COLLEGE LIBRARIES
Vol. 40 No. 4 December 2025 pp. 51-60

Received on 12-05-2025 Reviewed on 08-11-2025 Paper Accepted on 25-12-2025

Research Publications of Artificial Intelligence in India: Trends, Collaborations and Insights during 2014-2023

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Abstract

The present study aims to analyze the publications of Artificial Intelligence (AI) in India from 2014 to 2023. It aims to explore publication trends, authorship patterns, gender-based contributions, and open-access publishing practices, while also mapping collaborative networks and influential entities in AI research. The study seeks to identify India's position in the global AI research landscape and highlight areas for strategic improvement and collaboration. The data comprising 4,910 publications was sourced from the OpenAlex database and analysed by VOSviewer advanced tools for bibliometric mapping, and used the Open Refine was used for data wrangling. The analysis reveals that Indian authors significantly contribute to AI research, with open- access publications categorized as Bronze (979), Gold (3,084), Green (143) and Hybrid (674). The gold open-access publications category (3084) is the most accessible publication in open- access. Co-authorship and citation networks illustrate strong collaborations among authors, institutions and countries, with Vellore Institute of Technology emerging as the top-performing organization. Bibliographic analysis reveals influential authors, organizations and countries, emphasizing collaboration's importance in advancing AI research. This study provides valuable insights into AI research trends in India, serving as a foundation for strategic planning and fostering interdisciplinary partnerships. By helping this study, future studies should focus on expanding collaborations and exploring the emerging domains of AI research field.

Keywords: Artificial Intelligence, Bibliometric Analysis, Co-authorship, Citation Analysis, Open Refine, VOSviewer.

1. Introduction

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think, reason, learn, and solve problems like humans. Since its introduction by John McCarthy in 1956 at the Dartmouth Conference, AI has grown rapidly, becoming one of the most significant technological advancements of the 21st century. AI technologies are now applied in various sectors, including healthcare, finance, education, defence, and information science.

In India, AI research has received

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Barman, S. (2025, December). Research publications of Artificial Intelligence in India: Trends, collaborations and insights during 2014-2023. *College Libraries, 40*(4), 51-60

considerable attention due to increasing investments, technological collaborations, and educational initiatives. However, despite the growing number of publications, a systematic evaluation of research trends and collaborations in the field has remained limited. Bibliometric analysis, which studies the characteristics of scholarly publications, offers a powerful method to uncover patterns, research gaps, and emerging domains within scientific literature.

The aim of the study is to evaluate the performance in AI from 2014 to 2023 in India by using visualizing bibliometric software VOSviewer and the data wrangling software OpenRefine. The research explores publication trends, open-access practices, gender wise contributions, authorship patterns, and collaborations at institutional and international levels.

2. Literature Review

The field of AI research bibliometrics has gained attention worldwide, though studies. Nath & Jana (2020) studied and analyzed authorship pattern and collaboration trends and testing Lotka's law of author's productivity in the field of biotechnology research. The authorship data was collected from Indian Journal of Biotechnology Research during the period 2008-18. Abanga & Acquah (2024) found an annual growth rate of 25.93%, indicating a substantial increase in AI research effort. Seema Parmar (2024) intended to identify and analyses the Indian research output on AI in the field of social sciences from 2014 to 2023. Yassine Sekaki (2025) analyzed AI research in management (2014-2025) using Scopus, Bibliometrix, and VOSviewer. Tunga (2013) presented a case study of the authorship pattern and degree of collaboration in the field of horticulture based on a sample of 8437 journal articles and 1327 books citations appended to 80 doctoral dissertations of Bidhan Chandra Krishi Viswavidyalaya (BCKV) and Uttar Banga Krishi Viswavidyalaya (UBKV). West Bengal during 1991 to 2010. Subramanyam (1983) in this paper, several types of collaboration have been identified, and earlier research on collaboration has been reviewed. Ramakrishnan & Thavamani (2015) examined authorship pattern in the field of Hepatitis C. Tunga (2021) analyzed India's AI research using open-access data, applying Lotka's law, and exploring gender authorship and collaboration-areas largely overlooked in country-specific bibliometric studies. Parabhoi & Kainchi (2023) showed men publish more, but women's citation growth is higher, revealing persistent imbalance in Indian research (1999-2018). Pandey, Manoj, & Shukla (2021) finding the India need become more competitive with the world leaders in artificial intelligence research. (U & Kumar, 2025) investigates gender disparity in research productivity in Indian Library and Information Science (LIS) journals, focusing on authorship patterns, professional engagement, prolific institutions, and regional productivity. Roy, Shukla, & Tripathi (2025) examined the Open Access (OA) landscape of Indian state agricultural universities, focusing on OA growth, leading institutions, prolific authors, preferred sources, funding, APC usage, and trending topics. Karadiab & Mohanty (2023) presented a comprehensive analysis of the evolving landscape of open-access (OA) scholarly publications originating from India during the period spanning 2013 to 2022.

