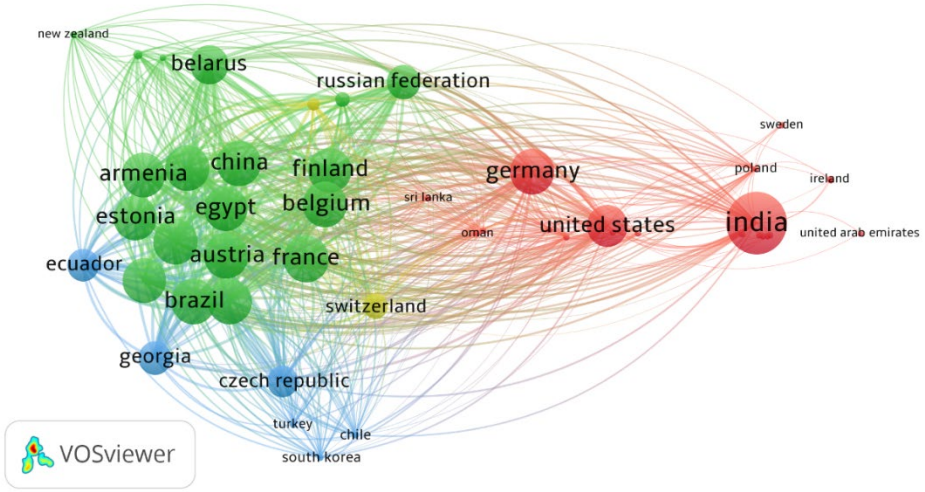

Figure 5.19.5.(a): Co-Authorship Of Countries of IIT Kanpur

Co-Authorship of the authors of IIT Kanpur

The visualization showed that the strongest link strength is found among 301 authors out of 2670 authors. And the 301 authors are divided into 25 clusters of different colours. Cluster 1 has authors such as Ateeq Bushra, Avasthi Ilesha, Bajpai Anjali, Gupta Nilesh, Manzar Nishat, etc. cluster 2 has 23 authors, some are Gupta Nandini, Mahajan a, Basu Sumit, Kumar amrendra, etc. cluster 3 has 23 authors which are Chatterjee urbi, Agrawal Anand, Dey Soumyajit, Mukhopadhyay Deb deep, Chatterjee Durba, etc. cluster 4 is made of 23 items, Parveen Nagma, Sharma Anurag, Negi Geetanjali, Dey Manorama, dhanawat garvita, harshan Krishnan h, etc, cluster 5 has 22 authors, Katiyar monisa, bindu surya, Balakrishnan Muralidharan, mandal saumen, gupta Ashish, Kumar Piyush, etc, cluster 6 has 21 authors, ojha Richa, Kumar Saurabh, Sharma Asha, Sharma Rahul k, etc, cluster 7 is made of 19 items, Nayak Jayita, kumara Nitesh, Fecher Gerhard h, Roy barman Sudipta, Agarwal Amit, etc, cluster 8 has 16 authors, Halder Arpita, Ramarao Vijaya, Kedia Sunita, Reddy m Srinivas, etc, cluster 9 has 15 authors, Goel anudha, Jain supreme,

Rajput Prashant, etc, are some of them. Cluster 10 has 14 authors, some are Gupta Shilpi, Khosla Meenakshi, Sharma Naresh, Garg Vivek, Kumar Govind, etc. Cluster 11 has 13 authors, Tripathy Twinkle, Sinha Arpita, Shrinate Aashi, Behera Laxmindhar, etc. cluster 12 is made of 13 authors, cluster 13 has 11 authors, cluster 14 has 10 authors, cluster 15 and 16 has 8 authors, cluster 17 has 7 authors, cluster 18 and 19 has 6 authors, cluster 20 has 5 authors, cluster 21 has 4 authors, cluster 22 is made of 3 authors and lastly, cluster 23,24 and 25 has 2 authors each.

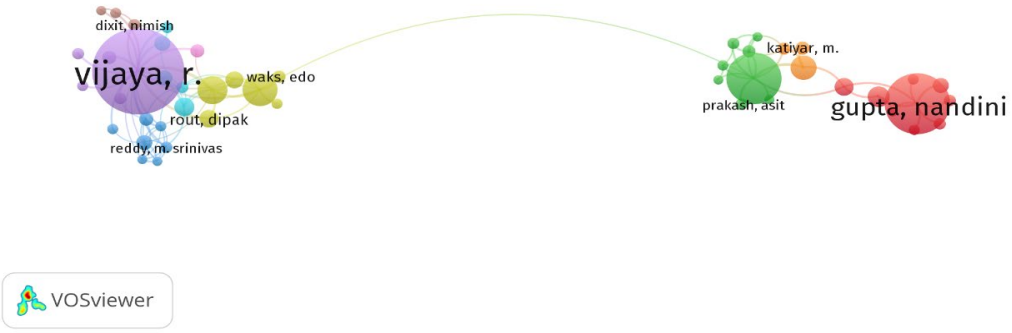

Figure 5.19.5.(b): Co-Authorship of the authors of IIT Kanpur

5.20 Analysis of Keywords

Keyword's co-occurrences network

The illustration depicts a VOSviewer keyword co-occurrence network map that demonstrates the intellectual framework of the research field.

A scientometric review is not complete without keyword analysis. Keywords are a reflection of the research area of a particular paper or article. For any research publication, keywords are an indispensable part. The keyword Analysis has been done in three phases; firstly, keywords with prominent occurrences are identified. Secondly, it has been analyzed based on clusters, followed by highly occurring keywords and analysis of trending topics. The dimensions of each node represent the frequency of keyword occurrence, whereas the thickness of the connecting lines signifies the strength of co-occurrence relationships.

5.20.1 Keyword's co-occurrences network of IIT Madras

The analysis of prominent keywords and their occurrences has been conducted to identify research areas with the most activity. This analysis is important for understanding key research domains in a specific field, providing textual data on keywords that frequently appear in research by female faculty at IIT Madras. The top 20 keywords are also listed according to their number of occurrences in the publications. Figure (5.20.1.1) was created using the VOSviewer software tool, applying the "Association Strength" algorithm and considering keyword occurrences multiplied by 10. The keywords that have the highest link strength in co-occurrence with the strongest connections.

Figure 5.20.1.1 shows the overlay visualization of keywords that are found to be connected in the research areas of IIT Madras's female faculty. The node size represents frequency of occurrence, which indicates strength of co-occurrence, and the color gradient shows the chronological progression of research themes. The areas are computer simulation, drug theory, biodegradation, wastewater treatment, etc.

Figure was also developed using the same algorithm in VOS Viewer, where the density of each prominent keyword is shown. The keywords which are deeper in colour and larger in font size are more commonly used than those that are lighter in colour. The keywords in the centre are computer simulation, magnetic properties, photonics, biodegradation, animal experiment, etc.

Every keyword which are common in nature are most likely included in the same cluster or group. The analysis reveals that research is mainly concentrated around core domains as well as simultaneously expanding into interdisciplinary and emerging areas. The following graphs portray the areas evolving and appear to be more prominent research areas among the female faculty of IIT Madras during the study period.

Keywords' co-occurrences network of IIT Madras

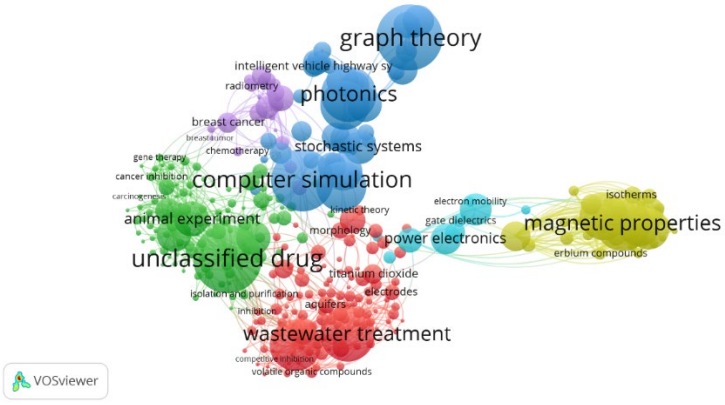

Figure 5.20.1.1: Keywords' co-occurrences network of IIT Madras

Overlay visualization of keywords of IIT Madras

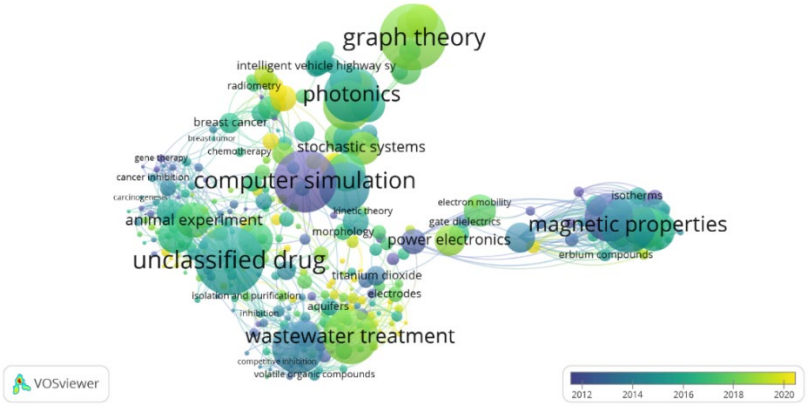

Figure 5.20.1.2: Overlay visualization of keywords of IIT Madras

Density map of keywords of IIT Madras

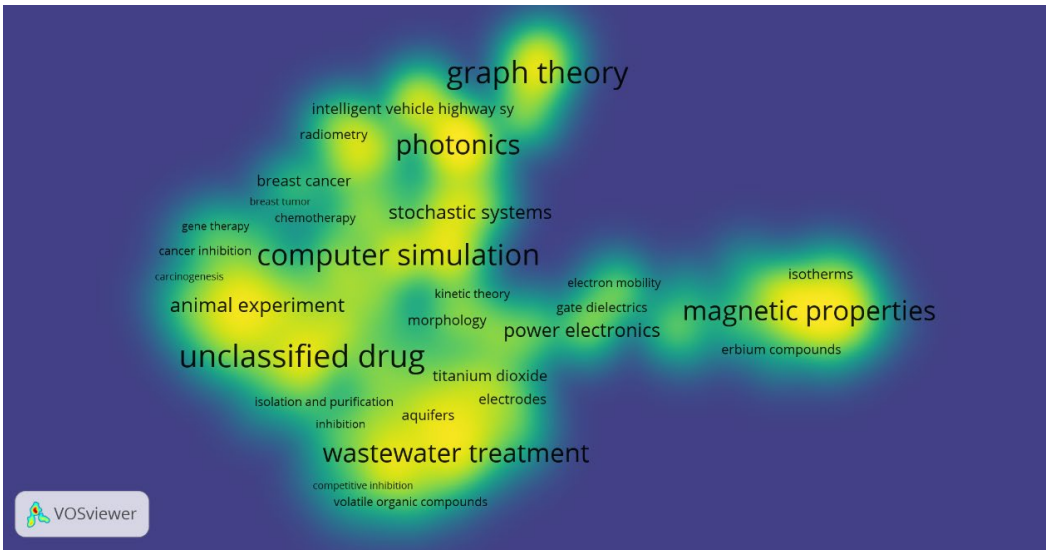

Figure 5.20.1.3: Density map of keywords of IIT Madras

Keywords' co-occurrences network of IIT Madras

Table 5.20.1.1: List of prominent keywords of IIT Madras

Keyword	Frequency
Biodegradation	68
Unclassified Drugs	90
Computer Simulation	82
Wastewater Management	72

Magnetic Properties	73
Graph Theory	87
Parameter Estimation	45
Stochastic Systems	43
Monte Carlo Methods	40
Breast Cancer	15

(Source: VOSViewer)

5.20.2 Keyword's co-occurrences network of IIT Delhi

The following figures were developed using the VOSviewer software tool by considering the algorithm "Association Strength", and taking the number of occurrences of keywords as 10 times. The keywords with the greatest link strength of the co-occurrence links with the other keywords are selected and are found to have the greatest link strength. The following visualization graphs are generated based on the keywords.

Figure 5.20.1.2 shows the overlay visualization of keywords that are found to be connected in the research areas of IIT Delhi's female faculty. In the visualization, node size reflects the frequency of keyword occurrence, which indicates the strength of co-occurrence. The core research theme is centred around nanocomposites, scanning electron microscopy, unclassified drugs, and catalyst activity, which links multiple subfields and presents an interdisciplinary nature of research. The other research areas are neutron diffraction, nanocomposites, nematic liquid crystals, unclassified drug, computer simulation, finite element method, genetics, temperature, nanoparticles, etc.

Figure (5.20.1.2) was also developed using the same algorithm in VOS viewer, where the density of each prominent keyword is shown. The keywords that are deeper in colour and larger in font size are more commonly used than those that are lighter in colour. The keywords in the centre are article, human, computer simulation, nanocomposite, nanoparticle, catalysts, non-human, female, etc.

The keyword network reveals a highly evolving research ecosystem, where materials science research is increasingly integrated with biomedical, environmental, and computational domains. Every keyword which are common in nature is most likely

included in the same cluster or group. The graphs portray the areas evolving and appear to be more prominent research areas among the female faculty of IIT Delhi during the study period.

