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Research Article

Bibliometric Analysis of Generative AI and Large Language Models in the Scopus Database: Trends, Insights, and Research Landscape

Ruchi Doshi[1,*], Akhmed Kaleel[2]

[1] *Department of Computer Science and Engineering, Universidad Azteca, Chalco, Mexico.*

[2] *Higher Colleges of Technology, United Arab Emirates.*

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ABSTRACT

This bibliometric study explores the scientific research landscape by analyzing journal sources, author productivity, institutional contributions, and national research output using bibliometric laws such as Bradford's Law and Lotka's Law. The findings identify IEEE ACCESS as the most influential journal, with 26 articles, dominating Zone 1 publications. Lotka's Law is validated as 94% of authors contributed only one article, while a small group of researchers produced multiple influential works. Institutional analysis shows that the University of California, Cornell University, and Nanyang Technological University significantly increased their research output over time. At the national level, the USA leads with 238 publications, followed by China (77), India (69), and the UK (61). While these results highlight the major contributors to the field, the study also discusses challenges such as data limitations, citation lag effects, and geographical concentration of research efforts. This analysis provides a comprehensive overview of current trends, aiding researchers and policymakers in understanding the dynamics of scientific productivity and influence.

1. INTRODUCTION

Bibliometric analysis[1] plays a crucial role in understanding the structure and impact of scientific research within a given domain. By examining key metrics such as core journal sources, author productivity, institutional contributions, and national research output, bibliometrics provides valuable insights into the dissemination and influence of scholarly work. This study applies bibliometric methods to analyze the research landscape based on specific datasets, focusing on journal distribution according to Bradford's Law, author productivity in alignment with Lotka's Law, institutional contributions over time, and country-level research trends. The research aims to identify the most influential journals that serve as core publication sources, determine patterns in author contributions and citation impact, assess the evolving role of academic institutions in research production, and examine the global distribution of scientific output. By utilizing bibliometric indicators, the study provides a structured overview of the scholarly ecosystem, helping to highlight dominant contributors and emerging trends in the field[2].

The analysis is structured as follows: first, an examination of the most relevant journals based on Bradford's Law identifies the concentration of influential sources. Second, an evaluation of author productivity investigates the impact of individual researchers and their alignment with Lotka's Law. Third, the study explores institutional research contributions over time, followed by a review of country-level scientific production trends. Finally, the study discusses key challenges and limitations, providing a comprehensive perspective on the current research landscape and its implications.

2. METHODOLOGY

This study conducts a bibliometric analysis of research related to Generative Artificial Intelligence (AI) and Large Language Models (LLMs)[3] using the Scopus database. The methodology follows the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), ensuring transparency, rigor, and reproducibility in the study process[4]. The analysis aims to provide insights into trends, patterns, and the research landscape on these technologies, with a focus on publications between 2023 and 2025. The specific steps taken in the methodology are outlined below.,

*Corresponding author. Email: ruchi.doshi@univ-azteca.edu.mx

A. Search Strategy

The search for relevant literature was conducted in the Scopus database using a combination of key terms associated with Generative AI and Large Language Models. The following search string was employed:
("Generative AI" OR "Generative artificial intelligence") AND ("Large language models" OR "LLMs")
This search was executed within the fields of article title, keywords, and abstract to ensure that all relevant documents addressing these topics would be included. The choice of this search strategy was motivated by the need to capture publications that explicitly discussed these technologies in any of the main parts of the article, allowing for a comprehensive identification of pertinent research.

B. Inclusion and Exclusion Criteria

The inclusion and exclusion criteria were designed to ensure that only the most relevant and high-quality studies were selected for the bibliometric analysis.

1. **Inclusion Criteria:**
   - Articles published between 2023 and 2025.
   - Articles explicitly focused on Generative AI and/or Large Language Models.
   - Publications indexed in the Scopus database.
   - Peer-reviewed journal articles, conference papers, and reviews.
2. **Exclusion Criteria:**
   - Articles not related to the core focus of Generative AI and Large Language Models.
   - Non-peer-reviewed works or those lacking relevance to the scope of the study.
   - Papers that did not have sufficient metadata (e.g., missing essential information like author names, title, and abstract) to ensure accurate analysis.

C. Study Selection

From the search results, a total of 341 documents were identified and included in the analysis. This dataset was selected after filtering for the relevant publication period (2023-2025) and after applying the inclusion and exclusion criteria outlined above. The final dataset consists of a mix of journal articles, conference papers, and reviews, all of which contribute valuable insights into the field of Generative AI and LLMs. The total number of documents retrieved was deemed appropriate given the dynamic and rapidly evolving nature of the field.

