# Trends and Trajectories in India's STEM Research for the period 2014-2023: A Scientometric Study

A Research Report from DST-CPR, IISc, Bengaluru

Authors: Dr. Avinash Kumar
Dr. Chandan G N
Dr. Moumita Koley

DST Centre for Policy Research
Indian Institute of Science
Bengaluru

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This report is compiled by Dr. Avinash Kumar, Dr. Chandan GN and Dr. Moumita Koley

Bengaluru, June 2026

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सत्यमेव जयते
प्रो. अभय करंदीकर
Prof. Abhay Karandikar

सचिव
भारत सरकार
विज्ञान एवं प्रौद्योगिकी मंत्रालय
विज्ञान एवं प्रौद्योगिकी विभाग
**Secretary**
**Government of India**
Ministry of Science and Technology
**Department of Science and Technology**

08th May, 2026

## FOREWORD

It gives me immense pleasure to present this report titled "Trends and Trajectories in India's STEM Research, 2014–2023: A Scientometric Study", prepared under the aegis of the Department of Science and Technology (DST), Government of India. This report is the outcome of exploratory research undertaken by the team at the DST Centre for Policy Research (DST-CPR), Indian Institute of Science (IISc), Bengaluru. It builds on the Centre's sustained engagement with bibliometric and scientometric approaches to better understand the structure, growth, and impact of India's scientific ecosystem.

The report reflects the dedication and scholarly rigour of the research team, as well as the guidance and support received from mentors, peers, and collaborating institutions. I hope that this work will be of value to policymakers, researchers, and other stakeholders engaged in the domains of science, technology, and innovation. The in- sights presented here are expected to inform ongoing policy discussions, stimulate further inquiry, and serve as a useful resource for students, scholars, and practitioners.

I commend the research team for their commitment, perseverance, and analytical depth in carrying out this study. It is my hope that this work will contribute to strengthening India's STI policy ecosystem and encourage continued research and innovation in the field of scientometric and bibliometric studies.

(Abhay Karandikar)

**Technology Bhavan, New Mehrauli Road, New Delhi - 110016**
**Tel: +91 11 26511439 / 26510068 | Fax: + 91 11 26863847 | e-mail: dstsec@nic.in | website: www.dst.gov.in**

# Acknowledgements

This Report distils the results from our ongoing research projects at the Centre for Policy Research (DST-CPR), Indian Institute of Science (IISc), Bengaluru. Covering the 10-year period from 2014 to 2023, it traces the evolution of India's STEM research landscape viewed primarily through its journal publications. Scientometric analysis has been a central research theme at the DST-CPR at IISc right since its inception in 2014. Thus, we are pleased to contribute to the Centre's research under this theme and present a summary of some of our key results in this Report.

We express our profound and heartfelt gratitude to Prof. Abhay Karandikar, former Secretary, Department of Science and Technology, Government of India, for penning an appreciative foreword to this Report. His interest has been pivotal in shaping and advancing our work. We thank him for his support and encouragement.

We express our sincere gratitude to the DST Centre for Policy Research (DST-CPR) at the Indian Institute of Science (IISc) for the opportunity to apply a scientometric / bibliometric lens to the studies presented in this report. We are grateful to the Department of Science and Technology (DST), Government of India, for financial support for this work through DST-CPR at IISc.

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(DST-CPR Team)

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# Acronyms

| | |
|---|---|
| **AI** | Artificial Intelligence. |
| **ANRF** | Anusandhan National Research Foundation. |
| **ARP** | Article, Reviews, Proceedings. |
| **BHU** | Banaras Hindu University. |
| **BITS** | Birla Institute of Technology & Science. |
| **BRICS** | Brazil, Russia, India, China, South Africa. |
| **CAGR** | Compound Annual Growth Rate. |
| **CPP** | Citations Per Paper. |
| **CPR** | Centre for Policy Research. |
| **CSIR** | Council of Scientific & Industrial Research. |
| **CWTS** | Centre for Science and Technology Studies. |
| **DAE** | Department of Atomic Energy. |
| **DBT** | Department of BioTechnology. |
| **DoS** | Department of Space. |
| **DRDO** | Defence Research and Development Organisation. |
| **DST** | Department of Science & Technology. |
| **ERA** | European Research Area. |
| **FWCI** | field-weighted citation impact. |
| **G20** | Group of Twenty. |
| **GII** | Global Innovation Index. |
| **HHS** | Department of Health and Human Services (US). |
| **ICAR** | Indian Council of Agricultural Research. |
| **ICMR** | Indian Council of Medical Research. |
| **IDN** | INDONESIA. |
| **IIITs** | Indian Institutes Information Technology. |

| | |
|---|---|
| **IIMs** | Indian Institutes of Management. |
| **IISc** | Indian Institute of Science. |
| **IISERs** | Indian Institutes of Science Education Research. |
| **IITs** | Indian Institutes of Technology. |
| **ISI** | Institute for Scientific Information. |
| **ISIs** | Indian Statistical Institutes. |
| **JIF** | Journal Impact Factor. |
| **KIIT** | Kalinga Institute of Industrial Technology. |
| **KISTI** | Korea Institute of Science & Technology Information. |
| **LLMs** | Large Language Models. |
| **MAHE** | Manipal Academy of Higher Education. |
| **ML** | Machine Learning. |
| **MoE** | Ministry of Education. |
| **MoH&FW** | Ministry of Health and Family Welfare. |
| **NCBS** | National Centre for Biological Sciences. |
| **NEMMP** | National Electric Mobility Mission Plan. |
| **NGHM** | National Green Hydrogen Mission. |
| **NIH** | National Institutes of Health (US). |
| **NIRF** | National Institutional Ranking Framework. |
| **NITs** | National Institutes of Technology. |
| **NM-ICPS** | National Mission on Interdisciplinary Cyber-Physical Systems. |
| **NPAI** | National Program on Artificial Intelligence. |
| **NQM** | National Quantum Mission. |
| **NSF** | National Science Foundation (US). |
| **NSFC** | National Natural Science Foundation of China. |
| **NTIS** | National Science & Technology Information Service. |
| **PfPIs** | Publicly Funded Premier Institutes. |
| **Q1** | First Quartile. |
| **Q2** | Second Quartile. |
| **Q3** | Third Quartile. |
| **Q4** | Fourth Quartile. |
| **REF** | Research Excellence Framework (UK). |
| **S&T** | Science and Technology. |
| **SAARC** | South Asian Association for Regional Cooperation. |

| | |
|---|---|
| **SERB** | Science and Engineering Research Board. |
| **SRM** | SRM Institute of Science & Technology. |
| **STEM** | Science, Technology, Engineering and Maths. |
| **STI** | Science, Technology, and Innovation. |
| **SWZ** | SWITZERLAND. |
| **THE** | Times Higher Education. |
| **TiO2** | Titanium Dioxide. |
| **UGC** | University Grants Commission. |
| **UK** | United Kingdom. |
| **UKRI** | UK Research & Innovation. |
| **US** | United States. |
| **USA** | United States of America. |
| **VIT** | Vellore Institute of Technology. |
| **WoS** | Web of Science. |
| **YoY** | Year-on-Year. |
| **ZnO** | Zinc Oxide. |

# KEY POINTS

## Research Publications (STEM) of India between 2014-2023

1348569 Total publications: 5.86% of global contribution

Global publications: 23016602
China: 5358834 (23.28%) & USA: 4969568 (21.59%)

By 2022, India had emerged as the world's third-largest producer of scientific publications.

China ranked 1st & USA ranked 2nd

Focus: Three broad research domains account for the largest share of India's scholarly output

Clinical & Life Science (1), Chemistry (2), and Electrical Engineering, Electronics & Computer Science (3)

Focus: The most frequently researched topics among Indian researchers are

Nano-fluids, Nano-toxicology, Wireless-Sensor Network

# KEY POINTS

## Research Publications (STEM) of India between 2014-2023

### Top three collaborating countries:

United States of America, United Kingdom and China

### International collaboration is getting stronger than domestic collaboration

Industry collaboration remains low, far lower than other leading knowledge producing countries

### Collaboration positively impact citation metrics

Domestic collaborative publications receive lower citation per papers than international & Industry collaborative ones

### Top five funding agencies: DST, CSIR, UGC, DBT, SERB

Based on funding acknowledgement data appearing in publications

### Among the BRICS countries India ranks 2nd in publication number

China is leading in quantity, while South Africa has highest citation per paper

### Private institutions are steadily narrowing the gap with public institutions in terms of publication output

In 2021, Private institutions crossed the contribution from MoE institutions

# 1

# Introduction

## 1.1 Introduction

The past decade has witnessed significant transformations in the global research landscape, with progress in scientific knowledge production and increasing international collaboration. As a rising global player in science and technology, India has made considerable progress in its research publications. The country is now one of the world's leading contributors to scientific knowledge and has improved its global position, climbing from 7th in 2010 to 3rd in 2022 (Figure 3.5). The number of patents granted to Indian scientists has also significantly risen, jumping from 2,511 in 2018-19 to 25,082 in 2023-24[1]. This upward trend is further reflected in India's ranking on the (gii) 2022, which improved from $81^{st}$ in 2015 to a commendable with India ranking $38^{th}$ in the GII 2025 and emerging as the top-ranked economy among the 10 in Central and Southern Asia, highlighting its growing influence and strength in innovation and research[2]. Along with the quantity, the country is showing promise in quality. India now ranks $9^{th}$ in the Nature Index[3].

This report presents a scientometric assessment of India's research performance from 2014 to 2023, based on InCites (Web of Science) data. Scientific publications—key indicators of knowledge creation—offer insights into research productivity, visibility, and impact. By benchmarking India against the world's top 10 knowledge producers and international groupings such as the G20 and BRICS, the analysis highlights India's strengths, emerging opportunities, and pressing challenges within the global research ecosystem. Designed as a resource for policymakers, funding agencies, and the academic community, the report provides an evidence base to guide strategic investments, foster collaboration, and inform decisions in science, technology, and innovation (STI). It examines India's research ecosystem through multiple dimensions: growth in publications, citation impact, journal quality, institutional contributions, funding agency roles, collaboration patterns, and discipline-specific trends. India's

[1] Source: Indian Patent Office (IPO) Annual Report 2024-2025 https://ipindia.gov.in/storage/uploads/media/English_Annual_Report_2024-25.pdf
[2] Source: https://www.wipo.int/edocs/gii-ranking/2025/in.pdf
[3] Source: https://www.nature.com/nature-index/research-leaders/2024/country/all/global

rising global footprint underscores its potential, yet debates persist around quantity versus quality of research, mission-driven versus curiosity-driven inquiry, and balancing national priorities with global challenges. Addressing these tensions requires rigorous, data-driven assessment. The establishment of the Anusandhan National Research Foundation (ANRF) in 2023 reflects a renewed national commitment to building a dynamic research ecosystem through stronger academia–industry–government linkages. This report aims to support that ambition by offering actionable insights for both policy and practice.

The key areas of analysis include:

- **Quantitative Growth :** Trends in India's publication output over the past decade, with international benchmarking against leading countries and groupings..
- **Research Quality & Impact :** Citation performance, share of highly cited papers, and journal quality indicators (quartiles and impact factors).
- **Institutional Contribution :** Comparative analysis of contributions from different institutional settings; highlighting the contribution from MoE institutions, Central & state universities and private institutions of the country.
- **Collaborative Aspects :** Measurement of the extent of domestic, industrial, and international collaborations in India and collaboration with other leading knowledge-producing countries using co-authorship as a proxy.
- **Focused Research Areas :** Identification of India's core areas of scientific excellence, global strengths, emerging disciplines, and potential niches by analyzing citation topics.
- **Funding Impact :** Exploration of the contributions of key funding agencies in driving India's research output and its quality, as measured by citation metrics.

While the present report provides a comprehensive overview of India's publication landscape, it should be noted that, to maximize the impact of such study, it is vital to recognize that scientometric studies cannot be one-off exercises, but needs to be performed in a regular interval. Regular scientometric reporting enables policymakers to monitor emerging trends, assess policy effectiveness, and adjust priorities in real time. Scientific and technological frontiers evolve rapidly—fields such as artificial intelligence, quantum technologies, and climate science, once peripheral, have now become central to global competitiveness and national security. Tracking these shifts systematically allows India to align funding with emerging opportunities, benchmark progress against peers, and ensure responsiveness to fast-changing global dynamics. Internationally, several countries have already institutionalized scientometric reporting as an important exercise of science policy. The U.S. National Science Foundation publishes Science and Engineering Indicators biennially to track output, impact, and innovation. The United Kingdom's Research Excellence Framework (REF) regularly assesses research quality, shaping funding decisions and ensuring accountability. The European Union's ERA Progress Reports monitor member states' research performance and cross-border collaboration to align with EU-wide priorities. Similarly, China and South Korea conduct periodic national bibliometric evaluations to guide strategic investments in priority domains. For India, embedding scientometric reporting into a regular cycle would strengthen continuity, comparability, and long-term strategic planning. Beyond enhancing transparency, it would position the country to compete more effectively in the global knowledge economy. By institutionalizing such reporting, India can ensure that its expanding research base not only contributes to global scholarship but also advances national development priorities—from health and sustainability to digital transformation and inclusive growth.

### 1.1.1 Previous Studies

- In 2012, A report was prepared by Elsevier [4] for the DST on India's Scientific Research from 2006 to 2010. Keyhighlights from the study are,
  - In 2010, India produced 65,487 scientific publications, representing 3.4% of the world's output, up from 2.5% in 2006.
  - Four Indian subject areas showed above world average citation impact: Energy (1.26), Chemical Engineering (1.18), Engineering (1.04), and Materials Science (1.01).
  - India's overall world normalized citation impact was 0.68 in 2006-2010, below the world average of 1.0 but an improvement from 0.58 in 2002-2006. The quality of Indian research ranked above Russia, China, and Iran, but below Brazil and significantly below the US, UK, Israel, Singapore, and South Africa.
  - India's research output is concentrated in Medicine, Chemistry, Physics & Astronomy, Engineering, and Materials Science, but many of these show below world average citation impact, notably Medicine (0.52).
  - International collaboration was relatively low for India at 17.6% of publications having at least one international co-author, similar to Iran and higher than China (13.1%), but much lower than countries like South Africa and Singapore (both over 43%).
- The DST commissioned bibliometric study in 2015 [5] of India's research output and collaboration analyzing for the period from 2005 to 2014, carried out by Thomson Reuters based on Web of Science data. A few highlights from the study are,
  - Growth in Output: India's research output doubled from about 25,000 papers in 2005 to over 52,000 in 2014. In all fields combined, India produced around 407,276 papers in 2005-2014, ranking 8th among established research economies and 3rd overall including emerging economies.

[4] Source: International Comparative Performance of India's Scientific Research https://www.nstmis-dst.org/pdfs/InternationalComparativePerformanceIndiaDecember11th.pdf

[5] Source: India's Research Output and Collaboration (2005-14) https://www.nstmis-dst.org/Pdfs/Thomson.pdf

- Share of World Output: India increased its share from 2.65% in 2005 to 4.05% in 2014, significantly faster growth than many established countries.
- Fields of Focus: India's major contributions are in Chemistry, Physics, Engineering, Materials Science, and Clinical Medicine, with marked growth in Psychiatry/Psychology, Economics, Pharmacology, and Molecular Genetics.
- Citation Impact: India's citation impact is below the world average (normalized citation impact 0.72-0.74 in recent years), generally lower than established countries but higher than some emerging economies like Brazil and Russia.
- Highly Cited Papers: India produces fewer highly cited papers than the world average in all fields and thresholds but shows improvement in some areas over time.

- In 2016, the DST commissioned another study "International Comparative Performance of India's Research Base (2009-2014)" [6] carried out by Elsevier. Some keyhighlights from the study are given here,
  - India's share of the world's science and technology (S&T) scholarly output grew significantly from 3.1% in 2009 to 4.4% in 2013. India's scholarly citation share reached 3.4% of the world's citations in 2013, but its citation impact remained below the world average, with a field-weighted citation impact (FWCI) of 0.75 (25% less than the global average).
  - Key research focus areas for India are chemistry and pharmacology, where it emphasizes more compared to the world average; engineering and materials science are the most impactful fields but still cited below global averages.
  - Collaboration has increased, with 16% international, 32.1% national, and 46.2% institutional collaboration in India's research output by 2013; only 5.7% of papers were single-authored.
  - In academic-corporate collaborations, India's share increased from 1.7% to 2.2% globally in 2013.
- In 2019, the Clarivate Analytics was commissioned to prepare the report for the DST to examine the research output of India from 2011 to 2016[7]. The highlights from the study are,
  - India ranked $10^{th}$ globally in the number of research publications in 2016, reaching 64,267 papers, up from 47,081 in 2011, faster than the global average. India's global share in scientific publications increased from 3.6% in 2011 to 4.1% in 2016. Among emerging research countries (including

[6] Source: International Comparative Performance of India's Research Base https://www.nstmis-dst.org/Pdfs/Elsevier.pdf

[7] Source: Bibliometric study of India's Research Output and Collaboration (2011-2016) https://www.nstmis-dst.org/Pdfs/Bibliometric%20Study%20(%20Web%20of%20Science),%202019.pdf

BRICS), India improved from 3rd to 2nd in rank by publication output, behind only China.
  - India's research output is concentrated in physical sciences, technology, and applied sciences, with Chemistry (21.2%), Engineering (10.1%), Physics (9.8%), Clinical Medicine (9.6%), and Materials Science (8.8%) as top fields. Rapid growth was seen in Computer Science, Psychiatry/Psychology, and Engineering. Social sciences fields remain the least productive for India.
  - About 32% of Indian papers in 2016 published in top-quartile journals by impact factor, up from 29% in 2011. India's international collaboration rate is below most comparator countries but close to the BRICS average.
  - International collaboration increased from 22.4% of papers in 2011 to 26.0% in 2016. Industry-academia collaboration is small but growing, mostly in pharmaceuticals and information technology sectors. Collaboration rates vary by field, with high collaboration in economics & business (53.3%) and low in agricultural sciences (11.7%) and engineering (18.3%).

- A study covering the period from 2011 to 2016 was commissioned by the DST and conducted by Elsevier in 2020[8].
  - India's scholarly output grew strongly, increasing from 90,864 publications in 2011 to 136,238 publications in 2016, a 50% rise. India's share of global publications rose from 4.0% in 2011 to 5.4% in 2016.
  - India ranked 1st among SAARC countries, 2nd among BRICS countries, and 5th among G20 countries in publication volume in 2016. In 2017 and 2018, India continued as the 5th largest producing country in scholarly output globally.
  - India's share of global citations increased from 3.0% to 4.1% over 2011-2016. India's Field-Weighted Citation Impact (FWCI), which normalizes for subject and year, was 0.76 in 2016, meaning Indian research was cited about 24% less than the world average.
  - India's share of highly cited publications (top 1%, 5%, 10%, 25%) increased but remained below its overall publication share, suggesting that while quantity grew rapidly, top-level impact lagged somewhat.
  - International collaboration accounted for 16.4% of Indian publications in 2016, increasing steadily from previous years. India's domestic (national and institutional) collaboration is strong, with 31.9% of publications involving national collaboration in 2016.
  - Research output continued to grow rapidly, reaching about 171,879 documents in 2018. Key research areas driving this growth remained Engineering and Computer Science, followed by Medicine, Physics & Astronomy.

[8] Source: International Comparative Performance of India's Research Base, 2011-2016 https://www.nstmis-dst.org/Pdfs/Bibliometric%20Study%20(SCOPUS),%202020.pdf

### 1.1.2 Longitudinal Shifts

**Criterion for Selecting the Historical Benchmark Report** While the Department of Science and Technology (DST) has commissioned multiple bibliometric studies over the past decade, the longitudinal analysis comparing the pre-2016 period to the current 2014–2023 data is restricted exclusively to the 2011–2016 in the report commissioned by DST, prepared by Clarivate Analytics)[a].
This strict selection criterion is necessary to maintain **data homogeneity** and **metric consistency**. The initial 2011–2016 commissioned study, while carried out by the former Thomson Reuters (now Clarivate Analytics), explicitly used data sourced from the **Web of Science (WoS) Core Collection**. Similarly, the current in-house report is also based on WoS data obtained using the **InCites Benchmarking & Analytics tool**. *The exclusion of other previous DST-commissioned reports (which may have utilized the Scopus database) is deliberate. Using reports from different databases (WoS vs. Scopus) to compare absolute publication counts or normalized citation metrics would introduce an irreconcilable indexing bias, making it impossible to distinguish genuine research shifts from methodological discrepancies. Hence, the longitudinal shift is analysed only for the 2011–2016.*

[a] Source: Bibliometric study of India's Research Output and Collaboration (2011-2016) https://www.nstmis-dst.org/Pdfs/Bibliometric%20Study%20(%20Web%20of%20Science),%202019.pdf

Based on the comparison between the 2011–2016 commissioned Report and the current 2014–2023 DST-CPR Report (developed in-house), there has been a dramatic transformation in India's research landscape.

| **Feature** | **Report (by Clarivate: Data 2011–2016)** | **Report (by DST-CPR: Data 2014–2023)** |
|---|---|---|
| **Global Rank** | 10th | 3rd |
| **Primary Growth Driver** | Government Labs & IITs | Private Universities |
| **Citation Impact** | Below average (0.75) but rising | Lowest among top 10 nations; Q1 share declining |
| **Subject Focus** | Chemistry & Physics | Clinical Medicine, AI, & Interdisciplinary |

**Table 1.1:** *Longitudinal Transformation of India's Research Ecosystem: A Comparative Analysis of Key Bibliometric Indicators, Institutional Drivers, and Quality Metrics between the 2011–2016 (Clarivate Analytics) and 2014–2023 (DST-CPR) Assessment Periods.*

The longitudinal shift is characterized by an unprecedented explosion in volume (moving India from a top-10 to a top-3) coupled with a significant shift in the institutional drivers of this research (from public to private). India transitioned from a steady grower to one of the fastest-growing research ecosystems in the world, largely driven by a surge in volume between 2019 and 2021. The research landscape was dominated by the IIT system, CSIR, and ICAR. Government research institutions held an unusually large proportion of domestic research compared to academic institutions. However, the challenge of research quality has persisted and, in some metrics, arguably intensified.

A profound shift occurred where **Private Institutes surpassed Publicly Funded Premier Institutes (PfPIs)** in publication volume by 2021. While PfPIs (like IITs) continue to lead in quality (high citation impact), the sheer volume is now being driven by private universities (e.g., Vellore Institute of Technology, Saveetha Institute). The burden of knowledge production has shifted from being an exclusive domain of government labs/IITs to a mixed model where private universities contribute the largest share of volume (33.1% in 2023). The decade witnessed India successfully solving the "quantity" challenge, achieving scale that rivals the US and China. However, the "quality" challenge identified in the 2011–2016 report has not only persisted but concerning due to the rapid expansion of lower-impact research outputs from the burgeoning private sector.

# 2

# Methodology

## 2.1 Study Design and Scope

This study adopts a quantitative scientometric approach to examine India's research output in Science, Technology, Engineering, and Mathematics (STEM) disciplines over a ten-year period from 2014 to 2023. The analysis focuses on three document types—articles, proceedings papers, and reviews—and is confined exclusively to publications categorized under STEM subject areas. The study uses bibliometric indicators to assess publication volume, growth trends, collaboration patterns, funding support, and citation impact, with comparisons contextualized against global research output.

## 2.2 Data Sources and Coverage

Data for this study were collected from InCites, a research analytics platform developed by Clarivate.[1] InCites draws its publication and citation data from the Web of Science Core Collection and provides a suite of normalized indicators for benchmarking research performance across countries, institutions, disciplines, and time periods. The database is updated regularly, and newly published documents are incorporated annually to ensure continuity and comparability in longitudinal analyses.

## 2.3 Subject Classification and STEM Delimitation

Publications included in this study were classified using the Citation Topics schema employed by InCites. Citation Topics is an algorithmic and hierarchical classification system that organizes research papers into subject areas based on citation relationships rather than journal-level assignments. The schema was developed with the expertise of the Centre for Science and Technology Studies (CWTS), Leiden, and the Institute for Scientific Information (ISI).

The Citation Topics schema consists of a three-level hierarchy: macro, meso, and micro levels. At present, it includes 10 broad subject categories at the macro level, 326

[1] https://incites.clarivate.com/

topics at the meso level, and 2,444 topics at the micro level.[2] This structure allows for flexible selection of analytical granularity depending on the research question. Unlike traditional journal-based classification systems used in the Web of Science, which assign subject categories at the level of entire journals or proceedings, the Citation Topics schema offers greater precision by classifying individual publications.

At the macro level, publications are categorized into ten broad subject areas: Clinical & Life Sciences; Chemistry; Agriculture, Environment & Ecology; Electrical Engineering, Electronics & Computer Science; Physics; Social Sciences; Engineering & Materials Science; Earth Sciences; Mathematics; and Arts & Humanities. To operationalize STEM disciplines for this study, the macro-level categories of Social Sciences and Arts & Humanities were excluded. The remaining eight macro topics were retained and collectively treated as the STEM domain. This approach ensured methodological transparency and consistency while focusing on core scientific and technological research fields.

## 2.4 Data Extraction and Baselines

Publications were retrieved using the "Search by Location" feature available in the InCites platform. This functionality enables aggregation of publications based on the geographical location of author affiliations as indexed in the Web of Science. By applying filters for document type, publication year (2014–2023), and STEM subject areas defined through the Citation Topics schema, a total of 23,336,827 publications (Global Baseline) produced by 213 countries were identified. Data extraction was performed on 12 December 2024.

In this study, two types of baselines provided by InCites are used for contextualization: the Global Baseline and the Baseline for All Items. A baseline in InCites represents a reference set of publications used for benchmarking and comparison. The Global Baseline includes all publications indexed worldwide that meet broad criteria such as document type and publication year, serving as a normative reference for global research output. In contrast, the Baseline for All Items refers specifically to the filtered dataset used in this study after applying all selection criteria, including location-based filters, document types, time period, and STEM classification. The Baseline for All Items comprised 23,016,662 publications. The difference between these two baselines reflects the distinction between overall global research production and the specific analytical dataset generated for this study.

## 2.5 Institutional and Organizational Classification

India's research ecosystem comprises a wide range of institutional and organizational entities, including academic institutions, government research laboratories, non-profit

[2] https://clarivate.com/blog/introducing-citation-topics/

organizations, and corporate enterprises. To examine the contributions of different organizational types to India's STEM research output, institutions were classified into the following categories:

- **Publicly Funded Premier Institutions:** Institutions under the purview of the Ministry of Education, including Indian Institutes of Technology (IITs), Indian Institute of Science (IISc), National Institutes of Technology (NITs), Indian Institutes of Science Education and Research (IISERs), Indian Institutes of Information Technology (IIITs), Indian Institutes of Management (IIMs), and Indian Statistical Institutes (ISIs).
- **State Universities:** Public universities funded and administered by individual state governments.
- **Central Universities:** Universities established and funded by the central government.
- **Private Universities:** Universities established and operated by private organizations.
- **Councils, Departments, and Research Laboratories:** Research organizations such as the Council of Scientific & Industrial Research (CSIR), Indian Council of Medical Research (ICMR), Indian Council of Agricultural Research (ICAR), and laboratories funded by the Department of Science and Technology (DST), Department of Biotechnology (DBT), Department of Atomic Energy (DAE), Defence Research and Development Organisation (DRDO), and other line ministries.

## 2.6 Collaboration Indicators

Collaboration was measured using three key indicators provided by InCites: Domestic Collaboration, International Collaboration, and Industry Collaboration. These indicators are defined as follows:

- **Domestic Collaboration:** Publications with two or more authors representing distinct addresses and organizations, where all addresses are located within the same country.
- **International Collaboration:** Publications that include one or more international co-authors, indicating collaboration across national boundaries.
- **Industry Collaboration:** Publications involving two or more organizations, with at least one organization identified as a corporate or global corporate entity. When a corporate organization is searched in InCites, all associated publications are classified under the Industry Collaboration indicator.

## 2.7 Funding Data and Sources

Funding information was collected using the Funding Agencies Explorer available in InCites. This tool utilizes unified funding acknowledgment data from the Web of Science and supports analysis of funding patterns in relation to publication output and citation impact. The Funding Agencies Explorer includes data on more than 1,000 unified funding organizations curated from funding acknowledgments.

Within this tool, funding information can be retrieved from three sources:

- **Funding Text:** Funding information reported in the acknowledgments section of publications.
- **Funding Agency:** Grant information obtained directly from funding agency records.
- **All Sources:** A combined dataset integrating funding information from both publication acknowledgments and direct funding agency sources, including databases such as National Science Foundation (NSF), Korea Institute of Science & Technology Information (KISTI), and Department of Science & Technology (DST), etc.

For this study, the "All Sources" option was selected to ensure comprehensive coverage of funding data related to Indian STEM research.

## 2.8 Bibliometric Indicators and Analytical Measures

To assess publication trends and research quality, this study employed a set of production and impact indicators available through the InCites Benchmarking & Analytics module. These indicators are widely used in scientometric research and are normalized within InCites to enable meaningful comparisons across fields, years, and document types.

### 2.8.1 Publication Counts and Growth Trends

Research growth was measured using publication counts, which represent the total number of scientific outputs produced within a given time period and subject area. Annual publication counts were tabulated to examine temporal trends in India's STEM research output.