This study addresses the gaps by providing a comprehensive bibliometric analysis focused exclusively on India's AI research, incorporating collaboration patterns, gender contributions, and bibliometric laws to provide actionable insights for researchers, policymakers, and educational institutions.

3. Objectives of the Study

The main objectives of this study are as follows:

- To evaluate the national research performance of India in AI publications between 2014 and 2023.

- To classify AI research publications based on open-access categories.
- To analyze gender-wise authorship distribution in AI research publications.
- To examine authorship trends and patterns, collaboration and map co-authorship collaboration networks.
- To identify key research topics, influential authors, and institutional contributions in AI research publications.

4. Methodology

To obtain the set of specific objectives, the data has been collected from the OpenAlex databaseofthepublicationsonArtificialIntelligenceresearchduringthetimespan2014to2023. The API search string used to retrieve data on Artificial Intelligence research was as follows:
"https://api.openalex.org/works?page=1&filter=default.search:Artificial+Int elligence+or+AI+or+Machine+Learning+or+Deep+Learning,publication_year:2014+-+2023,open_access.is_oa:true,type:types/article,authorships.countries:countries/in"

The study has covered only open access journal article publications for ten years study period from 2014-2023 in India. The total number of 4910 publications was retrieved on 29/06/2024 to conduct the study and the data analysis has been carried out using data wrangling software OpenRefine for Open access categories and authors tenderization, and VOSviewer visualization software was applied for co-authorship map, co-occurrence concept network mapping.

5. Data Analysis and Interpretation

The present study systematically analyzes India's contribution to AI research during 2014-2023 using bibliometric techniques. By examining open access trends, gender participation, collaboration networks, institutional performance, keyword co-occurrence, and citation patterns, the study provides a comprehensive picture of the evolving research landscape.

Table1: Demographic information of the study

Description	Results
Time span	2014 - 2023
Database	OpenAlex
Geographical area	India
Document types	Journal Article Open access
Total no. of Documents	4910
Total no. of Authors	16,871
Total no. of Organizations	3317
Total no. of Keywords	5175

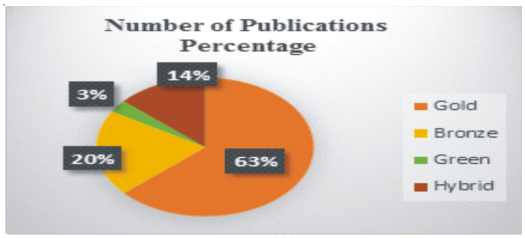
5.1. Open Access Categories

Unpaywall is the largest bibliographic storehouse for open contents. It allows free access to the dataset on top of REST/API call against a generous call limit of 1,00,000 calls per day. This study has a total of 4910 publications with a DOI, and the API call structure for Unpaywall value is DOI "https://api.unpaywall.org/v2/" + value + "?email=suchitrabarman52@gmail.com". 4880responsesare received, and result has come into four open access categories: Bronze 979, Gold 3084, Green 143, and Hybrid 674.

Table 2:Open Access Categories

Categories	Number of Publications	%
Gold	3,084	62.81%
Bronze	979	19.93%
Green	143	2.91%
Hybrid	674	13.73%

Figure 1: Percentage-wise Open Access Categories



The majority of publications in India's AI research are published as Gold Open Access, 62.79% indicating that authors prefer fully open-access journals where content is immediately available for reuse. Bronze and Hybrid categories show some restrictions on usage rights, while Green represents a small portion.

5.2. Gender-wise Authorship Pattern

There are gender differences in research productivity in AI publications. In this study, 4910 publications from 2014 to 2023 were reviewed by the first author. Out of 4910 publications, the female authors 1253 and 2497 are detected, and the difference but the remaining 1160 are unable to be detected by the data wrangling software Open Refine.