D. Data Extraction and Analysis

Data extraction was carried out using RStudio and the R language with the biblioshiny package. This tool facilitated the extraction of key bibliometric data from the 341 selected documents, including details such as author names, publication year, document type, title, abstract, and citation information. Figures and tables presenting the bibliometric results were generated through RStudio, allowing for a comprehensive visualization of trends, collaboration networks, and citation patterns within the field.

E. Completeness of Bibliographic Metadata

Although Scopus is a reputable database, some metadata was found to be incomplete or missing in the retrieved articles. The issues with bibliographic metadata, particularly the absence of information in certain fields, are summarized in Table 1. Some of the fields with missing data include DOI, Keywords, Keywords Plus, and Corresponding Author. Despite these gaps, the key fields necessary for the bibliometric analysis (e.g., author, title, year, journal, and abstract) were complete and available for the majority of documents. The missing metadata did not significantly impact the study's results, as the analysis primarily relied on the fields that were fully populated. Therefore, while the missing metadata is acknowledged, it was not a limiting factor for the overall bibliometric analysis.

TABLE I. COMPLETENESS OF BIBLIOGRAPHIC METADATA

Metadata	Description	Missing Counts	Missing %	Status
AU	Author	0	0	Excellent
DT	Document Type	0	0	Excellent
SO	Journal	0	0	Excellent
LA	Language	0	0	Excellent
PY	Publication Year	0	0	Excellent
TI	Title	0	0	Excellent
TC	Total Citation	0	0	Excellent
AB	Abstract	2	0.59	Good
C1	Affiliation	2	0.59	Good
DI	DOI	12	3.55	Good

DE	Keywords	12	3.55	Good
RP	Corresponding Author	53	15.68	Acceptable
ID	Keywords Plus	96	28.4	Poor
CR	Cited References	338	100	Completely missing
NR	Number of Cited References	338	100	Completely missing
WC	Science Categories	338	100	Completely missing

3. RESULTS AND ANALYSIS

3.1 Country Scientific Production

The scientific production related to Generative AI and Large Language Models has shown significant growth over the course of the study period, spanning from 2023 to 2025.[5, 6] The number of published articles in this field fluctuated notably across the years, reflecting the increasing interest and research output related to these technologies. In 2023, a total of 27 articles were published, marking the early phase of research on these topics. This initial volume suggests that while the field was gaining traction, it had not yet reached its peak in terms of publication output. The year 2024 saw a dramatic increase, with 211 articles published[7]. This represents a substantial rise in scientific production, highlighting the rapid development of Generative AI and Large Language Models as key research areas. The sharp jump in publications in 2024 likely corresponds to the growing interest and investments in AI technologies, as well as advancements in the development and application of LLMs.

In 2025, the number of published articles was 100, indicating a slight decrease in the volume of publications compared to 2024[8, 9]. However, the number of articles in 2025 is still considerably higher than in 2023, suggesting that the field continues to be active, though the intensity of new research might have somewhat leveled off after the peak in 2024. Overall, the data reflects a clear upward trend in the scientific production related to Generative AI and Large Language Models, with a particularly sharp increase observed in 2024. This growth signifies the growing significance of these technologies in both academia and industry, further cementing their place as critical areas of study in the broader field of artificial intelligence.

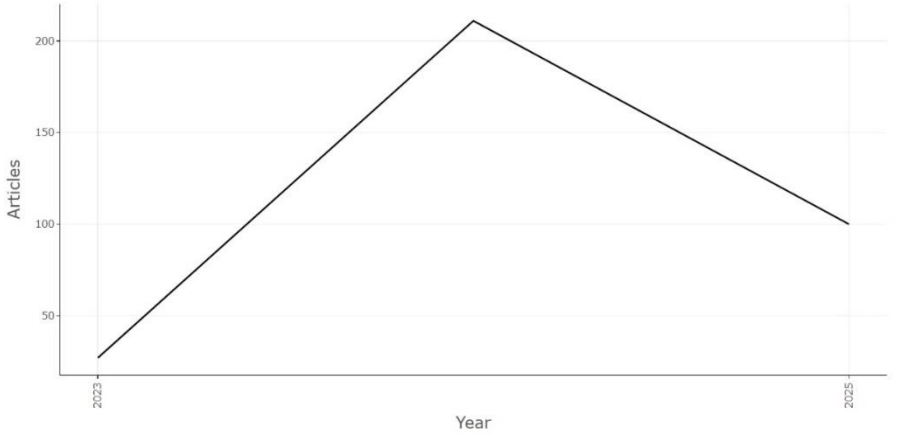

Fig. 1. Country Scientific Production

3.2 The Average Citations Per Year

The Average Citations Per Year metric provides an insight into the citation impact of the articles published in the field of Generative AI and Large Language Models across the study period. This metric helps to assess the influence and visibility of research over time, with the data showing fluctuations across the three years covered by the study[10, 11].