Keywords' co-occurrences network of IIT Delhi

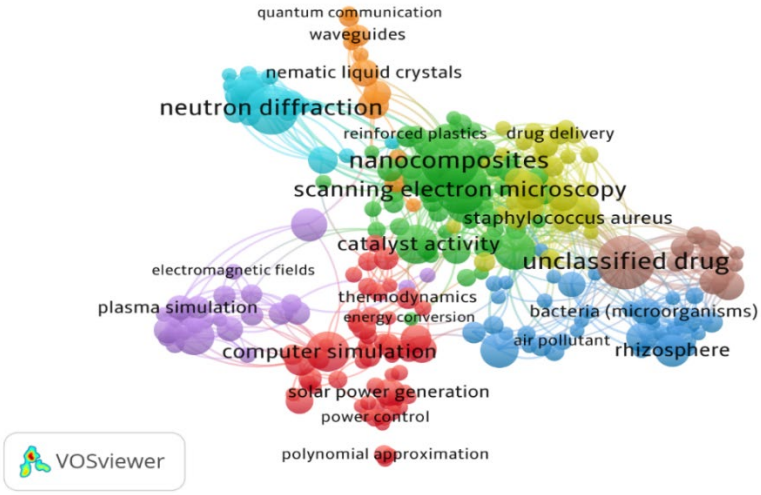

Figure 5.20.2.1: Keyword's co-occurrences network of IIT Delhi

Overlay visualization of keywords of IIT Delhi

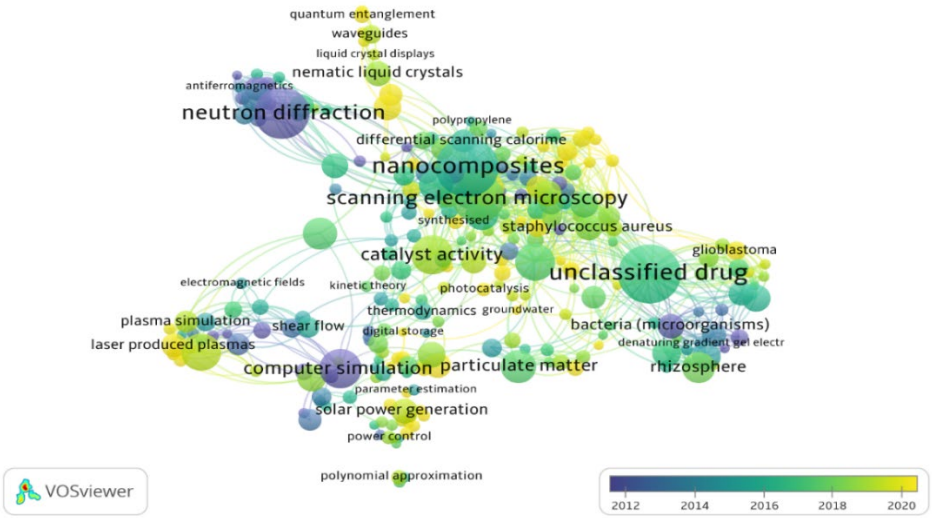

Figure 5.20.2.2: Overlay visualization of Keyword's of IIT Delhi

Density visualization of keywords of IIT Delhi

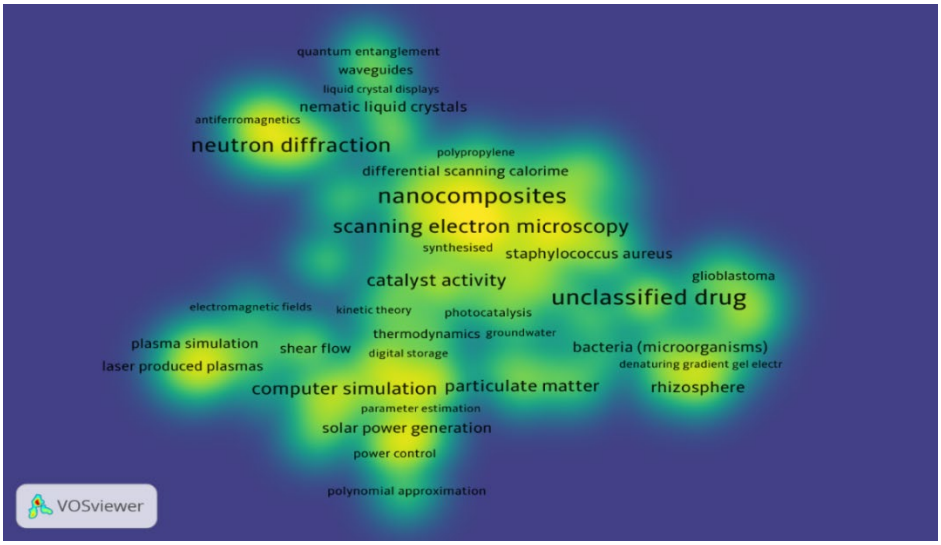

Figure 5. 20.2.3: Density visualization of keywords of IIT Delhi

Table 5.20.2: List of prominent keywords of IIT Delhi

Keyword	Frequency
Magnetic Plasma	47
Finite Element method	33
Computer Simulation	51
Cryptography	26
Nanocomposites	80
Scanning electron microscopy	64
Neutron diffraction	69
Catalyst activity	50
Nematic liquid crystals	30
Unclassified drugs	80

(Source: VOSViewer)

5.20.3 Keyword's co-occurrences network of IIT Bombay

The following Figures were developed using the VOSviewer software tool by considering the algorithm "Association Strength", and taking the number of occurrences of keywords as 10 times. The keywords with the greatest link strength of the co-occurrence links with the other keywords are selected. The following visualization graphs are generated based on the keywords.

Figure 5.20.1.3.2 shows the overlay visualization of keywords that are found to be connected in the research areas of IIT Delhi's female faculty. The areas are Controlled Study, CMOS integrated circuits, speech recognition, crystal structure, binary alloy, etc. Figure 49 was also developed using the same algorithm in VOS Viewer, where the density of each prominent keyword is shown. The keywords that are deeper in colour and larger in font size are more used than those that are lighter in colour. The most dominant high-density region is centred around "controlled study", suggesting experimental and empirical research methodologies, particularly in biomedical and applied science. The keywords in the centre are speech recognition, carbon, photon, female, genetics, crystal structure, etc.

The keyword co-occurrence visualization reveals a strong dominance of experimental biomedical and nanoscience research. The emerging areas, such as artificial intelligence and environmental studies indicate a gradual shift toward technology-driven and sustainability-oriented research trends. The graphs portray the areas evolving and appear to be more prominent research areas among the female faculty of IIT Bombay during the study period.

Keywords' co-occurrences network of IIT Bombay

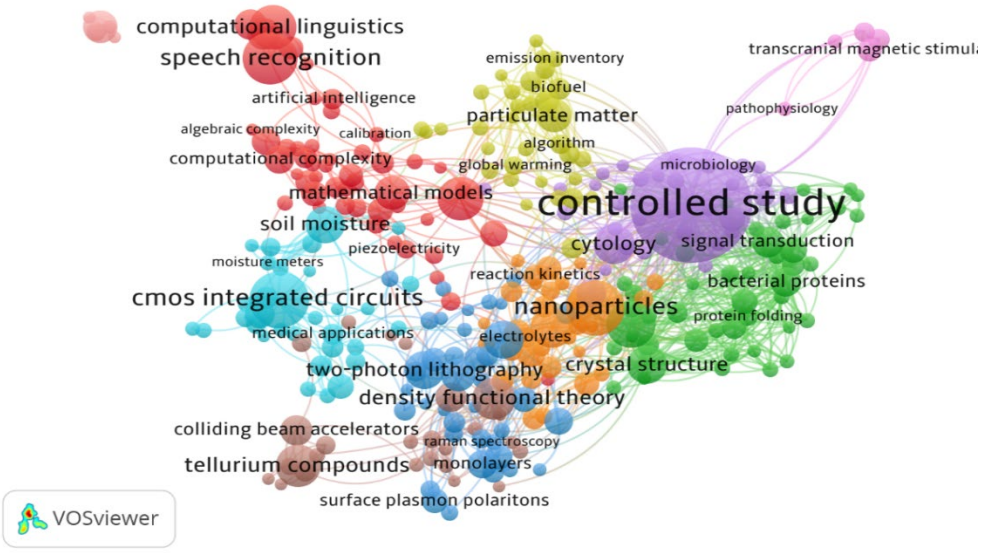

Figure 5.20.3.1: Keyword's co-occurrences visualization of IIT Bombay

Overlay Visualization of Keywords Of IIT Bombay

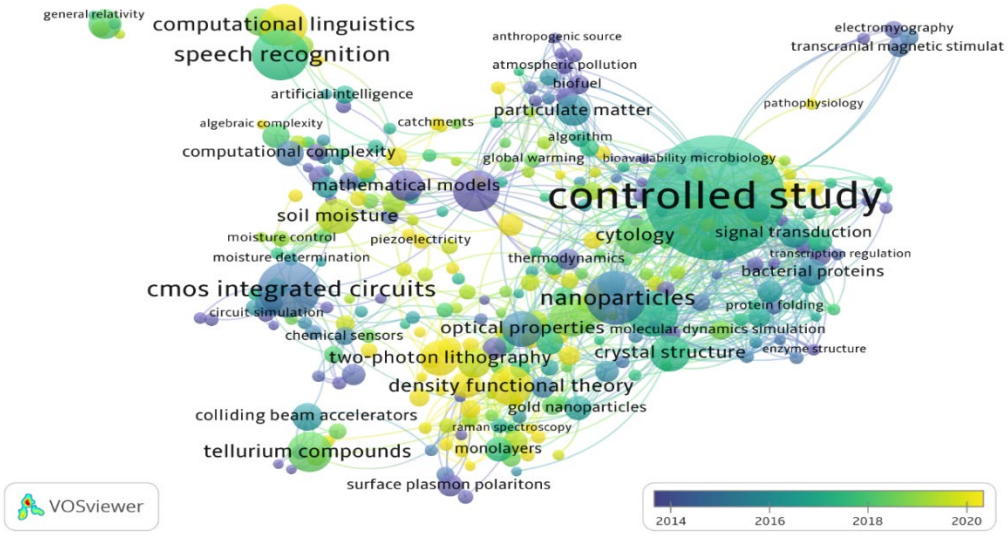

Figure 5.20.3.2: overlay visualization of keywords of IIT Bombay

Density visualization of keywords of IIT Bombay

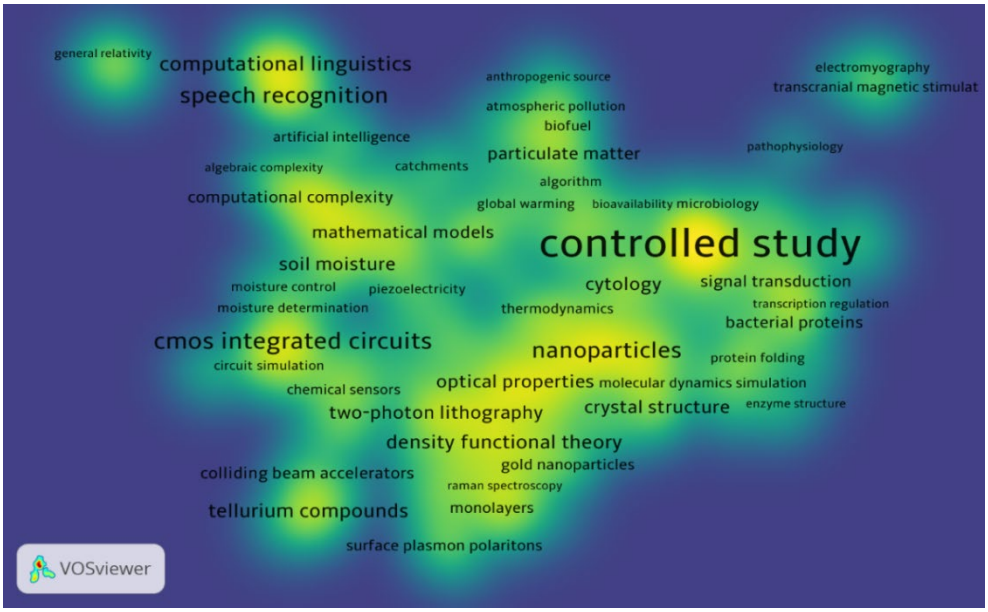

Figure 5.20.3.3: Density visualization of keywords of IIT Bombay

Table Figure 5.20.3.: List of prominent keywords of IIT Bombay

keyword	Occurrences
Controlled study	230
CMOS Integrated circuits	85
Speech recognition	76
Computational Linguistics	61
Nanoparticles	82
Cytology	50
Crystal structure	49
Soil moisture	47
Density functional theory	55
Particulate matter	41

(Source: VOSViewer)

5.20.4 Keyword's co-occurrences network of IIT Kharagpur

The following Figure was developed using the VOSviewer software tool by considering the algorithm "Association Strength", and taking the number of occurrences of keywords as 10 times. The keywords with the greatest link strength of the co-occurrence links with the other keywords are selected. The following visualization graphs are generated based on the keywords.

Figure 5.20.1.4.2 shows the overlay visualization of keywords that are found to be connected in the research areas of the IIT KGP female faculty. The areas are, microstructure, electron microscopy, cryptography, biomass, finite element method, etc. the nodes that are large and highly connected indicates the form of core research network. The strong link are found among the terms such as biocompatibility, chemical structure and sintering suggesting the materials characterization and structural analysis as primary research areas.

Figure 5.20.1.4.3 was also developed using the same algorithm in VOS Viewer, where the density of each prominent keyword is shown. The keywords that are deeper in colour and larger in font size are more commonly used than those that are lighter in colour. The keywords in the centre are speech recognition, microstructure, scanning electron microscopy, unclassified drugs, chemical structure, security of data, enzyme activity, crystal structure, biocompatibility, etc.

The co-occurrence network demonstrates a highly multidisciplinary research network, and further overlay visualization highlights a transition from fundamental research to emerging technological areas. Every keyword which are common in nature is most likely included in the same cluster or group. The graphs portray the areas evolving and appear to be more prominent research areas among the female faculty of IIT KGP during the study period.