Table 3: Gender-wise Authorship Pattern

Gender	No. of Principal Author	Percentage
Male	2,497	50.85%
Female	1,253	25.51%
Undefined	1,160	23.62%

According to this analysis, we can differentiate male has positive perspective and high competencies compared to female. As well as the male and female author both are productive. However male author is more involved than female in this field.

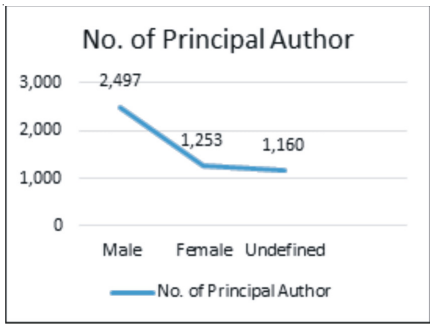


Figure 2: Graph of Principal Author

The analysis reveals that male authors dominate AI research in India, contributing more than twice the number of publications compared to female authors. This indicates (Figure 2) that male authors are more actively engaged in research productivity within this field. However, the presence of 1,253 female authors (25.49%) demonstrates a significant and growing involvement of females in AI research, reflecting a gradual shift towards gender diversity in the academic landscape.

The undefined category (23.74%) arises due to incomplete or ambiguous metadata in databases, which limits the accuracy of gender-based analysis. This highlights the need for more comprehensive author profiling and metadata standardization in bibliometric studies.

5.3 Year-wise Publications Analysis

From 2014 to 2023, constituting the 10 different years. It's a golden decade of the technological era, especially in the field of AI. In this decade total no. of 4910publications were found from OpenAlex database. According to these publications, it is clear that revolutionary and drastic changes have come in

the field of AI research in India. A huge number of publications have proved it.

Figure 3: Year-wise Publications Analysis

The year-wise distribution of 4910 articles published in Openalex during the period 2014-2023 is presented in the graph (Figure- 3). It is seen that the number of articles published is highest in the year 2023 with 2503 (50.98%) articles. 1162 (23.66%) is the publication rate of the year 2022 followed by 655 (13.34%) in 2021, 234 (4.76%) in 2020, 175 (3.56%) in 2019, 116 (2.36%), 32 (0.65%) in 2017, 16 (0.33%) in 2016, 9 (0.18%) in 2015 and 12 (0.24%) in 2014. The result shows that there was a steady increase in the number of publications from the year 2014 to 2023, and the year 2015 showed a slight decrease but 2023 showed a drastic change in the publication number. This study of year-wise publications gives a clear picture of the growth of literature in the field of Artificial Intelligence in India during the prescribed period.

5.4. Collaboration Analysis among Authors

The co-authorship analysis was conducted using VOSviewer software to map and interpret collaborative patterns among authors in Indian AI research publications. A threshold of a minimum of 5 documents per author (without a minimum citation requirement) was applied. Out of 16,871 authors, only 184 met the threshold, and among them, 125 authors were finally mapped for visualization.

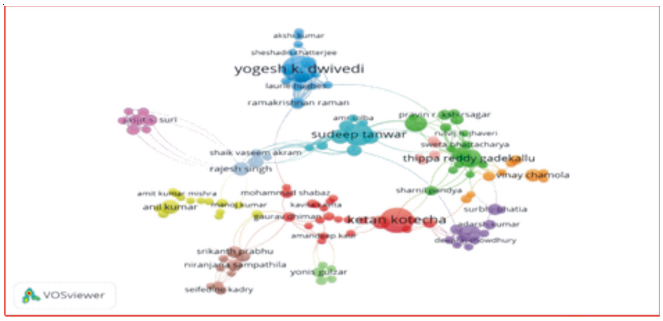


Figure 4: Mapping visualization Patterns Co-Authorship

The network analysis revealed 12 clusters, 327 links, and 952 total link strength. Each node (circle) in the visualization represents an author, where larger nodes indicate higher publication productivity, while the connecting lines represent collaboration intensity. Authors positioned closer to each other demonstrate stronger and more frequent co-authorship relations.