### 2.8.2 Paper Percentage and Annual Increase

In addition to absolute counts, percentage shares and year-on-year growth rates were calculated to capture changes in India's relative contribution to global STEM research and to identify patterns of acceleration or deceleration over time.

### 2.8.3 Citation Impact (Citations per Paper, CPP)

Citation impact was measured using Citations per Paper (CPP), defined as the average number of citations received per publication. CPP serves as an indicator of research visibility and influence, although it does not account for disciplinary differences in citation practices or citation age effects.

### 2.8.4 Percentile-Based Highly Cited Papers

To capture relative citation performance, percentile-based indicators were used, including the percentage of publications falling within the top 1%, 5%, 10%, and 25% of most-cited papers worldwide within the same subject area, publication year, and document type. These indicators are normalized against global citation distributions and are particularly useful for identifying research excellence in large datasets.

### 2.8.5 Journal Impact Factor Quartiles (Q1–Q4)

Journal quality was assessed using quartile rankings derived from Journal Citation Reports (JCR). Journals were classified into four quartiles (Q1–Q4) based on impact factor rankings within their subject categories. The proportion of publications appearing in each quartile was calculated as a proxy for the prestige and visibility of publication venues.

## 2.9 Normalization and Interpretation

Many indicators used in this study, particularly percentile-based metrics and journal quartiles, are normalized by field, publication year, and document type within InCites. This normalization accounts for variations in citation behavior across disciplines and mitigates biases arising from differences in citation age and field-specific citation norms.

## 2.10 Data Limitations

### 2.10.1 Dependence on a Single Data Source

The study relies exclusively on data from the Web of Science accessed through InCites. While this database is widely regarded for its quality and curation, it does not provide exhaustive coverage of all scholarly outputs, particularly regional journals, non-English publications, and locally significant conference proceedings.

### 2.10.2 Database Coverage Bias

Web of Science has historically emphasized high-impact journals from North America and Europe, which may result in underrepresentation of Indian and regional journals, as well as emerging open-access venues.

### 2.10.3 Institutional Coverage Incompleteness

InCites indexed bibliometric data for only four Indian Institutes of Information Technology (IIITs), leading to incomplete representation of the IIIT system and potential underestimation of its research output.

### 2.10.4 Limitations of Citation-Based Classification

The Citation Topics schema is dependent on citation behavior, which varies across disciplines and time. Newly published works with limited citation histories may be weakly represented or misclassified, particularly at finer levels of granularity.

### 2.10.5 Temporal Coverage Constraints

Citation data for recent years, especially 2022 and 2023, may be incomplete due to citation lag, potentially underestimating the impact of recent publications.

### 2.10.6 Document Type Restriction

The exclusion of document types such as books, patents, preprints, and policy reports may limit coverage of applied and interdisciplinary research outputs.

### 2.10.7 Annual Updating of Classification Schema

Annual updates to the Citation Topics schema may introduce minor shifts in topic boundaries, potentially affecting longitudinal comparisons.

### 2.10.8 STEM Delimitation

Interdisciplinary research spanning STEM and non-STEM domains may not be fully captured due to the strict STEM classification applied in this study.

## 2.11 Methodological Differences from Previous National Reports

This study employs a methodological framework that differs from those used in earlier scientometric reports published by the Department of Science and Technology (DST), Government of India. Differences in search strategies, data extraction criteria, document selection, and subject classification may affect comparability, and results should therefore be interpreted with caution when compared with previous national assessments.

# 3

# Data and Discussions

## 3.1 Discussions

### 3.1.1 Global Publication Trends (2014–2023): A Focus on Quantity

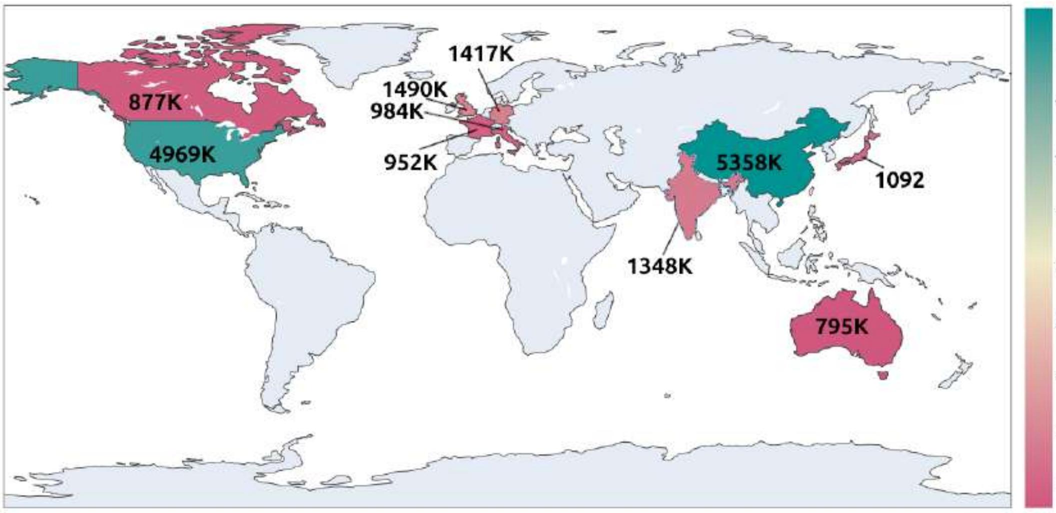


**Figure 3.1:** *Top 10 Knowledge-Producing Countries Based on Publications (2014–2023)*

The global research landscape between 2014 and 2023 has seen a growth in scientific output. During this period, the top 10 countries—China, the United States, the United Kingdom, Germany, India, Japan, Italy, France, Canada, and Australia—dominated global scientific publication metrics, accounting for a substantial share of the world's research output, and India also advanced to enter the top five knowledge-producing countries. Although India reached 3rd position in 2022, its publication output, while impressive, still falls short of the scale seen in leading nations such as China and the United States, indicating significant scope for further growth. The following section examines the publication trends of the top 10 countries during 2014–2023, highlighting India's trajectory within this global context.

### 3.1.2 Leading Knowledge Producers: Top 10 Countries by Total Publications (2014–2023)

Analyzing cumulative publications by countries in the STEM fields from 2014 to 2023 reveals that China (23.28%) and the United States (21.59%) dominate, with the UK (6.39%) as a distant third and India (5.86%) in fifth place (Figure 3.2). Notably, while China leads in cumulative publications, surpassing the US, the annual trends show that the US was ahead in yearly publications until 2018 (Figure 3.5). While China's growth is remarkable, India also showed good progress. India surpassed Germany in 2021 and the UK in 2022, securing third place in annual publications by this time, as evidenced by the yearly trends (Figure 3.5).

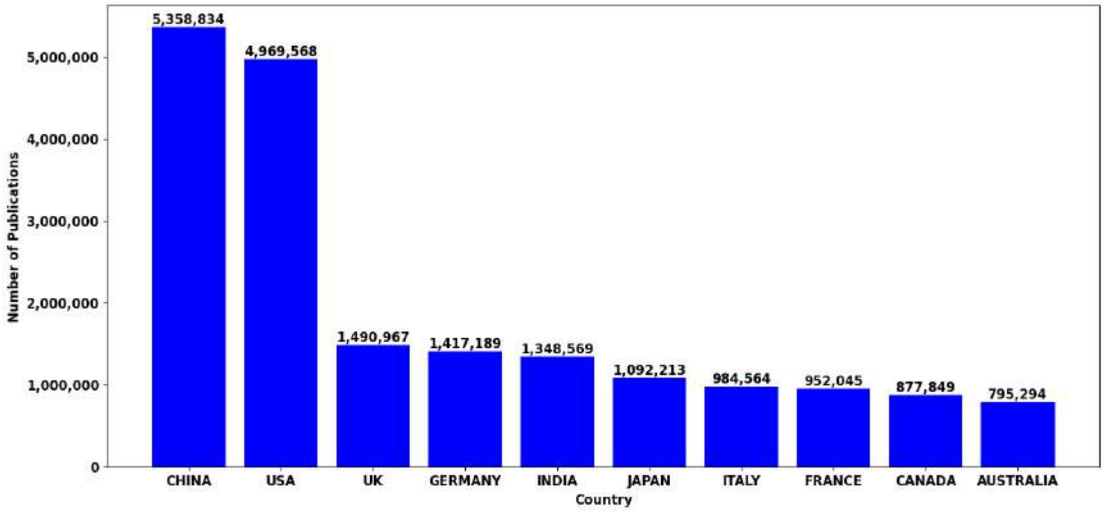


**Figure 3.2:** *The total publications of the top 10 countries in the STEM field in the period 2014-2023.*

The publication data from 2014 to 2023 is segmented into two distinct 5-year periods: 2014-2018 in the figure 3.3 and 2019-2023 Figure 3.4. The objective of this split is to provide a clearer view of publication trends over time for the top 10 countries in the dataset.

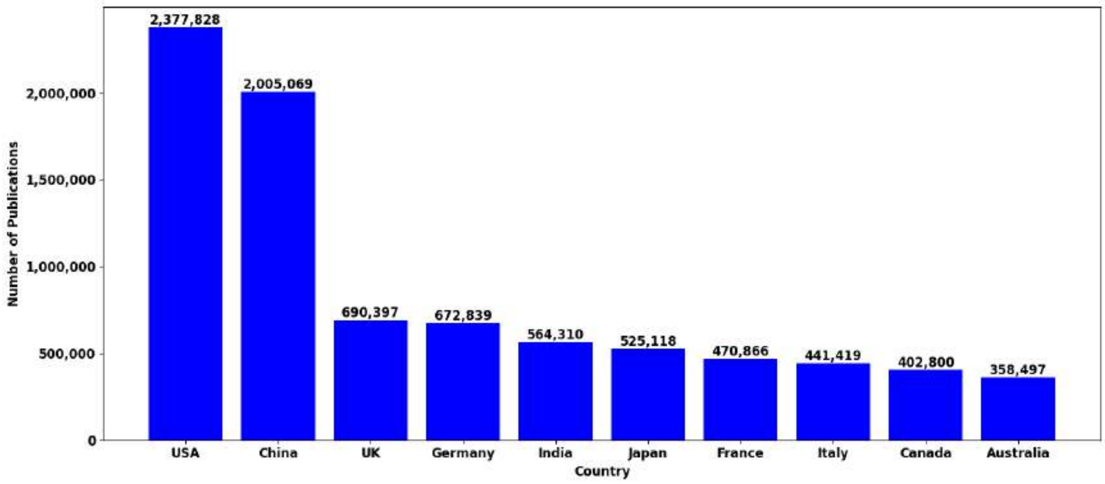


**Figure 3.3:** *Total publications in the first 5-year period in the STEM field (2014-2018).*

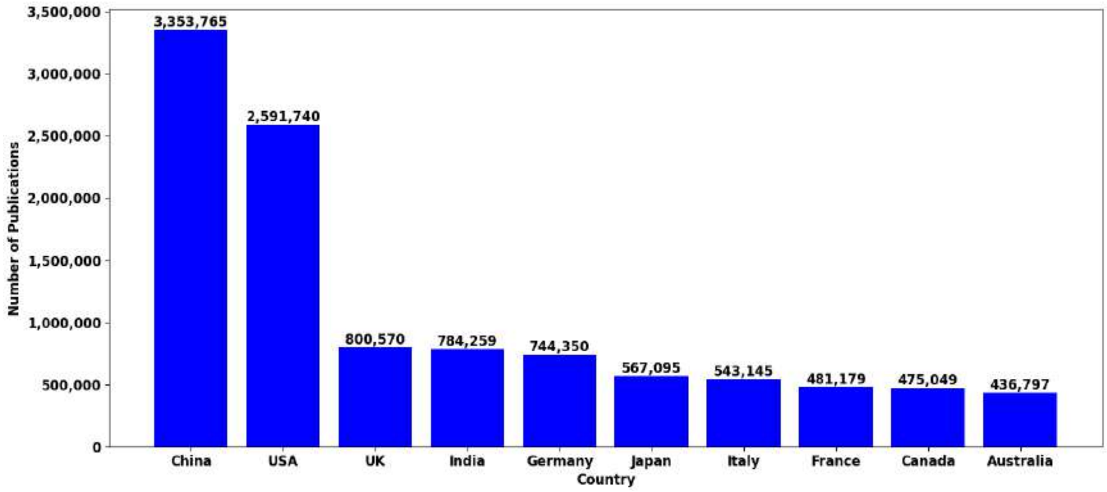


**Figure 3.4:** *Total publications in the second 5-year period in the STEM field (2019-2023).*

Total global publications in the first 5-year period are 10,525,433, and for the next 5-year period, it is 12,811,394. This increase not only highlights the overall expansion of STEM research worldwide but also provides insights into shifting patterns of research productivity across countries. By examining the two periods separately, it becomes possible to observe whether growth has been evenly distributed or whether certain countries have accelerated more rapidly than others. Such reflections are important for understanding the dynamics of global research competition, collaboration, and capacity-building over the past decade.

### 3.1.3 Analysis of STEM Document Publication by top 10 Countries

#### Publication trend

The figure 3.5 shows while China and India are on a clear growth trajectory, several of the other leading countries appear to be experiencing stagnation or even a decline in publication output, suggesting a potential slowdown in their R&D activities when measured through publication counts.

Critically, China (green line) overtook the USA(maroon line) around 2019, and its document count continued a steep upward trend, peaking in 2022 before a slight dip in 2023, demonstrating a rapid escalation in research output. The USA's trend was slower, peaking in 2021 before showing a noticeable decline in the final two years. India (orange line) showed a steady, significant increase over the decade, consistently holding the third-highest rank since 2016 and closing the gap with the USA & China.

This divergence raises important questions about the underlying drivers of research productivity & research quality. For instance, the rapid growth of China and India may be linked to expanding research infrastructure, increased public and private investment in science, or policies incentivizing only the publication, which can have a negative impact on research quality. The cluster of developed nations—including the UK, Germany, Japan, Italy, France, Canada, and Australia—shows relatively stable

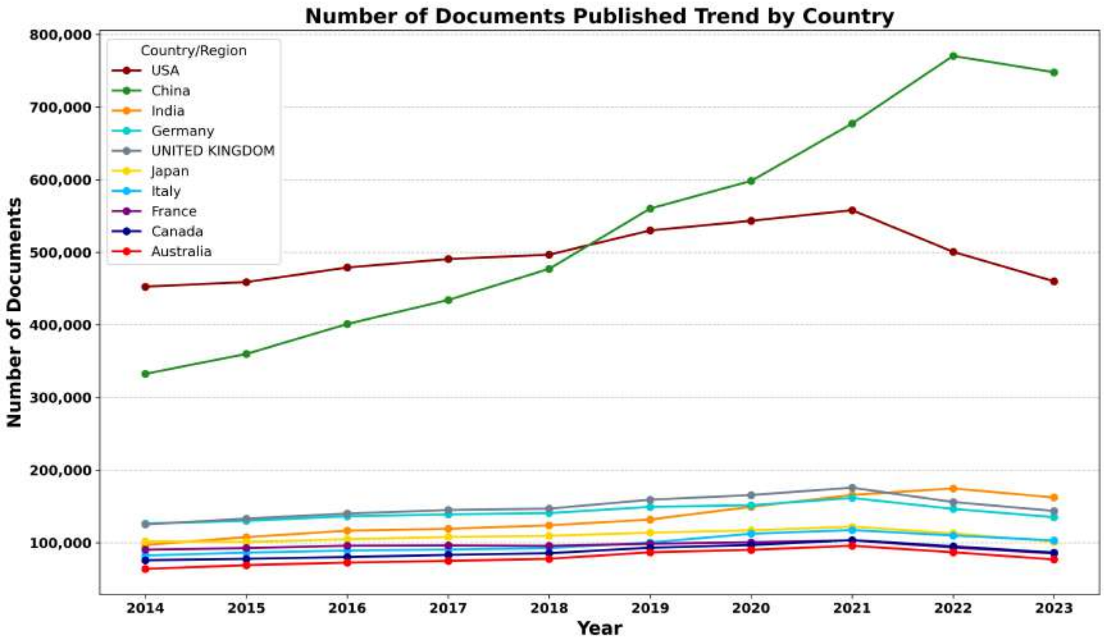


**Figure 3.5:** *Country-wise yearly publication trend for the top 10 countries in STEM between 2014-2023*

publication counts, with most experiencing a slight peak around 2021 before a minor decline in the following years. In contrast, the decline observed in most of the countries can be related to a global re-balancing of research focus following the unprecedented disruption due to COVID-19.

It is worth noting that publication counts alone may not fully capture the nuances of research activity. For example, a decline in volume does not necessarily imply reduced scientific impact; some countries may be placing greater emphasis on high-quality publications, interdisciplinary research, or innovation-driven outputs such as patents and technologies. Similarly, national policy priorities, demographic changes in the research workforce, or shifts in funding landscapes could be influencing these trajectories. Moreover, because this report relies on the Web of Science (WoS) database—which applies relatively stringent indexing criteria—the trends may underrepresent research outputs published in regional or emerging journals, many of which are increasingly indexed in open-access databases such as OpenAlex or Lens. Incorporating data from these broader sources would provide a more inclusive view of global research activity and help validate whether the observed differences are consistent across indexing platforms.

#### Average Annual Increase in STEM Publications by Country using best-fit

The bar chart in the figure 3.6 shows the average number of additional STEM publications each country added per year over 2014–2023, calculated using linear regression. For each country, a best-fit straight line was fitted to its annual publication counts; the slope of that line (rounded to whole numbers) is the average annual increase and is

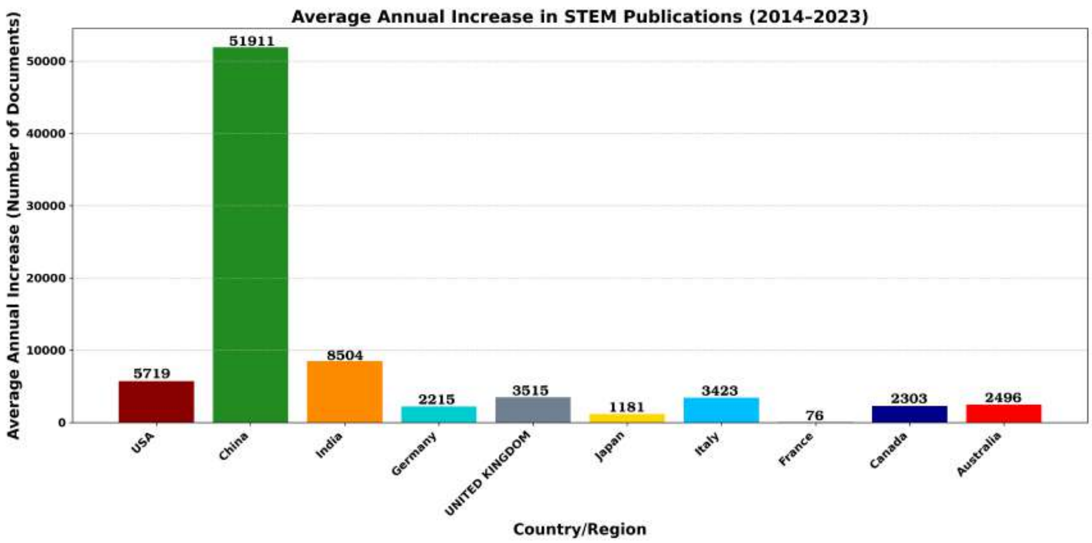


**Figure 3.6:** *Average Annual Increase in STEM Publications by Country (2014–2023).*

shown as the bar height. This metric smooths out year-to-year fluctuations to summarize the overall growth trend. Taller bars indicate faster absolute growth in publication volume. The values above each bar show the exact average annual increase in number of documents.

### Year-on-Year growth rate

The YoY growth rate plot highlights considerable variation in publication growth trajectories across countries during 2015-2023. China and India generally recorded higher growth rates than the other countries examined, maintaining positive growth throughout 2015-2022 before both experiencing negative growth in 2023. China, in particular, exhibited the highest growth rates during much of the study period, including a pronounced peak in 2019.

In contrast, mature research systems such as the USA, Germany, the UK, France, Italy, Canada, Australia, and Japan generally exhibit more moderate growth rates than China and India, with year-to-year fluctuations and occasional periods of negative growth. Several countries recorded elevated growth rates around 2019, while others reached their peak growth in 2020 or 2021, indicating that the timing and magnitude of publication expansion varied across research systems.

A common feature across nearly all countries is the marked slowdown observed in 2022 and 2023. Most countries recorded substantially lower growth rates during these years, with many transitioning into negative growth territory by 2023. This pattern contrasts with the generally positive growth observed during most of the preceding period and suggests a broad moderation in publication output growth across the major research systems considered.

The horizontal dashed line at 0% denotes the threshold between positive and negative annual growth. Although the underlying publication data span 2014-2023, the

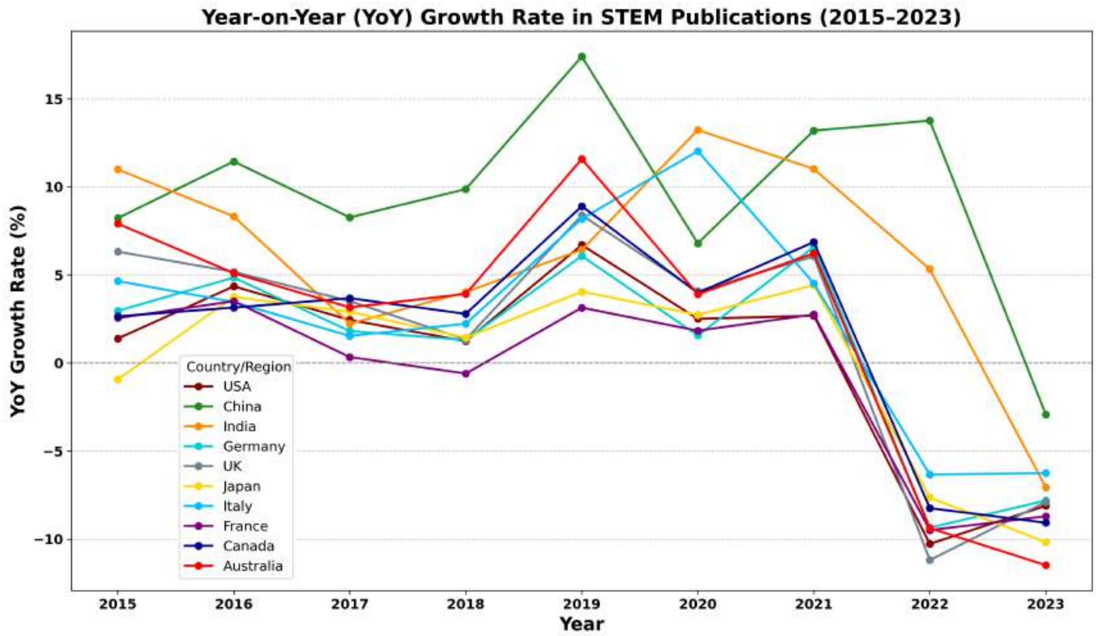


**Figure 3.7:** *Year-on-Year (YoY) Growth Rate in STEM Publications by Country (2015–2023).The plot shows the annual percentage change in Web of Science STEM document counts for major countries/regions. Each line represents a country's YoY growth rate.*

YoY growth-rate series begins in 2015 because growth rates are calculated relative to the previous year; consequently, a growth rate cannot be computed for 2014.

### 3.1.4 India's Publication Output and Impact: Trends from 2014 to 2023

An analysis of India's publication trends with the number of papers published in each year between 2014 to 2023 (Figure 3.8) reveals a steady increase in the number of research papers, with the period between 2019 and 2021 experiencing the highest publication growth of the decade (2014–2023). However, in 2023, growth declined slightly.

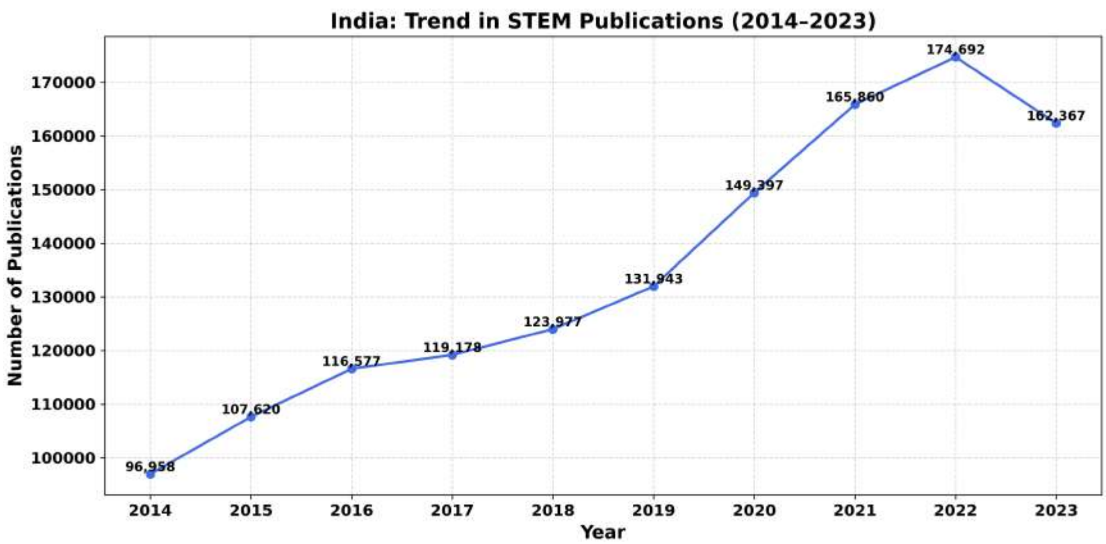


**Figure 3.8:** *India's Publication Growth Trajectory in STEM (2014-2023)*

### 3.1.5 India's Publication Growth Trend and Linear fit in STEM (2014–2023)

The figure 3.9 clearly shows a sustained, positive, upward trend in actual output, peaking in 2022, followed by a noticeable dip in 2023. The regression line, however, maintains its steady path, signifying the long-term, structural growth achieved over the full decade. The combination of the strong slope and the high $R^2 = 0.932$ value statistically validates the narrative of sustained, structural growth, while the volatility in the actual output highlights recent policy-relevant events, with the average annual increase of ≈8,504 publications, while the 2023 data point shows a sharp deviation below the trend line.

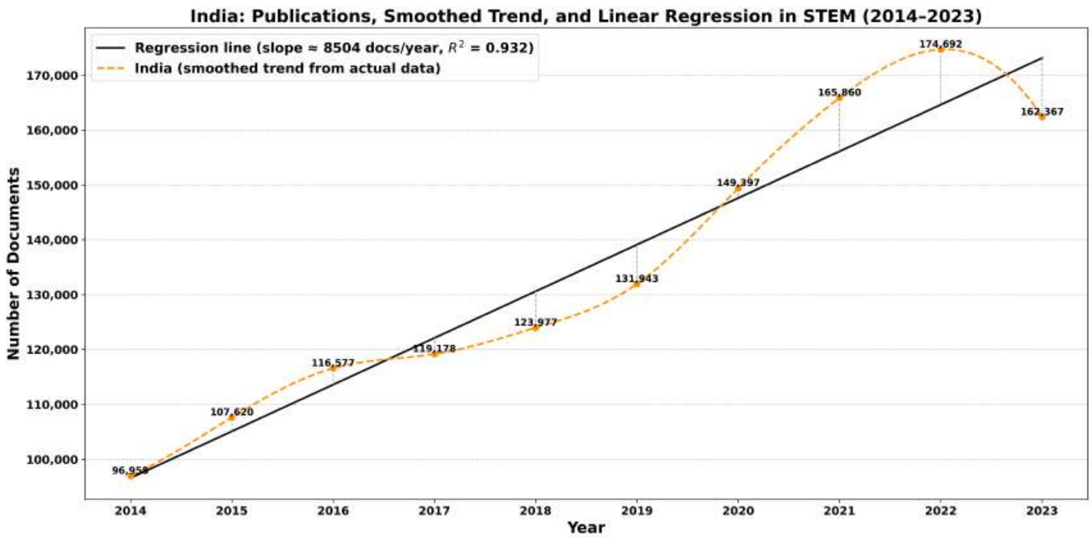


**Figure 3.9:** *India's Annual Publication Output in STEM (2014–2023) with Best-Fit Linear Trend. Actual Annual Output (Orange dashed Line): Shows the raw, year-by-year publication count. Best-Fit Linear Trend (Black solid Line): Represents the constant, underlying average rate of increase determined by linear regression.*

**Acceleration:** In (2019–2022), the actual output line curves noticeably above the black linear-fit line during this period, indicating that the annual growth rate was higher than the decade-long average of 8,504 publications. This marks the "unprecedented explosion in volume".

**Deceleration/Correction (2023):** The actual output shows a sharp decline of ≈7.06% in 2023 (from 174,692 in 2022 to 162,367 in 2023). This deviation means the 2023 output falls significantly below the estimated long-term trend line, signaling a potential loss of momentum or a post-pandemic correction that must be investigated.