Keywords' co-occurrences network of IIT Kharagpur

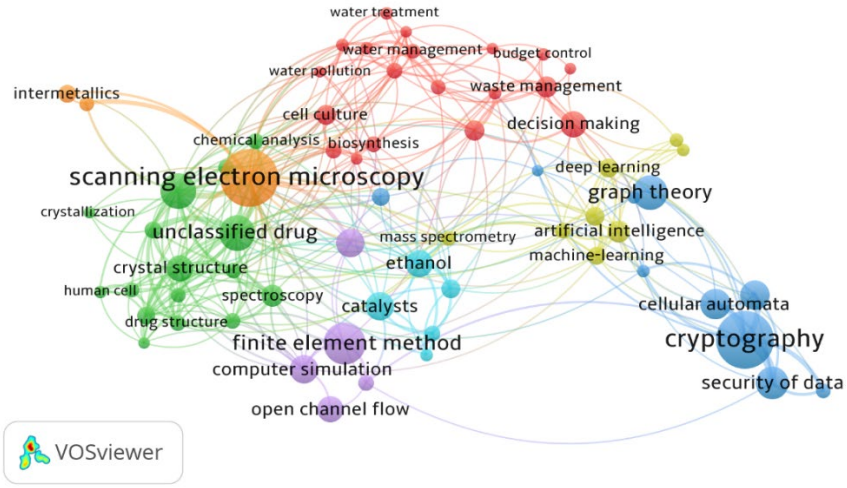

Figure 5.20.4.1: keyword co-occurrences visualization of IIT KGP

Overlay Visualization of Keywords of IIT KGP

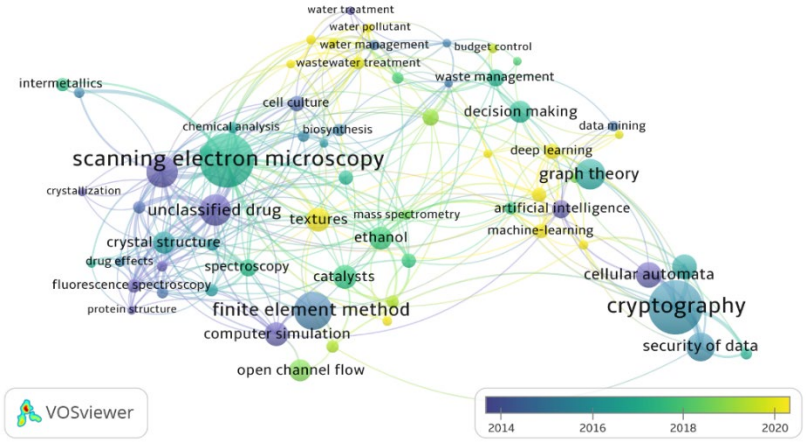

Figure 5.20.4.2: overlay visualization of keywords of IIT KGP

Density visualization of keywords of IIT KGP

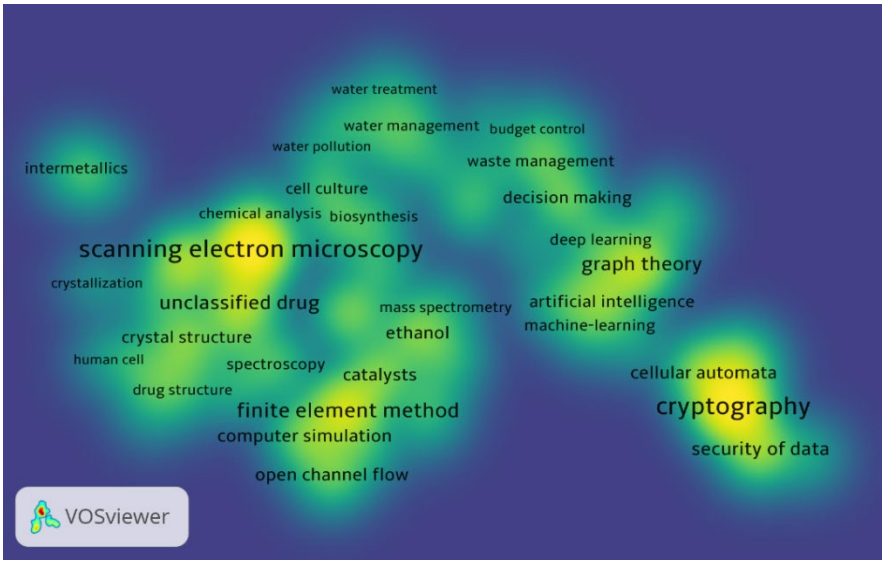

Figure 5.20.4.3: Density visualization of keywords of IIT KGP

Table 5.20.4: List of prominent keywords of IIT KGP

Keyword	Occurrences
Cryptography	137
Microscopy	137
Unclassified drugs	63
Graph theory	60
Deep learning	23
Finite element method	82
Waste management	27
Scanning electron microscopy	739
Florescence spectroscopy	20
transmission electron microscopy	63
Wastewater treatment	17

(Source: VOSViewer)

5.20.5 Keyword's co-occurrences network of IIT Kanpur

Graph (53,54,55) was developed using the VOSviewer software tool by considering the algorithm "Association Strength", and taking the number of occurrences of keywords as 10 times, where keywords with the greatest link strength of the co-occurrence links with the other keywords are selected. The following visualization graphs are generated based on the keywords.

Figure 54 shows the overlay visualization of keywords, which are found to be connected in the research areas of IIT Kanpur's female faculty. The areas are dielectric materials, crystal structure, photon crystals, cryptography, prostate cancer, sustainable development, etc.

The density visualization (Figure 55) was also developed using the same algorithm in VOS Viewer, where the intensity and distribution of research themes of each prominent keyword are shown. The keywords that are deeper in colour and larger in font size are more commonly used than those that are lighter in colour. The most prominent cluster is centred around dielectric materials, which indicates it is a core research theme. The keywords in the centre are drug effect, rough set theory, cryptography, photonic crystals, chemical structure, digital storage, machine learning, etc.

The density map reveals that research is highly concentrated in a few core domains, particularly materials science and biomedical sciences, followed by artificial intelligence and sustainability emerging as fields. Every keyword which are common in nature is most likely included in the same cluster or group. The graphs portray the areas evolving and appear to be more prominent research areas among the female faculty of IIT KGP during the study period.

Keywords' co-occurrences network of IIT Kanpur

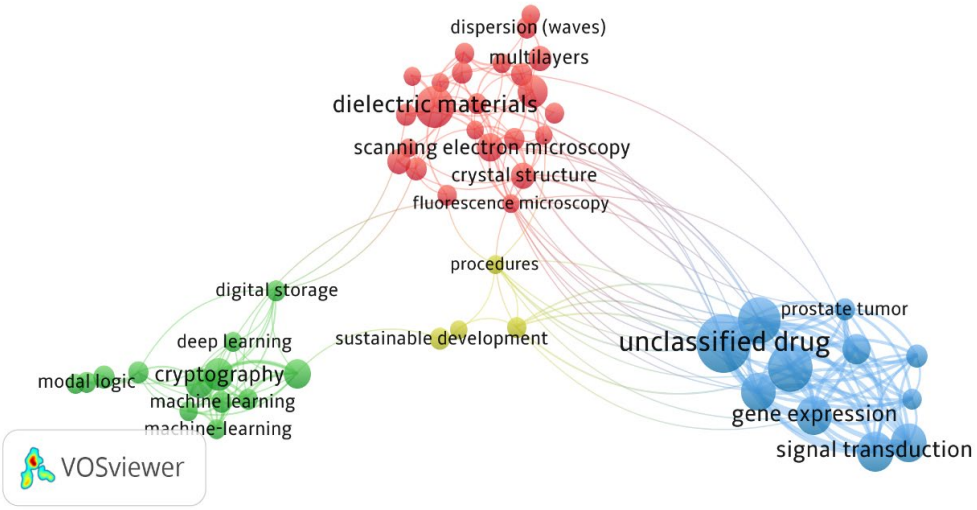

Figure 5.20.5.1: Keyword's co-occurrences network of IIT Kanpur

Overlay visualization of keywords of IIT Kanpur

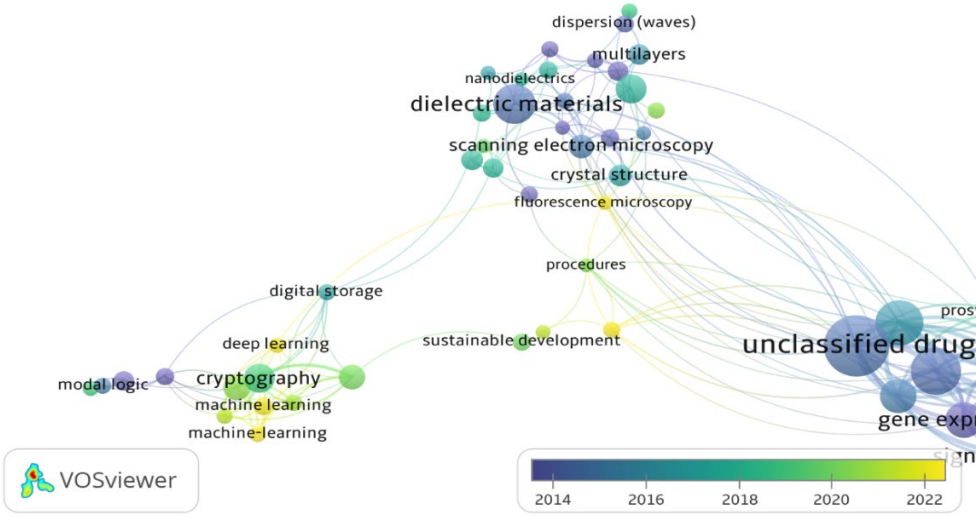

Figure 5.20.5.2: Overlay visualization of keywords of IIT Kanpur

Density map of keywords of IIT Kanpur

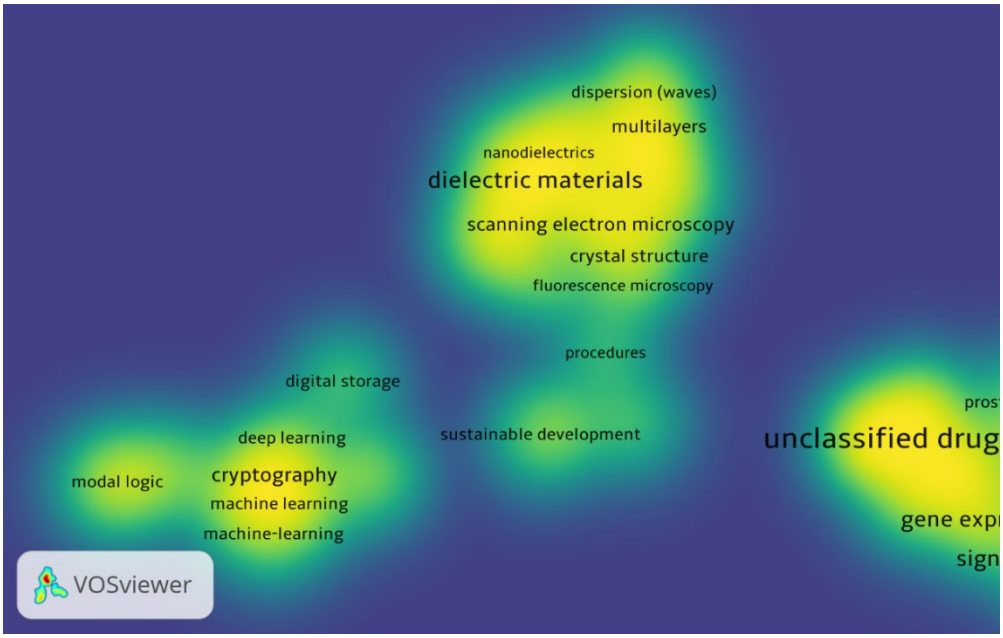

Figure 5.20.5.3: Density map of keywords of IIT Kanpur

Table of Occurrences of keywords

Table 5.20.5: Prominent occurring keywords of IIT Kanpur

Keyword	Frequency
Unclassified drugs	51
Gene Expression	28
Signal Transduction	29
Dielectric Materials	32
Covid 19	12
Scanning Electron Microscopy	18
Crystal Signature	16
Cryptography	22
Deep learning	11
Digital Storage	12

(Source: VOSViewer)

The table shows that the keyword "unclassified drugs" was used the maximum times. The map depicts a highly interconnected research landscape, with "unclassified drugs" as the main node, indicating it is the most commonly indexed document type.

The proximity and concentration of nodes reflect strong interdisciplinary links among key research themes. It is followed by "gene expression", "dielectric materials" 32, and "signal transduction." Controlled studies emphasize that a significant portion of the research employs experimental and scientific methodologies, ensuring the reliability and validity of findings. The keyword co-occurrence network depicts a multidisciplinary research framework mainly centered on biomedical sciences, environmental studies, materials science, and chemistry. The strong links between clusters indicate increasing interdisciplinary integration, especially between chemistry and life sciences, as well as materials science and applied physics. Overall, the map illustrates a diverse yet interconnected research ecosystem spanning both fundamental and applied areas.

The overall keyword frequency distribution shows that the research is very interdisciplinary, with a strong emphasis on life sciences, chemistry, and engineering applications. The prevalence of experimental terms and advanced analytical techniques suggests a strong empirical and scientific research orientation, while the frequent mention of India indicates a significant regional research contribution.

5.21 Testing of the hypotheses

For The Study, Two Hypothesis Were Formulated Listed Below. To Investigate the Correlation Between Publication and Date of Joining, the Pearson Correlation Test Was Deployed. The Significance of the Correlation Coefficient Was Evaluated Using a Paired T-Test, As the Dataset Satisfies the Conditions of Normality and Independence.

Hypotheses

1. There is a correlation between the number of publications and the date of joining.
2. There is a significant citation variation between open-access publications and closed-access publications.

Table 5.21: Analysis Of Correlation and Coefficient

Hypothesis	Variable Studied	Test Used	Value	P-Value	Decision
H1	Publications Vs Joining Date	Correlation Analysis	R=0.171162	1.63×10^{-16}	Accepted
H2	Open Access Vs Closed Access	Comparative Analysis(T-Test)	Significant Variation Observed	<0.05	Accepted

(Source: Survey data)

The analysis shows that H1 shows a weak but statistically significant correlation, while H2 confirms a significant difference between open access and closed access publication in citation count.

The correlation analysis shows a weak positive relationship (r=0.171162) between publications and joining date. This results in the faculty who have joined earlier tend to have more publications. However, the p-value (1.63×10^{-16}) is very low, confirming that the result is statistically significant. Therefore, H1 is accepted.

The comparative analysis was done using a t-test, which indicated a significant difference in citation counts between open-access and closed-access publications. Since the p-value is less than, the accessibility of publications plays a crucial role in influencing citation impact.

However, it can be concluded that both hypotheses are accepted. While H1 demonstrates a statistically significant but weak relationship, H2 highlights a meaningful difference in citation patterns, emphasizing the importance of open access in enhancing research visibility and impact.

5.22 Conclusion

The study presents a detailed analysis of the research output of 393 women faculty at the top five NIRF-ranked IITs. The faculty data was collected from the Scopus database and also from the respective institute's website. The study analyzed 25 years of data by using different scientometric parameters, such as performance analysis and enriched scientometric techniques. The analysis of the study is solely based on the data collected from the Scopus database during the years 2000-2024.