This co-authorship analysis highlights that Indian AI research is not isolated but strongly collaborative, with several core authors acting as central connectors across clusters. The existence of 12

distinct clusters shows thematic diversification in AI research, ranging from cloud computing and IoT to healthcare and interdisciplinary social applications.According to Figure-4, the high link strengths of authors such as Sudeep Tanwar, Yogesh K. Dwivedi, and Thippa Reddy Gadekallu indicate that Indian AI research is being driven by collaborative efforts rather than individual contributions.

5.5. Keyword Co-occurrence Network Analysis

The co-occurrence analysis provides a systematic way to explore the intellectual structure and thematic relationships within Indian artificial intelligence (AI) research. Out of 5175 unique keywords identified during 2014-2023, a minimum threshold of 25 occurrences was applied. As a result, 1223 keywords met the inclusion criteria, and 341 significant keywords were selected for the final network visualization.

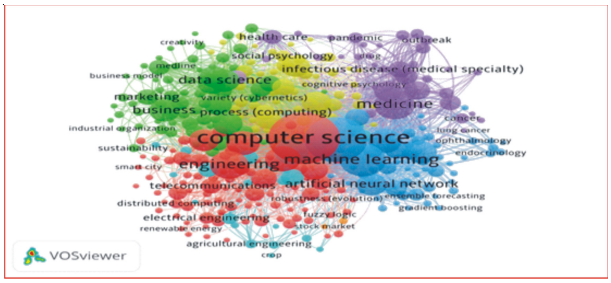
Table 4: Top 10 Keywords in Indian AI Research

Sl	Keyword	Occurrences	Total link strength
1	Computer Science	4597	48023
2	Artificial Intelligence	3428	37275
3	Machine Learning	1733	20081
4	Medicine	1333	15479
5	Engineering	1222	14458
6	Mathematics	994	12540
7	Biology	981	12100
8	Deep Learning	915	10716
9	Operating System	891	10869
10	Data Science	768	9180

The analysis reveals that the term Computer Science dominates the field, occurring 4597 times with the highest total link strength of 48,023, indicating its centrality as the foundational discipline of AI research. This is followed by Artificial Intelligence (3428 occurrences; TLS = 37,275) and Machine Learning (1733 occurrences; TLS = 20,081), both of which emerge as major research hotspots. Other important domains include Medicine (1333; TLS = 15,479), Engineering (1222; TLS = 14,458), Mathematics (994; TLS = 12,540), and Biology (981; TLS = 12,100), which illustrate the interdisciplinary nature of AI applications.

Emerging methods such as Deep Learning (915; TLS = 10,716) and Data Science (768; TLS = 9,180) are positioned as growing fields of interest. Interestingly, Operating System (891; TLS = 10,869) also appears in the top ten, suggesting infrastructural and computational considerations remain an active area of research.

Figure 5: Visualization of Keyword co-occurrence network analysis



The co-occurrence visualization (Figure5) clearly demonstrates that high-frequency keywords such as Computer Science, Artificial Intelligence, and Machine Learning are clustered at the center of the map, reflecting their dominance and strong interconnectedness with other disciplines. Conversely, lower-occurrence keywords are located toward the periphery, highlighting more specialized or emerging themes. This systematic keyword mapping confirms that Indian AI research is primarily grounded in core computational sciences while simultaneously expanding into applied domains such as medicine, biology, and engineering. Deep learning and data science within the top ten also highlights.

5.6 Visualization of Research Collaboration among Organizations

The co-authorship analysis at the organizational level highlights the structural pattern of institutional collaborations in Indian AI research. A total of 3317 organizations were identified through bibliometric mapping.

Table 5: Top 10 Organizations in Indian AI Research (2014-2023):

Sl	Organization	Documents	Citations	Total link strength
1	Vellore Institute Of Technology University	241	6196	85
2	Srm Institute Of Science And Technology	127	1496	48
3	Symbiosis International University	107	7163	50
4	Graphic Era University	95	1593	52
5	University Of Petroleum And Energy Studies	80	3036	91
6	Chandigarh University	78	2046	63
7	Koneru Lakshmaiah Education Foundation	73	990	41
8	Saveetha University	72	1302	48
9	Lovely Professional University	66	2255	50
10	Manipal Academy Of Higher Education	65	1767	28

By applying a threshold of a minimum of 25 documents per organization, 54 organizations were included in the network, of which 53 demonstrated strong interconnections, indicating a cohesive collaboration environment.