### 3.1.6 Highly cited papers

The figure 3.10 illustrates the percentage of highly cited papers. Highly cited papers are those that fall within the top 1%, 5%, or 25% most cited publications worldwide in their respective fields. These thresholds reflect how often a paper is cited compared to others, with a higher share indicating stronger influence and visibility. For instance, papers in the top 1% represent a stronger impact. Tracking India's share of these highly cited papers provides an important measure of research quality, complementing publication volume. The share of Indian publications in the top 25% most cited papers has shown improvement, with the share rising from 18% in 2014 to 20.76% in 2023, peaking at 22.2% in 2021. However, India's contribution to most cited papers (top 1%, 2% and 5%) is still quite low.

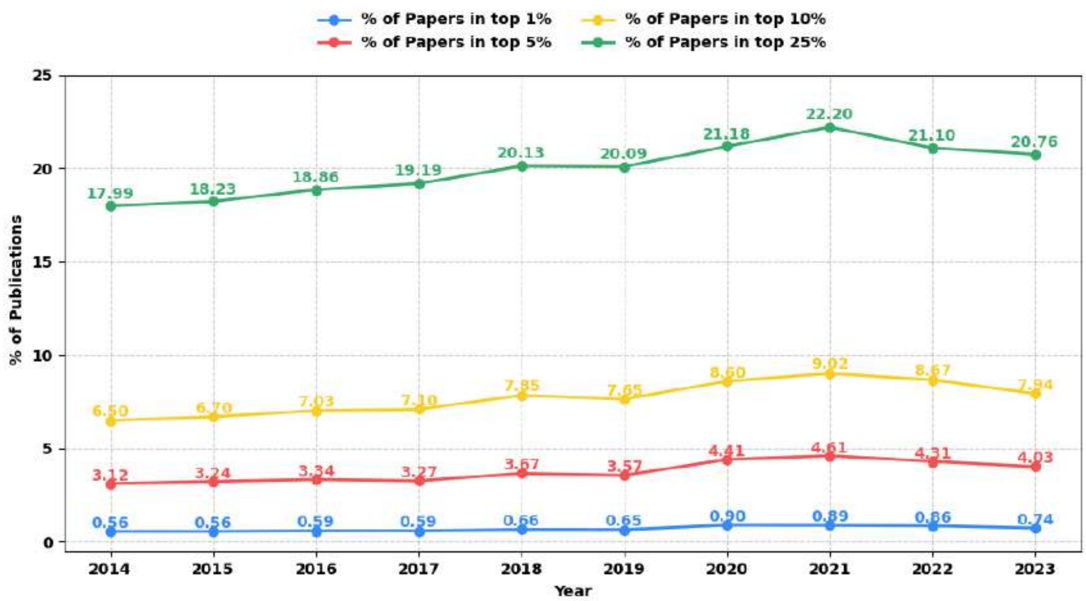


**Figure 3.10:** *Annual distribution of Top 1%, 5%, 10%, and 25% (India: 2014-2023)*

The journal quartile and the journals with the Journal Impact Factor (JIF) are traditional measures of the quality of the journals. The proportion of publications appearing in journals with a Journal Impact Factor (JIF), as well as those categorized into quartiles (Q1 to Q4), serves as a measure of research quality. Publications in Q1 and Q2 journals, which represent the highest-ranking and most prestigious journals in their respective fields, indicate a country's ability to produce high-quality, globally impactful research. Conversely, a higher proportion of publications in Q3 and Q4 journals may signal a focus on quantity over quality.

The percentage of Indian publications in Q1 journals and journals with JIF is significantly lower compared to top-performing countries. A detailed comparison with other countries is presented in later sections, while this section provides an overview of trends in India's publications across Journal Impact Factor (JIF) and quartile-ranked (Q1–Q4) journals. A closer examination of the year-wise distribution of Indian publications in the JIF journals and Q1, Q2, Q3 and Q4 journals reveals a somewhat concerning trend (Figure. 3.11).

Over the years, there has been a decline in the proportion of Indian papers published in Q1 journals, which are considered the highest quality. However, there is a slight increase in publications in Q2 journals and a more substantial shift toward Q3 journals. One note of caution regarding the data is the sharp increase in the proportion of JIF in 2023. There is no apparent reason to explain this behavior, and further investigation is needed regarding the data quality for this year.

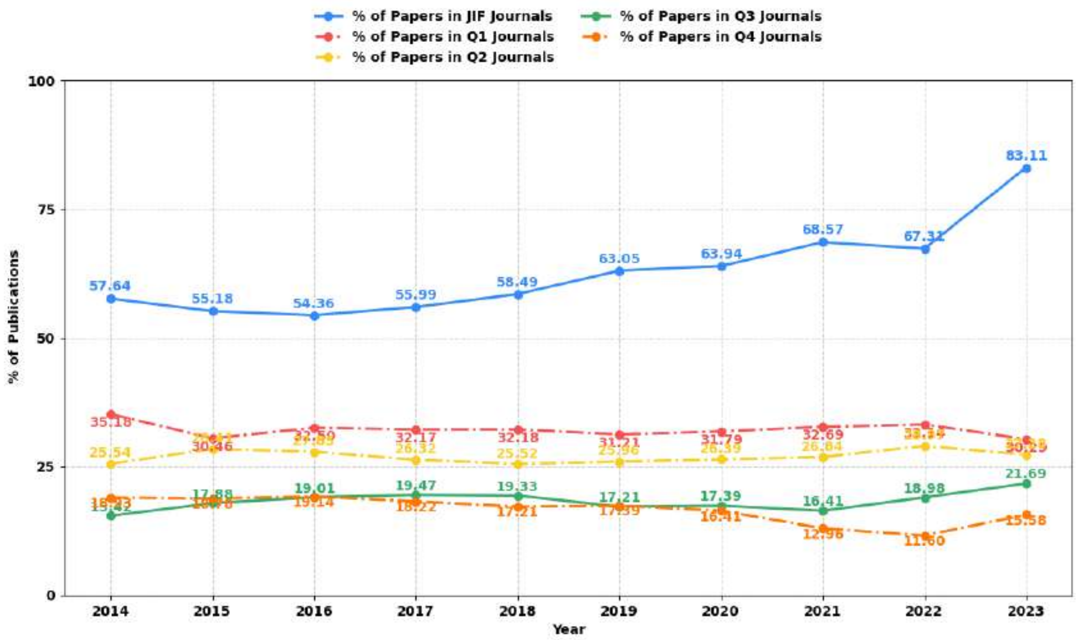


**Figure 3.11:** *Distribution of publications in JIF, Q1, Q2, Q3, and Q4 Journals over the years for India*

## 3.2 Publication Landscape Across Indian Higher Education and Research Institutions

This section examines the publication contributions, trends, and citation impact of different categories of Indian institutions. For analytical clarity, institutions have been grouped into four broad categories: those under the Ministry of Education (formerly MHRD)-referred to as Publicly funded premier institutes (PfPI), State universities, Central universities, and private universities and institutions. Within each category, the analysis focuses on the top 10 institutions based on publication counts. This categorization helps illustrate not only the volume of research produced but also the relative influence and quality of outputs across these institutional types. The analysis sheds light on how different parts of India's higher education and research system contribute to the national research ecosystem, highlighting areas of strength and opportunities for improvement.

### 3.2.1 Contribution by Public & Private

The figure 3.12 counts the percentage of publications from Public and Private organizations. The publications from private organizations compared with publicly funded academic organizations over 2014–2023, showing totals of 347,203 for private and 1,001,366 for public, useful for contrasting outputs across ownership types.

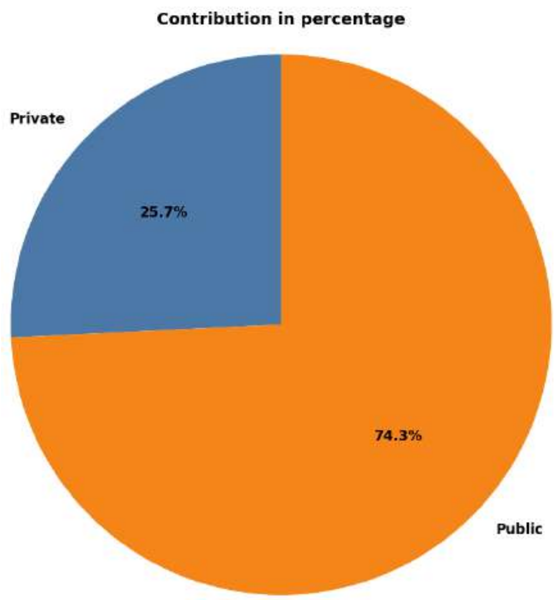


**Figure 3.12:** *Percentage of publications by Private & Public (2014–2023).*

The dataset counts publications from private organizations compared with publicly funded academic organizations over 2014–2023, showing totals of 347,203 for private and 1,001,366 for public, useful for contrasting outputs across ownership types.

### 3.2.2 Indian Higher Education Institution & Universities

Private institutions have played a significant role in driving India's overall publication growth (Figure 3.13). Their output has shown steady growth over the years, and by 2021, they even surpassed the PfPIs in terms of publication volume (Figure 3.13). However, despite this quantitative expansion, private institutions continue to record the lowest citation impact among all institutional categories (Figure 3.13).

Historically, the institutions categorized under PfPI in this report have been the backbone of India's academic research system. They are widely recognized for their research quality, which is reflected in their consistently high share of publications appearing in top-tier (Q1) journals, as seen in Figure 3.15. This contrast between quantity-driven growth in private institutions and quality-driven output from PfPIs India's research ecosystem. The figures in this section present detailed trends in publication output and citation impact across each institutional category. Together, these figures provide a self-explanatory overview of how different types of institutions are shaping India's research profile, highlighting both emerging strengths and persistent challenges.

In Figure 3.13, the bar graph displays the total number of publications for each category on the right y-axis, while the blue line illustrates the citation impact of publications within different institutional setups on the left y-axis.

Private institutes have demonstrated a consistent and significant increase in their share of publications from 2014 to 2023, rising from 19.0% to 32.8% as seen in the figure

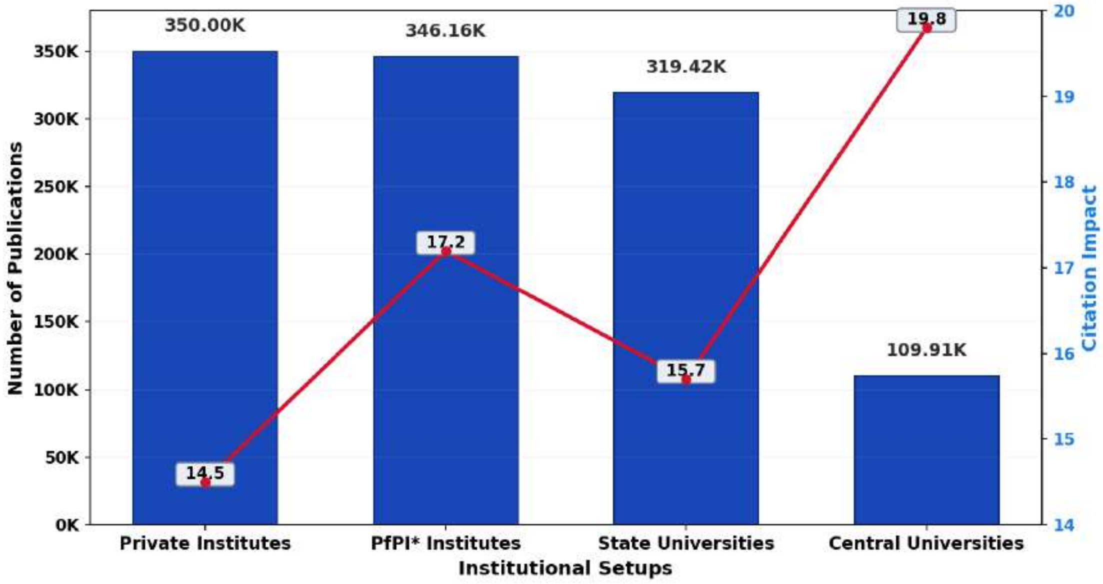


**Figure 3.13:** *Contribution by the four categories of Higher education Institutions*

3.14, thus becoming the largest contributor by 2023. PfPI institutes showed a relatively stable share initially, peaking at 28.5% in 2019, but their share declined afterward and stabilized around 25.3% from 2021 to 2023.

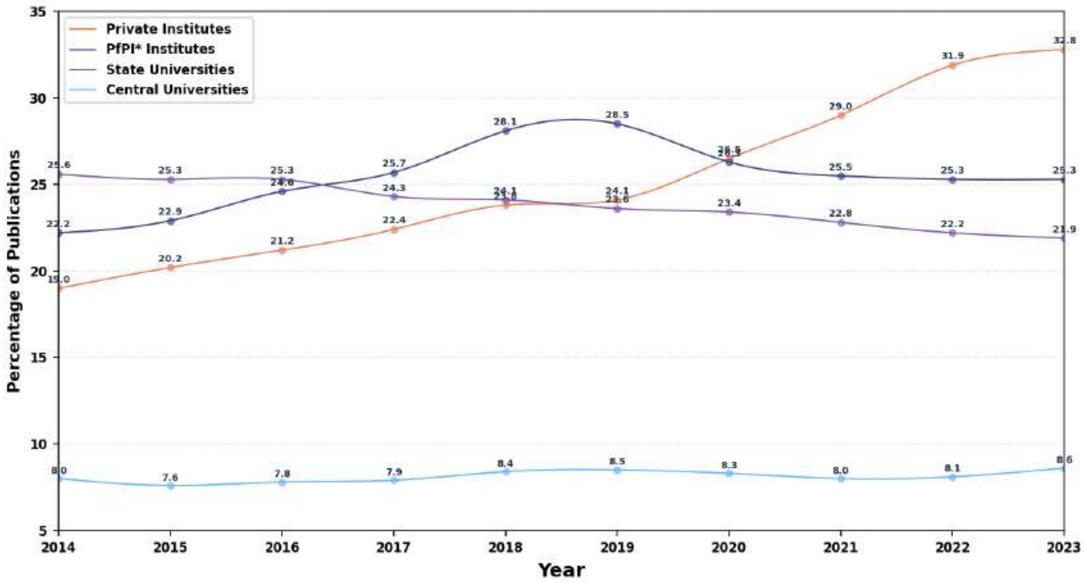


**Figure 3.14:** *Percentage share of publications contributed by Institutional setups from 2014 to 2023*

State universities experienced a gradual decline in publication share, decreasing from 25.6% in 2014 to 21.9% in 2023. Central universities maintained a steady share, fluctuating near 8% throughout the decade, representing the smallest and most stable contribution among the categories. Overall, the trend indicates a clear shift in publication contributions, with private institutes surpassing both PfPIs and state universities by 2023. The pivotal cross-over point occurred between 2019 and 2020 when private institutes overtook PfPIs in publication share.

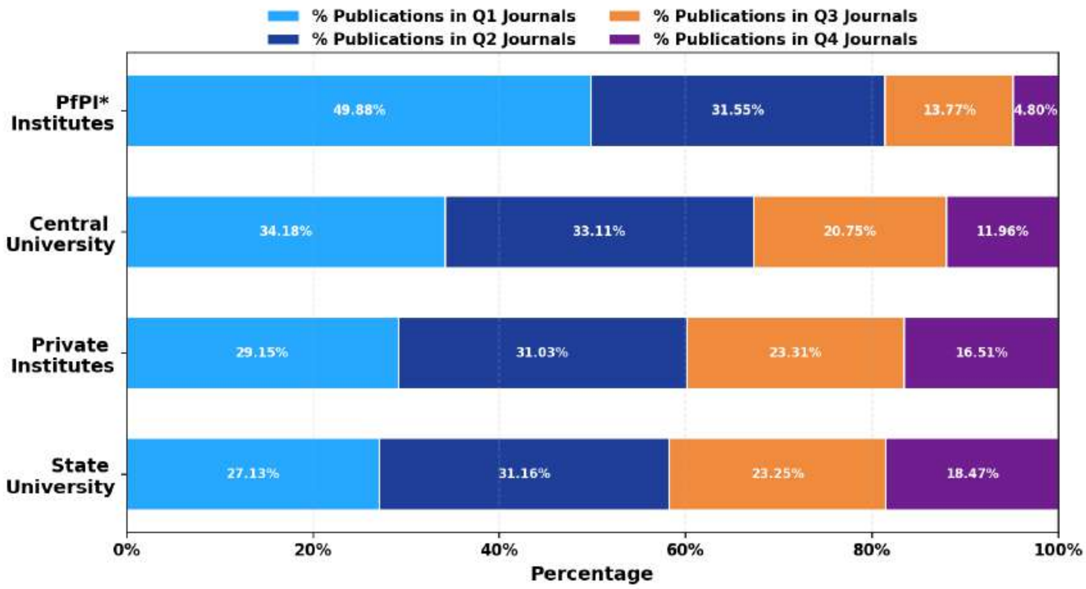


**Figure 3.15:** *Journal quartile distribution across four institutional categories*

The figure 3.15 displays the percentage distribution of papers published by different institutional setups across journal quartiles (Q1, Q2, Q3, Q4). PfPIs have the highest proportion of their papers in top-tier Q1 journals (49.88%), followed by Central Universities (34.18%). State Universities and Private Institutes have similar shares in Q1 journals (27.13% and 29.15% respectively). For Q2 journals, the proportions are fairly consistent across all categories, ranging from about 31.03% to 33.11%. PfPI Institutes also have the smallest shares in Q3 and Q4 journals (13.77% and 4.80%), while State Universities and Private Institutes exhibit higher percentages in these lower quartiles. Overall, PfPI Institutes lead in publishing in higher-impact journals, while Private and State Universities show a more balanced distribution across quartiles, and Central Universities have higher shares in Q1 and Q2 compared to Q3 and Q4.

The heatmap depicts the percentage of papers from each institutional setup placed in the top 1%, 5%, 10%, and 25% of publication impact metrics. PfPs lead across all metrics, with 0.73% of their papers in the top 1%, 4.37% in the top 5%, 9.32% in the top 10%, and 24.71% in the top 25%. Central Universities follow closely, slightly exceeding PfPIs in the top 1% (0.83%) and top 5% (4.44%), but have a slightly lower presence in the top 10% (9.08%) and top 25% (23.50%). Private Institutes show comparable proportions, especially in the top 1% (0.84%) and top 5% (4.42%), but less in the highest impact brackets compared to PfPIs. State Universities consistently report the lowest percentages, with only 0.67% of their papers in the top 1% and 19.98% in the top 25%. Overall, PfPIs and Central Universities demonstrate the strongest performance in producing highly impactful research outputs.

The figure 3.17 illustrates the number of publications and citation impact for the top ten PfPIs in India. The bar graph shows publication counts, while the line graph

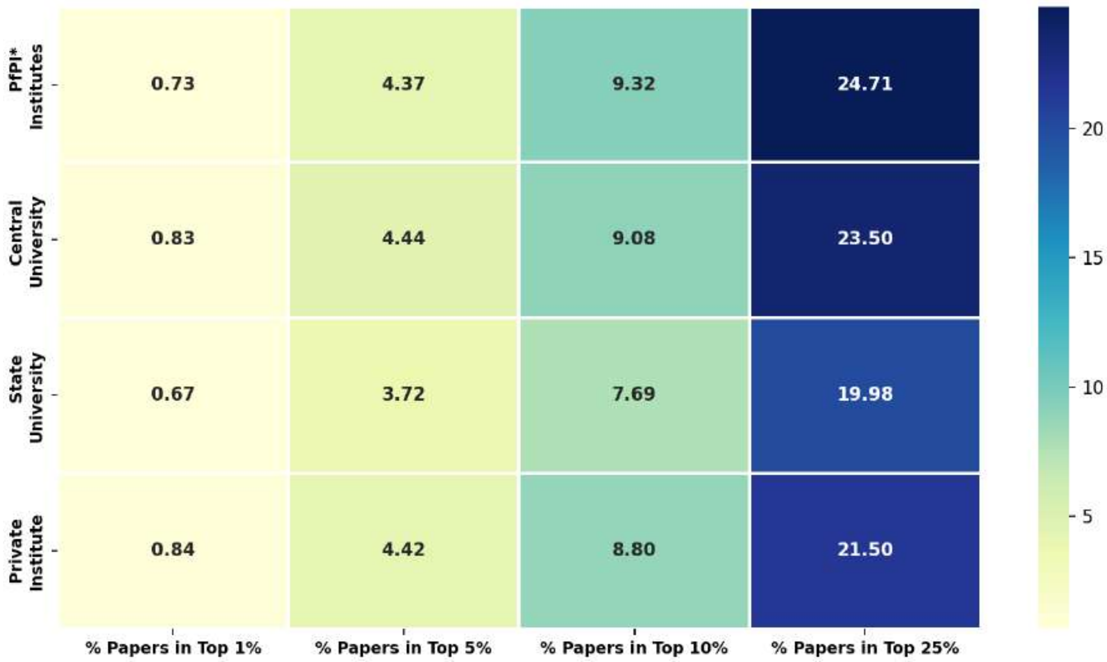


**Figure 3.16:** *Heatmap of top papers from the four institutional categories*

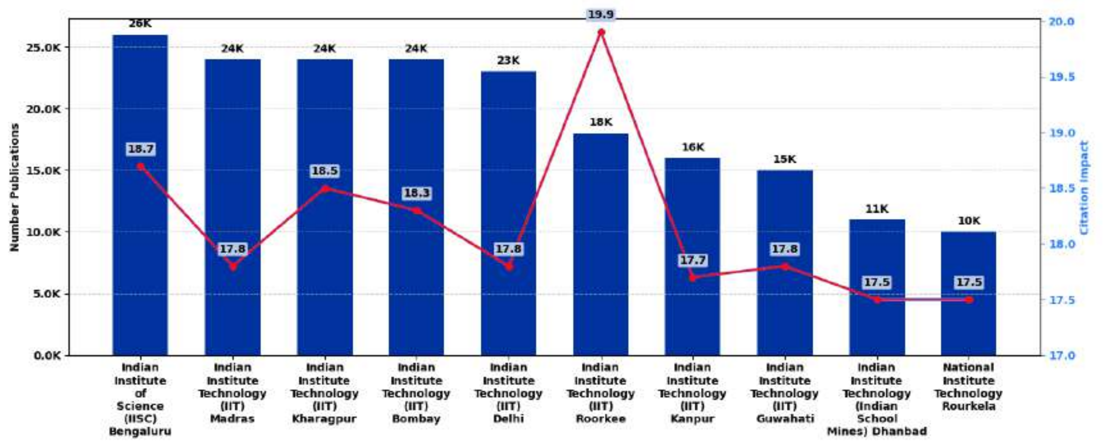


**Figure 3.17:** *Number of publications and citation impact of the top ten PfPIs*

indicates citation impact values for each institute:

- Indian Institute of Science (IISc) Bengaluru leads with the highest number of publications (26K) and the highest citation impact (18.7).
- Indian Institute of Technology (IIT) Madras, Kharagpur, Bombay, and Delhi each have around 23K–24K publications, with citation impact values ranging from 17.8 to 18.5.
- IIT Roorkee uniquely stands out with an 18K publication count but the highest citation impact of 19.9 among all listed institutes.
- IIT Kanpur, Guwahati, Indian School of Mines Dhanbad, and NIT Rourkela have progressively lower publication numbers (16K down to 10K), with citation impact values from 17.5 to 17.8.

Overall, IISc Bengaluru and IIT Roorkee are notable for their exceptional citation impact, while the remaining IITs and NIT Rourkela display a strong but more consistent performance in both publication volume and citation impact. The chart demonstrates both research productivity and quality across leading PfP institutes.

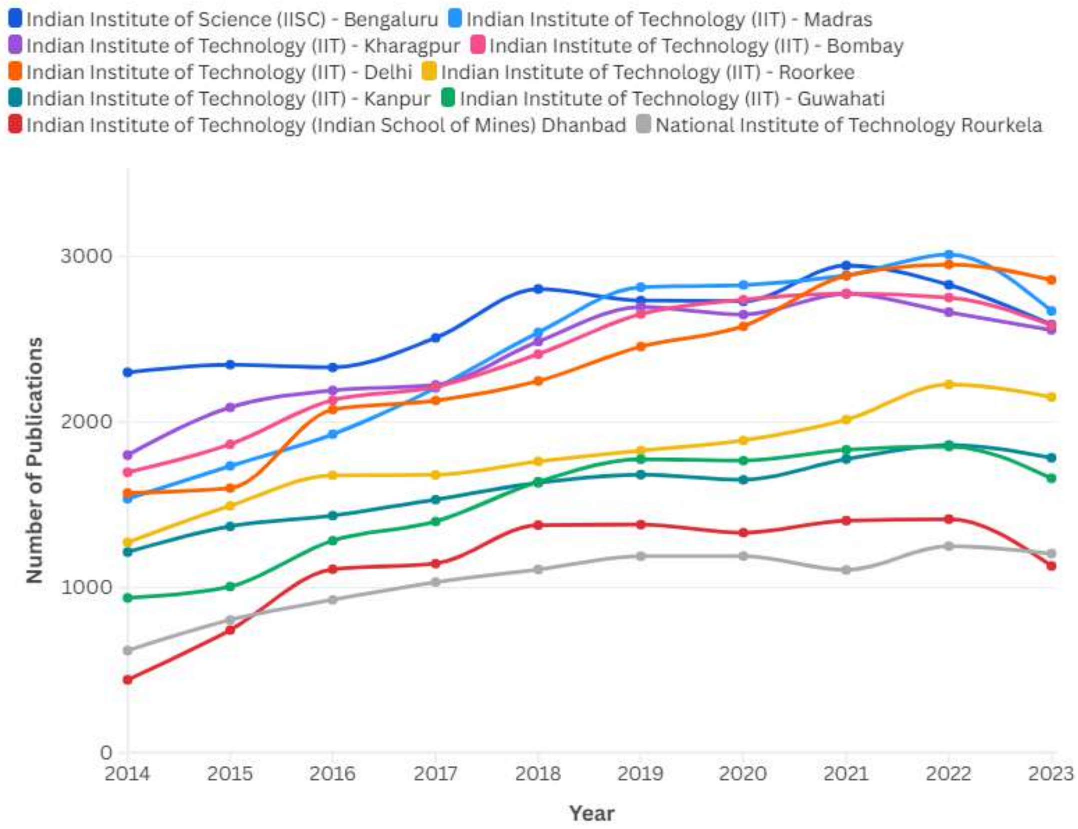


**Figure 3.18:** *Trends in annual publication counts from 2014 to 2023 for the top ten PfPIs*

The figure 3.18 shows the growth trend of PfPI institutes from 2014 to 2023.

- Overall Growth in Publications: All top ten PfPIs have seen a general increase in the number of publications from 2014 to 2022, with most institutes peaking in

2021 or 2022.

- Consistent Leaders: The Indian Institute of Science (IISc) Bengaluru and IIT Madras are consistently among the highest contributors in annual publication count, with both maintaining top positions throughout the years.
- Rapid Riser: IIT Roorkee displays a notable upward trend, showing one of the strongest growth rates, eventually outperforming several peers and peaking among the top institutes in later years.
- Sustained Performance: IIT Bombay, IIT Kharagpur, and IIT Delhi remain strong performers, with publication counts closely trailing the leaders and showing steady progress.
- Moderate Growth: IIT Kanpur, IIT Guwahati, IIT Dhanbad, and NIT Rourkela exhibit more modest yet consistent growth, with stable publication numbers and minor fluctuations in recent years.
- Peak and Decline: Several institutes, including IISC Bengaluru, IIT Madras, and IIT Bombay, show a slight decline or plateau in publication numbers in 2023 compared to their peak years, suggesting possible saturation or changes in publication trends.

Overall, the chart reflects sustained growth in research output across PfPIs, with certain institutes continuously leading and others narrowing the gap through steady increases.

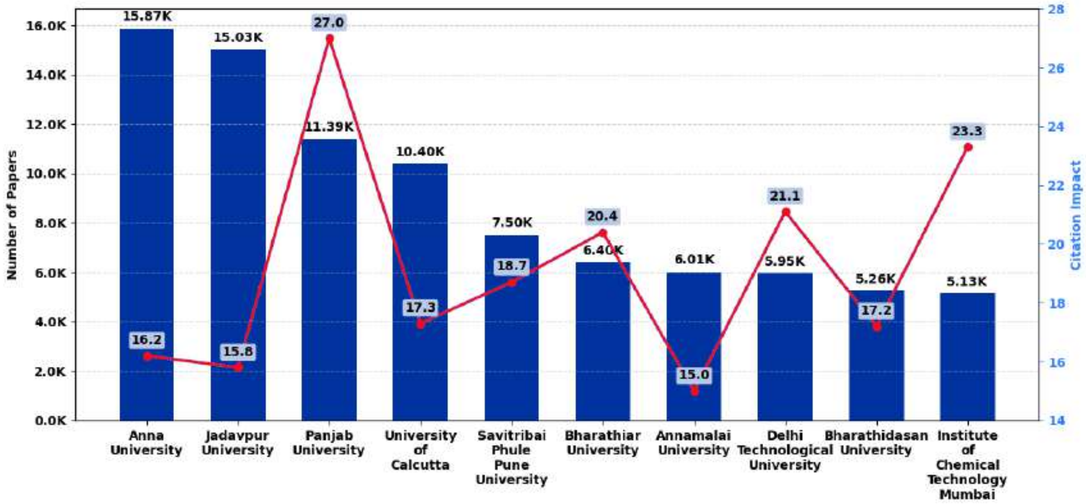


**Figure 3.19:** *Number of publications and citation impact for the top ten state universities in India*

The figure 3.19 presents the number of papers and citation impact scores for the top ten state universities in India. Anna University and Jadavpur University have the highest publication counts, with over 15,000 papers each. Panjab University stands out with the highest citation impact (27.0) despite a lower paper count (11,390). Other universities such as University of Calcutta, Savitribai Phule Pune University, and Bharathiar University display moderate publication volumes (7,500–10,400 papers) and citation impact of around 17–20.4. Annamalai University has a lower citation impact (15.0), while Delhi Technological University and Institute of Chemical Technology – Mumbai excel with citation impacts of 21.1 and 23.3, respectively, despite having fewer papers. Overall, the chart highlights significant variation in both research output and impact among leading state universities, with Panjab University distinguished by exceptionally high citation influence.