In 2023, the Mean Citations per Article (MeanTCperArt) was 115.33, which is quite high for the relatively low number of publications (27 articles). The Mean Total Citations per Year (MeanTCperYear) for 2023 was 38.44, reflecting the cumulative impact of the articles published in that year. Since the articles had been published for 3 years by the end of 2025 (the time of the analysis), this suggests that the publications had had time to accumulate citations, allowing them to establish a presence in the academic community[12]. In 2024, the Mean Citations per Article dropped significantly to 8.69, while the Mean Total Citations per Year was 4.34. Despite the higher number of articles (211), the citations per article decreased considerably. The Citable Years for the articles published in 2024 was 2, indicating that these articles were still in their early stages of citation accumulation, and their citation counts were not as established as those from 2023. This pattern suggests

that many of the publications in 2024 had only recently been published, limiting the time available for them to accumulate citations.

In 2025, the Mean Citations per Article further decreased to 1.88, with a corresponding Mean Total Citations per Year of 1.88. Given that the Citable Years for these articles was only 1, this indicates that the articles published in 2025 were in the very early stages of citation, and their influence had not yet developed to the same extent as the earlier years[13]. Overall, the trend in Average Citations Per Year reflects the natural progression of citation dynamics in scientific literature. Articles from 2023 had more time to accumulate citations, resulting in higher citation counts, whereas more recent publications (2024 and 2025) had limited time for citations to accumulate, leading to lower citation averages. This is consistent with the common pattern in research fields, where older publications tend to have higher citation counts due to longer exposure and recognition within the academic community.