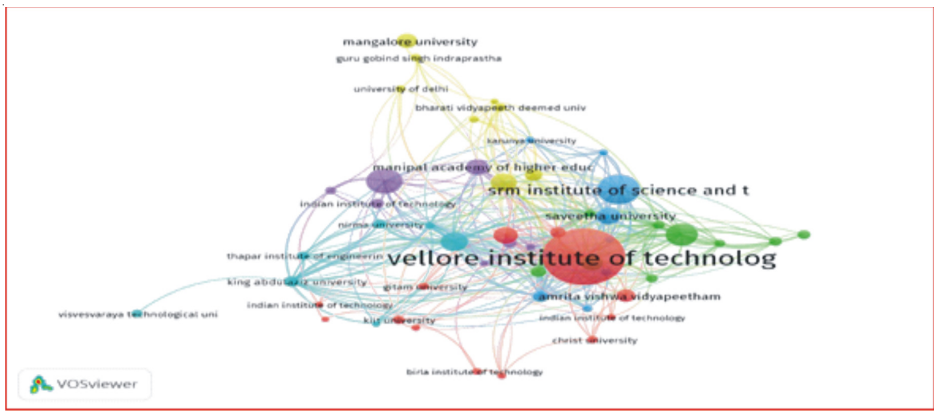


Figure 6: Visualization of research collaboration among organizations

In this Figure6, Vellore Institute of Technology (VIT) emerges as the leading institution with 241 documents, 6196 citations, and a total link strength of 85. University of Petroleum and Energy Studies (UPES) shows remarkable collaborative intensity with the highest link strength (91) despite having only 80 documents, reflecting its central role in fostering partnerships. Interestingly, Symbiosis International University produced 107 documents but achieved the highest citation count (7163) among the top ten organizations, signifying its high research impact and visibility. Other important contributors include SRM Institute of Science and Technology, Graphic Era University, Chandigarh University, Saveetha University, Lovely Professional University, and Manipal Academy of Higher Education, all of which have demonstrated significant productivity and collaboration.

The findings reveal that Indian AI research is not only expanding in terms of publication volume but also becoming increasingly institutionally collaborative. The strong interconnection among 53 of the 54 qualified organizations demonstrates the synergistic nature of Indian research institutions, where collaborative networks strengthen both research visibility and academic impact. Mean while, the dominance of VIT highlights the leadership of private universities in driving research output.

6. Discussion

The present bibliometric analysis provides a comprehensive overview of India's contribution to Artificial Intelligence (AI) research during 2014-2023 using open-access data from Scopus. The findings are discussed in light of existing studies to highlight similarities, differences, and unique insights.

Our study shows that Gold Open Access dominates Indian AI research (62.79%). Similar results were reported by Piwowar et al. (2018), who highlighted the global preference for Gold OA in maximizing visibility and citation advantage. Male authors are contributed 50.77%, whereas female authors constitute only 25.49%. Previously, Gupta (2011) indicated a gradual improvement in inclusivity. The co-authorship analysis revealed 12 clusters, with leading authors such as Sudeep Tanwar, Yogesh K. Dwivedi, and Thippa Reddy Gadekallu serving as central connectors. This aligns with findings from Garg & Sharma (2017), who emphasized India's increasing collaborative research culture in emerging technologies. Core keywords such as Computer Science, Artificial Intelligence, and Machine Learning dominate, while emerging trends like Deep Learning indicate India's productivity.

The results indicate that India's AI research has matured rapidly in the past decade, demonstrating strong growth, increasing collaboration, interdisciplinary expansion, and international integration. However, gaps remain in gender inclusivity, open-access diversity and organizational collaborations.

7. Conclusion

The present study systematically analyzes India's contribution to AI research during 2014-2023 using bibliometric techniques. By examining open access trends, gender participation, collaboration networks, institutional performance, keyword co-occurrence, and citation patterns, the study provides a comprehensive picture of the evolving research landscape. The novelty of this work lies in its country-specific focus using open-access data, the application of bibliometric exploration of gender-wise authorship patterns, which are rarely addressed in AI literature. The key findings reveal that India's AI research has grown exponentially, is dominated by male authors but with rising female participation, and is increasingly collaborative across both individuals and institutions. Core computational fields continue to dominate, but healthcare and emerging technologies like deep learning are rapidly expanding. In terms of relevance, the study highlights India's integration into global AI research, with influential authors and institutions shaping international collaborations. It also

identifies structural gaps, such as limited female authorship and uneven open access models.

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