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CHAPTER 6
FINDINGS, SUGGESTIONS AND CONCLUSION

6. Findings, Suggestions, and Conclusion

6.1 Introduction

The chapter deals with major findings, discussion, and suggestions as per the objectives and conclusions of the study. The chapter is divided into 5 parts: 1. Findings based on the objectives of the study, 2. Discussion 3. Conclusion 4. Suggestions 5. Direction and scope for future research

6.2 Findings based on the objectives of the study

Objective 1: **To study the overall research contribution of women faculty at the Indian Institute of Technology (IIT).**

a. A total of 18030 documents was found during the study period of 2000 to 2024. A total of 393 faculty members were recorded during the study period.

b. Professors form the largest group, with approximately 170–175 faculty members. Assistant professors constitute the second-largest group, numbering around 130–135. Associate professors are the smallest group, with roughly 90–95 faculty members.

c. The IIT Madras has a total of 728 faculty members, of whom 88.19% are male and 11.81% are female. Departments such as Electrical Engineering, Civil Engineering, and Mechanical Engineering have the highest faculty strength. Female representation is highest in management studies (11) and biotechnology (10). Departments such as Data Science and AI (0 female), Mechanical Engineering (2 female), and Aerospace Engineering (2 female) show very low female participation.

d. IIT Delhi has 567 faculty members, with 478 (84.30%) male and 89 (15.70%) female. Electrical Engineering (59) and Mechanical Engineering (53) are the largest departments, followed by Physics (49) and Civil & Environmental Engineering (48). Humanities and Social Sciences and Management Studies show relatively higher female participation, with 19 and 11 female faculty members, respectively.

e. Total faculty strength of IITB is 610, 522 male (85.57%) and 88 female (14.43%). The highest number of faculty members is found in Electrical Engineering (69), followed by Mechanical Engineering (53) and Civil Engineering (49). Humanities

and Social Science is most gender-balanced department where female representation (45%) is significantly higher compared to technical disciplines.

f. IIT KGP has a total of 527 faculty members, 460 males (87.29%) and 67 females (12.71%). Mechanical Engineering (48) is the largest department, followed by Computer Science and Engineering (42) and Electrical Engineering (42). Female faculty is highest in Humanities and Social Science (10).

g. IITK has a total faculty strength of 593, 526 males (88.70%) and 67 females (11.30%). Electrical Engineering (67) is the largest department, followed by Mathematics & Statistics (54) and Aerospace Engineering / Physics (49 each). Humanities and Social Science (10) and mathematics & statistics (10), followed by Management Sciences (8) and Economic Sciences (7) have the greatest number of female faculties.

h. Overall the results show that, Male faculty significantly outnumber female faculty in every institution. The gap between male and female faculty is substantial. IIT Kanpur (IITK) shows the highest ratio, ~0.20, with relatively better female representation. IIT Madras (IITM) shows the lowest ratio, ~0.14.

i. Based on the analysis of the faculty data extracted from the Scopus database, it has been found that, among the 5 IITs, IIT Bombay has the highest number of publications IITB is the leading contributor, by more than one-fourth of total publications. Whereas IITK records the relatively lower research output

j. In case of citation also, during the study period, which is 2000-2024, IIT Bombay ranks at the top of the list with a total of 240949 citations. IIT Kanpur, with 85542 citations, holds the second position, followed by IIT Kharagpur (82482), IIT Delhi (76010), and IIT Madras (64274) with citations.

k. IITM has 3,914 publications & 64,274 citations. Electrical Engineering is the most prolific dept. 872 publications followed by Civil Engineering Department (533) and the mathematics dept with 418 publications. Civil Engineering Dept has the highest citation count (15,388 citations), indicating the production of highly influential research.

d. In the case of IIT Delhi, the year 2022 records the highest number of publications, 376, whereas the year that has the highest citations of 4966 is 2021. IIT Delhi has 4032 total publications; the Department of Physics emerges as the most prolific contributor, by 775 publications and 12,154 citations.

e. IIT Bombay has 5120 total publications, and the Department of Physics turned out to be the most prolific contributor, with 1,293 publications and 131,431 citations. It is followed by the Dept of Mathematics, which has produced 845 publications. The highest productive year, 2023, with 429 publications, and 2016 holds the highest number of impacts recorded, 31711.

f. IIT Kharagpur has a total of 4066 publications, Agricultural and Food Engineering is the most productive with 568 publications, followed by the Department of Metallurgical and Materials Engineering (543) and Mathematics (544). Agricultural and Food Engineering has the highest citation impact by 19,895 citations as well. The highest publication rate in the year 2024, whereas citations were recorded as the highest in the year 2016, 5547.

g. The year 2023 shows the highest growth of publications for IIT Kanpur, and the year 2018 is the most impactful in terms of citations, with a total of 10878. IITK has a total of 2613 publications, where the Department of Physics is the dominant dept with 1,426 publications & 63,966 citations.

h. The analysis of year-wise growth of IIT's shows that year 2024 has the highest number of publications (1577) out of the total publications. It is followed by Year 2023 by 1561, and 1472 in the year 2022. The overall findings show that IIT Bombay is the leading institution throughout the period 2000-2024 by a total of 4730 publications, followed by IIT Delhi and IIT Kharagpur. It is also noticeable that after the year of 2013, all the IITs have had significant growth in publications, which shows a rapid research expansion, funding, collaboration, and academic output.

i. While analyzing the form of documents of (IIT M), Articles make up the largest share, accounting for 60% of all documents. Conference papers are the second-largest category, 32%.

j. In the case of IIT Delhi, articles are by far the most common sort of document, making up 72%, followed by 14% conference papers.

k. Out of the total publications of IIT Bombay, articles account for 69% of all publications, followed by conference papers, 24%.

l. In IIT KGP, Articles Account For 71% Of All Publications, Followed by Conference Papers, Which Make Up 19% Of the Total Output.

m. In Case of IITK Articles, Has Covered 77% Of the Total Publication Output. Followed by Conference Papers For 17% Of Total Publications.

n. In IITM, a total of 3,625 publications were produced from 2000 to 2024. In The Beginning, The Number of Publications Was Still Pretty Low 0.69%, By 2005, The Cumulative Percentage Had Risen to Only 5%, Indicating That Research Activity Was Limited In the Early Stages.

o. The Highest Levels of Research Productivity Were Recorded in the Most Recent Years: 2020: 277 Publications (7.64%); 2022: 276 Publications (7.61%); And 2024: 297 Publications (8.19%), Which Were the Highest Over the Entire Period.

p. The AGR shows that research output increased from 87 (2000) to 187 in 2004. Year 2016 shows a growth rate of 22.91%, which was followed by 13.06% in 2017. This period coincides with a significant increase in IIT research productivity. Despite AGR fluctuations, the consistent increase in cumulative publication frequency confirms the ongoing strengthening of research output at all IITs, indicating long-term institutional stability and sustained scholarly productivity.

q. CAGR shows a clear pattern of long-term growth with a gradual decline in the annual growth rate over time. The initial years of 2000 to 2005 saw a relatively high growth rate, with CAGR falling from 12.3% in 2000 to 8.1% in 2005. This indicates a strong expansion phase.

r. The overall trend shows a decreasing CAGR with an increasing cumulative frequency, indicating that the publication has grown steadily. Overall CAGR 2000 to 2024 is around 12.8%, indicating a strong long-term growth trend despite a gradual decline in annual growth percentages in later years.

s. The initial rapid growth stage was indicated by an RGR of 0.76 in 2001. The RGR declined from 0.53 to 0.24 between 2002 and 2008, indicating a stabilization in publication growth. Indicating moderate long-term growth, the mean RGR for the entire period is approximately 0.22.

t. The DT was 0.92 in 2001, indicating the number of publications doubled in less than one year. DT experienced a substantial increase from 2018 to 2024, culminating in a value of 7.58 years in 2024. The publication output, on average, doubled every four years during the study period, as indicated by the mean doubling time of approximately 4.12 years.

u. In the case of Journal articles, RGR reveals a decreasing trend over time. During 2000 to 2005, RGR was at its highest in 2001 (0.74), which was indicative of the rapid expansion of journal article output. The RGR declined from 0.16 in 2015 to 0.10 in 2024. The rate of exponential growth decreased, despite the high annual output of 1082 articles in 2024.

v. The consistent decrease in RGR suggests that, despite an increase in productivity, the rate of growth has decreased over time, suggesting a transition from expansion to consolidation. RGR is inversely related to Doubling Time (DT), which exhibits an increasing trend. The total number of journal articles increased markedly from 74 to 12,537, which signifies long-term productivity.

Objective 2: **To find out the most productive authors, journals, and research areas.**

a. The overall findings show that Swagata Mukherjee (IIT Kanpur) is the most prolific faculty 1104 publications, a h-index of 112, and 60,723 citations. Dash, Sadhana (IITB) with 608 publications, an h-index of 110, and 42,979 citations.
b. Among all the faculties, Pai, Archana (IIT Bombay), is ranked eighth in productivity (208 publications), with the highest citation count (81,077) and a high h-index of 86.
c. The findings shows that Dash, Sadhana (IITB), is the most prolific faculty with 608 publications, 42,979 citations, and an h-index of 110. Pai, Archana, has the highest citation impact (81,077 citations) and an h-index of 86.

d. The findings show, as Das, Amita R. (IITD), is the most productive faculty with 342 publications, 6,855 citations, and an h-index of 41. Followed by Ashu Kumar Verma with 174 publications, and citation impact (2,590 citations; h-index 27).
e. The findings show Swagata Mukherjee (IITK) is the most prolific author, 1104 publications, 60,723 citations, and an h-index of 112; Vijaya Ramarao has 159 publications. Ateeq, Bushra is the most impactful author, with 7,558 citations.
f. The findings show Banerjee, Rintu (IITKGP), as the most prolific author with 229 publications, 8,713 citations, and an h-index of 51. Dutta-Majumdar, Jyotsna, with 216 publications, 6,813 citations, and an h-index of 43.
g. In case of IITM, Venkitesh, Deepa is the most prolific faculty with 273 publications, 999 citations, and an h-index of 14. Philip Ligy has a significant research influence of 7,744 citations.
h. The results shows that “Lecture Notes in Computer Science (including subseries)”, published by Springer Verlag (341 articles), followed by Journal of High Energy Physics (182 articles), Physical Review D (171), Physics of Plasmas (168 articles), and Physical Review Letters (149 articles). The list is followed by The Economic and Political Weekly's (112 articles).
i. The article “Observation of Gravitational Waves from a Binary Black Hole Merger” (2016), published in Physical Review Letters, has 12,274 citations, the most cited article of IITB.
j. The article of IITD "A microRNA signature of hypoxia," published in Molecular and Cellular Biology (2007), has 972 citations.
k. "Efficient lattice (H) IBE in the standard model" (2010), published in Lecture Notes in Computer Science, has 843 citations. (IITM)
l. "Guided wave-based structural health monitoring: A review" (2016), published in Smart Materials and Structures, with 1,005 citations. (IITKGP)
m. "The mutational landscape of lethal castration-resistant prostate cancer," published in Nature (2012), received 2,159 citations. (IITK

Objective 3: **To study the pattern of authorship collaborations between authors and impact by using different index measures.**

a. The findings reveal a substantial increase in research output, rising from 87 in 2000 to 1577 in 2024. The distribution of publications by number of authors shows a clear dominance of collaborative research. Out of the total 18,030 publications, single-author contributions account for only 635, 3.52%. Collaborative authorship constitutes the majority of publications. Double-authored 4334 (24.04%) and triple-authored 4367 (24.21%) papers together represent nearly half of the total output. Notably, multiple-authored publications 8691 (48.23%) form the largest share.

b. The findings show that multi-authored publications comprise nearly half (48.21%) of the total research output. In all institutes, multiple-authored papers account for the majority of publications. The Degree of Collaboration (DC) varies greatly across institutes, ranging from 0.95 to 0.98, implying that more than 95% of publications are collaborative.

c. The authorship distribution shows that single-author publications account for only 3.52% (635 out of 18,030) of the total output. Conversely, collaborative authorship dominates the dataset.

d. The Degree of Collaboration has increased from 0.35 in 2000 to 0.52 in 2024, which indicates a significant transition from solo-authored research to collaborative research.

e. Collaborative Index has risen from 2.82 in 2000 to 3.23 in 2024, indicating an increase in the average number of authors per paper. A CI value above 3 suggests that most publications involve more than 4 authors.

h. Degree of Collaboration and Collaborative Index of IITB (2000 to 2024), produced 4,730 publications, 143 single authors, 853 double authors, 1,010 triple authors, and 2,721 multiple authors. DC ranged 0.12 - 0.29, & modest CI of 2.3-2.8 indicates a low level of collaboration. The highest DC (0.65) was measured in 2023; CI also attains a high value of 3.48, indicating nearly 3.8 authors per paper.

i. Degree of Collaboration for IIT KGP, during 2000–2002, varied between 0.74 and 0.89, signifying robust collaboration. The peak DC values (0.99) were recorded in 2009, 2012, 2013, 2019, and 2023, signifying nearly total prevalence of co-authored publications. The CI values span from 2.53 to 3.19, indicating a moderate to strong team size.

j. Degree of Collaboration and Collaborative Index for IITK shows a total of 2,418 publications and a notable upward trajectory over time. During the 2000-2010 period, DC was comparatively low, fluctuating between 0.10 and 0.50; maximum DC (0.81) was documented in 2018, signifying a strong collaborative intensity. The peak CI (3.68) was found in 2018, signifying extensive collaborative research teams.

e. The Degree of Collaboration varies greatly across institutes, ranging from 0.95 to 0.98, implying that more than 95% of publications are collaborative. IIT Kanpur and IIT Madras have the highest collaboration level (DC = 0.98). The CI ranges from 2.99 to 3.40, with IIT Kanpur having the highest CI (3.40), indicating a larger average number of authors per paper.

f. The results show that IIT Bombay produced 4,730 publications, with 143 single authors, 853 double authors, 1,010 triple authors, and 2,721 multiple authors. The majority of publications have multiple authors. DC ranged between 0.13 and 0.31 in the early years (2000-2005), indicating a relatively low level of collaboration. Since 2008, DC has exceeded 0.48, indicating a significant increase in co-authorship. From 2016 to 2024, DC remained consistently high, ranging between 0.53 and 0.66. The highest DC (0.66) was measured in 2023.

g. IIT Delhi published 3,629 papers, with 214 single authors, 889 double authors, 1,055 triple authors, and 1,471 multiple authors. The DC values range from 0.25 to 0.58, indicating moderate to strong collaboration. The highest DC (0.58) was recorded in 2002. The CI values range from 2.68 to 3.24, implying an average of nearly three authors per paper.

h. IIT Kanpur produced 2,418 publications from 2000 to 2024, comprising 62 single authors, 488 double authors, 301 triple authors, and 1,567 multiple authors. The

maximum DC (0.81) was documented in 2018. The peak CI (3.68) was documented in 2018, signifying extensive collaborative research teams.

i. IIT Kharagpur has 3,628 publications, including 133 single-author, 1,115 double-author, 1,008 triple-author, and 1,372 multiple-author works. The peak DC values (0.99) were recorded in 2009, 2012, 2013, 2019, and 2023, signifying nearly total prevalence of co-authored publications. The CI values span from 2.53 to 3.19, indicating a moderate to strong team size. The peak CI (3.19) was observed in 2023, signifying marginally larger collaborative groups in recent years. Consistent CI values near 3.0 affirm a robust culture of collaboration and teamwork.