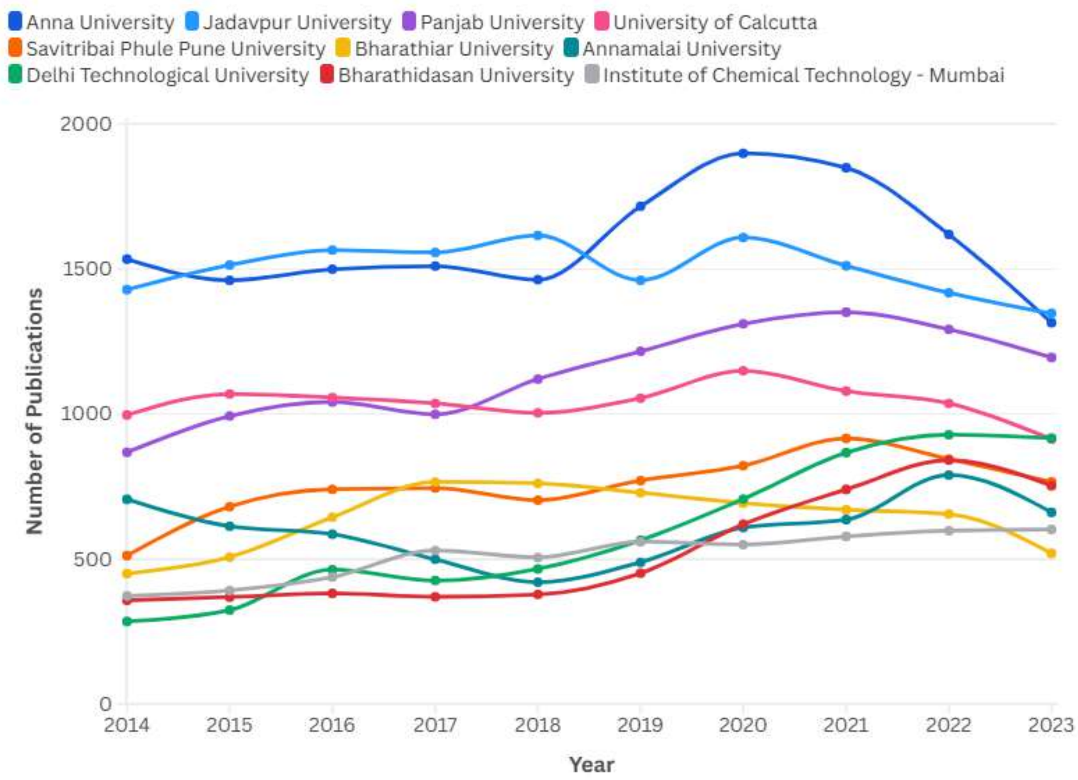


**Figure 3.20:** *Annual publication trends (2014–2023) for the top ten state universities in India*

The figure 3.20 illustrates publication trends from 2014 to 2023 for the top ten state universities in India. Anna University and Jadavpur University consistently lead in publication numbers, peaking around 2020, but both show a decline in output after 2021. Panjab University and University of Calcutta demonstrate steady upward trends before experiencing slight drops in recent years. Several universities, including Bharathiar University, Annamalai University, Delhi Technological University, Bharathidasan University, and Institute of Chemical Technology - Mumbai, show gradual increases in publication numbers over the period, with most reaching their highest output in 2022 or 2023. The chart highlights both the sustained productivity of leading universities and the rising research activity among others, alongside a recent dip in publication counts for top performers.

The figure 3.21 shows both the number of papers published and citation impact scores for the top ten central universities in India. The University of Delhi has the highest publication count with 20,070 papers and a citation impact of 19.5. Banaras Hindu University (BHU), while second in output with 17,510 papers, also stands out for its high citation impact of 24.0, matched only by Jawaharlal Nehru University and

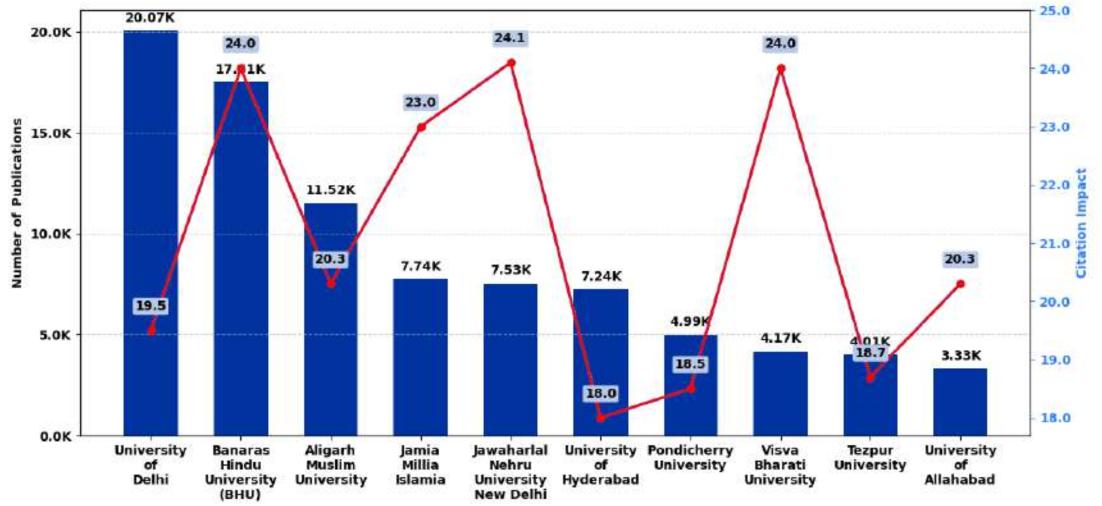


**Figure 3.21:** *Number of publications and citation impact for the top ten central universities in India*

Visva Bharati University at 24.1 and 24.0, respectively, despite their lower publication counts. Aligarh Muslim University ranks third in publication numbers (11,520) with a citation impact of 20.3. Among other universities, Jamia Millia Islamia, Jawaharlal Nehru University, and University of Hyderabad maintain moderate output but exhibit relatively strong citation impacts. The lower portion of the chart reflects universities such as Pondicherry University, Visva Bharati University, Tezpur University, and University of Allahabad, all with fewer than 5,000 publications but respectable citation impacts (ranging from 18.5 to 20.3). Overall, the chart highlights both research productivity and scholarly influence, with some universities achieving high academic impact regardless of publication volume.

The figure 3.22 presents annual publication trends from 2014 to 2023 for the top ten central universities in India. The University of Delhi and Banaras Hindu University (BHU) lead consistently, with both showing steady increases in publication counts over the years, peaking in 2023 at over 2,500 and 2,200 publications, respectively. Aligarh Muslim University follows with a notable rise up to around 1,500 papers before a slight dip in 2023. Other universities like Jamia Millia Islamia, Jawaharlal Nehru University, and University of Hyderabad display moderate growth, reaching around 1,000 publications. Pondicherry University, Visva Bharati University, Tezpur University, and University of Allahabad collectively represent lower but gradually increasing publication volumes, each generally staying below 600 annual publications. Overall, the chart shows robust upward trajectories for the top universities, indicating growing research output and scholarly activity in central universities over the decade, with leading institutions widening their gap over others. The figure 3.23 displays the number of publications and citation impact scores for the top ten private institutes in India. Vellore Institute of Technology (VIT) leads with the highest publication count at 24,430, followed by Manipal Academy of Higher Education (MAHE) and SRM Institute of Science & Technology Chennai with 15,440 and 14,450 papers, respectively.

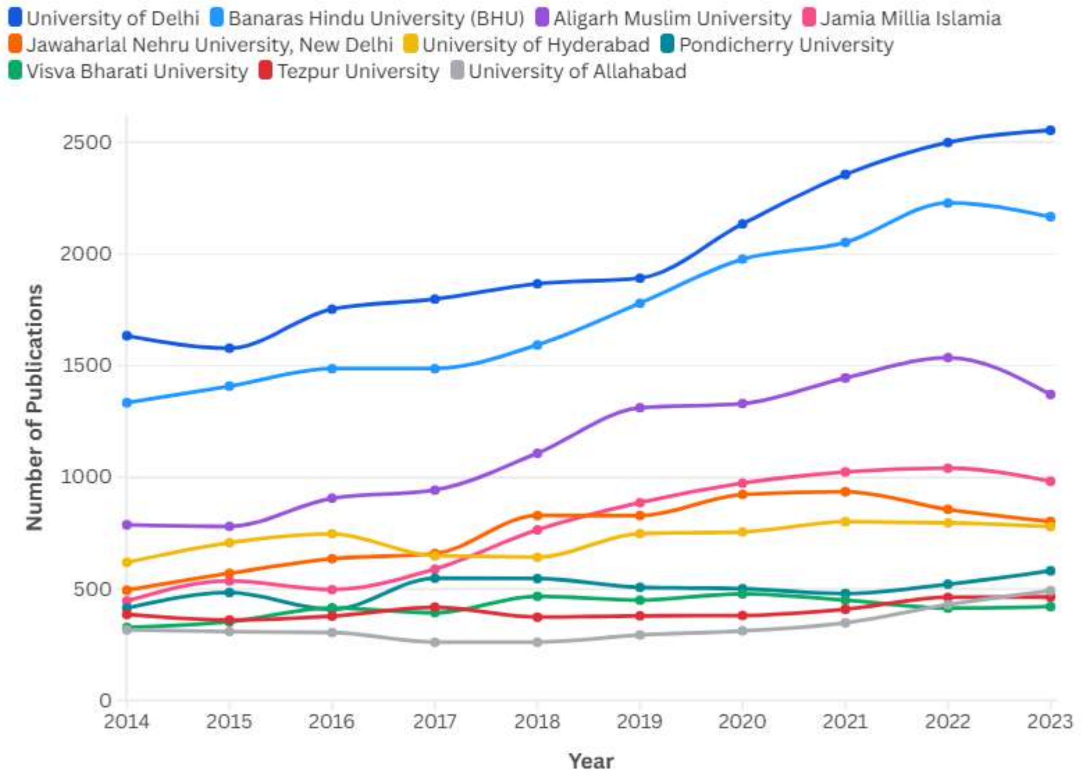


**Figure 3.22:** *Annual publication trends from 2014 to 2023 for the top ten central universities in India*

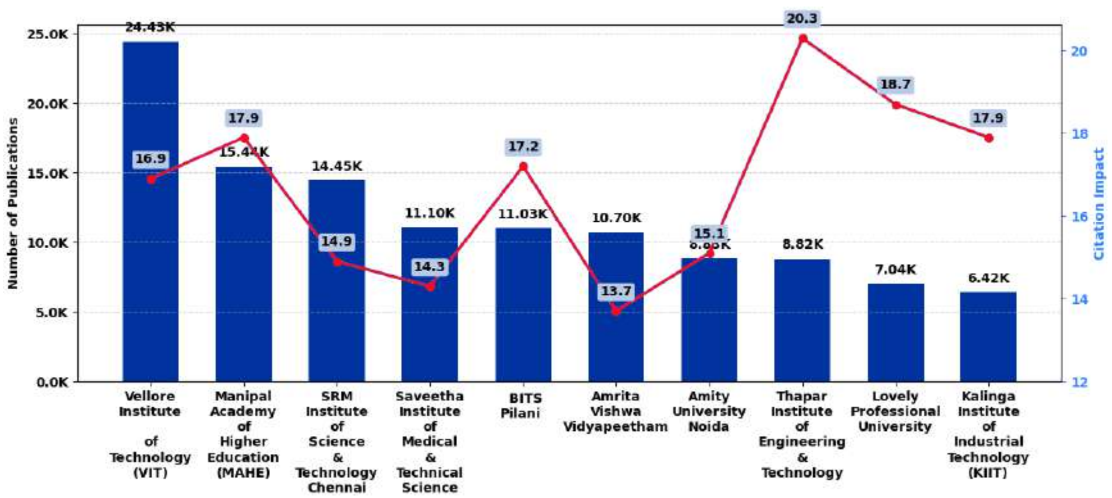


**Figure 3.23:** *Top-10 Private University*

Citation impact varies, with Thapar Institute of Engineering & Technology achieving the highest score (20.3) despite a lower publication count of 8,820. Other institutes, such as Birla Institute of Technology & Science Pilani (BITS Pilani) and Lovely Professional University, display moderate outputs and citation impacts. Most institutes have citation impacts ranging from 13.7 to 18.7, highlighting diversity in research influence. Overall, the chart demonstrates both publication volume and scholarly impact, with some institutes excelling in citation influence irrespective of total publications.

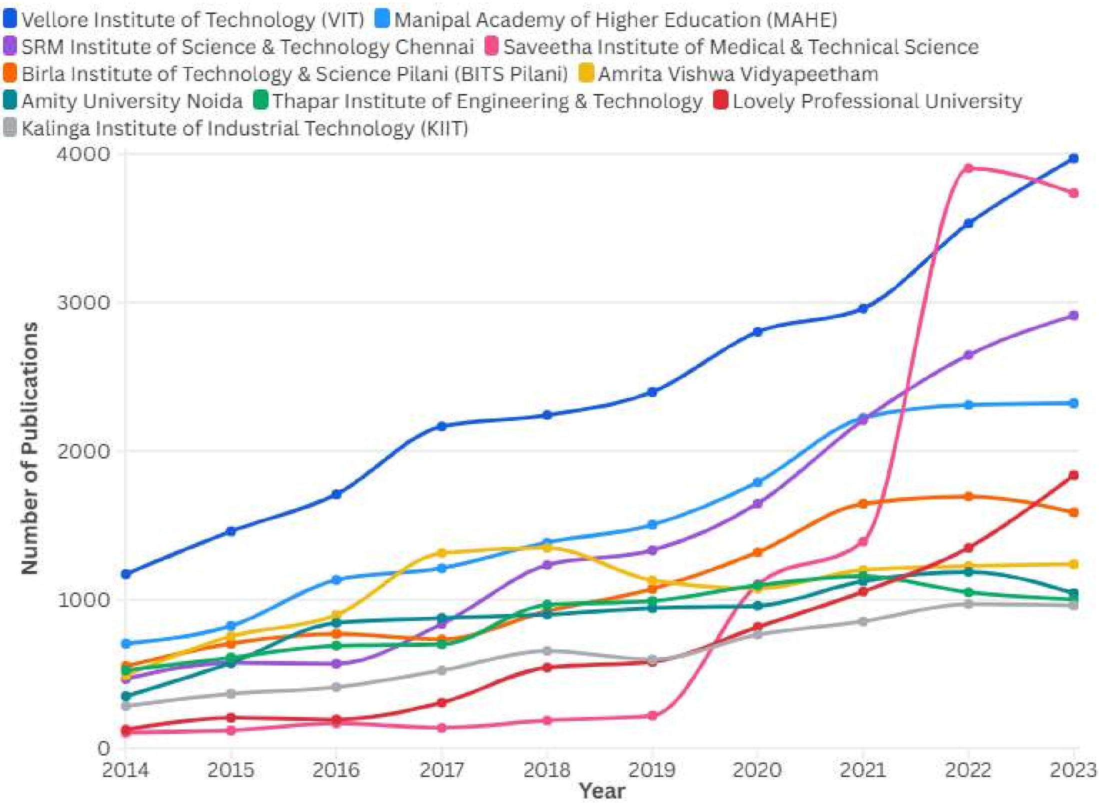


**Figure 3.24:** *Annual publication trends from 2014 to 2023 for the top ten private institutes in India*

The figure 3.24 shows annual publication trends from 2014 to 2023 for the top ten private institutes in India. Vellore Institute of Technology (VIT) stands out with a steep and consistent rise in publications, reaching 4,000 papers in 2023. Saveetha Institute of Medical & Technical Science demonstrates the most dramatic growth, rapidly overtaking many peers and nearly matching VIT at over 3,600 publications by 2022-2023. Manipal Academy of Higher Education (MAHE), SRM Institute of Science & Technology Chennai, and Birla Institute of Technology & Science Pilani (BITS Pilani) also show strong upward trends. Other institutes such as Amrita Vishwa Vidyapeetham, Amity University Noida, Thapar Institute of Engineering & Technology, Lovely Professional University, and Kalinga Institute of Industrial Technology (KIIT) exhibit moderate but positive growth with publication counts below 2,000 by 2023. The chart highlights a rapid surge in research output, particularly among leading private universities, with several institutes narrowing the gap with traditionally dominant institutions, reflecting dynamic growth and increasing competitiveness within the private sector.

### 3.2.3 Research Institutions under Ministry, Departments & Councils

The following figures present an overview of publication output associated with major Indian science and research bodies. It captures both the research directly funded by these departments and councils and publications emerging from institutions operating under their purview. This analysis highlights the knowledge production and quality trends driven by the Department of Science and Technology (DST), Department of Biotechnology (DBT), Council of Scientific and Industrial Research (CSIR), Indian Council of Medical Research (ICMR), Indian Council of Agricultural Research (ICAR), Ministry of Health and Family Welfare (MoH&FW), Department of Atomic Energy (DAE), Department of Space (DoS), and Defence Research and Development Organisation (DRDO).

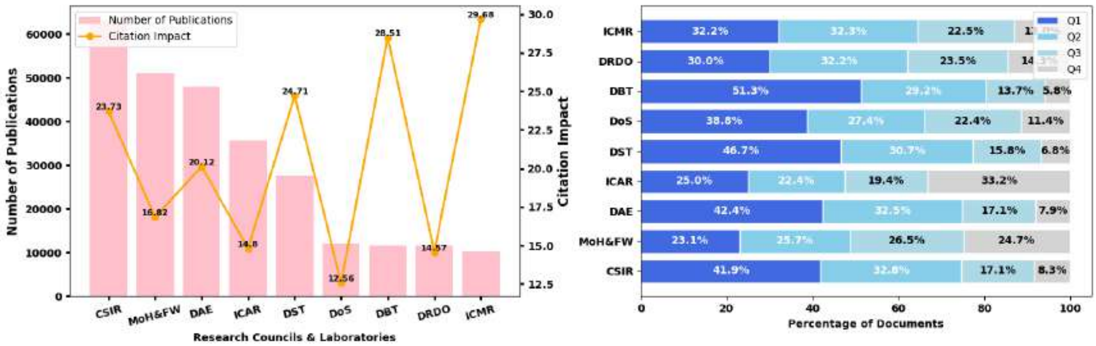


**Figure 3.25:** *Distribution of publications funded by various departments & councils during 2014-2023*

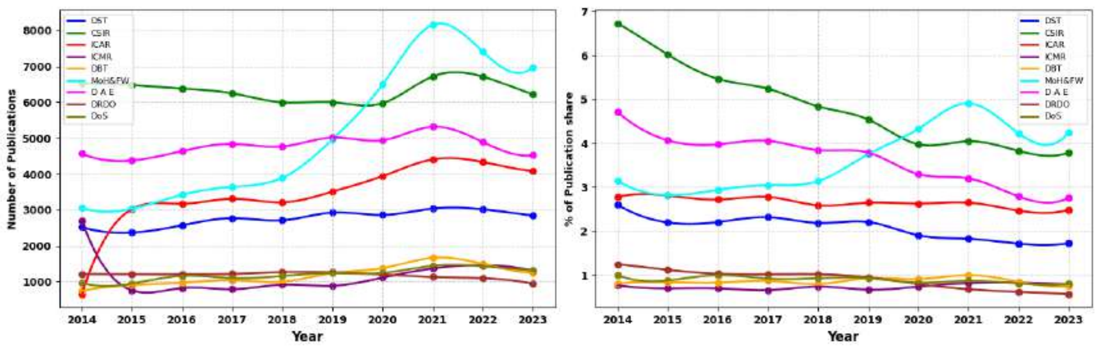


**Figure 3.26:** *Publication trends & percentage share between 2014-2023 of publications funded by or under these various departments & councils*

## 3.3 Topic Analysis 2014-2023

### 3.3.1 Macro-Topic Trend

Examining the growth trend in Figure 3.28 in various research subject areas reveals some notable patterns. In most cases, there is no significant growth; however, positive trends are evident in areas such as clinical medicine. Earth sciences also show

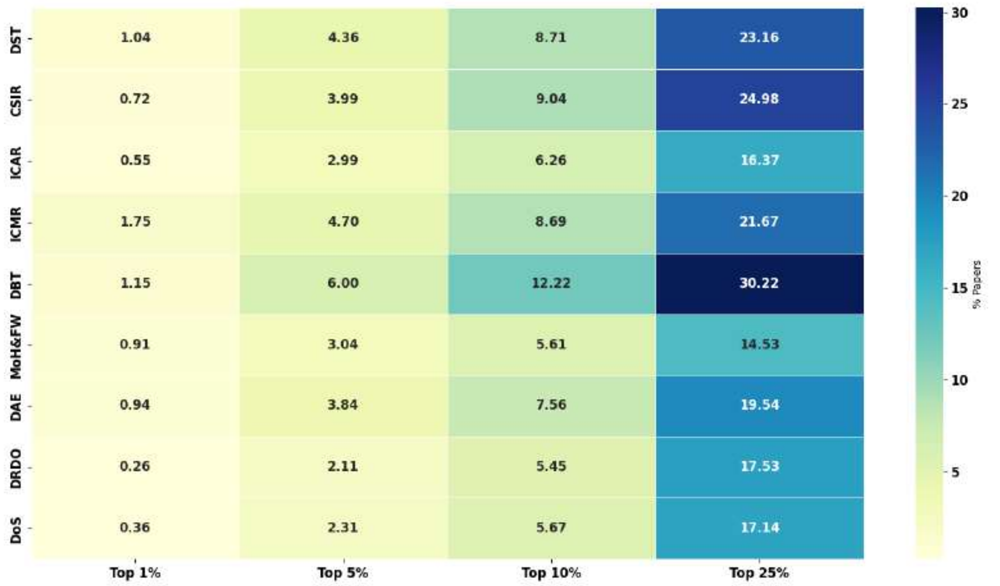


**Figure 3.27:** *Heatmap of Top papers by different councils. Please note that this chart is intended to represent the data for each council individually. It is not designed for direct comparison across councils, as the research fields vary significantly and are cited at different rates.*

a positive growth trajectory, with agriculture, environment & ecology experiencing a moderate increase.

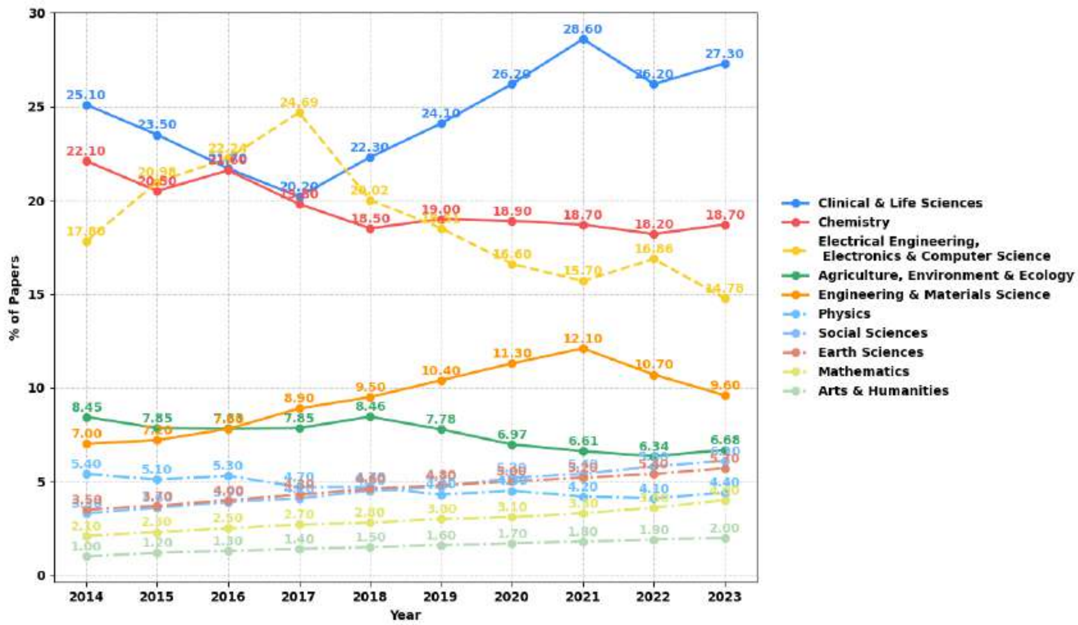


**Figure 3.28:** *Trend of the percentage of papers published in the topic - INDIA*

In contrast, traditional fields such as physics and chemistry appear to be on a declining trend, with fewer publications over time. This suggests a shift in research focus away from classical STEM disciplines toward more interdisciplinary subjects. These emerging fields often integrate knowledge from physics, chemistry, and related areas, contributing to the observed growth in publication trends for these interdisciplinary domains.

### 3.3.2 Meso-Topics

The figure 3.29 visualizes the publication output and citation impact across various scientific disciplines using a treemap visualization. Larger boxes represent macro topics whereas smaller boxes within the larger boxes represent meso topics, the size of the box is proportional to the number of publications in the respective field, and each box is labeled with the total number of publications (PUB) and the average number of citations per publication (CPP) in that respective field. The map shows a hierarchical structure, grouping related fields. The same hierarchical breakdown occurs for major fields like Physics, Chemistry, Engineering & Materials Science, Agriculture, Environment & Ecology, Clinical & Life Sciences, Earth Sciences, and Mathematics. The chart allows for a quick comparison of relative publication volume and citation impact across numerous scientific sub-fields.

### 3.3.3 Micro-topic in the period 2014-2023, India

- Nanofluid leads overall (13,096) Figure 3.30, highlighting sustained strength in research across the decade.
- Wireless Sensor Networks (11,013) and Antenna Design (8,518) reflect a durable communications and IoT hardware focus.
- Nanotoxicology (11,411) and Adsorption (8,621) priorities alongside nano-innovation.
- TiO2 Photocatalysis (9,810) and ZnO Nanostructures (8,750) indicate increased research in semiconductor materials.
- Advanced Machining (8,582), Power Quality (8,279), and Electrode Materials (8,276) show strong applied engineering in manufacturing, grids, and energy storage.

The radar chart in Figure 3.31 shows the collaboration patterns within various macro topics in India between 2014 and 2023. The chart distinguishes between domestic and international collaborations. Each axis extends to a maximum value of about 40, which is in percentage. The chart visually allows for a comparison of collaboration patterns across the different scientific disciplines.