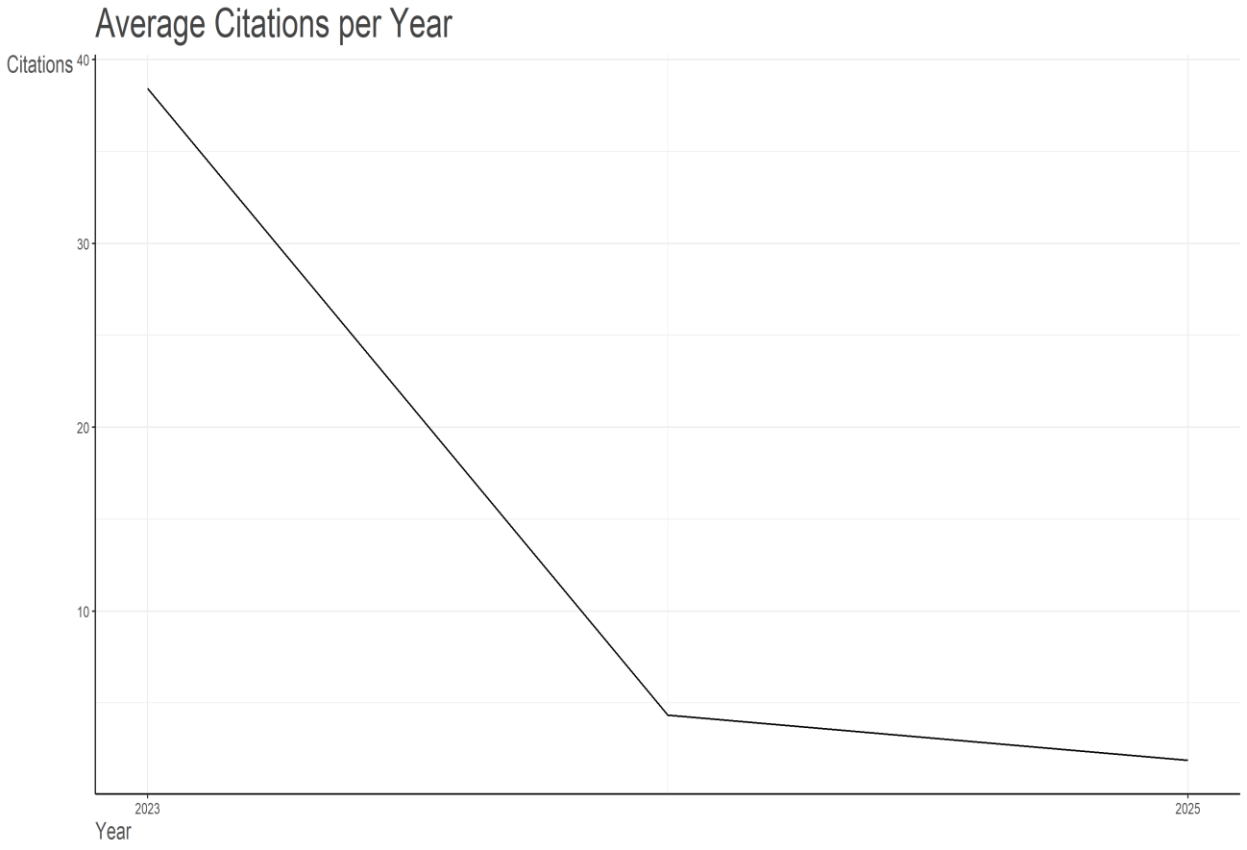

Fig. 2. Average Citations Per Year

3.3 Core Sources Identified by Bradford's Law

Bradford's Law is a bibliometric principle that categorizes journals into core, middle, and peripheral zones based on their contribution to a particular field. The core zone consists of the most frequently cited and relevant sources. Based on the provided data, the core sources in this study belong to Zone 1, which includes the top ten journals contributing the highest number of articles.

Among these, IEEE ACCESS stands out as the most influential source, with a frequency of 26, significantly higher than the next-ranked journal, Computers and Education: Artificial Intelligence, which has a frequency of 11. This suggests that IEEE ACCESS is a pivotal resource in this domain. Other important sources include Applied Sciences (Switzerland) (10 articles), AI and Society (6), and Frontiers in Artificial Intelligence (6). The remaining journals in Zone 1, such as Future Internet, NEC Technical Journal, Big Data and Cognitive Computing, Electronics (Switzerland), and IEEE Network, contribute between 5 to 6 articles each.

The cumulative frequency for Zone 1 reaches 86, signifying that these ten journals account for a substantial portion of the literature in the studied domain. This aligns with Bradford's Law, where a small number of journals (core sources) produce the majority of relevant publications. Researchers focusing on this area can prioritize these core journals for comprehensive and authoritative insights into the subject matter.