Objective 4: **To visualize the national and international collaborations of publications and their impact using scientific measures.**

a**.** Notably, multiple-authored publications (48.23%) form the largest share, demonstrating the growing importance of large-scale collaboration.

b. The Collaboration Index (CI), value rose from 2.82 in 2000 to 3.23 in 2024, indicating that the average team size has grown over time.

c. The analysis of co-authorship of countries IITM shows the mostly collaborated countries are found to be with the US, UK, Germany, and Japan, etc.

d. The analysis of co-authorship of authors (IITM) shows the strength of the co-authorship. And most collaborating faculties are found to be among Venkitash Deepa, Philip Liggy, Arunachalam Kavitha, Dasgupta Nandita, Lakshminarasamma M, sarkar Sunetra.

e. IITB is found to have collaboration with 113 countries, and with only 62 countries, collaboration is found to be too strong and greatest, which are the US, UK, Australia, France, South Korea, Singapore, and Taiwan.

f. Co-authorship of IITB was shown to having the strongest link strength among 418 authors. Baghini Maryam Shojai, Shukla Shobha, Mukherjee Asmita, Rao Preeti,

Indu j, Bhattacharya Amrita, and Venkataraman Chandra are the most collaborating authors.

g. IITD is found to have collaboration with 61 countries, Germany, the UK, Australia, Canada, Japan, Switzerland, Italy, Singapore, Croatia, etc.

h. Co-authorship of the authors of IITD found that 893 authors seem to have the greatest link strength of collaboration. Which is Upadhyayula Shreedevi, Chakraborty Tanushree, Verma Priyanka, Sinha Aloka, Verma Ashu, Sharma Shilpi, Das A, Joshi Mangala, Mehra Aparna, etc.

i. IIT KGP has collaborations with 35 countries, including the UK, France, Switzerland, Australia, Poland, South Korea, Norway, South Africa, etc.

j. IIT KGP has found to be collaborating with 870 authors, DasGupta Swagata, Banerjee Rintu, Chakraborty Debjani, Jenamani Mamata, Sarkar Sudeshna, Mukherjee Jenia, Singh Chandrani, etc. have the most collaboration.

k. The greatest Co-Authorship of Countries of IITK found to be 127 countries; Germany, France, Switzerland, Belgium, Poland, UK, Italy, Ireland, Israel, etc.

l. Strongest link strength of co-authorship is found among 301 authors, Ateeq Bushra, Tripathy Twinkle, Goel Ayush, Parveen Nagma, Chatterjee Urbi, Vijaya R, Katiyar Monica, Gupta Nandini, etc. (IITK).

Overall, it has been found from the findings that 168 countries participated in the research collaboration. By putting the data into the VOSviewer software with the simple algorithm by ignoring the documents co-authored by a large number of countries, 67 countries are found to be the greatest in link strength of the co-authorship. The greatest group of collaboration networks is found among 39 countries. Which are India, Austria, Bangladesh, Bulgaria, Chile, Colombia, Denmark, Egypt, Ethiopia, etc. The collaboration network of co-authorship is developed using the VOSviewer by ignoring the documents with a large number of authors. The networks are generated using data fed into VOSviewer, and to create network maps, the normalization method used is “Association Strength. " Authors with at least 5 publications are included to define the network.

Objective 5: **To analyze the trends of research themes over the years by analyzing keywords.**

a. The co-occurrence of keywords was developed using the VOSviewer software tool by considering the algorithm "Association Strength", and taking the number of occurrences of keywords as 10 times. In case of IIT Madras, a total of 27887 keywords were found, where keywords with the greatest link strength of the co-occurrence links with the other keywords are found to 909 and have the greatest link strength. The keywords in the centre are computer simulation, drug theory, biodegradation, wastewater treatment, etc.
b. Keywords' co-occurrences of IIT Delhi show the core research theme is centred around nanocomposites, scanning electron microscopy, unclassified drugs, and catalyst activity, which links multiple subfields. Other research areas are neutron diffraction, nanocomposites, nematic liquid crystals, unclassified drug, computer simulation, finite element method, genetics, temperature, nanoparticles, etc.
c. The areas evolving and appearing to be more prominent research areas among the female faculty of IIT Bombay during the study period are article, Controlled study, human, Priority journal, CMOS integrated circuits, speech recognition, carbon, photon, female, genetics, crystal structure, etc.
d. The areas appear to be more prominent research areas among the female faculty of IIT KGP are article, Controlled study, Chemistry, scanning electron microscopy, human, speech recognition, carbon, photon, enzyme activity, Microstructure, etc.
e. Keywords' co-occurrences of IIT Delhi show that the core research theme is centred around nanocomposites, scanning electron microscopy, unclassified drugs, and catalyst activity. The other research areas are neutron diffraction, nanocomposites, nematic liquid crystals, unclassified drug, computer simulation, finite element method, genetics, temperature, nanoparticles, etc.

The map created by VOSViewer depicts a highly interconnected research landscape. The results depict a highly interconnected research landscape. The proximity and concentration of nodes reflect strong interdisciplinary links among key research themes. The keyword co-occurrence network depicts a multidisciplinary research

framework. The overall keyword frequency distribution shows that the research is very interdisciplinary, with a strong emphasis on life sciences, chemistry, and engineering applications. The prevalence of experimental terms and advanced analytical techniques suggests a strong empirical and scientific research orientation, while the frequent mention of India indicates a significant regional research contribution.

6.3 Discussion

The study presents an investigation based on scientometrics tools of the research productivity of women faculty of IITs in India. The application of scientometrics turns out to be an effective and reliable means for understanding the current status and forecasting the future perspective in the domain of any research domain. An enriched scientometric technique is the creation of network visualization maps by using tools meant for the purpose, like VOSviewer and Biblioshiny. The maps are created based on information and computer science, scientometrics, and analysis of these figures; this highlights the process and thematic relationship of knowledge in research areas.

So, the application of scientometric and visualization analysis will provide the pattern and growth of research by the female faculties of the top five IITs and will provide the details of publication, impact, and productive authors, as well as journals and countries; co-authorship; collaboration patterns; keyword analysis based on the performance and citation-related metrics; and analysis of research areas with visualization techniques.

Chapter 1 provides a brief overview of the study and includes the core portion that defines the research work. It consists of the introduction of the research topic, scope, significance, methodology, research gap, objectives, and chapterization of the study. The second chapter provides the analysis of previously published articles and research work, as the study of the background provides the detail observation of the research study. By using platforms such as Research Gate, Google Scholar, Scopus database, and Mendeley, the literature search has been done with extreme care and appropriate terms to collect the literature related to the scientometrics and

bibliometric analysis. The study of literature provides a research gap of any particular subject area. Chapter 3 provides a brief overview of communication and further scholarly communication. The research publication, or the research output, is an important factor in academia. It provides a major link for communication among the research and academic communities. knowledge economy, scientific research, and technological developments are considered key factors in the development of a country like India. Scientific research is an information-producing activity, and the essence of which is communication. The dissemination of the accomplished result is the initial stage in communication via publications. Chapter 4 provides the profile of the IIT's and their contribution towards the community and nation. It gives an overview of the top 5 NIRF-ranked IITs. The chapter also provides the list of all the IIT's along with their address and establishment year. Chapter 5 is the major part of the study as it provides the analysis and interpretation part. The growth and trend of research productivity of women faculty have been analyzed by using different scientometric indicators. The visualization tools, such as VOSViewer, are used to analyze and visualize the collaboration and co-authorship of the authors and journals at the national as well as international level. The Biblioshiny by R was used to conduct the keyword analysis based on co-occurrences, overlay, density visualization, and analysis of trending topics. Chapter 6 provides the findings based on the analysis of the faculty data extracted from the Scopus database. It also summarizes the entire research work.

6.5 Suggestions

Based on the research work and analysis of the study, these are the suggestions that were advocated:

1. The faculties also need to consider publishing single authored publication.
2. There is a need to maintain consistency in publication, as it is noticeable that even though the author is highly cited, they are not consistent in publication.
3. It has been found from the analysis that the fields of engineering and science have a great coverage of publications compared to social science and

humanities. Therefore, it is suggested that faculty from the humanities publish more of their research work in their respective subject areas.

4. It is observed from the study that many of the faculty's profiles and CVs are missing from the institute website and are nowhere to be found. So, the faculty members need to maintain a research profile that is accessible to other researchers when in need.
5. To increase the accessibility of the scholarly findings, it is recommended that faculties maintain a profile in Scopus and other research platforms.
6. It is also recommended that the institute maintain a directory of faculty members along with their details (CV), which should include their researcher ID, Scopus ID, and Google Scholar ID, and an updated list of research publications. The accessibility to that information will increase the visibility and help those in need.
7. Based on the findings of the study, it is noticeable that articles constitute a large area of publication. So, it is recommended that the faculty consider publishing in other formats of publication as well.
8. The institutes can systematically maintain their websites by arranging the schools, departments, and centers.
9. The faculties can also consider having a profile in IRINS, as it is a web-based Research Management Service to showcase their academic output and its impact.

6.4 Conclusion

Communication is essential for human beings. It involves exchanging information, ideas, thoughts, and personal feelings. Scholarly communication refers to the system through which academic knowledge is created, evaluated, disseminated, and preserved. Communications play an important role in advancing knowledge, which involves researchers, institutions, publishers, and libraries. The advancement of technologies is transforming scholarly communication. Because of this, accessing and storing information has gradually become easy. Earlier, the communication was mainly limited to printed resources, but modern platforms and equipment made it more reliable and accessible. The channels of communication mainly include

journals (printed or electronic), books, conference papers, book chapters, theses and dissertations, institutional repositories, and various digital platforms. Traditional scholarly communication was primarily print-based, which had limited access, and because of that, dissemination was quite slow. Today, digital platforms have made information widely available to everyone, which enables readers to have easier access and reach a wider audience in a short period of time.

A research paper is known to be a standard way of presenting the research findings or the new information of any subject area, which is based on some scientific experiments and observations. The global research landscape is gradually changing. Science and technology research is a dynamic and rapidly evolving field, supported by a combination of government initiatives, private sector investments, and academic excellence. In the contemporary era, accessing scholarly publications is one of the key concerns of information professionals. Evaluating the published scholarly communication makes us understand the research trends and social and intellectual structures of a particular subject domain. The performance of scholars and scholarly communication can be evaluated through impact factors that enable the performance and value of the contribution. The impact of the research or scholarly activities can be estimated by citation counts, journal impact factors, and other citation-based impact values. In a premier institution like IIT, scholarly communication plays a key role in advancing scientific and technological innovations. IITs are the institutions of national importance that are established to promote innovation, research, and leadership in technical fields. They are mostly recognized for their expertise in engineering, science, and technology-enhanced education. In a country like india, women's participation in all fields is very low, but it is gradually increasing. Nowadays, there is no particular subject area that has not been influenced by women. They are actively participating in and demonstrating their talent and contributing in every field, which includes education, research, politics, sports, etc. However, even though education has improved the status and roles of women in society, the number of women participating in higher institutions remains low. To understand their position and impact in academia, it is necessary to examine the performance trends of research output and productivity of women. In the field of Library and information

science, many research assessment metrics have evolved, which are Librametrics, bibliometrics, scientometrics, infometrics, and webometrics. And significantly, bibliometrics and scientometrics were the primary tools that are mostly used for measuring authors and research, and evolved as computational measurement and scientific mapping.

This study presents a detailed analysis of research productivity of women faculty of the top five NIRF-ranked IITs, which are IIT Madras, IIT Bombay, IIT Delhi, IIT Kharagpur, and IIT Kanpur. The findings from each objective of the study shed light on essential facets of the academic landscape. Many faculties have engaged in publications in the Scopus-indexed journals. Among the faculty members, assistant professors formed the largest group (131), followed by professors and associate professors. The study also highlights the disparities among the faculties and institutions. Among the top five IIT's, the IIT Bombay is the most productive institution based on the study findings, with the most Scopus-indexed publications. profesors tend to have more publications despite their small number than assistant professors. The reason may be their experience and expertise as well as collaborating tendency. The year-wise distribution shows an increased scholarly output, with 2024 being the most prolific year with 1577 publications. In case of citation also, during the study period, IIT Bombay ranks at the top of the list with a total of 240949 citations. The departmental distribution of scholarly output also reveals a preference for Science and Technology disciplines. The findings of the study demonstrate a strong awareness of open-access publishing among faculty members, with a notable percentage confident in accessing and distributing scholarly materials online.

The findings show that multi-authored publications comprise nearly half (48.21%) of the total research output. In all institutes, multiple-authored papers account for the majority of publications, which implies that more than 95% of publications are collaborative. The keyword co-occurrence network depicts a multidisciplinary research framework mainly centred on biomedical sciences, environmental studies, materials science, and chemistry. The overall keyword frequency distribution shows that the research is very interdisciplinary. At last, the study highlights the growth of research productivity of women faculty of various disciplines of the top five IITs and

their research impact. It also emphasizes the need for participation among the women faculty members in research activities and, most importantly, the need for the recruitment of women faculty. Additionally, the study provides valuable information for stakeholders to make decisions regarding the scholarly communications made by women faculty of the top five Indian Institutes of Technology.

6.6 Scope for future research

Based on the study, the following scope for research has been suggested for research professionals.

1. The present study is confined only to the data available in the Scopus database. However, there are other platforms as well (WoS, Google Scholar, Dimensions, IEEE Explore, etc) which can also be considered to conduct further studies.
2. The researchers can also initiate and conduct studies on other IIT's based on other rankings, and also conduct comparative analysis among them as well.
3. There is also a scope to conduct the altmetric aspect of research publication.
4. The study is confined only to research publications of women faculty, so there may be some comparative studies among the male and female faculty members.