The collaboration pattern shows that the topic Agriculture, Environment, and Ecology lead in domestic collaborations (32.54%), followed closely by Earth Sciences and Engineering & Materials Science (both 32.18%). Chemistry also exhibits strong domestic collaboration (30.95%). In terms of international collaboration, Mathematics stands out with the highest percentage (34.38%), followed by Physics (32.34%) and Earth Sciences (27.4%), indicating robust global partnerships in these fields. However, industry collaboration remains relatively low across all domains, with the highest percentage seen in Electrical Engineering, Electronics, and Computer Science (1.61%), followed by Physics (1.33%) and Clinical & Life Sciences (1.28%). Arts & Humanities

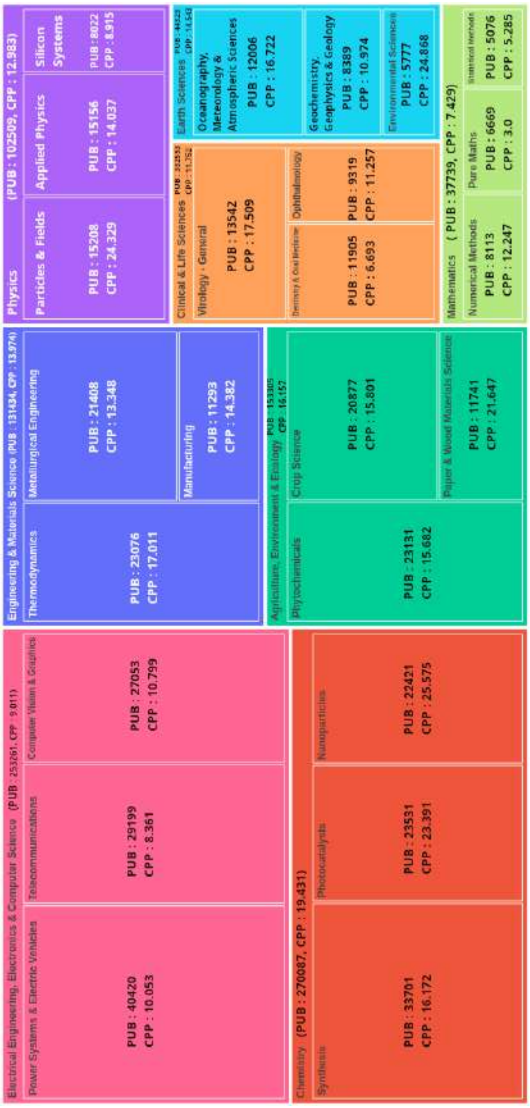


**Figure 3.29:** *Tree map representing topics and subtopics, with the size of each block corresponding to the number of publications (PUB), and CPP is the total citations accrued by all publications in that field.*


**Figure 3.30:** *Top MicroFields in India 2014-2023*

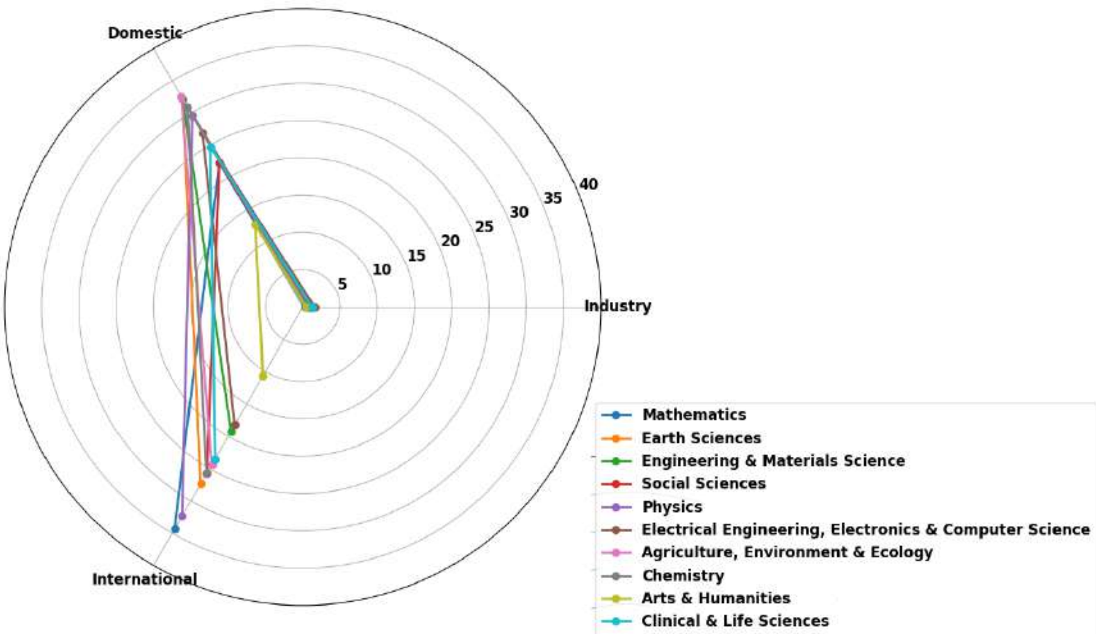


**Figure 3.31:** *Collaboration pattern in topics - INDIA*)

and Mathematics show the lowest industry collaboration rates, at 0.41% and 0.3%, respectively. These patterns suggest that while India has made significant strides in domestic and international research collaborations, industry engagement remains a critical area for improvement across most fields.

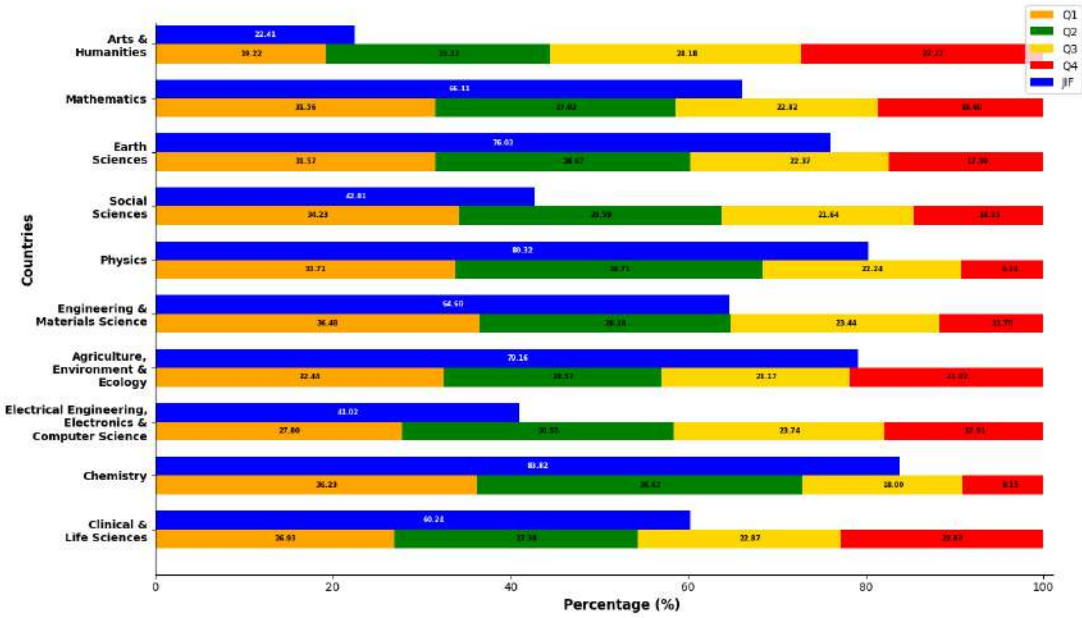


**Figure 3.32:** *Topic-wise distribution of Journal quartiles - INDIA*

Chemistry and physics lead in publishing papers in journals with a Journal Impact Factor (JIF), with over 80% of their papers appearing in such journals represented in the figure 3.32. They are followed by agriculture, environment & ecology, and earth sciences, where more than 75% of publications are in JIF-indexed journals.

In contrast, computer science has a significantly lower proportion of publications in JIF journals (Figure 3.32). This is **likely because conference proceedings hold high prestige in this field, often based on the reputation of the conferences themselves, this data is not captured in this study**.

When examining journal quartiles, around 30% of publications across most subjects are published in Q1 journals. However the life sciences stand out with a lower proportion of Q1 publications, in the 20% range, and only about 60% of their publications appear in JIF-journals.

As highlighted earlier, a notable trend for Indian publications is their higher prevalence in Q2 and Q3 journal categories, reflecting challenges in achieving broader representation in top-tier Q1 journals.

The heatmap in the figure 3.33 visualizes the percentage of publications from different academic topics in India that fall within the top 1%, top 5%, and top 10% of publications. While Indian researchers publish extensively in fields like clinical medicine and chemistry, the percentage of publications ranked among the top 1%, 5%, or 10% of highly cited publications is relatively low. Similar trends are observed in physics and electronics & computer science.

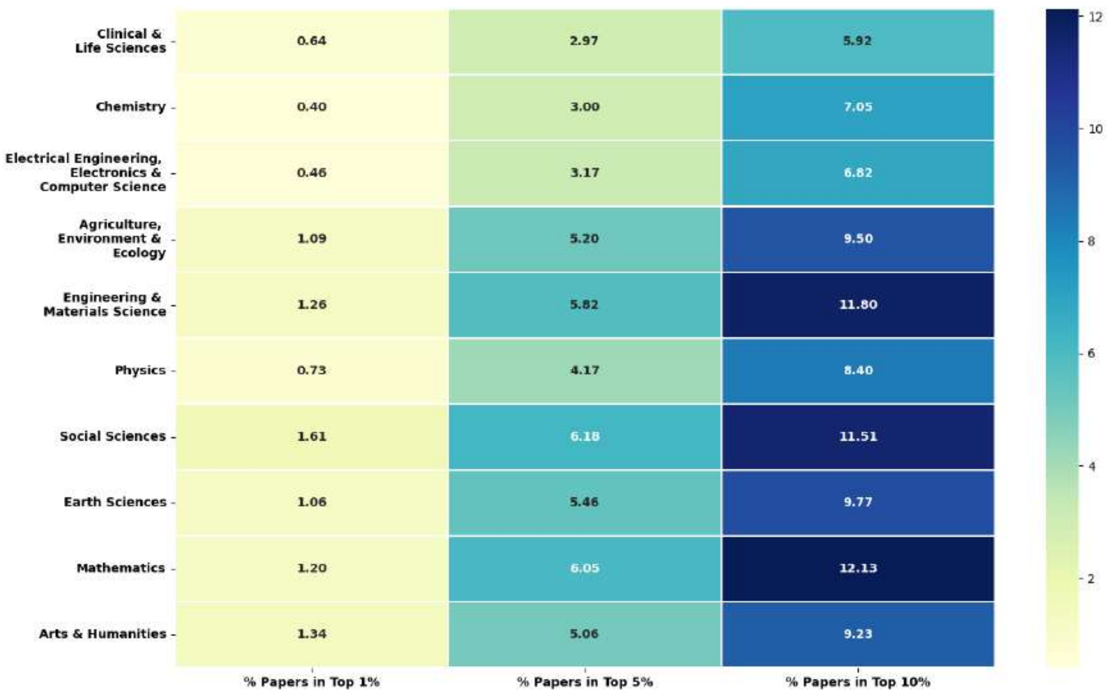


**Figure 3.33:** *Topic-wise top publications - INDIA. Please note that this chart is intended to represent the data for each field. It is not designed for direct comparison across the fields, as they are cited at different rates.*

However, in emerging fields such as engineering, materials science, mathematics, and environmental science, the proportion of highly cited publications from India shows a more promising trend. This indicates a growing presence of impactful research in these areas.

Although this report primarily focuses on bibliometric analyses of STEM subjects, a notable observation emerges in social sciences and arts & humanities. In these fields, the percentage of highly cited publications from India is significantly higher, showcasing stronger global recognition.

## 3.4 Selected Strategic Research Priority Areas for India

India has launched a series of ambitious national missions to advance research and innovation in areas that are expected to shape the country's scientific and economic future. These initiatives focus on technologies with transformative potential, global relevance, and strong societal impact. The National Program on Artificial Intelligence (NPAI)[1], the National Electric Mobility Mission Plan (NEMMP), the Nanoscience and Nanotechnology Initiative, National Mission on Interdisciplinary Cyber Physical Systems (NM-ICPS), National Green Hydrogen Mission, India AI mission and the National Quantum Mission (NQM) represent carefully chosen priorities that align with India's developmental needs while also positioning the country as a contributor to

[1] Reflects an earlier strategic policy framework, whereas the IndiaAI Mission represents a more recent, implementation-driven initiative with dedicated funding and institutional mechanisms.

cutting-edge global research in research fields such as Artificial Intelligence, Electric Mobility, Nanoscience & Nanotechnology, and Quantum Science & Technology.

This section offers a broad overview of knowledge production trends related to the four research topics related to the missions, without attempting a critical evaluation of the missions themselves. With the exception of the Nano-Initiative, the other three are relatively recent, making it premature to assess their publication trends in depth.

### 3.4.1 Artificial Intelligence & Machine Learning


**Figure 3.34:** *Publication trend, citation impact & collaboration pattern of AI-related research publications: Context NPAI*

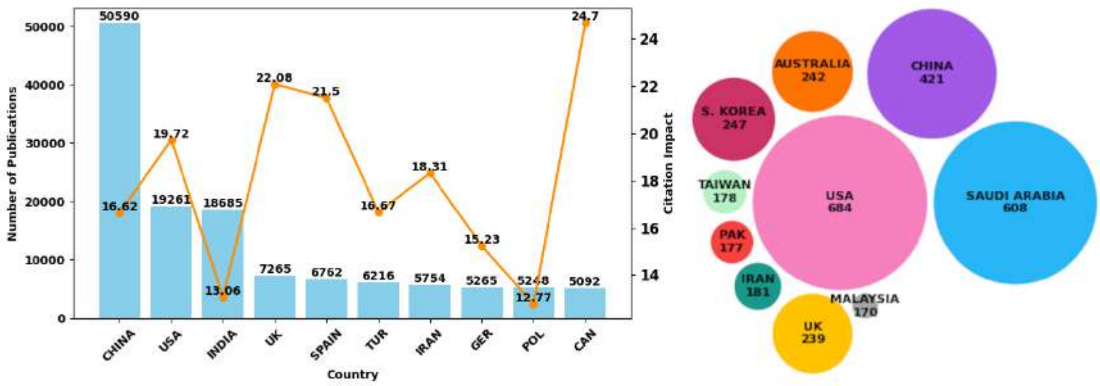


**Figure 3.35:** *Comparative publication trends of top knowledge-producing countries in AI-related research & top collaborating countries of India: Context NPAI*

- India's publication output in AI/ML has grown significantly over the last decade, increasing from around 1,150 documents in 2014 to a peak of about 2,400 in 2022.
- The bubble chart demonstrates that the USA (684 collaborative publications) and Saudi Arabia (608) are India's strongest international partners, followed by

China (421), South Korea, Australia, and the UK (240 each). Notably, Pakistan is among the top 10 international collaborators with India in AI/ML research publications, with 177 joint publications. This occurrence is surprising given the often tense geopolitical relationship between the two countries.

- While India's publication quantity is high, there remains scope for quality improvement—fewer top-cited publications compared to Western leaders, but competitive with several emerging countries.
- The majority of Indian AI/ML research collaborations occur within India, with 26.94% of publications with domestic collaborations, and the international collaborations stand at 20.07%, vital for knowledge exchange and raising research impact. With only 0.87%—indicates limited direct engagement with the private sector, suggesting an opportunity for academia-industry partnerships to enhance application and commercialization.

### 3.4.2 Power System & Electric Vehicles

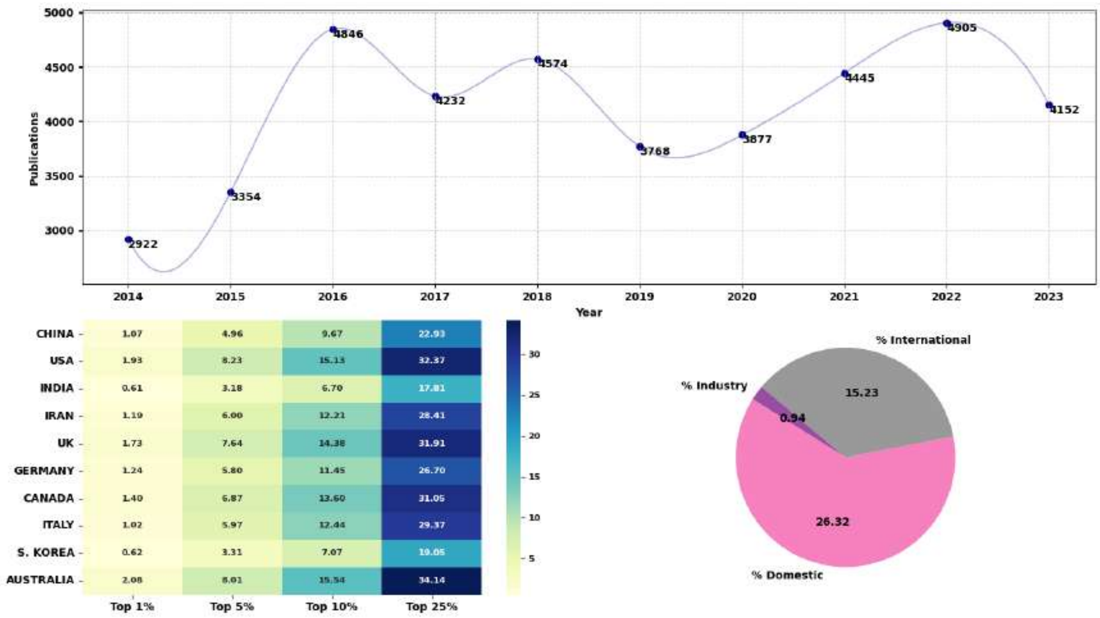


**Figure 3.36:** *Publication trend, citation impact and collaboration pattern of Electric Mobility-related research publications: Context NEMMP*

- India has consistently produced a substantial volume of publications in the field of Electric Mobility, with around 2,900 in 2014 and reaching peaks of approximately 4,800 in both 2016 and 2022.
- The USA (1,019 collaborations) leads as India's largest research partner, followed by Saudi Arabia (872), the UK (532), Malaysia (491), Denmark (433), and Canada (410).
- While India's research output in this field is substantial in volume, its citation impact remains relatively modest, indicating scope to enhance both the quality and global influence of its contributions.

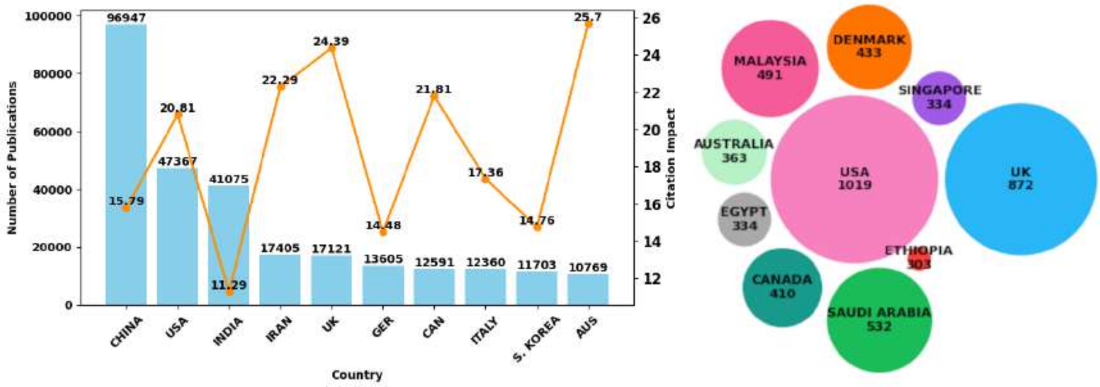


**Figure 3.37:** *Comparative publication trends of top knowledge-producing countries in Electric Mobility-related research and top collaborating countries of India: Context NEMMP*

- Collaboration patterns show that domestic partnerships account for the largest share, contributing 26.32% of publications. International collaboration is fairly strong at 15.23%, though lower than domestic levels. In contrast, industry participation is minimal at just 0.94%, pointing to limited translational engagement and weak commercialization linkages.

### 3.4.3 NanoScience & Nanotechnology.


**Figure 3.38:** *Publication trend, citation impact and collaboration pattern of Nanoscience-related research publications: Context Nano-mission*

- India's publications in Nanoscience & Technology have shown continuous growth, increasing from about 2,100 in 2014 to over 3,600 in 2023.
- The USA (2,178), South Korea (1,363), Saudi Arabia (1,153), China (848), Germany (723), UK (720) and Japan (631) are the largest collaborators. Australia, Taiwan, France, and Malaysia also feature prominently.

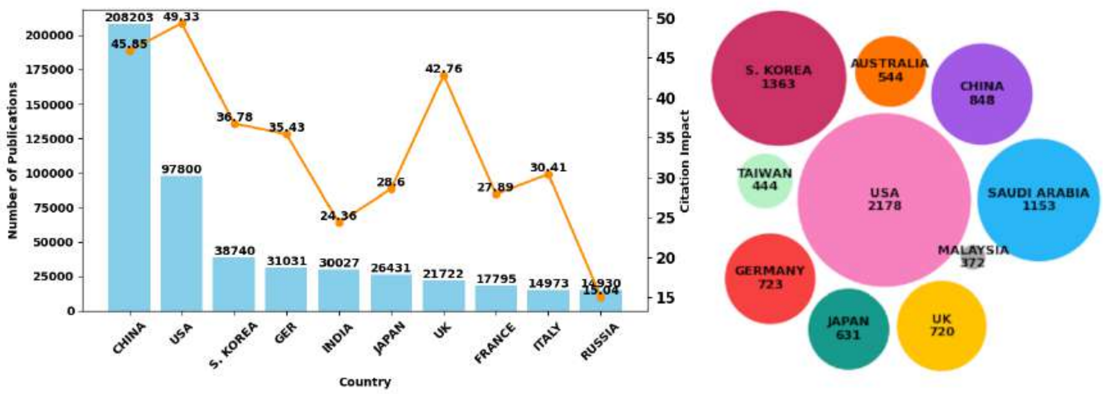


**Figure 3.39:** *Comparative publication trends of top knowledge producing countries in Nanoscience-related research and top collaborating countries of India: Context Nano-mission*

- India's percentage of highly-cited publications is lower compared to leading countries, but is competitive among mid-tier international peers, reflecting good but improvable research influence.
- Strong international collaboration producing 31.92% of publications in the field, also a significant share (29.22%), showing strong national network and capacity. Industry engagement is very low, and this shows that most work remains in academia/research institutes.

### 3.4.4 Quantum Science & Technology.

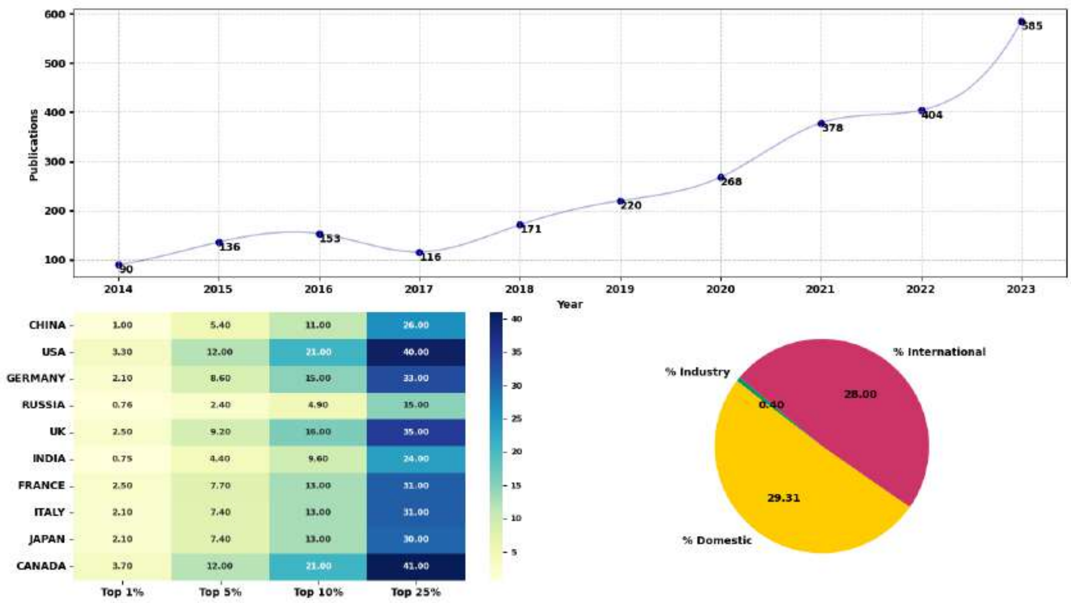


**Figure 3.40:** *Publication trend, citation impact and collaboration pattern of Quantum-related research publications: Context NQM*

- India's quantum science publications have grown they from under 100 documents in 2014 to nearly 600 in 2023. Yet, they are very low. The most rapid

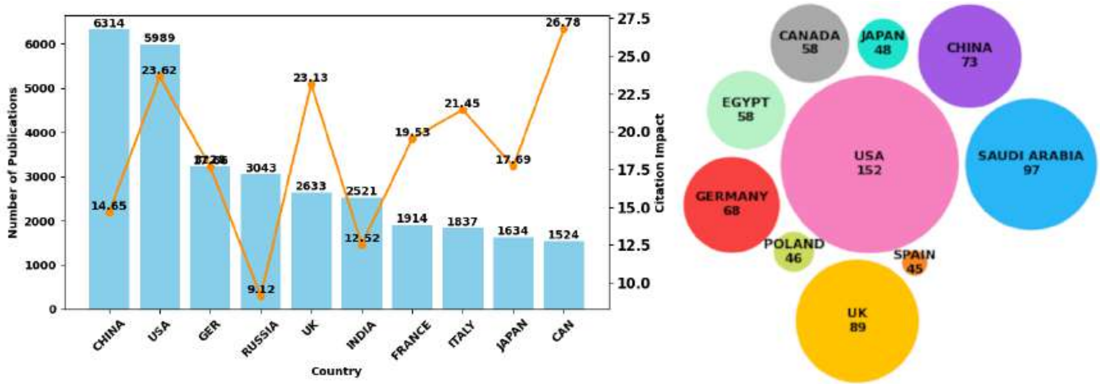


**Figure 3.41:** *Comparative publication trends of top knowledge-producing countries in Quantum-related research and top collaborating countries of India: Context NQM*

increase occurred post-2020, with output more than doubling between 2021 and 2023—a sign of escalating national and global interest in quantum technologies and possibly related to new mission-level initiatives.

- The USA (152), Saudi Arabia (97), China (73), Germany (68), and the UK (89) are India's top global partners. Also notable are Egypt, Canada, Japan, Poland, and Spain, showing robust links across North America, Europe, Asia, and the Middle East.
- India's quantum research is rapidly expanding in quantity but has fewer very high-impact, top-cited publications than Western leaders and Japan, indicating an opportunity for growth in breakthroughs and global influence.
- Domestic Collaboration is at 26.29% while the International Collaboration 17.83%, indicating that the majority of work is within India. Industry integration remains low, similar to other fields, highlighting potential for greater partnership and technology transfer.

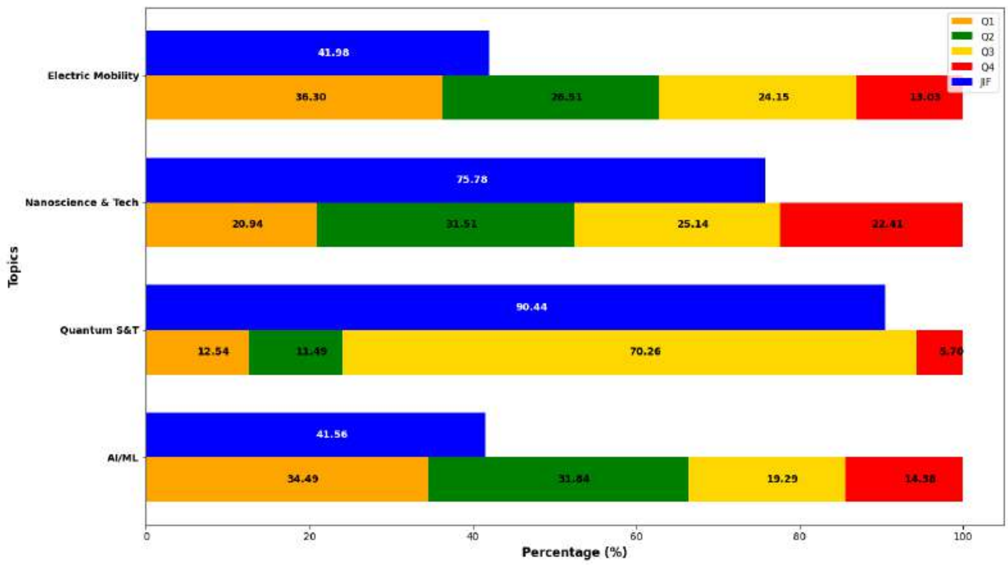


**Figure 3.42:** *Journal quartiles in National Missions - India*

The figure 3.42 compares the distribution of publications from India across journal quality tiers—Q1 (top quartile), Q2, Q3, Q4 (bottom quartile), and Journals with JIF — across Electric Mobility, Nanoscience & Tech, Quantum S&T, and AI/ML.

In Electric Mobility, more than a third is published in Q3, substantial publications in Q2, and best among all fields in the top quartile (Q1) penetration after nanoscience.

India's publication growth across various fields is underway but remains slow.Much of this work is published in journals with moderate or lower impact factors journals, particularly in the Quantum and Nano domains. Despite being the oldest initiative among the ones analyzed, the Nano Mission has yet to make a significant impact in terms of both the quantity and quality of research output. While it shows steady growth and active international collaboration, its publication volume and proportion of high-impact publications remain comparatively modest.

To maximize global scientific leadership, there should be a concrete effort to publish breakthrough work in Q1 journals—signifying higher standards, impact, and international recognition.

## 3.5 Funding Agency

Funding agency acknowledgment trends provide insights into the sources of financial support driving research publications in various countries. If funding data are available, numerous insights can be drawn, such as how funding patterns influence research priorities, collaboration networks, and overall scientific productivity. A comparison between India and other top knowledge-producing countries reveals the culture of funding agency acknowledgments of these countries.

### 3.5.1 Funding Agency Acknowledgment Trends in Top Knowledge-Producing Countries: A Comparison with India

The practice of acknowledging funding agencies in research publications is well established in countries like China, the US, and the UK (Figure 3.43). A detailed analysis of the funding agencies acknowledged in papers published from these countries between 2014 and 2023 reveals that in China, over 60% of research publications of all the papers published in this period include acknowledgments of funding agencies, while this number is 25% in India.

A closer look at India's publications between 2014-2023 reveals which are the top five funding agencies acknowledged by authors based on available funding acknowledgment data. While it is known that most publications from India do not acknowledge the funding agencies, among the total publications with acknowledgment data, the Department of Science and Technology (DST) leads with 31.9% of publications with funding support data acknowledging its support. It is followed by the Council of Scientific and Industrial Research (CSIR) and the University Grants Commission (UGC), with 21% and 20%, respectively 3.44.