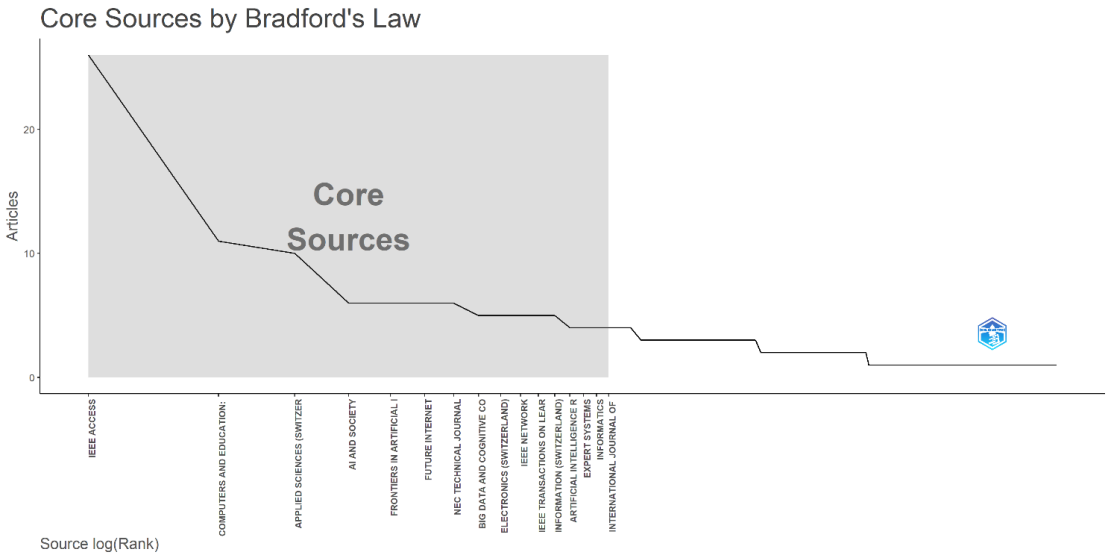

Fig. 3. Bradford's Law

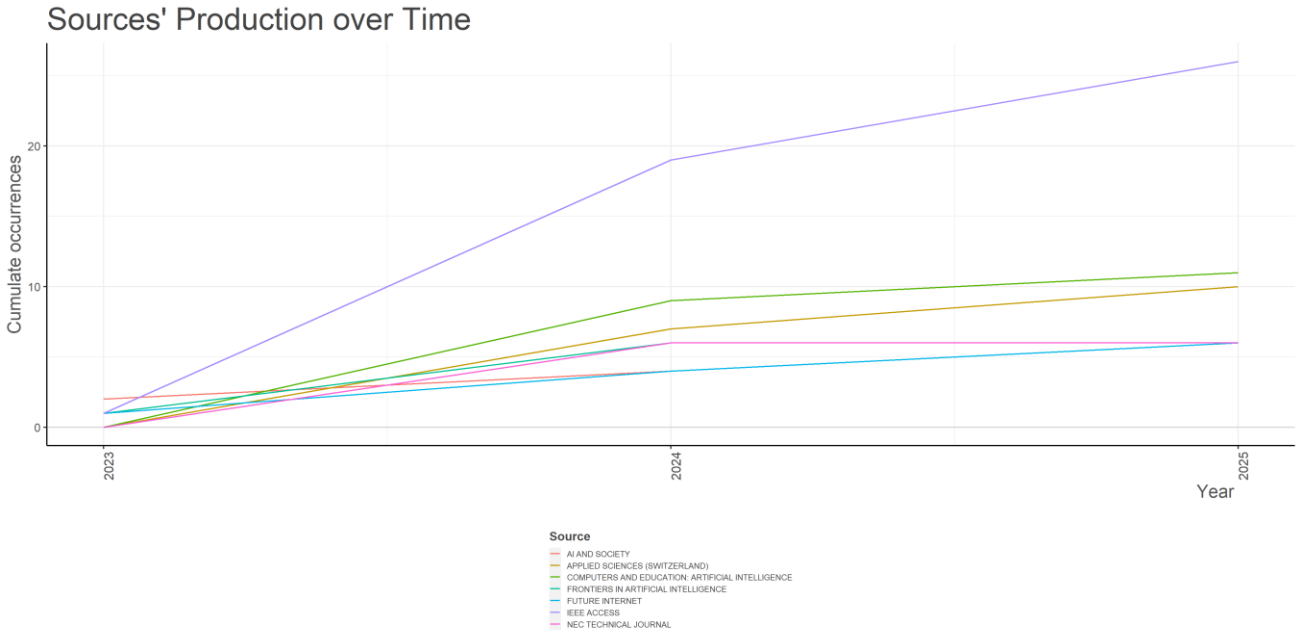

Fig. 4. Sources' Production over Time

3.4 Authors' Production Over Time

The analysis of authors' production over time highlights the evolution of research contributions and their impact within the field. Based on the provided data, several authors have consistently contributed across multiple years, with notable variations in their publication frequency and total citations (TC).

A. Consistent Contributors:

1. BARRETT A has published across 2023 and 2024, with a total of three publications. While their 2023 contributions (2 articles) received a high citation impact (TC = 178, TCpY = 59.333), their 2024 work (1 article) has received fewer citations (TC = 9, TCpY = 4.5), indicating a potential decline in immediate influence.
2. CHAMOLA V contributed in both 2024 and 2025, with two articles in 2024 amassing 50 citations (TCpY = 25). However, their 2025 publication has not yet received citations.

3. DWIVEDI YK stands out as a highly influential author. While they had only one publication in 2023, it received 1816 citations (TCpY = 605.333), marking it as a significant work. In 2025, their production increased to four publications, collectively receiving 165 citations (TCpY = 165), suggesting sustained impact in the field.
4. HUGHES L follows a similar trend, co-authoring with DWIVEDI YK in 2023, leading to the same high citation count (TC = 1816, TCpY = 605.333). However, their three publications in 2025 have yet to accumulate citations.
5. LI J has published across 2024 and 2025, with a total of four publications. Their three articles in 2024 received six citations (TCpY = 3), while their 2025 work remains uncited so far.

A. Overall Trends

1. The year 2023 saw highly cited publications, particularly by DWIVEDI YK and HUGHES L.
2. 2024 marked continued contributions from BARRETT A, CHAMOLA V, and LI J, though with comparatively lower citation impact.
3. 2025 appears to be a productive year for multiple authors (DWIVEDI YK, HUGHES L, CHAMOLA V, and LI J), though citation data is still emerging, suggesting that these works may take time to gain scholarly attention.