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LIST OF PUBLICATIONS

Journal publication

1. **Bhagyashree chetia** and lalngaizuali (2026). Growth Trend of ICSSR Funded Research: A Scientometric Study. Journal of Advances in Library and Information Science, 15(2), 144-152.
2. Ruth Lalthlamuanpuii **Bhagyashree Chetia**, MM Yashir Ahamed, and Lalngaizuali. (2024). A Scientometric Analysis of Extension Education in Web of Science Databases (2014-2023). Annals of Library and Information Studies 71(4), 355-361.
3. MM Yashir Ahamed, **Bhagyashree Chetia**, Ruth Lalthlamuanpuii, and Lalngaizuali. (2024). Uses of Library Resources and Services by the Nursing Students: A case study of the College of Nursing, RIMS, Imphal. Qualitative and Quantitative Methods in Libraries (QQML) 13(1).
4. **Bhagyashree Chetia**, Ruth Lalthlamuanpuii, MM Yashir Ahamed, Lalngaizuali (2023). Sentiment Analysis on the Union Budget 2023: An evaluation based on YouTube comments. Qualitative and Quantitative Methods in Libraries (QQML) 12(4), 635-651.
5. Mm, Yashir Ahamed, Ruth Lalthlamuanpuii, **Bhagyashree Chetia**, Lallawmawmi, and Lalngaizuali. (2023). Usage of Medical Library Resources: A Study in the Regional Institute of Medical Sciences, Imphal. Indian Journal of Information Sources and Services, 13(2), 1-6. (ISSN: 2231-6094).

Conference/Seminar Paper/Workshop

1. Presented a paper on the topic "**Exploring Viewer Sentiment: Analyzing Viewer Feedback on ChatGPT Tutorial Videos on YouTube**" in PLANNER 2024, organized by Rajib Gandhi University in collaboration with INFLIBNET Centre during 19-21 September 2024 at Rajib Gandhi University, Arunachal Pradesh.
2. Presented a paper on the topic "**A Metric-Based Analysis of Global Trends in Yoga Literature**" in an International Seminar on New Era of Social Responsibility, Sustainability, sustainability and Innovations organized by the School of Economics, Management and Information Science, Mizoram University, from March 4th to 6th, 2024. S
3. Presented a paper on the topic "**Marketing of Library and Information Services in the Information Society**" in the conference Digitizing Library Services Using Modern Technology, organized by the Central Library, Pachhunga University College, in June 2023.
4. Presented a paper on the topic "A **New Vision for Libraries: An Overview of the Concept of Green Library for Sustainable Development**" In the National

Seminar on Revamping Libraries and Librarianship in the Digital Environment, organized by Central Library, Mizoram University, in May 2023.Era.

5. Participated in a two-day workshop on "**Social Media Data Mining for Text and Sentiment Analysis: Tools and Approaches**" organized by the Department of Mass Communication, Mizoram University, Aizawl, from 29th to 30th September 2022, at Mizoram University.

Book chapter

1. **Bhagyashree Chetia &** Ruth Lalthlamuanpuii (2025). Marketing of Library and Information Services in the Information Society. *In The Future of Libraries: Innovation and Transformation in the Digital Age*. Published by Monica Bhandari Books. ISBN: 978-93-49446-82-3.

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DATE OF ADMISSION:	20-08-2022

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ABSTRACT

SCHOLARLY COMMUNICATION BY WOMEN FACULTY OF INDIAN INSTITUTES OF TECHNOLOGY: A SCIENTOMETRIC STUDY

AN ABSTRACT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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SCHOLARLY COMMUNICATION BY WOMEN FACULTY OF INDIAN INSTITUTES OF TECHNOLOGY: A SCIENTOMETRIC STUDY

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In partial fulfillment of the requirement of the Degree of Doctor of Philosophy in Library and Information Science of Mizoram University, Aizawl.

1. Introduction

Communication is essential for human interaction. It involves exchanging information, ideas, thoughts, and personal feelings. Scholarly communication refers to the system and process through which research and academic knowledge are created, evaluated, disseminated, and preserved. It plays a key role in advancing knowledge, involving researchers, institutions, publishers, and libraries. Technological advancements are transforming scholarly communication. In the past, communication was mainly limited to printed resources, but now modern platforms make communication more reliable and accessible. Channels of scholarly communication include journals (print and electronic), books, conference papers, theses and dissertations, institutional repositories, and various digital platforms. The process involves research or investigation, writing, publication, dissemination, and archiving or preserving the published work. Traditional scholarly communication was primarily print-based, which limited access and slowed dissemination. Today, digital publishing has made resources openly available to everyone, enabling easier access for readers and information users globally and providing a more efficient way to reach a wider audience.

However, this landscape has evolved significantly with the advent of the digital age, expanding the avenues for sharing and accessing scholarly work. The rise of digital repositories, online journals, preprint archives, academic social networks, and open-access platforms has democratized scholarly content, making it more inclusive and accessible to a broader audience. A research paper is a standard way of presenting the research findings of any area and subject that is based on some scientific experiments and observations. So, a research paper that undergoes multiple peer review processes before publication is one of the key documents in academia and a major part of scholarly communication.

The global research landscape is gradually changing. Science and technology research is a dynamic and rapidly evolving field, supported by a combination of government initiatives, private sector investments, and academic excellence. In the contemporary era, assessing scholarly publications is one of the key concerns of

information professionals. Evaluating published scholarly communication makes us understand the research trends and social and intellectual structures of a particular subject domain and predict the future research direction. The performances of scholars and scholarly communication can be evaluated through impact factors that enable the performance and value of the contribution to academia. The impact of scholarly activity can be estimated by citation counts, journal impact factors, and other citation-based impact values. In premier institutions like the Indian Institutes of Technology (IITs), scholarly communication plays a crucial role in advancing scientific and technological innovation. Institutes of Technology (IITs) are institutions of national importance established to promote innovation, research, and leadership in technical fields. They are internationally recognized for their expertise in engineering, science, and technology education, among other disciplines. IITs conduct cutting-edge research in fields such as artificial intelligence, nanotechnology, renewable energy, biotechnology, aerospace, and materials science. In global rankings, IITs consistently rank among the best engineering universities in the world. Each IIT functions independently, but they are connected through the IIT Council, which oversees national policies. In countries such as India, women's participation in all fields is low, but this is improving rapidly. Nowadays, there is no subject that has not been influenced by women; women are actively participating, demonstrating their talent, and contributing in every field, including education, research, sports, and politics. However, even though education has improved women's status and roles in society, women's participation and numbers in higher education and research institutes remain low. To understand their function in education and research, it is necessary to examine the position of women and analyze their role and perspectives on career advancement. The current study aims to identify and assess the performance trends of Indian women in science and technology. The evaluation of research output or productivity of scientists or researchers has become a special interest in the recent past because of the proliferation of so-called research output and literature masquerading as research output.

Over the years, library and information science have employed many metric fields as measurement applications. Examples include Librametrics, Bibliometrics,

Scientometrics, Informetrics, and Webometrics. Significantly, Bibliometrics and Scientometrics were the primary tools most widely used for measuring author and journal impacts and evolved as computational measurement and scientific mapping.

1.2 Scientometric analysis

Scientometrics is a field of study that focuses on measuring and analyzing science, technology, and innovation. It employs quantitative methods, particularly bibliometrics (the analysis of scientific publications), to understand scientific research's structure, development, and impact with numerous indicators and methods such as citation analysis, content analysis, impact factor (IF), Hirsch-index (h-index), and Egghe-index (g-index).

Scientometrics plays a crucial role in information science by providing methodologies for tracking, evaluating, and analyzing information resources, as well as managing knowledge. Scientometric investigations are primarily conducted to assess the quantitative and qualitative advancements within the scientific profession. To effectively characterize information phenomena, it is essential to acquire quantitatively reliable data, develop appropriate methodologies, and apply relevant indicators. A range of scientometric indicators is employed to assess research and measure the performance of journals, institutions, countries, and collaborative research groups. This set of scientometric indicators primarily consists of citation-based metrics, typically sourced from citation databases including the Science Citation Index (SCI), the Social Science Citation Index (SSCI), and the Journal Citation Reports (JCR). In reality, it involves the application of statistical indicators (particularly bibliometric indicators) as a measure for the evaluation of scientific activity. Egghe and Rousseau (1990).

The scientometric analysis has received considerable attention in recent years and has been widely applied to evaluate the research performance of scientists and the growth of various scientific disciplines. Scientometrics techniques are now being used for a variety of purposes, like the determination of various scientific indicators, the evaluation of scientific output, the selection of journals for libraries, etc. The metrics studies mostly deal with the quantitative analysis of science to find

relationships among various disciplines; evaluate scientific research by individuals, institutions, or countries; and analyze author and journal productivity, as well as the quantitative aspects of library and information studies. Obsolescence and growth of literature. Co-citation, bibliographic coupling, co-word analysis, rank distribution of words, etc.

2. Significance of the study

Scientometrics has emerged as the most active area in library and information science. It is widely used to evaluate intellectual quality in terms of research literature growth, level of collaboration, other collaboration measures, authorship patterns, citations, and their applications. One of the key topics of research in library and information science is tracing the breadth of ties among scholars and collaboration measures in a certain area, publication, or institute. It identifies the expansion of the literature in a specific area or discipline; citation analysis provides knowledge for publications impacted by other writers in the search for new inventions. Moreover, the study findings will offer insights into the women faculty's research contributions and help them to decide how to optimize scholarly communications for future publications and their impact.

2.1 Scope

The current study aims to identify and assess the performance trends of Indian women in science and technology. Therefore, the study is limited to analyzing the women faculty's research contribution and investigates the Top five NIRF-ranked IITs in India who work in a variety of fields. There are 23 IITs in India as of now, and based on NIIRF data (2022), the top five institutions are selected, which are IIT Madras, IIT Delhi, IIT Bombay, IIT Kharagpur, and IIT Kanpur. Institutional websites are used to gather information about female faculty members. The bibliographic data for articles was obtained only from the Scopus database. The faculty's output was collected from the day they joined the institute. This knowledge is crucial for monitoring and analyzing trends in the quality and quantity of research publications.

3. Research design

A research design is a methodological approach developed by the researcher to offer reliable and unbiased solutions to the problems. It is a blueprint of strategies to carry out the research work. It is an arrangement of parameters for collecting and evaluating the data that attempts to strike a balance between operational effectiveness and relevance to study objectives. It emphasized the preparation of strategies to carry out numerous procedures and responsibilities essential to successfully conducting the study.

Statement of the problem: Scientific mapping is an important factor in the research process, enabling the identification of growth and development in a specific domain. Nowadays, there is no such area that is untouched by women; in every field, women are participating actively and showing their ability and contributing in every field, i.e., education, research, sports, politics, etc. Although education has changed the status and role of women in society, it is noticeable that women's participation and numbers are still lower in higher education and research institutes. In order to see their role in education and research, it is important to look at the situation of women scientists and discuss their role and perspective on career development. The present study is an effort to determine and analyze the performance trend of Indian women in the field of science and technology.

3.1 Objectives

The objectives of the current study are to:

1. Study the overall research contribution of women faculty at the Indian Institute of Technology (IIT).

2. Find out the most productive authors, journals, and research areas. 3. Study the pattern of authorship collaborations between authors and impact by using different index measures.

4. Visualize the national and international collaborations of publication and their impact using scientific measures.

5. Analyze the trends of research themes over the years by analyzing keywords.

3.2 Research methodology

The present study examined and analyzed the research productivity of women faculty of the top five NIRF-ranked (Based on 2022) IITs. The study's objective is to quantify and measure both qualitative and quantitative aspects of publication, including the number of scientific publications published, the significance of their citations, publication topics, and the most influential authors and organizations among the 393 women faculty of various disciplines. For the study, the scientometric tools are used to evaluate the research growth and trends. Evaluation of scientific productivity is an important part of assessing research productivity. The scientometric study is a viable and relatively objective measure of a university and research institute's performance, particularly in science and technology.

The faculty data was gathered with the help of the Scopus database, Google Scholar, Research Gate, and IRINS. Starting on the day they joined the institute, the faculty's output was gathered. Having this knowledge is essential for tracking and examining trends in the quality and number of research publications. Additionally, the Scopus database from 2000 to 2024 served as the major source of data collection. the data required for the study were retrieved during September 2025 to December 2025 using the Scopus database up until the year 2024. The retrieved data were filtered, scrutinized, and arranged according to the study objectives by using Microsoft Excel. The total contribution of the faculties and their variations was identified manually using Biblioshiny (Bibliometrix R), an open-source tool for comprehensive scientific mapping and accessing scientific publications packages. The number of publication and their pattern, as well as the growth of the publication of the faculty members was analyzed and arranged manually using MS Excel. While the analysis of authors, collaboration, country collaboration, trending topics, and keywords was conducted using the VOSviewer visualization platform. It is a platform to visualize the large-scale bibliometric networks. Furthermore, the hypothesis testing was also done based on the study parameters. Later, the analyzed data were presented in the form of different tables, graphs, and figures for better interpretation of the results.

4. Hypothesis

H1: There is a correlation between the number of publications and the joining date.

H2: There is a significant citation variation between open-access publications and closed-access publications.