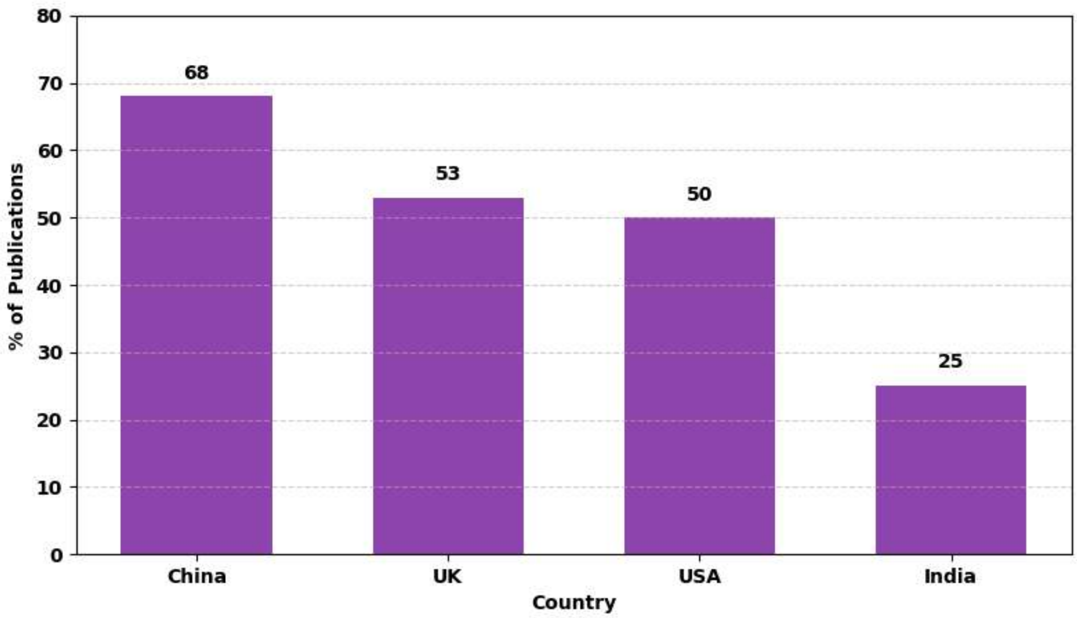


**Figure 3.43:** *Funding acknowledgment in countries*

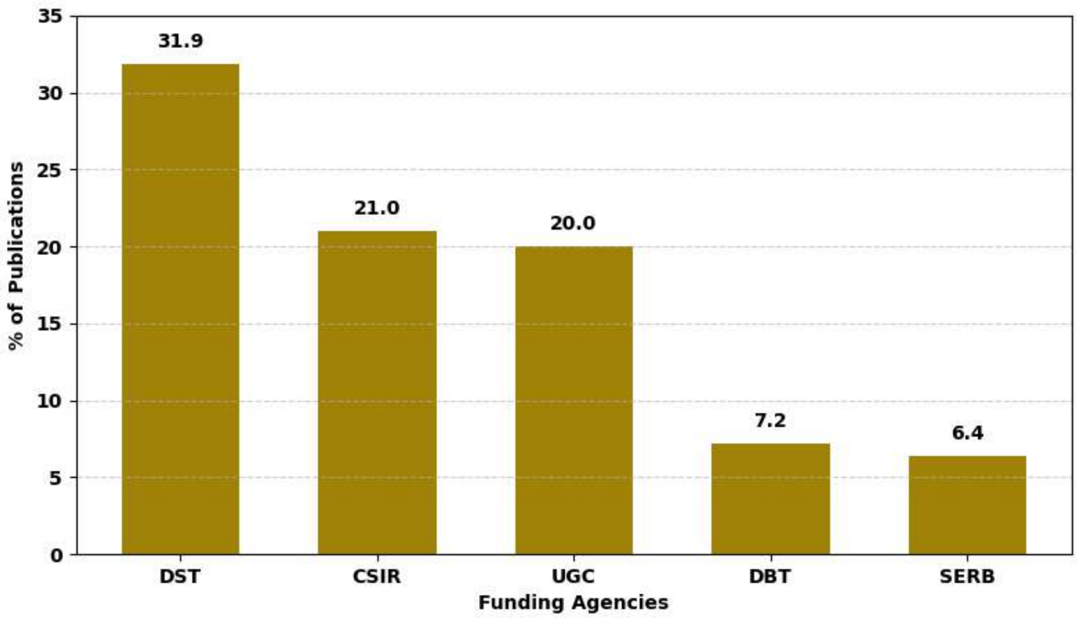


**Figure 3.44:** *Domestic funding agency acknowledgment pattern in India (top five agencies).*

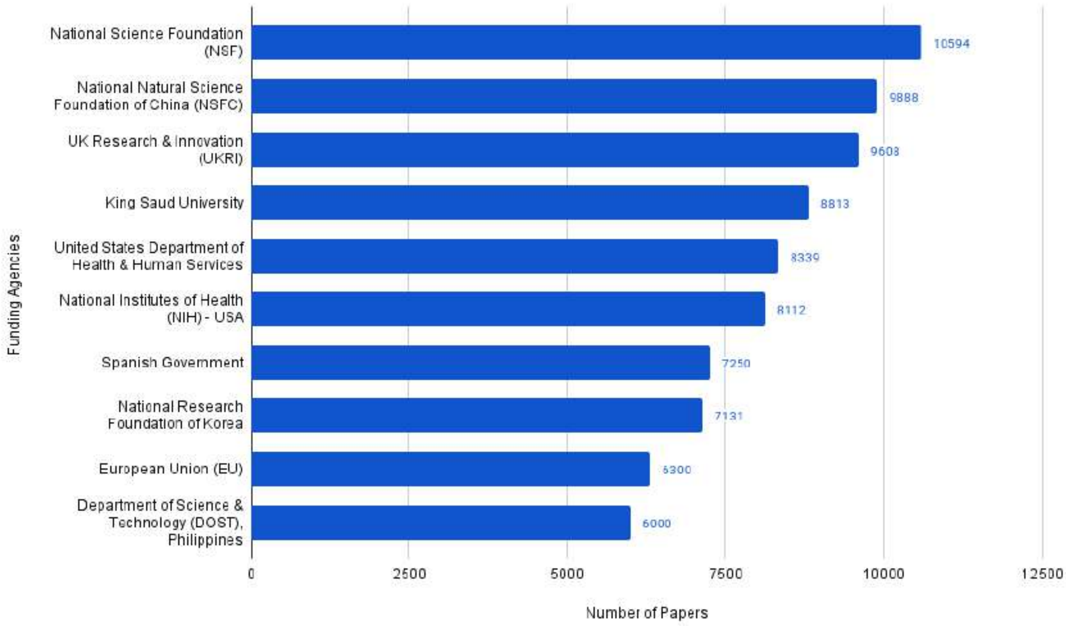


**Figure 3.45:** *International funding agencies acknowledged in the number of Indian publications*

During 2014-2023, Indian researchers acknowledged the support of 1287 funding agencies overall, highlighting the extensive role of international agencies in fostering India's research ecosystem as seen in Figure 3.45. The National Science Foundation (NSF) of the United States leads the acknowledgments, contributing to 10,594 publications, which account for 3.15% of India's total STEM publications. The National Natural Science Foundation of China (NSFC) follows closely, acknowledged in 9,888 publications (2.94%), showing the extent of Chinese funding agencies on India's research. The UK Research & Innovation (UKRI) is third, supporting 9,608 publications (2.86%), reflecting the strong role of UK funding institutions in an Indian research ecosystem. U.S.-based agencies (National Science Foundation (NSF), U.S. Department of Health and Human Services (HHS), and National Institute of Health (NIH)) contributed to 27,045 publications, accounting for 8.05% of India's total STEM publications during this period, emphasizing the critical role of the United States in supporting India's research ecosystem. These ten international agencies were collectively acknowledged in 6.92% of India's total STEM publications.

## 3.6 International Comparative Analysis of India's Research Output

This section presents a comparative analysis of India's research output in the global context. It examines India's research performance relative to other major groups such as BRICS, G20, and the international community as a whole. In addition to quantitative indicators such as publication volume over the period, this section also evaluates quality metrics based on citation impact, enabling a comparison of India's performance with the top 10 knowledge-producing countries as well as BRICS and G20 groupings. The analysis aims to highlight India's position, growth trends, and contributions to global research landscapes, providing valuable insights into its scientific development and international standing.

### 3.6.1 Research Publications Trends Among G20 Countries (2014–2023)

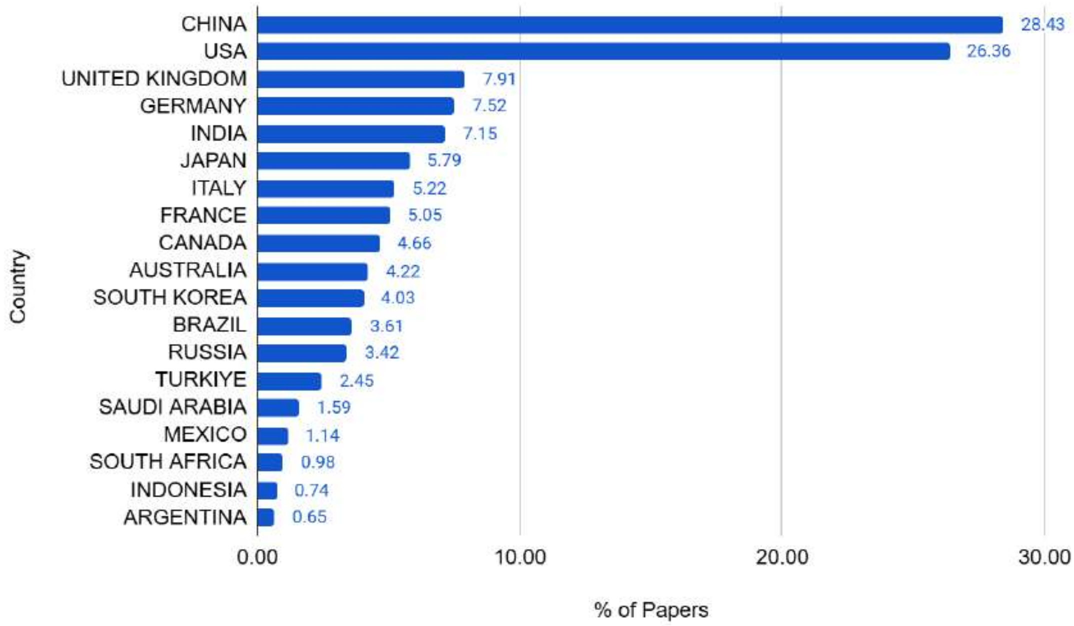


**Figure 3.46:** *Share of publications by each G20 country as a percentage of total G20 publications (2014–2023*

The total number of publications by G20 countries stands at 18852008, which is 80.78% of the total world publications. Examining the performance of G20 countries and comparing their publications from 2014 to 2023 reveals that China and the United States dominate, contributing 28% and 26%, respectively, to the total publications from these nations (Figure 3.46). This trend aligns closely with the data in Figure 3.2, which highlights overall publication output, reflecting a similar distribution pattern.

### 3.6.2 Research Publications Trends Among BRICS Countries (2014–2023)

Total publication by BRICS countries stands at 8104286 which is 34.73% of the total World's publications. Figure 3.47 represents the percentage contribution of publications of each BRICS country to the total publications of all the BRICS countries between 2014-2023 in STEM fields. Among the BRICS countries, China leads in research output and dominates the publishing landscape of BRICS countries with a contribution of nearly 66% of all publications coming from BRICS. India ranks a distant second, followed by Brazil and Russia, while South Africa produces significantly fewer publications compared to the other BRICS nations.

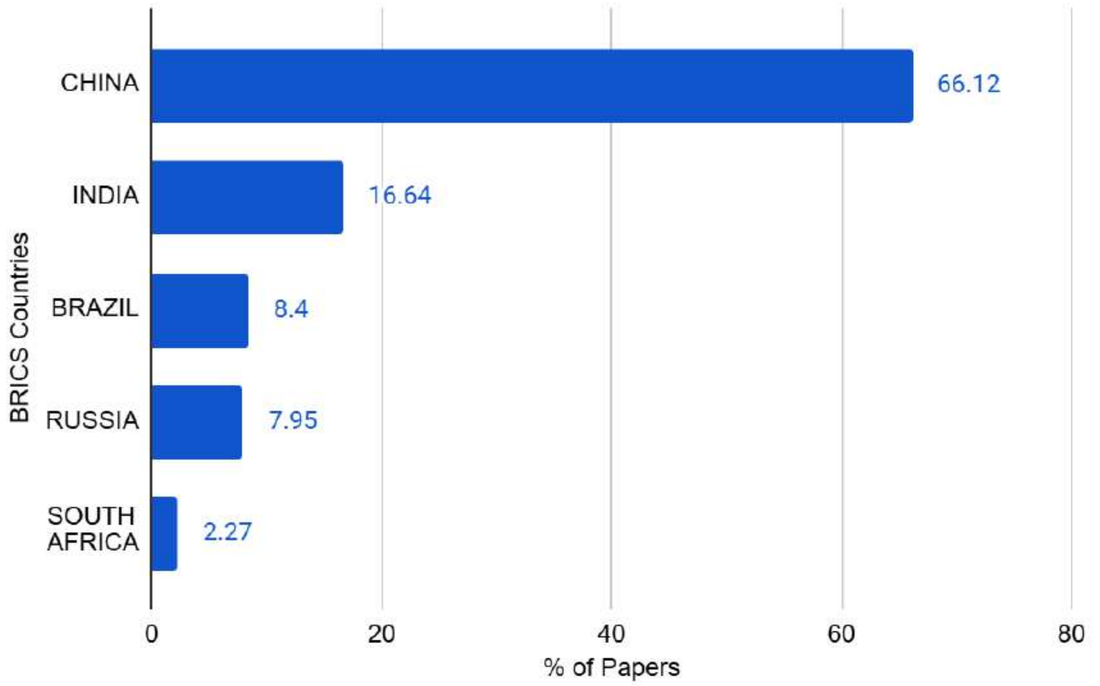


**Figure 3.47:** *Share of publications by each BRICS country as a percentage of total BRICS publications (2014–2023)*

Another interesting question is whether there is any significant increase or decrease in publication percentage over the years between 2014-2023. Looking into annual trends in percentage contribution, again, China dominates and shows a trend of the annual increase in percentage contribution, while the contributions of other countries remained nearly the same with slight fluctuations over the years analyzed in this report (Figure 3.48). A close look at the graph shows that India's contribution to BRICS has declined during the period 2019-2023 compared to the previous period of 2014-2018. This is in relative terms since China's research output is growing at a much faster rate. Interestingly, Russia's contribution has been on the decline since 2020.

### 3.6.3 Assessing Quality: Citation Impact and High-Quality Journal Publications (2014–2023)

The quality of scientific research is a crucial metric for understanding its global impact and relevance. This theme examines quality indicators, including citation per paper and the percentage of publications in high-quality journals categorized by quartiles (Q1 to Q4) as well as publications in journals with a Journal Impact Factor (JIF) for 10 knowledge-producing nations, G20, and BRICS countries.

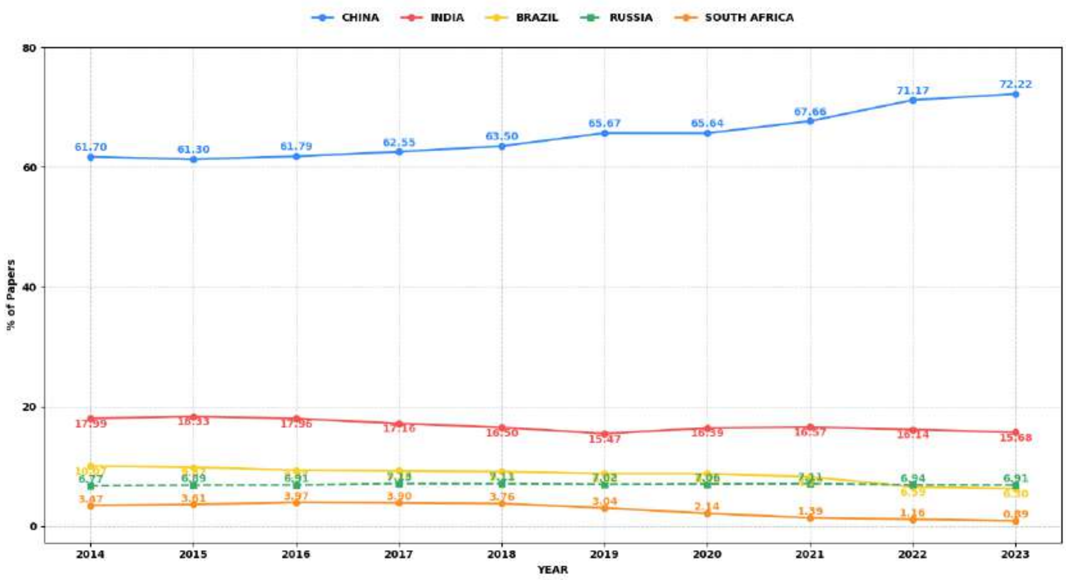


**Figure 3.48:** *Trends in Country-wise Publication Share of BRICS Nations (2014–2023*

### 3.6.4 Analyzing the Citations Impact of Top 10 Countries

The figure (Figure 3.49) illustrates the citations per paper for the top 10 countries analyzed, based on all STEM publications from 2014–2023 and the total citations accumulated during this period. Australia leads with the highest citation per paper of 27.66, followed by the UK and Canada. The United States ranks fourth with a value of 24.62. In contrast, India has the lowest citation per paper among these top 10 countries, at just 13.37, raising concerns about the quality of papers published in the country.

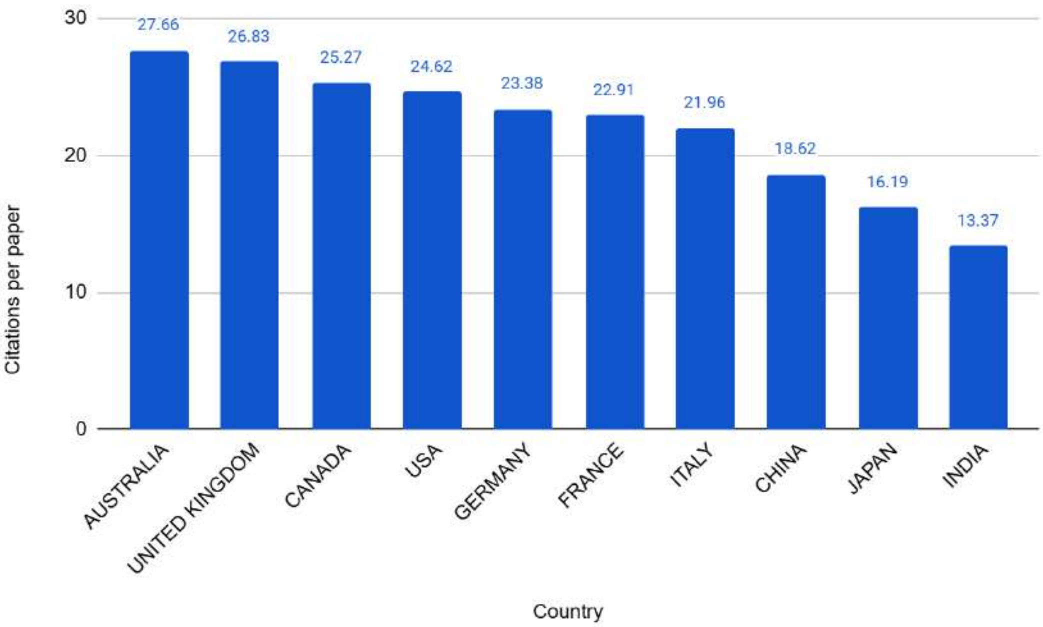


**Figure 3.49:** *Positions of Top 10 countries ordered by citation impact*

### 3.6.5 Analyzing the Citation Impact of G20 Countries

A comparison of citations per paper among G20 countries, which largely overlaps with the top 10 countries presented in this report, reveals a similar trend (Figure 3.50). Australia once again leads the ranking, with the same set of countries occupying the top five positions. In contrast, India ranks among the bottom five G20 countries, highlighting a continued emphasis on quantity over quality in its research output.

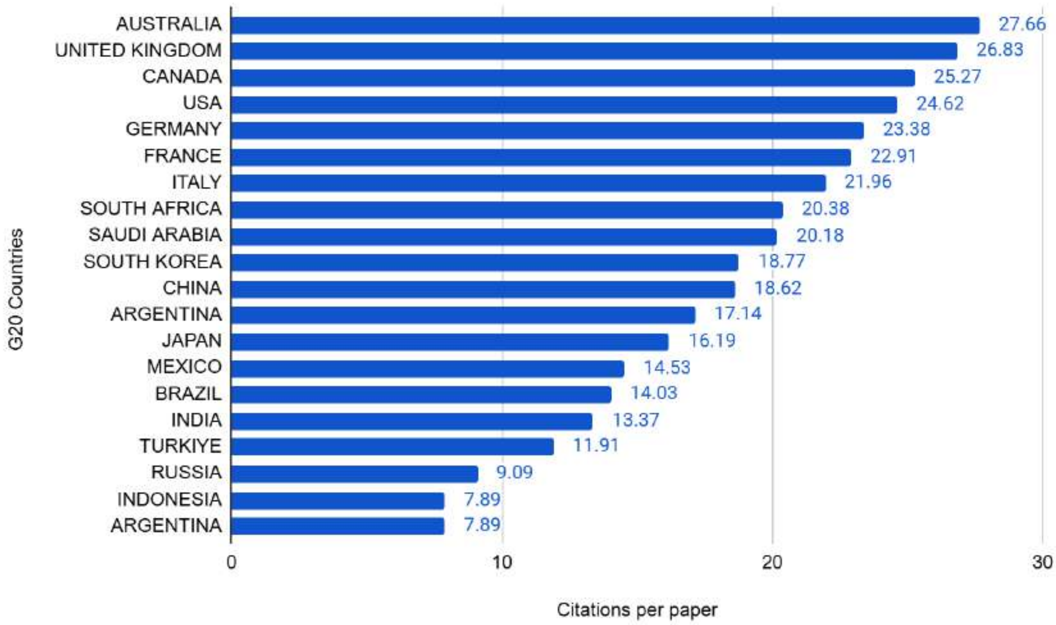


**Figure 3.50:** *Positions of G20 countries ordered by citation impact*

### 3.6.6 Analyzing the Citation Impact of BRICS Countries

A similar comparison among BRICS countries reveals that South Africa has the highest citation per paper (20.38), followed by China (18.62). India ranks fourth with a citation ratio of 13.37, positioned just above Russia, as seen from Figure 3.51.

### 3.6.7 Country-Wise Trends in Publishing Top 1% and Top 10% Highly Cited Papers

Another crucial indicator of research quality is the proportion of publications ranked among the top 1% and top 10% of highly cited papers globally. These metrics signify the impact and influence of research within the scientific community, reflecting the extent to which a country's publications contribute to advancing knowledge and shaping future research directions. A higher proportion of highly cited papers indicates stronger research quality and global recognition. Comparing India's performance in this regard against the top 10 knowledge-producing nations, G20 countries, and BRICS

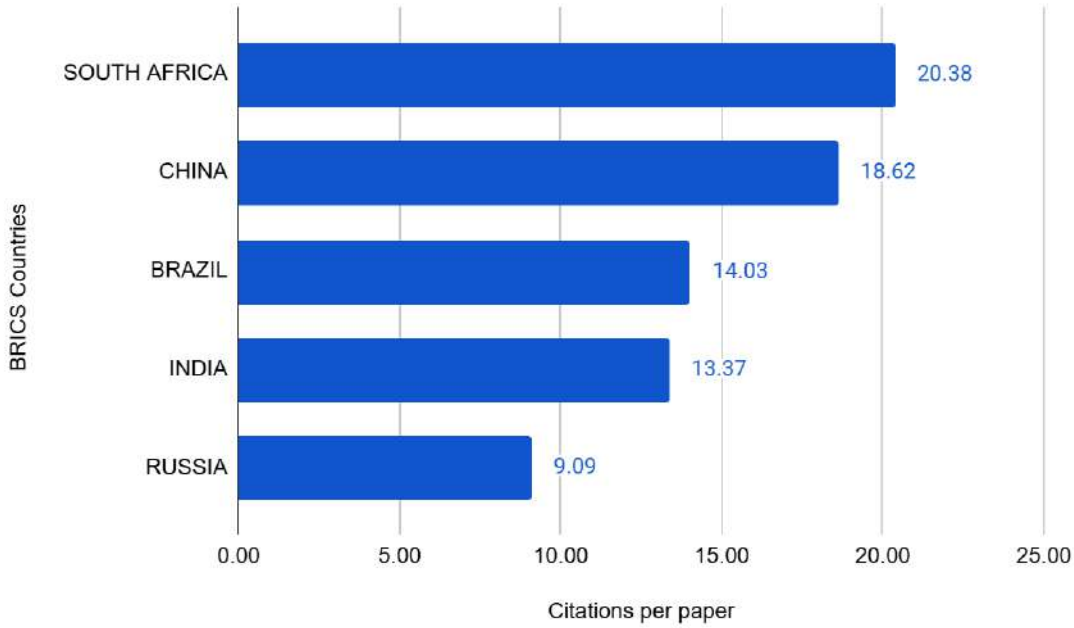


**Figure 3.51:** *Positions of BRICS countries ordered by citation impact*

nations can reveal critical insights. While India has made notable improvements in research productivity, its share of the top 1% and top 10% of highly cited papers remains below the global averages and lags behind many of its peers in these groups.

### 3.6.8 Contribution Towards Top 1%, 5% and 10% highly Cited Papers: Top 10 Countries

Among the top 10 countries, Australia leads, followed by the UK, Canada, and the US, which have the highest percentages of highly cited publications. In contrast, India has the lowest share in both the top 1% and top 10% categories as seen in Figure 3.52.

### 3.6.9 Contribution Towards Top 1%, 5% and 10% highly Cited Papers: G20 countries

A similar analysis among G20 countries shows India in the bottom five, with 0.72% of its publications in the top 1% and 7.85% in the top 10%, both below the G20 average (Figure 3.53).

### 3.6.10 Contribution Towards Top 1%, 5% and 10% highly Cited Papers: BRICS countries

Within BRICS nations, South Africa and China demonstrate stronger performance, with higher proportions of highly cited papers. India ranks third and remains below the BRICS average in this quality metric (Figure 3.54).