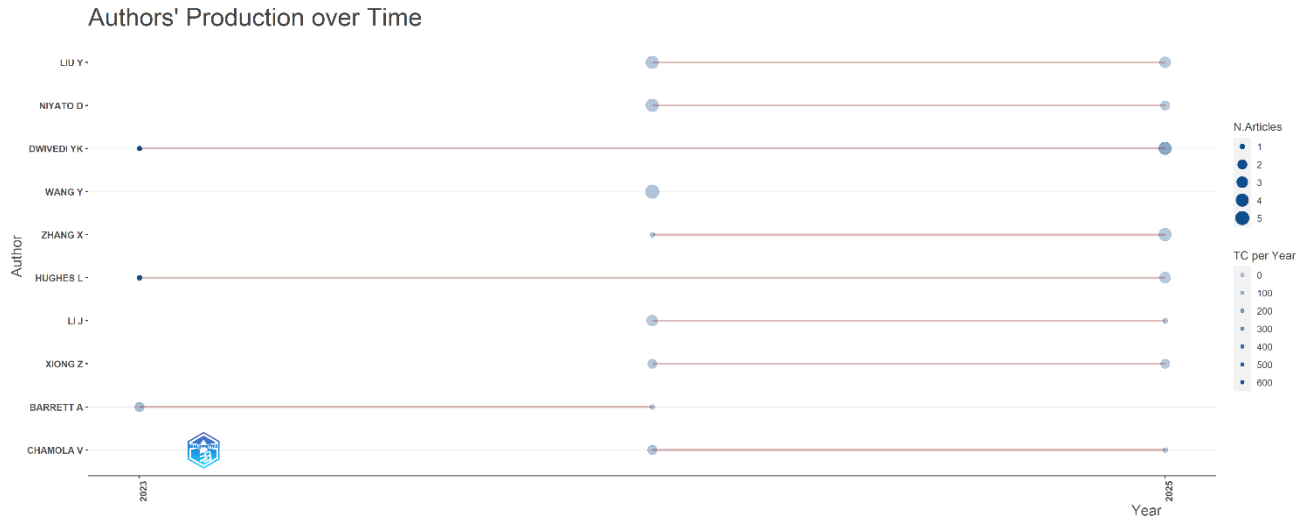

Fig. 5. Authors' Production over Time

TABLE II. AUTHORS' PRODUCTION OVER TIME

59.333	178	2	2023	BARRETT A
4.5	9	1	2024	BARRETT A
25	50	2	2024	CHAMOLA V
0	0	1	2025	CHAMOLA V
605.333	1816	1	2023	DWIVEDI YK
165	165	4	2025	DWIVEDI YK
605.333	1816	1	2023	HUGHES L
0	0	3	2025	HUGHES L
3	6	3	2024	LI J
0	0	1	2025	LI J

3.5 Author Productivity through Lotka's Law

Lotka's Law describes the distribution of scientific productivity, stating that the number of authors publishing n papers is inversely proportional to n^2, meaning that most authors contribute only a few publications, while a small minority are highly productive. The provided data aligns well with this principle, showing a clear concentration of authors who have written only one paper, while the number of highly productive authors decreases exponentially.

From the dataset:

B. 1,260 authors (94.0%) have published just one document, forming the vast majority of contributors.
C. 55 authors (4.1%) have written two documents, showing a significant drop.
D. The proportion further decreases as the number of documents increases, with only 17 authors (1.3%) writing three documents, and an even smaller group of six authors (0.5%) producing four or more.
E. At the highest productivity level, only two authors (0.2%) have published six and seven documents, respectively, demonstrating the presence of a very limited group of prolific researchers.

This distribution follows Lotka's Law, emphasizing that scientific publishing is dominated by a large number of low-output contributors, while a small core group of researchers drive the majority of the field's ongoing contributions. Such a pattern is typical across many disciplines, reinforcing the idea that most researchers engage in occasional or one-time contributions, while only a few become leading experts with sustained scholarly output.