5. Findings based on the objectives of the study

Objective 1: To study the overall research contribution of women faculty at the Indian Institute of Technology (IIT).

a. A total of 18030 documents was found during the study period of 2000 to 2024. A total of 393 faculty members were recorded during the study period.

b. Professors form the largest group, with approximately 170–175 faculty members. Assistant professors constitute the second-largest group, numbering around 130–135. Associate professors are the smallest group, with roughly 90–95 faculty members.

c. The IIT Madras has a total of 728 faculty members, of whom 88.19% are male and 11.81% are female. Departments such as Electrical Engineering, Civil Engineering, and Mechanical Engineering have the highest faculty strength. Female representation is highest in management studies (11) and biotechnology (10. Departments such as Data Science and AI (0 female), Mechanical Engineering (2 female), and Aerospace Engineering (2 female) show very low female participation.

d. IIT Delhi has 567 faculty members, with 478 (84.30%) male and 89 (15.70%) female. Electrical Engineering (59) and Mechanical Engineering (53) are the largest departments, followed by Physics (49) and Civil & Environmental Engineering (48). Humanities and Social Sciences and Management Studies show relatively higher female participation, with 19 and 11 female faculty members, respectively.

e. Total faculty strength of IITB is 610, 522 male (85.57%) and 88 female (14.43%). The highest number of faculty members is found in Electrical Engineering (69), followed by Mechanical Engineering (53) and Civil Engineering (49). Humanities and Social Science is most gender-balanced department where female representation (45%) is significantly higher compared to technical disciplines.

f. IIT KGP has a total of 527 faculty members, 460 males (87.29%) and 67 females (12.71%). Mechanical Engineering (48) is the largest department, followed by Computer Science and Engineering (42) and Electrical Engineering (42). Female faculty is highest in Humanities and Social Science (10).

g. IITK has a total faculty strength of 593, 526 males (88.70%) and 67 females (11.30%). Electrical Engineering (67) is the largest department, followed by Mathematics & Statistics (54) and Aerospace Engineering / Physics (49 each). Humanities and Social Science (10) and mathematics & statistics (10), followed by Management Sciences (8) and Economic Sciences (7) have the greatest number of female faculties.

h. Overall the results show that, Male faculty significantly outnumber female faculty in every institution. The gap between male and female faculty is substantial. IIT Kanpur (IITK) shows the highest ratio, ~0.20, with relatively better female representation. IIT Madras (IITM) shows the lowest ratio, ~0.14.

i. Based on the analysis of the faculty data extracted from the Scopus database, it has been found that, among the 5 IITs, IIT Bombay has the highest number of publications IITB is the leading contributor, by more than one-fourth of total publications. Whereas IITK records the relatively lower research output

j. In case of citation also, during the study period, which is 2000-2024, IIT Bombay ranks at the top of the list with a total of 240949 citations. IIT Kanpur, with 85542 citations, holds the second position, followed by IIT Kharagpur (82482), IIT Delhi (76010), and IIT Madras (64274) with citations.

k. IITM has 3,914 publications & 64,274 citations. Electrical Engineering is the most prolific dept. 872 publications followed by Civil Engineering Department (533) and the mathematics dept with 418 publications. Civil Engineering Dept has the highest citation count (15,388 citations), indicating the production of highly influential research.

d. In the case of IIT Delhi, the year 2022 records the highest number of publications, 376, whereas the year that has the highest citations of 4966 is 2021. IIT Delhi has

4032 total publications; the Department of Physics emerges as the most prolific contributor, by 775 publications and 12,154 citations.

e. IIT Bombay has 5120 total publications, and the Department of Physics turned out to be the most prolific contributor, with 1,293 publications and 131,431 citations. It is followed by the Dept of Mathematics, which has produced 845 publications. The highest productive year, 2023, with 429 publications, and 2016 holds the highest number of impacts recorded, 31711.

f. IIT Kharagpur has a total of 4066 publications, Agricultural and Food Engineering is the most productive with 568 publications, followed by the Department of Metallurgical and Materials Engineering (543) and Mathematics (544). Agricultural and Food Engineering has the highest citation impact by 19,895 citations as well. The highest publication rate in the year 2024, whereas citations were recorded as the highest in the year 2016, 5547.

g. The year 2023 shows the highest growth of publications for IIT Kanpur, and the year 2018 is the most impactful in terms of citations, with a total of 10878. IITK has a total of 2613 publications, where the Department of Physics is the dominant dept with 1,426 publications & 63,966 citations.

h. The analysis of year-wise growth of IIT's shows that year 2024 has the highest number of publications (1577) out of the total publications. It is followed by Year 2023 by 1561, and 1472 in the year 2022. The overall findings show that IIT Bombay is the leading institution throughout the period 2000-2024 by a total of 4730 publications, followed by IIT Delhi and IIT Kharagpur. It is also noticeable that after the year of 2013, all the IITs have had significant growth in publications, which shows a rapid research expansion, funding, collaboration, and academic output.

i. While analyzing the form of documents of (IIT M), Articles make up the largest share, accounting for 60% of all documents. Conference papers are the second-largest category, 32%.

j. In the case of IIT Delhi, articles are by far the most common sort of document, making up 72%, followed by 14% conference papers.

k. Out of the total publications of IIT Bombay, articles account for 69% of all publications, followed by conference papers, 24%.

l. In IIT KGP, Articles Account For 71% Of All Publications, Followed by Conference Papers, Which Make Up 19% Of the Total Output.

m. In Case of IITK Articles, Has Covered 77% Of the Total Publication Output. Followed by Conference Papers For 17% Of Total Publications.

n. In IITM, a total of 3,625 publications were produced from 2000 to 2024. In The Beginning, The Number of Publications Was Still Pretty Low 0.69%, By 2005, The Cumulative Percentage Had Risen to Only 5%, Indicating That Research Activity Was Limited In the Early Stages.

o. The Highest Levels of Research Productivity Were Recorded in the Most Recent Years: 2020: 277 Publications (7.64%); 2022: 276 Publications (7.61%); And 2024: 297 Publications (8.19%), Which Were the Highest Over the Entire Period.

p. The AGR shows that research output increased from 87 (2000) to 187 in 2004. Year 2016 shows a growth rate of 22.91%, which was followed by 13.06% in 2017. This period coincides with a significant increase in IIT research productivity. Despite AGR fluctuations, the consistent increase in cumulative publication frequency confirms the ongoing strengthening of research output at all IITs, indicating long-term institutional stability and sustained scholarly productivity.

q. CAGR shows a clear pattern of long-term growth with a gradual decline in the annual growth rate over time. The initial years of 2000 to 2005 saw a relatively high growth rate, with CAGR falling from 12.3% in 2000 to 8.1% in 2005. This indicates a strong expansion phase.

r. The overall trend shows a decreasing CAGR with an increasing cumulative frequency, indicating that the publication has grown steadily. Overall CAGR 2000 to 2024 is around 12.8%, indicating a strong long-term growth trend despite a gradual decline in annual growth percentages in later years.

s. The initial rapid growth stage was indicated by an RGR of 0.76 in 2001. The RGR declined from 0.53 to 0.24 between 2002 and 2008, indicating a stabilization in

publication growth. Indicating moderate long-term growth, the mean RGR for the entire period is approximately 0.22.

t. The DT was 0.92 in 2001, indicating the number of publications doubled in less than one year. DT experienced a substantial increase from 2018 to 2024, culminating in a value of 7.58 years in 2024. The publication output, on average, doubled every four years during the study period, as indicated by the mean doubling time of approximately 4.12 years.

u. In the case of Journal articles, RGR reveals a decreasing trend over time. During 2000 to 2005, RGR was at its highest in 2001 (0.74), which was indicative of the rapid expansion of journal article output. The RGR declined from 0.16 in 2015 to 0.10 in 2024. The rate of exponential growth decreased, despite the high annual output of 1082 articles in 2024.

v. The consistent decrease in RGR suggests that, despite an increase in productivity, the rate of growth has decreased over time, suggesting a transition from expansion to consolidation. RGR is inversely related to Doubling Time (DT), which exhibits an increasing trend. The total number of journal articles increased markedly from 74 to 12,537, which signifies long-term productivity.

Objective 2: To find out the most productive authors, journals, and research areas.

a. The overall findings show that Swagata Mukherjee (IIT Kanpur) is the most prolific faculty 1104 publications, a h-index of 112, and 60,723 citations. Dash, Sadhana (IITB) with 608 publications, an h-index of 110, and 42,979 citations.
b. Among all the faculties, Pai, Archana (IIT Bombay), is ranked eighth in productivity (208 publications), with the highest citation count (81,077) and a high h-index of 86.
c. The findings shows that Dash, Sadhana (IITB), is the most prolific faculty with 608 publications, 42,979 citations, and an h-index of 110. Pai, Archana, has the highest citation impact (81,077 citations) and an h-index of 86.
d. The findings show, as Das, Amita R. (IITD), is the most productive faculty with 342 publications, 6,855 citations, and an h-index of 41. Followed by Ashu

Kumar Verma with 174 publications, and citation impact (2,590 citations; h-index 27).

e. The findings show Swagata Mukherjee (IITK) is the most prolific author, 1104 publications, 60,723 citations, and an h-index of 112; Vijaya Ramarao has 159 publications. Ateeq, Bushra is the most impactful author, with 7,558 citations.
f. The findings show Banerjee, Rintu (IITKGP), as the most prolific author with 229 publications, 8,713 citations, and an h-index of 51. Dutta-Majumdar, Jyotsna, with 216 publications, 6,813 citations, and an h-index of 43.
g. In case of IITM, Venkitesh, Deepa is the most prolific faculty with 273 publications, 999 citations, and an h-index of 14. Philip Ligy has a significant research influence of 7,744 citations.
h. The results shows that “Lecture Notes in Computer Science (including subseries)”, published by Springer Verlag (341 articles), followed by Journal of High Energy Physics (182 articles), Physical Review D (171), Physics of Plasmas (168 articles), and Physical Review Letters (149 articles). The list is followed by The Economic and Political Weekly's (112 articles).
i. The article “Observation of Gravitational Waves from a Binary Black Hole Merger” (2016), published in Physical Review Letters, has 12,274 citations, the most cited article of IITB.
j. The article of IITD "A microRNA signature of hypoxia," published in Molecular and Cellular Biology (2007), has 972 citations.
k. "Efficient lattice (H) IBE in the standard model" (2010), published in Lecture Notes in Computer Science, has 843 citations. (IITM)
l. "Guided wave-based structural health monitoring: A review" (2016), published in Smart Materials and Structures, with 1,005 citations. (IITKGP)
m. "The mutational landscape of lethal castration-resistant prostate cancer," published in Nature (2012), received 2,159 citations. (IITK

Objective 3: To study the pattern of authorship collaborations between authors and impact by using different index measures.

a. The findings reveal a substantial increase in research output, rising from 87 in 2000 to 1577 in 2024. The distribution of publications by number of authors shows a

clear dominance of collaborative research. Out of the total 18,030 publications, single-author contributions account for only 635, 3.52%. Collaborative authorship constitutes the majority of publications. Double-authored 4334 (24.04%) and triple-authored 4367 (24.21%) papers together represent nearly half of the total output. Notably, multiple-authored publications 8691 (48.23%) form the largest share.

b. The findings show that multi-authored publications comprise nearly half (48.21%) of the total research output. In all institutes, multiple-authored papers account for the majority of publications. The Degree of Collaboration (DC) varies greatly across institutes, ranging from 0.95 to 0.98, implying that more than 95% of publications are collaborative.

c. The authorship distribution shows that single-author publications account for only 3.52% (635 out of 18,030) of the total output. Conversely, collaborative authorship dominates the dataset.

d. The Degree of Collaboration has increased from 0.35 in 2000 to 0.52 in 2024, which indicates a significant transition from solo-authored research to collaborative research.

e. Collaborative Index has risen from 2.82 in 2000 to 3.23 in 2024, indicating an increase in the average number of authors per paper. A CI value above 3 suggests that most publications involve more than 4 authors.

h. Degree of Collaboration and Collaborative Index of IITB (2000 to 2024), produced 4,730 publications, 143 single authors, 853 double authors, 1,010 triple authors, and 2,721 multiple authors. DC ranged 0.12 - 0.29, & modest CI of 2.3-2.8 indicates a low level of collaboration. The highest DC (0.65) was measured in 2023; CI also attains a high value of 3.48, indicating nearly 3.8 authors per paper.

i. Degree of Collaboration for IIT KGP, during 2000–2002, varied between 0.74 and 0.89, signifying robust collaboration. The peak DC values (0.99) were recorded in 2009, 2012, 2013, 2019, and 2023, signifying nearly total prevalence of co-authored publications. The CI values span from 2.53 to 3.19, indicating a moderate to strong team size.

j. Degree of Collaboration and Collaborative Index for IITK shows a total of 2,418 publications and a notable upward trajectory over time. During the 2000-2010 period, DC was comparatively low, fluctuating between 0.10 and 0.50; maximum DC (0.81) was documented in 2018, signifying a strong collaborative intensity. The peak CI (3.68) was found in 2018, signifying extensive collaborative research teams.

e. The Degree of Collaboration varies greatly across institutes, ranging from 0.95 to 0.98, implying that more than 95% of publications are collaborative. IIT Kanpur and IIT Madras have the highest collaboration level (DC = 0.98). The CI ranges from 2.99 to 3.40, with IIT Kanpur having the highest CI (3.40), indicating a larger average number of authors per paper.

f. The results show that IIT Bombay produced 4,730 publications, with 143 single authors, 853 double authors, 1,010 triple authors, and 2,721 multiple authors. The majority of publications have multiple authors. DC ranged between 0.13 and 0.31 in the early years (2000-2005), indicating a relatively low level of collaboration. Since 2008, DC has exceeded 0.48, indicating a significant increase in co-authorship. From 2016 to 2024, DC remained consistently high, ranging between 0.53 and 0.66. The highest DC (0.66) was measured in 2023.

g. IIT Delhi published 3,629 papers, with 214 single authors, 889 double authors, 1,055 triple authors, and 1,471 multiple authors. The DC values range from 0.25 to 0.58, indicating moderate to strong collaboration. The highest DC (0.58) was recorded in 2002. The CI values range from 2.68 to 3.24, implying an average of nearly three authors per paper.

h. IIT Kanpur produced 2,418 publications from 2000 to 2024, comprising 62 single authors, 488 double authors, 301 triple authors, and 1,567 multiple authors. The maximum DC (0.81) was documented in 2018. The peak CI (3.68) was documented in 2018, signifying extensive collaborative research teams.

i. IIT Kharagpur has 3,628 publications, including 133 single-author, 1,115 double-author, 1,008 triple-author, and 1,372 multiple-author works. The peak DC values (0.99) were recorded in 2009, 2012, 2013, 2019, and 2023, signifying nearly total prevalence of co-authored publications. The CI values span from 2.53 to 3.19,

indicating a moderate to strong team size. The peak CI (3.19) was observed in 2023, signifying marginally larger collaborative groups in recent years. Consistent CI values near 3.0 affirm a robust culture of collaboration and teamwork.