**Figure 3.52:** *Heatmap of the top 1%, 5% and 10% highly cited publications across the top 10 countries*

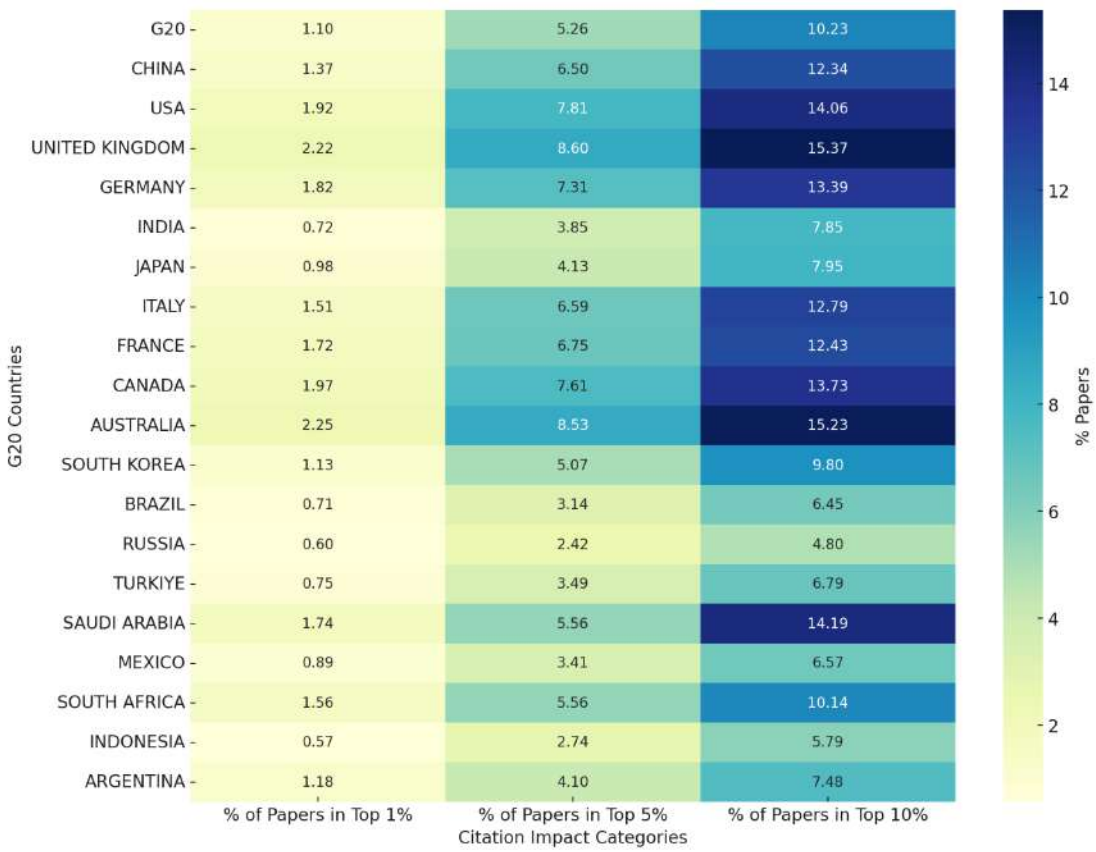


**Figure 3.53:** *Heatmap of the top 1%, 5% and 10% highly cited publications across G20 countries*

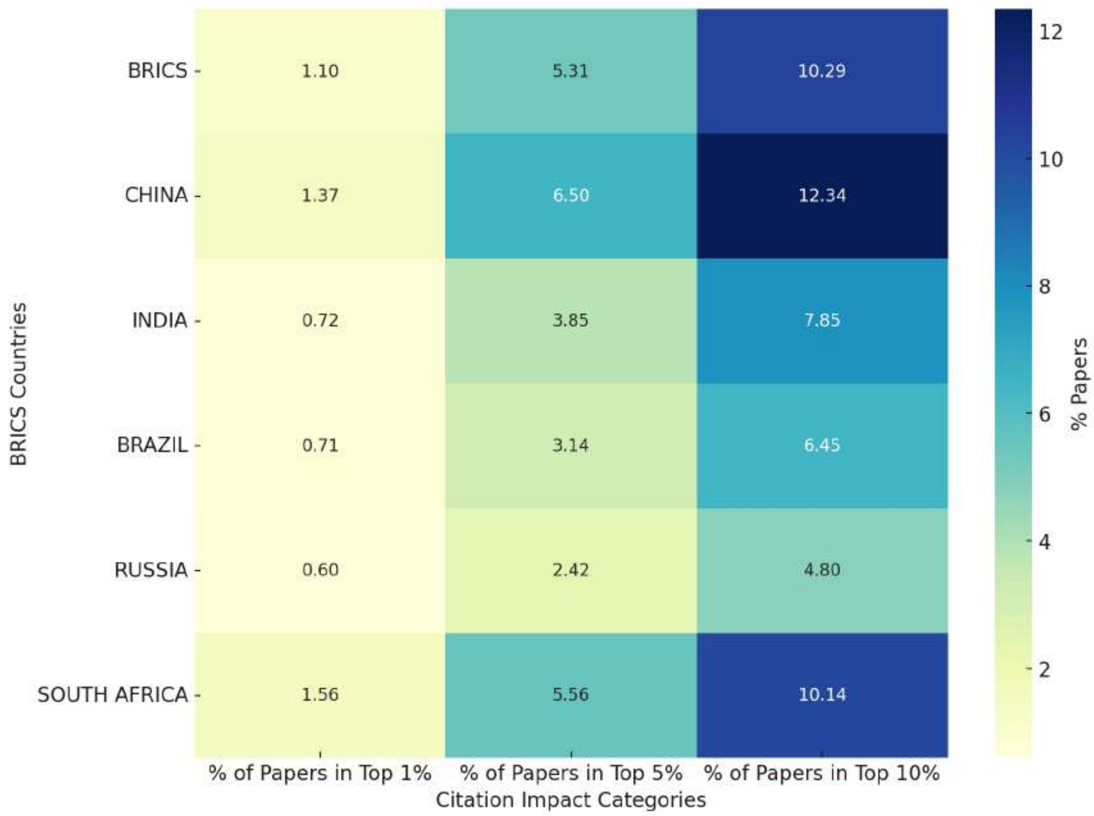


**Figure 3.54:** *Heatmap of the top 1%, 5% and 10% highly cited publications across BRICS countries*

### 3.6.11 Evaluating Research Quality through Journal Impact Factor and Quartile Rankings

Comparing India's performance against the top 10 knowledge-producing countries, G20 nations, and BRICS countries reveals that India lags behind in its share of publications in Q1 and JIF journals. While the proportion of Indian publications in Q2 has shown gradual improvement, the trend toward Q3 and Q4 publications highlights a persistent challenge in balancing research volume with excellence. Addressing these gaps is critical for India to enhance its global research reputation and impact.

### 3.6.12 Percentage of Papers in JIF, Q1, Q2, Q3, and Q4 Journals - Top 10 countries

Figure 3.55 presents the percentage of publications from each country across journal quartiles Q1, Q2, Q3, and Q4, as well as publication patterns in journals with a Journal Impact Factor (JIF). Nearly all countries in the top 10 show a strong presence in Q1 journals, with approximately 50% of their total publications between 2014 and 2023 appearing in this top-quality category, except India and Japan. India demonstrates weaker performance in quality metrics, with only 32% of its publications appearing in Q1 journals, which is quite below the global baseline of 44%. and around 30% in Q2 journals, which is slightly better than the global baseline of 29%. Furthermore, approximately 15% of India's publications are in Q4 journals, which are considered the least impactful in terms of quality and here the global baseline is 11%. In contrast, other leading knowledge economies publish significantly fewer papers in Q4 journals, typically around 5%, reflecting their focus on higher-quality outputs. Similarly, when considering another quality metric—publications in journals with JIF, which are widely recognized as quality journals—India performs the poorest among the top 10 countries. Over the 10 years, only 66% of Indian publications appeared in JIF-assigned journals, falling below the global average of 74%. These trends indicate that while India has made significant strides in publication volume, there is considerable room to improve the visibility and impact of its research in high-quality journals. Strengthening support for publications in top-quartile and high-impact journals could help enhance India's global research standing and better reflect the quality of its scientific output.

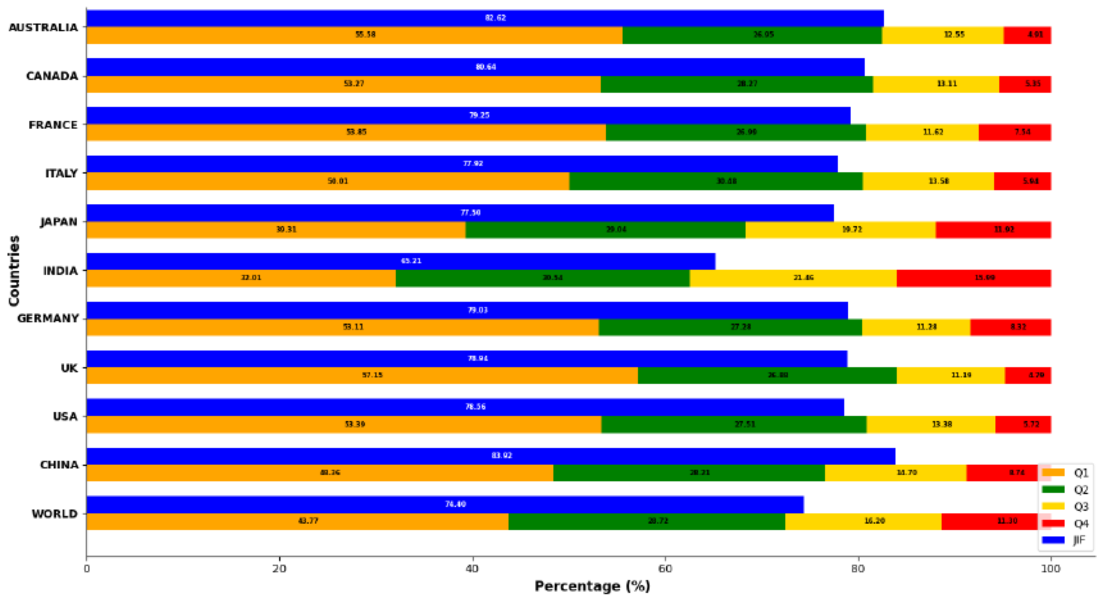


**Figure 3.55:** *Share of Publications in JIF-ranked and Quartile (Q1–Q4) Journals among the Top 10 Countries*

### 3.6.13 Percentage of papers in JIF, Q1, Q2, Q3, and Q4 Journals - G20 Countries

Figure 3.56 presents the percentage of publications from G20 countries across journal quartiles Q1, Q2, Q3, and Q4, as well as those published in JIF journals. The data highlights that India performs relatively poorly in these quality metrics compared to other G20 nations.

India's percentage of publications in Q1 journals is among the third lowest in the G20, with only Russia and Turkey being lower than India. Similarly, the share of Indian publications in JIF journals is 65.21%, which falls below the G20 average of 76.9% which is marginally higher than that of Russia and quite better than Indonesia. In several aspects, Indonesia can be considered an outlier as the country has a strong local journal system, which operates as Diamond Open Access and is free for readers and authors.

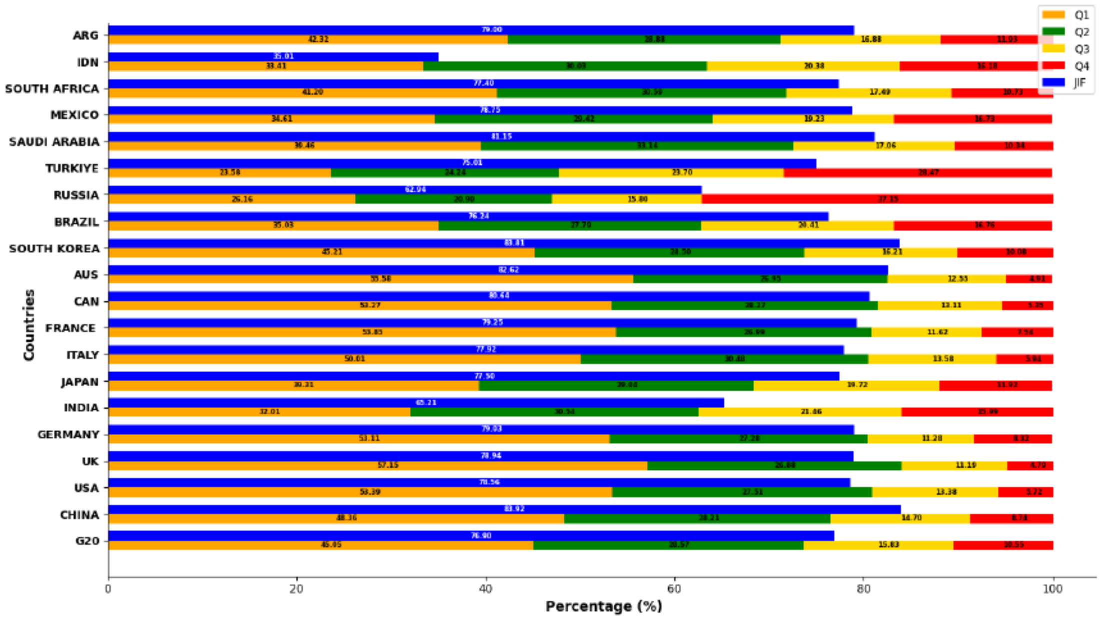


**Figure 3.56:** *Share of Publications in JIF-ranked and Quartile (Q1–Q4) Journals among G20 Countries*

### 3.6.14 Percentage of Papers in JIF, Q1, Q2, Q3, and Q4 Journals - BRICS Countries

Figure 3.57 illustrates the percentage of publications from each BRICS country across journal quartiles Q1, Q2, Q3, and Q4. Among BRICS nations, the share of Q1 publications is generally not very high, although China maintains a strong position with 48% of its publications in Q1 journals, exceeding the BRICS average of 43%. In contrast, India lags with only 32% of its publications in Q1 journals, falling below the BRICS average. South Africa, despite producing fewer publications overall compared to other BRICS nations, significantly contributes to raising the BRICS average in Q1 publications by demonstrating strong performance in quality metrics. A similar trend is observed with publications in journals with JIF. Here again, China and South Africa outperform, while India falls below the BRICS average; India's not-so-good performance in quality metrics is further highlighted by its relatively low share in JIF journals. These patterns suggest that while India continues to grow in research output, enhancing the quality and impact of its publications remains a key challenge. Targeted strategies to support high-quality research, including publishing in top-quartile and JIF journals, could help India improve its contribution to the global and BRICS research landscape.

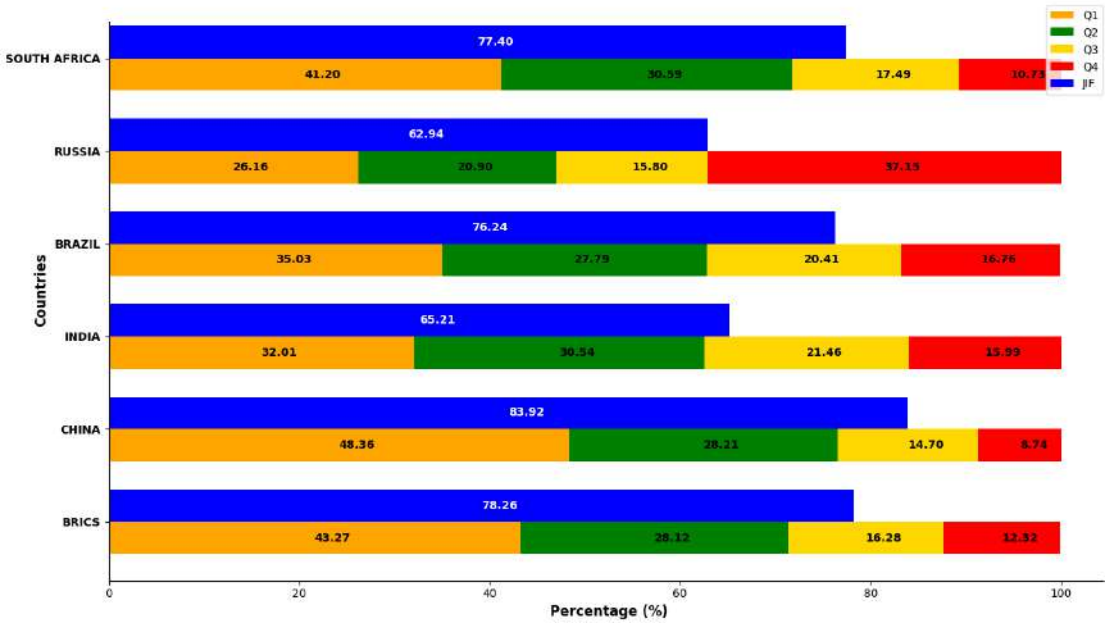


**Figure 3.57:** *Share of Publications in JIF-ranked and Quartile (Q1–Q4) Journals among BRICS Countries*

## 3.7 Impact of Collaboration

With a focus on India, the following section analyzes the effects of collaboration on citations per paper, the role of Indian researchers in collaborative projects, and the top countries with which India engages in scientific cooperation.

### 3.7.1 Collaboration Patterns and Their Impact on Citation Metrics: A Comparative Analysis

Collaboration is considered a driver of research excellence, often influencing the visibility and impact of scientific publications. This section examines the types of collaborations—domestic, international, and industry—across India's research landscape and their corresponding citation impacts. By comparing India's collaboration trends with those of other leading knowledge-producing nations, insights have been generated on the role of collaboration in enhancing research quality. While international collaborations are often associated with higher citation impact, domestic and industry partnerships also play significant roles in strengthening local innovation systems and addressing localized challenges. Understanding these patterns provides a valuable perspective on how India is leveraging collaboration to strengthen its position in the global research ecosystem.

### 3.7.2 Collaboration Pattern of Leading Knowledge Economies

Figure 3.58 illustrates the collaboration patterns within various countries' research ecosystems. Countries such as the United States, the United Kingdom, and Germany exhibit robust international collaborations alongside strong domestic partnerships. These nations also demonstrate substantial collaboration with industry. While in all the previous country-wise analyses, the top 10 countries are considered, an exception has been made to include South Korea in this section, which is known for its academia-industry collaboration in specific sectors. Interestingly, in the case of China, while collaboration is generally strong, the trend differs, with domestic collaborations significantly outweighing international ones. However, China's industry collaboration is weaker compared to countries like the US, UK, Germany, and Japan. Notably, Japan and Germany lead in fostering industry partnerships. In contrast, India lags behind these leading knowledge-producing nations across all collaboration dimensions. Of particular concern is India's industry collaboration, which is the weakest among the countries analyzed in this study.

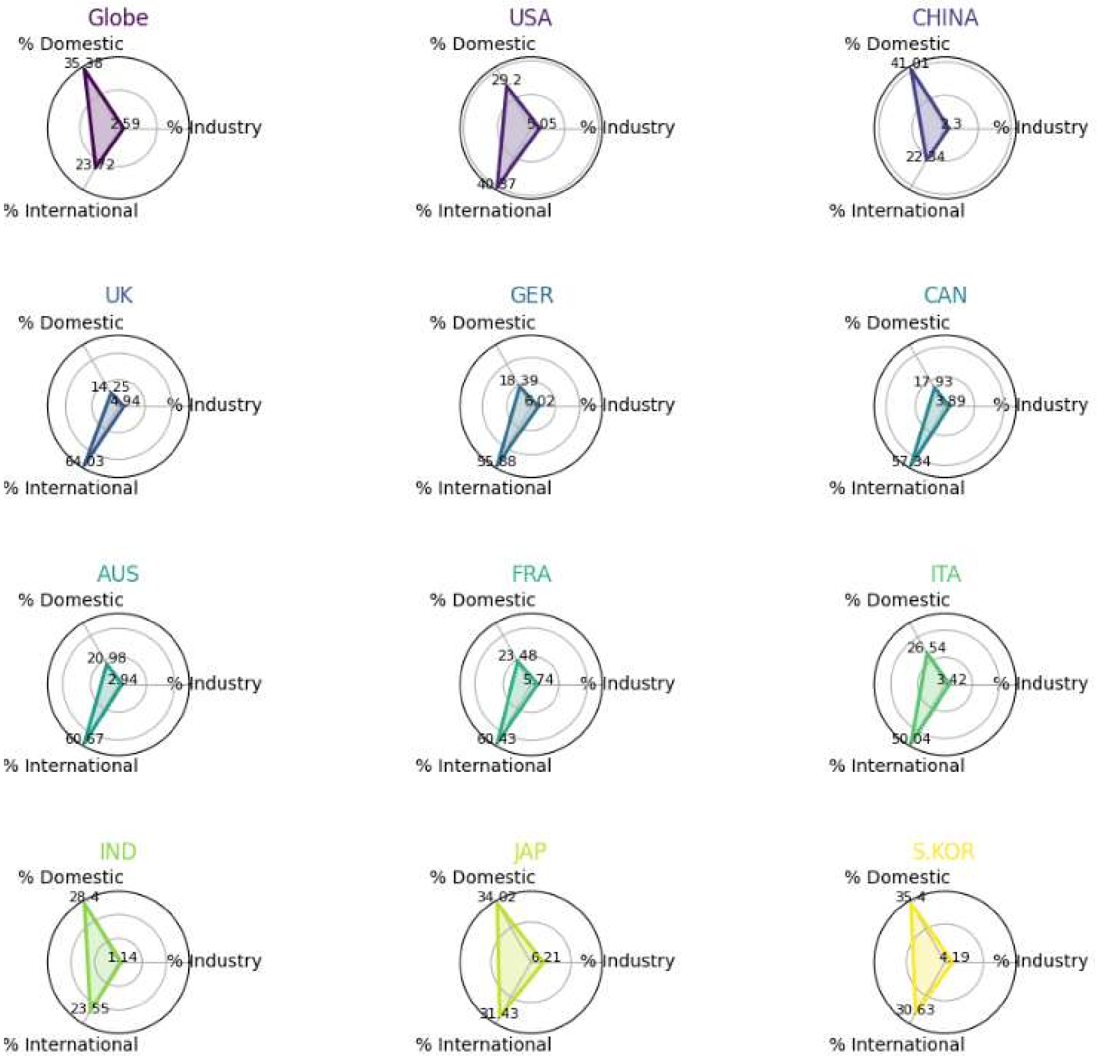


**Figure 3.58:** *Domestic, international and industry collaboration percentages of leading knowledge economies*

A closer examination of India's collaboration trends reveals that domestic collaboration has remained stagnant over the years (Figure 3.59). However, there has been a slight increase in international collaboration from 2014 to 2023. Notably, in 2023, the percentage of international collaborations surpassed that of domestic collaborations. On the other hand, industry collaboration has shown no improvement over the years, despite ongoing discussions about the need to strengthen such partnerships.

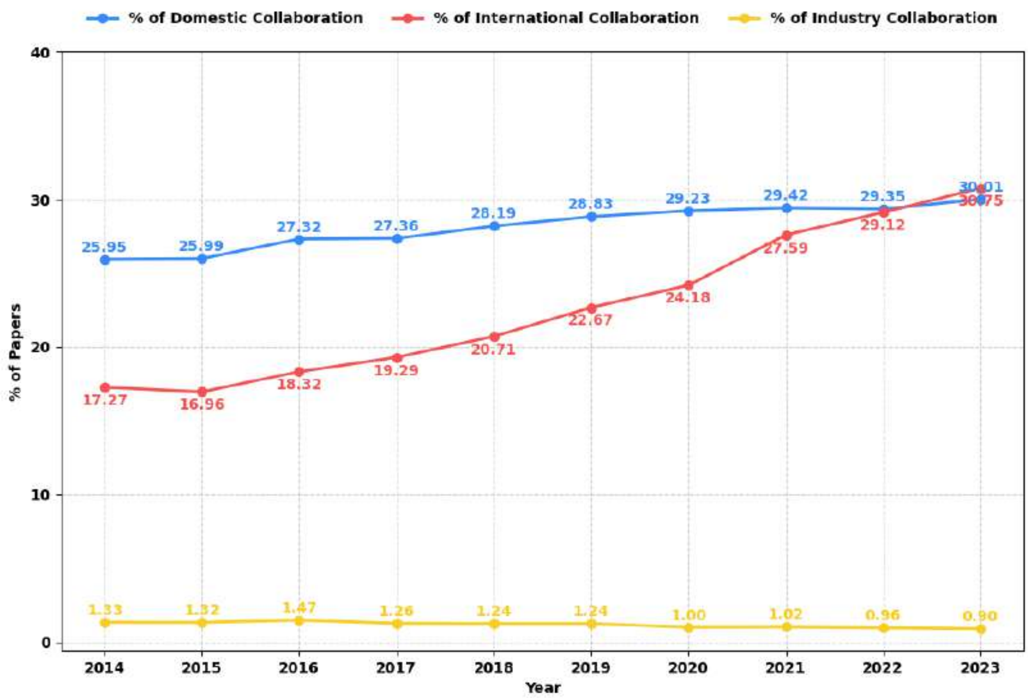


**Figure 3.59:** *Yearly trend in domestic, international and industry collaboration: India*

### 3.7.3 Collaboration impacts on Citations per Paper, Authorship position, and Top Collaborating Countries: The Indian Case

Which type of publications attract more citations: collaborative or non-collaborative? An analysis of Indian research output reveals that collaborative publications receive significantly more citations per paper compared to non-collaborative ones (Figure 3.60). Among collaborative publications, those involving industry partnerships achieve the highest citation per paper, followed by domestic and international collaborations. The higher citation impact of industry collaborations is likely due to their interdisciplinary and cross-sectoral nature, addressing both academic and practical challenges. International collaborations outperform domestic ones in terms of citation impact, which again intuitively seems to be the case; however, it warrants further investigation to uncover underlying factors contributing to this trend.

Publications with industry collaborations outperform both domestic and international collaborative papers across highly cited categories, including the top 1%, top 5%, and top 10% globally (Figure 3.61). However, when comparing domestic and international collaborations in these highly cited categories, international collaborative

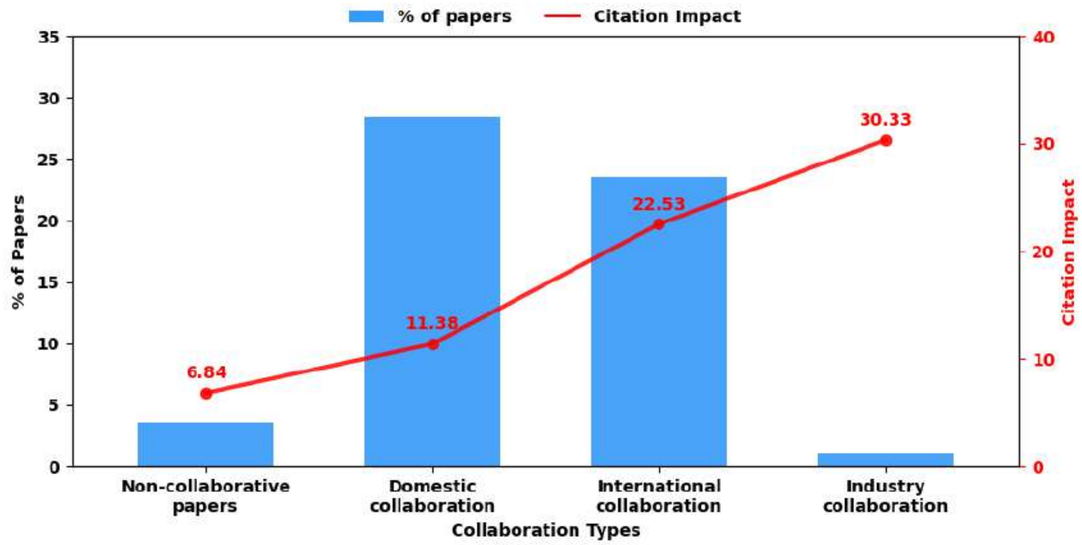


**Figure 3.60:** *Citation impact of collaborative and non-collaborative publications from India*

publications show better performance. The reasons behind this pattern, particularly the relative underperformance of domestic collaborations in the highest citation brackets, remain unclear and need further investigation to comprehend the reasons.

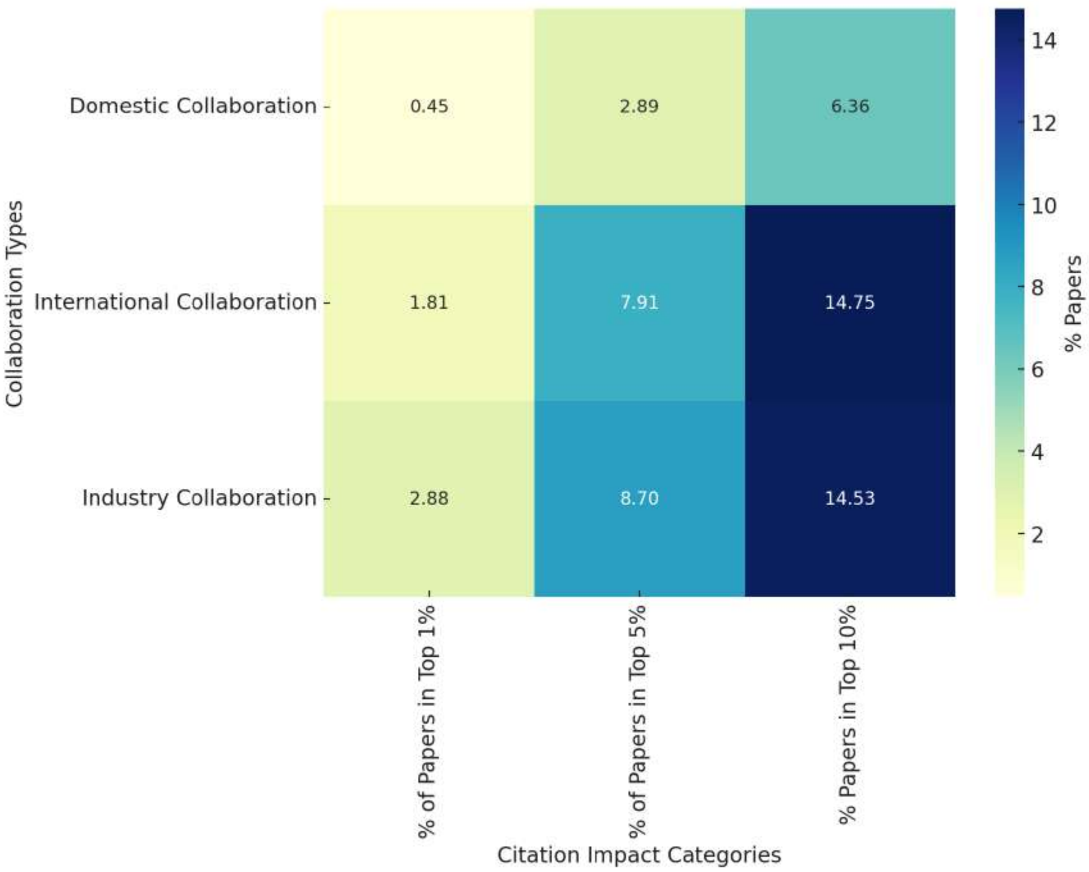


**Figure 3.61:** *Heatmap of the the top 1%, 5%, and 10% highly cited publications across the three collaboration types of India*

Another key quality aspect to consider is the proportion of papers published in journals with a JIF and their distribution across journal quartiles. As shown in the figure (Figure 3.62), publications resulting from international collaborations consistently outperform those from other collaboration types. Specifically, 81% of internationally collaborative publications are published in JIF journals, with 45% appearing in Q1 journals. In contrast, domestic collaborative papers lag in both these quality indicators, highlighting a relative underperformance in terms of publishing in high-impact and top-tier journals.