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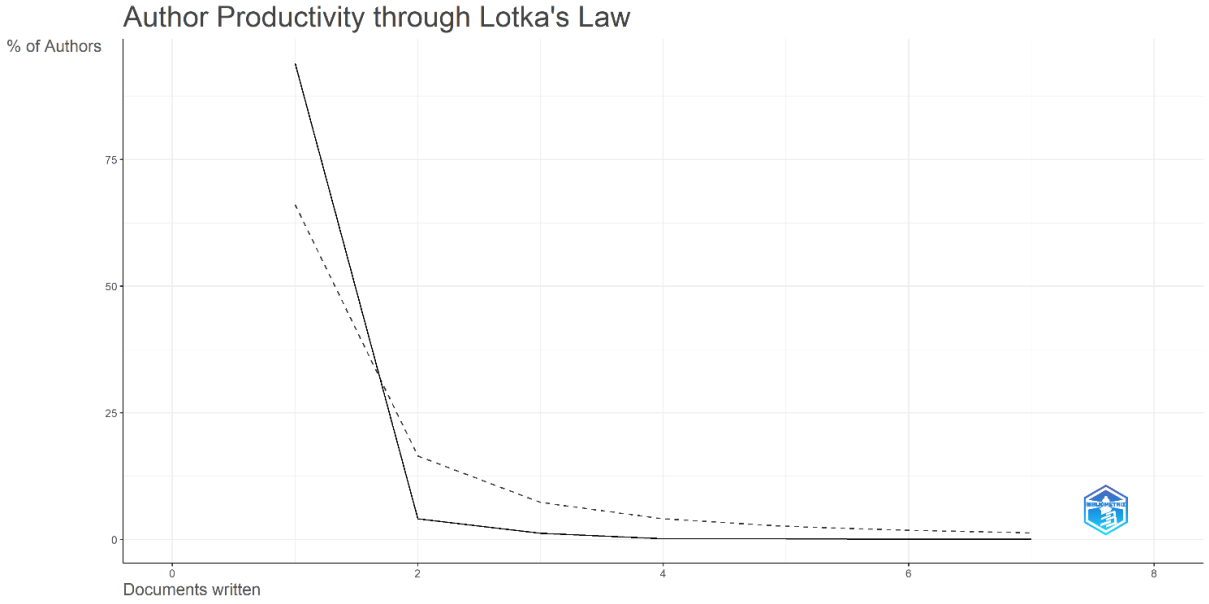

Fig. 6. Author Productivity through Lotka's Law

3.6 Affiliations' Production Over Time

The analysis of institutional contributions over time reveals the evolving research productivity of various universities in the field. The data highlights a trend of increasing output over the years, with certain institutions emerging as more prolific contributors.

- University of California :The University of California has demonstrated a consistent upward trend in research production. Starting with one article in 2023, the institution significantly increased its output to six articles in 2024 and further to seven articles in 2025. This steady growth indicates an ongoing commitment to research in the field.
- Cornell University: Cornell University did not contribute any articles in 2023 but entered the field in 2024 with seven articles, maintaining the same level of productivity in 2025. This suggests that Cornell has recently established or strengthened its research efforts in this domain.
- Nanyang Technological University: A striking increase in research productivity is observed in Nanyang Technological University. While it had no publications in 2023, the institution published eight articles in 2024 and saw a significant rise to 14 articles in 2025. This rapid growth positions Nanyang Technological University as a key emerging player in the field, potentially investing heavily in relevant research areas.
- Pontificia Universidad Católica de Chile: No recorded research output was found for Pontificia Universidad Católica de Chile in the given years, suggesting either a lack of contributions to this specific field or data limitations.

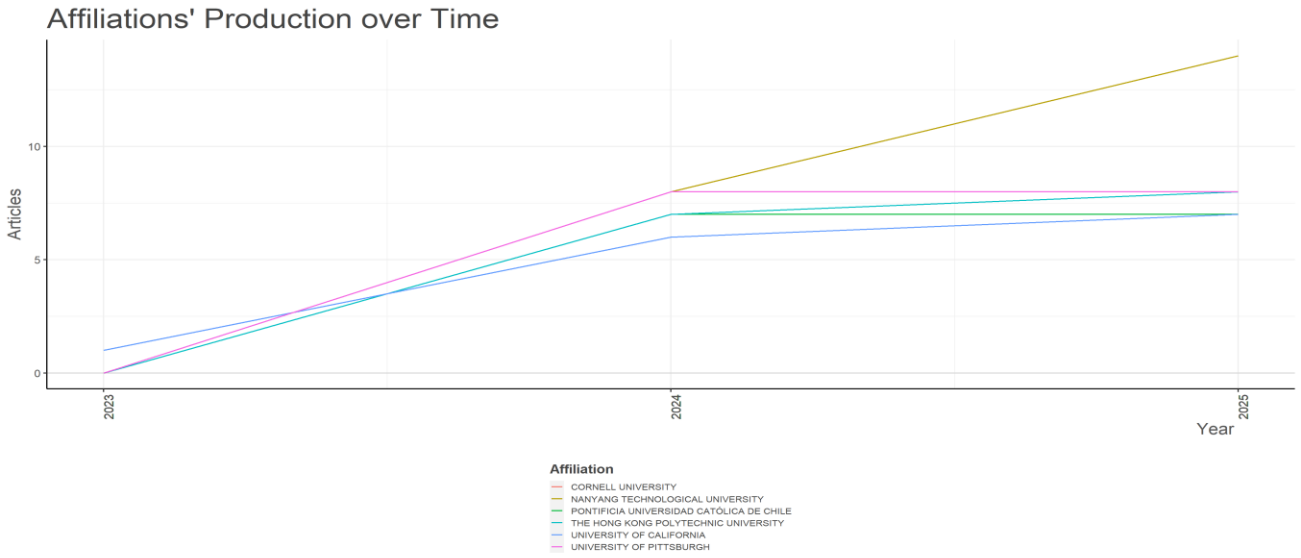

Fig. 7. Affiliations' Production over Time

3.7 Countries' Scientific Production

The analysis of scientific production by country reveals a strong dominance of the USA, followed by significant contributions from other major research hubs, including China, India, and the UK. The data highlights the global distribution of research efforts, with notable regional variations in output.