Objective 4: To visualize the national and international collaborations of publications and their impact using scientific measures.

a**.** Notably, multiple-authored publications (48.23%) form the largest share, demonstrating the growing importance of large-scale collaboration.

b. The Collaboration Index (CI), value rose from 2.82 in 2000 to 3.23 in 2024, indicating that the average team size has grown over time.

c. The analysis of co-authorship of countries IITM shows the mostly collaborated countries are found to be with the US, UK, Germany, and Japan, etc.

d. The analysis of co-authorship of authors (IITM) shows the strength of the co-authorship. And most collaborating faculties are found to be among Venkitash Deepa, Philip Liggy, Arunachalam Kavitha, Dasgupta Nandita, Lakshminarasamma M, sarkar Sunetra.

e. IITB is found to have collaboration with 113 countries, and with only 62 countries, collaboration is found to be too strong and greatest, which are the US, UK, Australia, France, South Korea, Singapore, and Taiwan.

f. Co-authorship of IITB was shown to having the strongest link strength among 418 authors. Baghini Maryam Shojai, Shukla Shobha, Mukherjee Asmita, Rao Preeti, Indu j, Bhattacharya Amrita, and Venkataraman Chandra are the most collaborating authors.

g. IITD is found to have collaboration with 61 countries, Germany, the UK, Australia, Canada, Japan, Switzerland, Italy, Singapore, Croatia, etc.

h. Co-authorship of the authors of IITD found that 893 authors seem to have the greatest link strength of collaboration. Which is Upadhyayula Shreedevi, Chakraborty Tanushree, Verma Priyanka, Sinha Aloka, Verma Ashu, Sharma Shilpi, Das A, Joshi Mangala, Mehra Aparna, etc.

i. IIT KGP has collaborations with 35 countries, including the UK, France, Switzerland, Australia, Poland, South Korea, Norway, South Africa, etc.

j. IIT KGP has found to be collaborating with 870 authors, DasGupta Swagata, Banerjee Rintu, Chakraborty Debjani, Jenamani Mamata, Sarkar Sudeshna, Mukherjee Jenia, Singh Chandrani, etc. have the most collaboration.

k. The greatest Co-Authorship of Countries of IITK found to be 127 countries; Germany, France, Switzerland, Belgium, Poland, UK, Italy, Ireland, Israel, etc.

l. Strongest link strength of co-authorship is found among 301 authors, Ateeq Bushra, Tripathy Twinkle, Goel Ayush, Parveen Nagma, Chatterjee Urbi, Vijaya R, Katiyar Monica, Gupta Nandini, etc. (IITK).

Overall, it has been found from the findings that 168 countries participated in the research collaboration. By putting the data into the VOSviewer software with the simple algorithm by ignoring the documents co-authored by a large number of countries, 67 countries are found to be the greatest in link strength of the co-authorship. The greatest group of collaboration networks is found among 39 countries. Which are India, Austria, Bangladesh, Bulgaria, Chile, Colombia, Denmark, Egypt, Ethiopia, etc. The collaboration network of co-authorship is developed using the VOSviewer by ignoring the documents with a large number of authors. The networks are generated using data fed into VOSviewer, and to create network maps, the normalization method used is “Association Strength. " Authors with at least 5 publications are included to define the network.

Objective 5: To analyze the trends of research themes over the years by analyzing keywords.

a. The co-occurrence of keywords was developed using the VOSviewer software tool by considering the algorithm “Association Strength”, and taking the number of occurrences of keywords as 10 times. In case of IIT Madras, a total of 27887 keywords were found, where keywords with the greatest link strength of the co-occurrence links with the other keywords are found to 909 and have the greatest

link strength. The keywords in the centre are computer simulation, drug theory, biodegradation, wastewater treatment, etc.

b. Keywords' co-occurrences of IIT Delhi show the core research theme is centred around nanocomposites, scanning electron microscopy, unclassified drugs, and catalyst activity, which links multiple subfields. Other research areas are neutron diffraction, nanocomposites, nematic liquid crystals, unclassified drug, computer simulation, finite element method, genetics, temperature, nanoparticles, etc.
c. The areas evolving and appearing to be more prominent research areas among the female faculty of IIT Bombay during the study period are article, Controlled study, human, Priority journal, CMOS integrated circuits, speech recognition, carbon, photon, female, genetics, crystal structure, etc.
d. The areas appear to be more prominent research areas among the female faculty of IIT KGP are article, Controlled study, Chemistry, scanning electron microscopy, human, speech recognition, carbon, photon, enzyme activity, Microstructure, etc.
e. Keywords' co-occurrences of IIT Delhi show that the core research theme is centred around nanocomposites, scanning electron microscopy, unclassified drugs, and catalyst activity. The other research areas are neutron diffraction, nanocomposites, nematic liquid crystals, unclassified drug, computer simulation, finite element method, genetics, temperature, nanoparticles, etc.

The map created by VOSViewer depicts a highly interconnected research landscape. The results depict a highly interconnected research landscape. The proximity and concentration of nodes reflect strong interdisciplinary links among key research themes. The keyword co-occurrence network depicts a multidisciplinary research framework. The overall keyword frequency distribution shows that the research is very interdisciplinary, with a strong emphasis on life sciences, chemistry, and engineering applications. The prevalence of experimental terms and advanced analytical techniques suggests a strong empirical and scientific research orientation, while the frequent mention of India indicates a significant regional research contribution.

Testing of the hypothesis

For The Study, Two Hypothesis Were Formulated Listed Below. To Investigate the Correlation Between Publication and Date of Joining, the Pearson Correlation Test Was Deployed. The Significance of the Correlation Coefficient Was Evaluated Using a Paired T-Test, As the Dataset Satisfies the Conditions of Normality and Independence.

Hypotheses

1. There is a correlation between the number of publications with the date of joining.
2. There is a significant citation variation between open-access publications and closed-access publications

Hypothesis	Variable Studied	Test Used	Value	P-Value	Decision
H1	Publications Vs Joining Date	Correlation Analysis	R=0.171162	1.63×10^{-16}	Accepted
H2	Open Access Vs Closed Access	Comparative Analysis(T-Test)	Significant Variation Observed	<0.05	Accepted

Analysis Of Correlation and Coefficient

The analysis shows that H1 shows a weak but statistically significant correlation, while H2 confirms a significant difference between open access and closed access publication in citation count.

The correlation analysis shows a weak positive relationship (r=0.171162) between publications and joining date. This results in the faculty who have joined earlier tend to have more publications. However, the p-value (1.63×10^{-16}) is very low, confirming that the result is statistically significant. Therefore, H1 is accepted.

The comparative analysis was done using a t-test, which indicated a significant difference in citation counts between open-access and closed-access publications. Since the p-value is less than, the accessibility of publications plays a crucial role in influencing citation impact.

However, it can be concluded that both hypotheses are accepted. While H1 demonstrates a statistically significant but weak relationship, H2 highlights a meaningful difference in citation patterns, emphasizing the importance of open access in enhancing research visibility and impact.

6. Discussion

The study presents an investigation based on scientometrics tools of the research productivity of women faculty of IITs in India. The application of scientometrics turns out to be an effective and reliable means for understanding the current status and forecasting the future perspective in the domain of any research domain. An enriched scientometric technique is the creation of network visualization maps by using tools meant for the purpose, like VOSviewer and Biblioshiny. The maps are created based on information and computer science, scientometrics, and analysis of these figures; this highlights the process and thematic relationship of knowledge in research areas. Chapter 1 provides a brief overview of the study and includes the core portion that defines the research work. It consists of the introduction of the research topic, scope, significance, methodology, research gap, objectives, and chapterization of the study. The second chapter provides the analysis of previously published articles and research work, as the study of the background provides the detail observation of the research study. By using platforms such as Research Gate, Google Scholar, Scopus database, and Mendeley, the literature search has been done with extreme care and appropriate terms to collect the literature related to the scientometrics and bibliometric analysis. The study of literature provides the research gap in any particular subject area. Chapter 3 provides a brief overview of communication and further scholarly communication. The research publication, or the research output, is an important factor in academia. It provides a major link for communication among the research and academic communities. knowledge economy, scientific research, and technological developments are considered key factors in the development of a country like India. Scientific research is an information-producing activity, and the essence of which is communication. The dissemination of the accomplished result is the initial stage in communication via publications. Chapter 4 provides the profile of the IIT's and their contribution

towards the community and nation. It gives an overview of the top 5 NIRF-ranked IITs. The chapter also provides the list of all the IIT's along with their address and establishment year. Chapter 5 is the major part of the study as it provides the analysis and interpretation part. The growth and trend of research productivity of women faculty have been analyzed by using different scientometric indicators. The visualization tools, such as VOSViewer, are used to analyze and visualize the collaboration and co-authorship of the authors and journals at the national as well as international level. The Biblioshiny by R was used to conduct the keyword analysis based on co-occurrences, overlay, density visualization, and analysis of trending topics. Chapter 6 provides the findings based on the analysis of the faculty data extracted from the Scopus database.

6. Suggestions

Based on the research work and analysis of the study, these are the suggestions that were advocated:

1. Authors need to publish articles. on their own, or there is a need to write articles

2. There is a need to maintain consistency in publication, as it is noticeable that even though the author is highly cited, they are not consistent in their publications.

3. It has been found from the analysis that the fields of engineering and science have a great coverage of publications compared to social science and humanities. Therefore, it is suggested that faculty from the humanities publish more of their research work in their respective subject areas.

4. It is observed from the study that many of the faculty's profiles and CVs are missing from the institute website and are nowhere to be found. So, the faculty members need to maintain a research profile that is accessible to other researchers when in need

5. To increase the accessibility of the scholarly findings, it is recommended that faculties maintain a profile in Scopus and other research platforms.

6. It is also recommended that the institute maintain a directory of faculty members along with their details (CV), which should include their researcher ID, Scopus ID,

and Google Scholar ID, and an updated list of research publications. The accessibility to that information will increase the visibility and help those in need.

7. Based on the findings of the study, it is noticeable that articles constitute a large area of publication. So, it is recommended that the faculty consider publishing in other formats of publication as well.

8. The institutes can systematically maintain their websites by arranging the schools, departments, and centers.

9. The faculties can also consider having a profile in IRINS, as it is a web-based Research Management Service to showcase their academic output and its impact.

6.4 Conclusion

Communication is essential for human beings. It involves exchanging information, ideas, thoughts, and personal feelings. Scholarly communication refers to the system through which academic knowledge is created, evaluated, disseminated, and preserved. Communications play an important role in advancing knowledge, which involves researchers, institutions, publishers, and libraries. Advances in technology are transforming scholarly communication. Because of this, accessing and storing information has gradually become easy. Earlier, the communication was mainly limited to printed resources, but modern platforms and equipment made it more reliable and accessible. The channels of communication mainly include journals (printed or electronic), books, conference papers, book chapters, theses and dissertations, institutional repositories, and various digital platforms. Traditional scholarly communication was primarily print-based, with limited access, and as a result, dissemination was quite slow. Today, digital platforms have made information widely available to everyone, which enables readers to have easier access and reach a wider audience in a short period of time.

A research paper is a standard way of presenting research findings or new information in any subject area, based on scientific experiments and observations. The global research landscape is gradually changing. Science and technology research is a dynamic and rapidly evolving field, supported by a combination of

government initiatives, private sector investments, and academic excellence. In the contemporary era, accessing scholarly publications is one of the key concerns of information professionals. Evaluating published scholarly communication helps us understand research trends and the social and intellectual structures of a particular subject domain. The performance of scholars and scholarly communication can be evaluated through impact factors, which indicate the performance and value of a contribution. The impact of research or scholarly activities can be estimated by citation counts, journal impact factors, and other citation-based impact values. In a premier institution like IIT, scholarly communication plays a key role in advancing scientific and technological innovations. IITs are institutions of national importance established to promote innovation, research, and leadership in technical fields. They are widely recognized for their expertise in engineering, science, and technology-enhanced education. In a country like India, women's participation in all fields is very low, but it is gradually increasing. Nowadays, no particular subject area has been left untouched by women. They are actively participating, demonstrating their talent, and contributing in every field, including education, research, politics, sports, etc. However, even though education has improved the status and roles of women in society, the number of women participating in higher institutions remains low. To understand their position and impact in academia, it is necessary to examine the performance trends of research output and productivity among women. In the field of Library and information science, many research assessment metrics have evolved, including Librametrics, bibliometrics, scientometrics, infometrics, and webometrics. Significantly, bibliometrics and scientometrics have been the primary tools used for measuring authors and research, and have evolved into computational measurement and scientific mapping.

This study presents a detailed analysis of the research productivity of women faculty of the top five NIRF-ranked IITs, which are IIT Madras, IIT Bombay, IIT Delhi, IIT Kharagpur, and IIT Kanpur. The findings from each objective of the study shed light on essential facets of the academic landscape. Many faculties have engaged in publications in the Scopus-indexed journals. Among the faculty members, assistant professors formed the largest group (131), followed by professors and associate

professors. The study also highlights the disparities among the faculties and institutions. Among the top five IIT's, the IIT Bombay is the most productive institution based on the study findings, with the most Scopus-indexed publications. profesors tend to have more publications despite their small number than assistant professors. The reason may be their experience and expertise as well as collaborating tendency. The year-wise distribution shows an increased scholarly output, with 2024 being the most prolific year with 1577 publications. In case of citation also, during the study period, IIT Bombay ranks at the top of the list with a total of 240949 citations. The departmental distribution of scholarly output also reveals a preference for Science and Technology disciplines. The findings of the study demonstrate a strong awareness of open-access publishing among faculty members, with a notable percentage confident in accessing and distributing scholarly materials online.

The findings show that multi-authored publications comprise nearly half (48.21%) of the total research output. In all institutes, multiple-authored papers account for the majority of publications, which implies that more than 95% of publications are collaborative. The keyword co-occurrence network depicts a multidisciplinary research framework mainly centred on biomedical sciences, environmental studies, materials science, and chemistry. The overall keyword frequency distribution shows that the research is very interdisciplinary. At last, the study highlights the growth of research productivity of women faculty of various disciplines of the top five IITs and their research impact. It also emphasizes the need for participation among the women faculty members in research activities and, most importantly, the need for the recruitment of women faculty. Additionally, the study provides valuable information for stakeholders to make decisions regarding the scholarly communications made by women faculty of the top five Indian Institutes of Technology.

9. Prospects of future research

Based on the study, the following scope for research has been suggested for research professionals:

1. The present study is confined only to the data available in the Scopus database. However, there are other platforms as well (WoS, Google Scholar, Dimensions, IEEE Explore, etc) which can also be considered to conduct further studies.

2. The researchers can also initiate and conduct studies on other IIT's based on other rankings, and also conduct comparative analysis among them as well.

3. There is also a scope to conduct the altmetric aspect of research publication.

4. The study is confined only to research publications of women faculty, so there may be some comparative studies among the male and female faculty members.