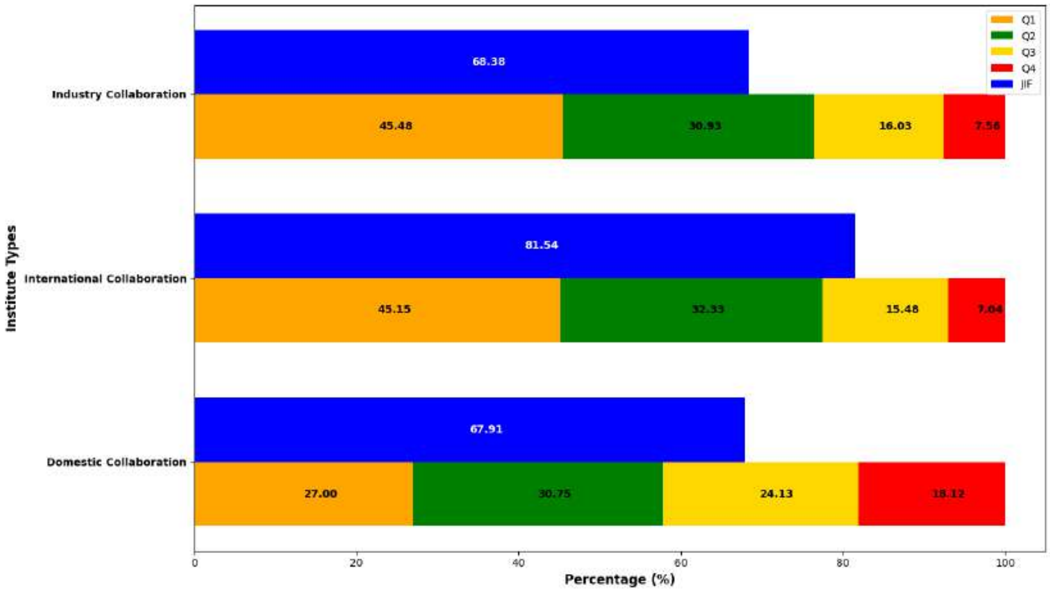


**Figure 3.62:** *Percentages of JIF, Q1-Q4 Papers with respect to collaboration pattern: India*

When Indian authors publish papers in collaboration with authors from other countries, those publications appear in more high-impact journals, as seen from the previous analysis. But what are the authorship patterns? Examination of the authorship position in such publications reveals that in 59% cases the Indian authors hold the first authorships and 54% cases the corresponding authorships (Figure 3.63).

Which countries does India collaborate with? Figure 3.64 highlights that the United States is India's most prominent collaborator, with the number of collaborative publications showing an increasing trend. The United Kingdom follows as the second most significant collaborator; however, the gap between India-US collaborations and those with other countries, including the UK, is substantial, with nearly twice as many collaborative publications between India and the US. After the UK, China ranks as the third most frequent collaborator with India.

**Which Subject Areas Dominate Publications in the Top 10 Knowledge-Producing Countries?**

The figure 3.65 highlights the ten fields in which publications are categorized. Clinical medicine stands out as the dominant field across all countries, as evident from the sharp spike in the chart. However, the proportion of publications in this field varies

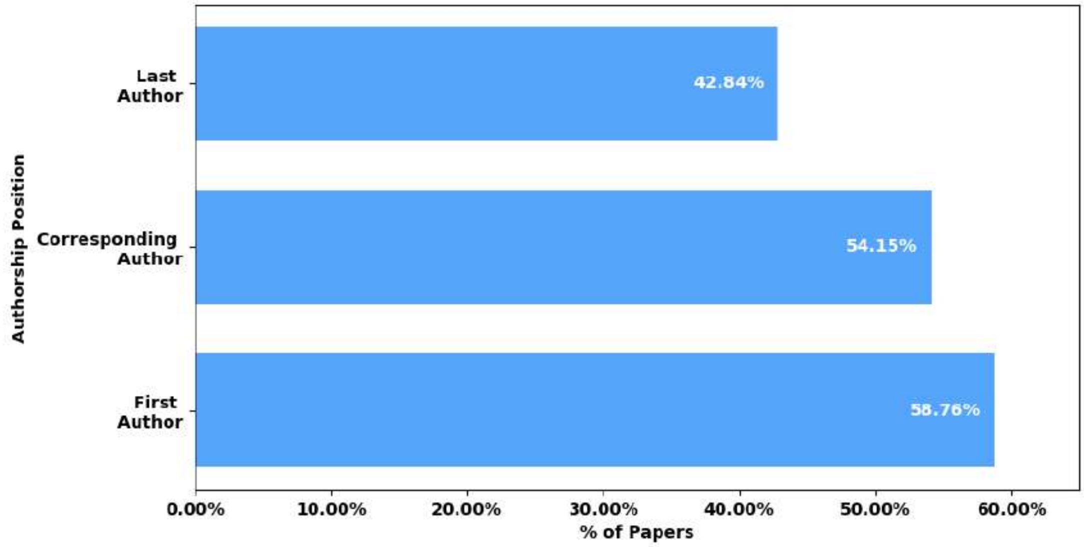


**Figure 3.63:** *Authorship position in publications published by Indian authors in collaboration with authors from other countries*

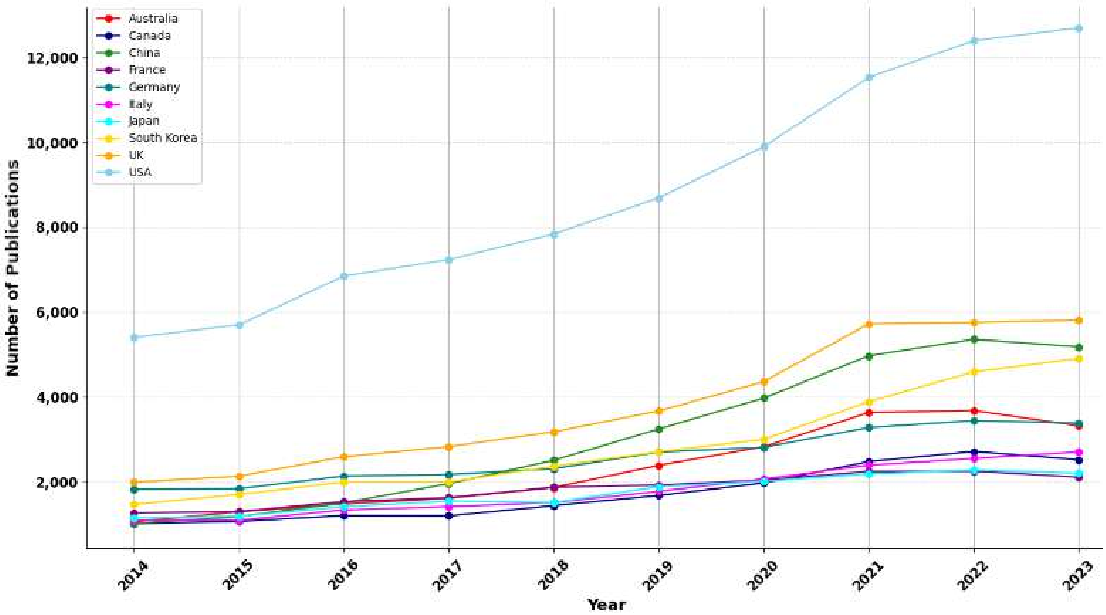


**Figure 3.64:** *Collaboration trend of India with other countries (2014-2023)*

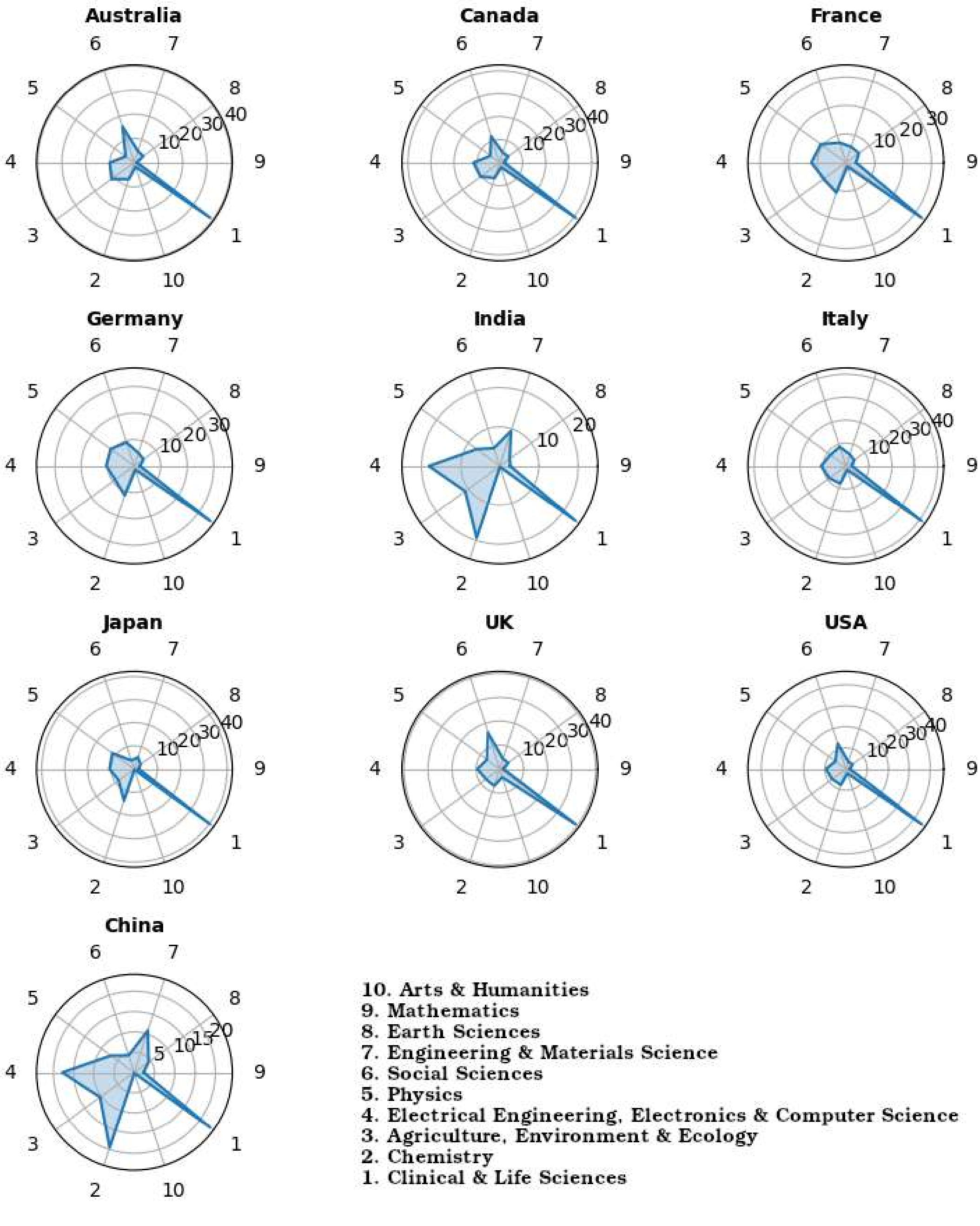


**Figure 3.65:** *percentage of publication in each topic for the top 10 countries* )

significantly among countries. For example, approximately 40% of the total publications from the United States, the United Kingdom, Australia, and Japan are related to clinical medicine. In contrast, for India and China, clinical medicine accounts for about 20% of their total research output. The figure 3.66 illustrates a similar concept, showcasing the distribution of publications for each topic across all countries in an overlay format.

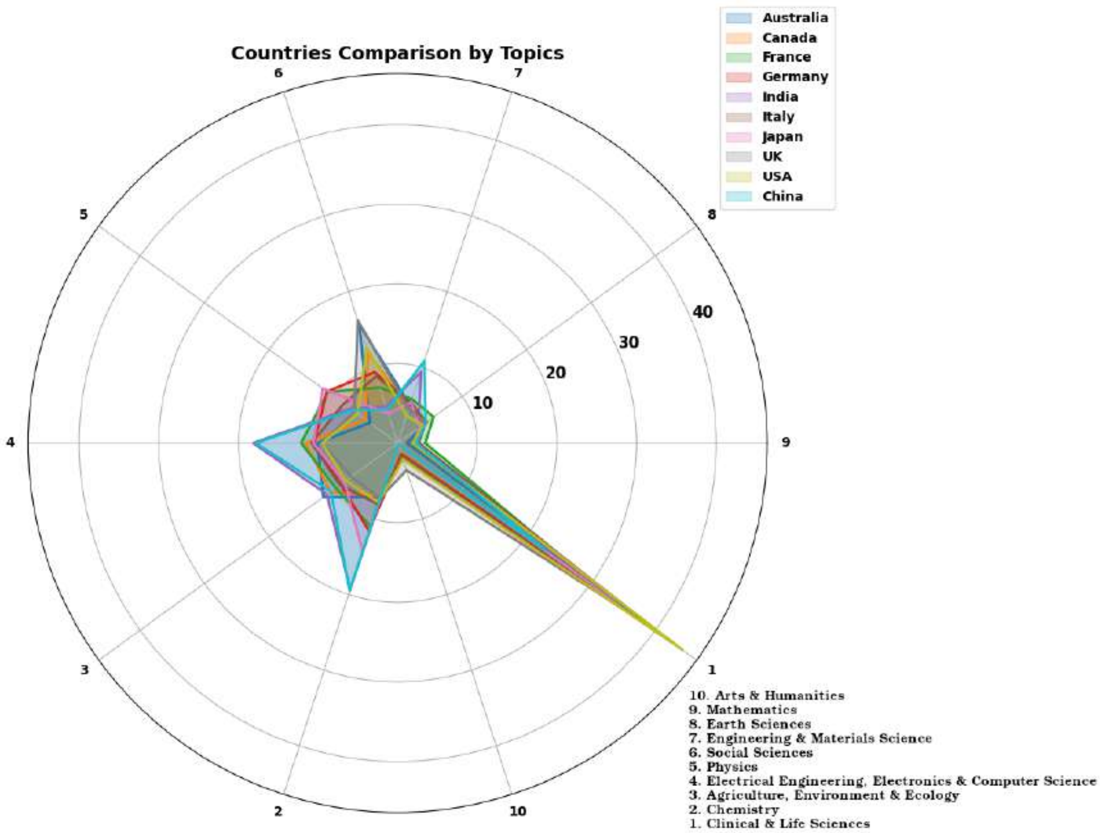


**Figure 3.66:** *Percentage of publication in each topic for the top 10 countries*

Arts and humanities consistently have the lowest publications. Interestingly, certain nations, such as the United States, Canada, the United Kingdom, and Australia, publish a relatively higher volume of papers in social sciences, as indicated by a noticeable but smaller spike in the chart.

Countries such as Italy, France, and Germany display a more balanced distribution of publications across the top 10 subject areas. Similarly, the United Kingdom and the United States show a relatively even spread of publications across these fields, apart from the prominent spike in clinical medicine and a smaller spike in social sciences.

India, Japan, and China exhibit a distinct spike in publications related to chemistry, making it the second most dominant field after clinical medicine. For China and India, another notable increase is seen in fields such as electrical engineering, electronics, and computer science.

It is essential to note that the indexing of social sciences and arts and humanities journals may not fully represent the breadth of available journals in these disciplines.

This limitation should be considered when interpreting the publication trends in these fields.

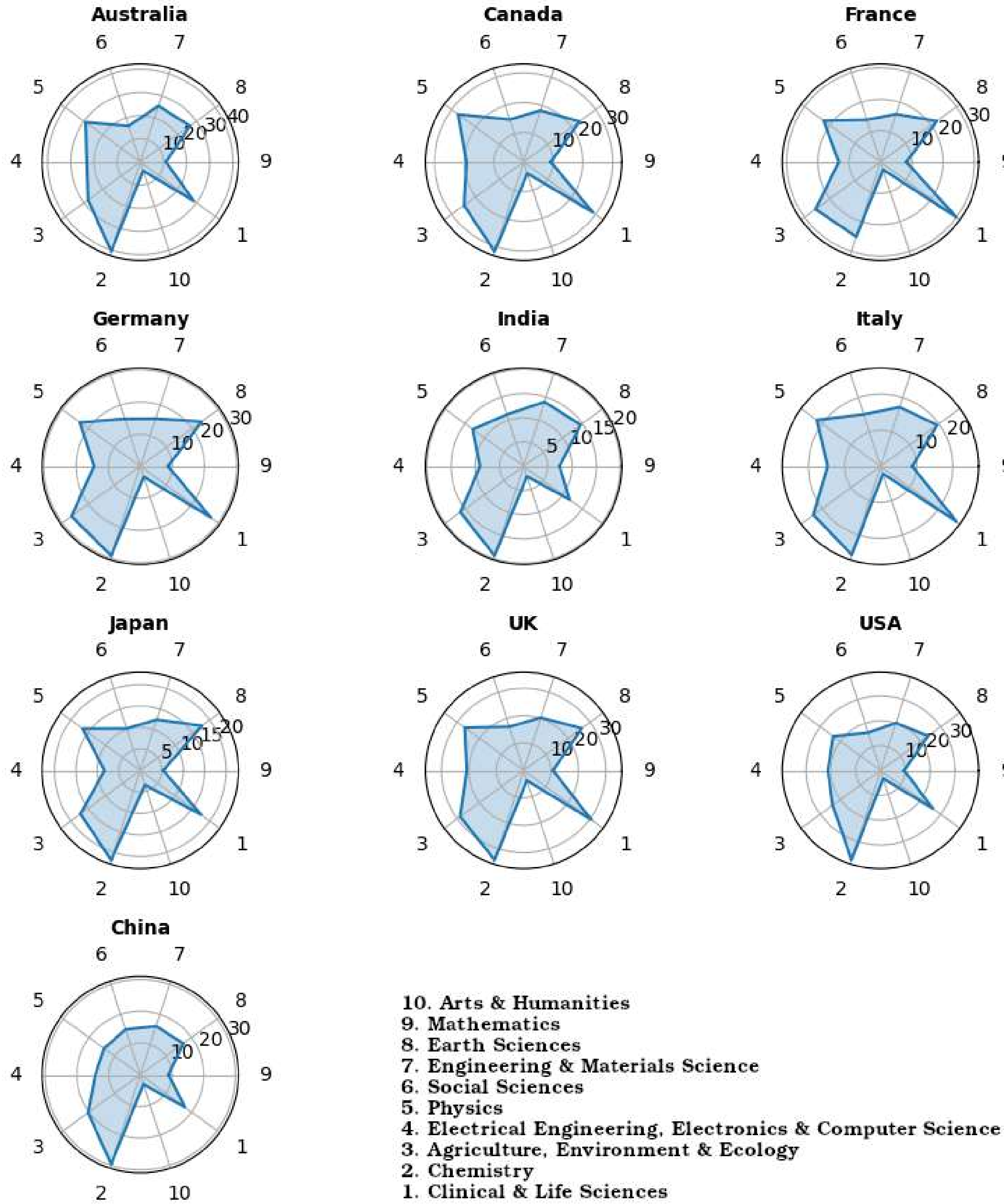


**Figure 3.67:** *citation impact in each topic for the top 10 countries*

Figure 3.67 illustrates the citation impact for each country within a given subject field. This metric represents the total citations generated from a country's publications in that field (e.g., clinical medicine) during the period 2014–2023, normalized by the total publications in the same field for the respective country during the same time frame. It is important to highlight that no normalization has been performed, making direct comparisons of citation impact across different fields inappropriate.

Upon examination of the citation impact values, it is evident that chemistry is the field with the highest citation impact among all countries. Australia tops the list with a citation impact in the 40s, followed by several other countries in the 30s range. In contrast, India, Japan, and Italy exhibit the lowest citation impacts in this field, each falling within the 20s. This trend is consistent across other subject areas as well, further underscoring the observation that Indian publications are trailing in terms of citation impact. Figure 3.68 illustrates a similar concept, showcasing the distribution of publications for each topic across all countries in an overlay format.

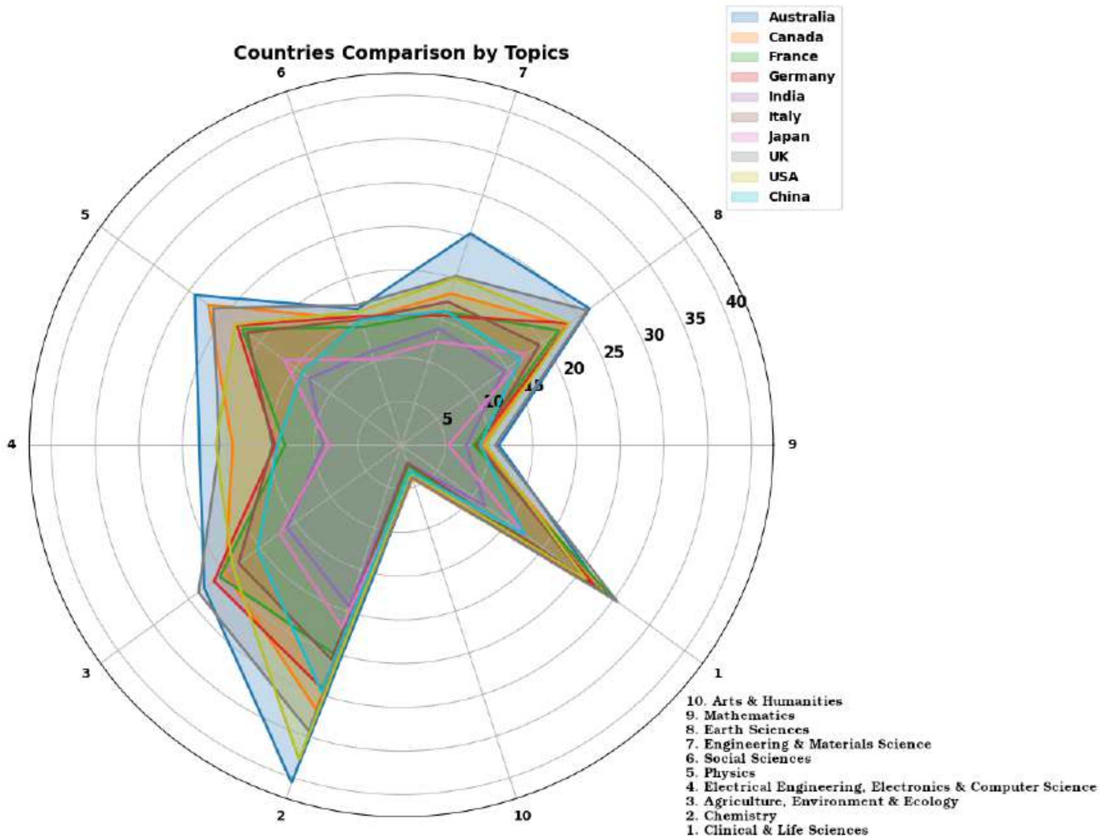


**Figure 3.68:** *citation impact in each topic for the top 10 countries*)

# 4

# Conclusion

India has made notable progress in its academic research output from 2014 to 2023, establishing itself as a significant contributor to the global research landscape. The country has rapidly emerged as one of the world's leading knowledge producers, surpassing traditional research powers such as Germany and the UK in annual publication volume. Its annual growth in publications—consistently above the global baseline—demonstrates a durable upward trajectory, positioning India as the third-largest contributor to global STEM research in recent years. Yet, this quantitative expansion has not been matched by a proportional increase in research quality, as indicated by relatively low shares of highly cited papers and declining representation in top-quartile journals. At the institutional level, the publication landscape is undergoing a profound shift. Private institutions have grown rapidly, showing much stronger growth than publicly funded premier institutions and central and state universities. However, this growth remains largely quantity-driven, as private universities have yet to demonstrate good citation impact, and they have weaker representation in Q1 journals. By contrast, premier institutions continue to anchor India's research quality, contributing the highest proportion of publications in top-tier journals and producing the largest share of highly cited papers. State universities show a declining share of national output, while central universities maintain a modest but steady role, performing well in quality-adjusted metrics relative to their size. This divergence indicates the need for differentiated policies that simultaneously sustain high-quality output in elite institutions and raise the standards of rapidly expanding private institutions. India's performance in mission-oriented programs—notably in Artificial Intelligence, Electric Mobility, Nanoscience, and Quantum Science—highlights the nation's ability to align research priorities with emerging technological frontiers. While publication volumes in these domains are steadily rising, the quality and global influence remain modest, and industry participation is negligible across all four missions. The analysis reveals that most outputs are concentrated in mid- and lower-tier journals, with limited breakthrough contributions in Q1 outlets. Strengthening academia–industry linkages and fostering translational research will be critical for these missions to realize their intended national and global impact. The collaboration landscape highlights both opportunities and gaps. Collaborative publications—whether domestic, international, or industry-linked—consistently achieve higher citation impact than solo efforts, with industry collaborations outperforming all others. However, industry engagement remains stagnant, pointing to weak commercialization and application pathways. While international collaboration has grown and, in 2023, even surpassed domestic partnerships, it remains concentrated with a few partners, especially the United States. Interestingly, for China, domestic collaboration is a major strength, while in countries like the US or UK, it is international collaboration. All these countries also have strong industry collaboration. India must strengthen its domestic collaboration which has not been prioritized so far. India's relatively low contribution to highly cited papers further highlights the gap between research volume and global recognition. Addressing this discrepancy will require a focused effort to improve research quality, foster interdisciplinary collaborations, and enhance the country's presence in high-impact journals. The lack of a well-established culture of acknowledging funding agencies also poses a challenge, hindering comprehensive analysis and understanding of the contributions of funding bodies to India's research ecosystem. Moreover, the country needs to maintain a balanced distribution of publications across various research areas, rather than overemphasizing a few specific fields. Striking the right balance between STEM and social sciences and humanities research is essential to ensuring that scientific discoveries and innovations benefit society as a whole. Another critical aspect is data availability, which requires significant improvement. Fostering a culture of making research data accessible in well-structured formats will enable deeper insights into publication trends in India. All these observations show that the Indian academic ecosystem needs to think about research funding strategies and how to incentivize quality. It is evident that there has been a unidirectional push for quantity in Indian academic and research institutions, and realigning this trend is not an easy task. Especially considering the current incentives, such as achieving a higher rank in the National Institutional Ranking Framework (NIRF) and international rankings such as Times Higher Education (THE) needs quantity. While rankings take quality using citation as the proxy, improving citation needs long-term vision in the research ecosystem, with continuous funding, ease of doing research, access to research facilities, and a conducive environment. Otherwise, the continued trend of publishing low-quality research will continue to grow further. Especially since with the digital format of journal publishing, there has been a surge in the number of journals, and every research gets a place in journals, even if it's a predatory one. With the availability of Large Language Models (LLMs), writing is now even easier and is expected to push even more inferior to absolute garbage research papers into the system. Moreover, the quest for metrics has led to research malpractices, not just data or image manipulations, but more and more manipulations of citation parameters as well. While this report, using bibliometric analysis, shows the lack of focus on quality in the Indian system, the solutions need to be designed through extensive policy research. This report, while trying to highlight the progress and gaps in Indian research, is also a step in building in-house capabilities to conduct large-scale scientometric analysis. DST has been instrumental in creating capabilities in STI policy research in the country and has established several DST Centre for Policy Research (DST-CPRs) across the country. This report is compiled at DST-CPR at the Indian Institute of Science (IISc) and highlights the importance of capacity building in STI policy research in the country.

**Disclaimer :** This report was written by the authors, while AI tools were used for grammatical corrections.

**Limitations :** There are various limitations associated with using Web of Science as the data source, as explained in the methodology section of this report.

# 5

# Appendix A

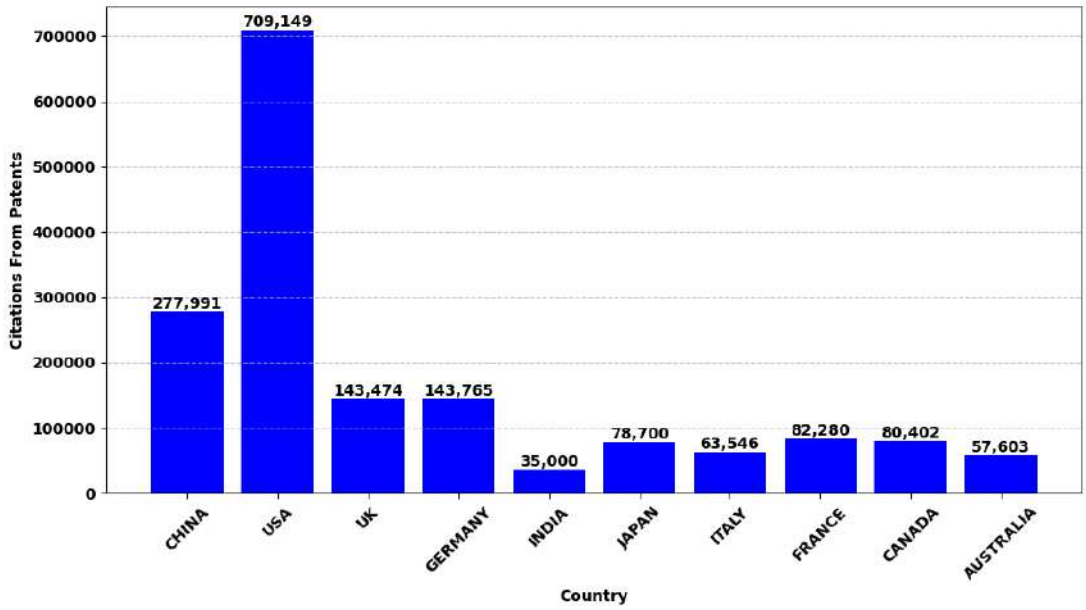


**Figure 5.1:** *Citation from patents for top top 10 countries (2014-23) with highest publication (STEM, ARP).*

The figure 5.1 portrays a clear hierarchy in patent citations, with China and the USA at the forefront of innovation, followed by several European countries and others, with India and Australia having comparatively fewer citations.