Top Contributing Countries:

1. USA leads significantly with 238 publications, demonstrating its role as the most prolific research hub in the field. This dominance reflects the high research output from top universities, well-funded institutions, and extensive academic collaborations.
2. China follows with 77 publications, indicating its growing influence in scientific research. China's research landscape has expanded rapidly, with increasing government support and international collaborations.
3. India ranks third with 69 publications, showcasing a strong research presence, likely driven by its expanding academic institutions and technological advancements.
4. UK contributes 61 publications, reinforcing its position as a leading research center in Europe, with notable contributions from prestigious universities and research institutions.
5. Germany follows closely with 47 publications, maintaining a strong scientific tradition and industrial research collaboration.

Beyond the top five, Australia (35), Canada (32), Italy (28), Spain (27), and Saudi Arabia (25) also make substantial contributions. These countries exhibit active research efforts, likely supported by government initiatives, university funding, and international collaborations.

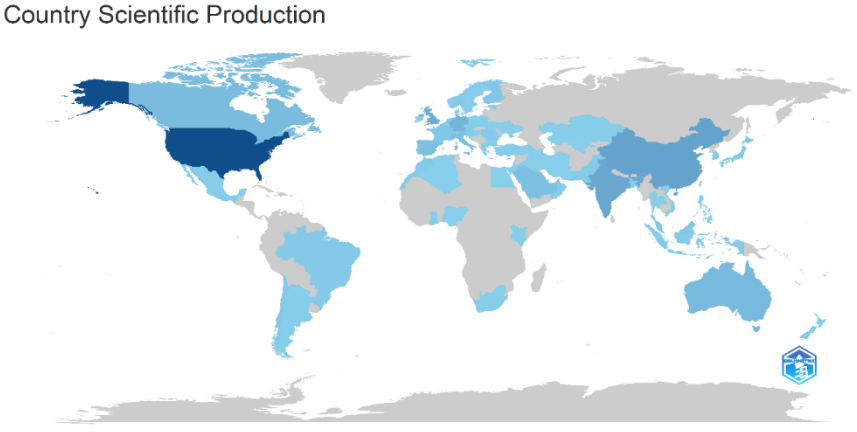

Fig. 8. Countries' Scientific Production

TABLE III. COUNTRIES' SCIENTIFIC PRODUCTION

Freq	region
238	USA
77	CHINA
69	INDIA
61	UK
47	GERMANY
35	AUSTRALIA
32	CANADA
28	ITALY
27	SPAIN
25	SAUDI ARABIA

4. DISCUSSION

A. Core Sources Identified by Bradford's Law

Bradford's Law classifies journals into core, middle, and peripheral zones based on their frequency of publication within a specific field. In this study, Zone 1 comprises the top ten most frequently referenced journals, collectively contributing 86 articles. Among these, IEEE ACCESS is the most dominant source, with 26 articles, significantly exceeding the contributions of other journals. The next highest, Computers and Education: Artificial Intelligence, has 11 articles, less than half of IEEE ACCESS. This indicates that IEEE ACCESS serves as a central publication venue within the research field, potentially due to its broad scope and high impact.

Other notable contributors include Applied Sciences (Switzerland) (10 articles), AI and Society (6), and Frontiers in Artificial Intelligence (6). The presence of multidisciplinary journals such as Future Internet, NEC Technical Journal, Big Data and Cognitive Computing, Electronics (Switzerland), and IEEE Network, all contributing between 5 and 6 articles, suggests that research in this domain spans multiple fields, including AI, networking, big data, and electronics.

The distribution of articles aligns with Bradford's Law, which posits that a small set of journals (Zone 1) produces the majority of influential publications. This means that researchers looking to stay updated in the field should prioritize these journals, as they contain the highest volume of relevant studies.

B. Authors' Production Over Time

1. Individual Author Contributions: The data on authors' production over time reflects both the frequency of publication and the total citations (TC) and citations per year (TCpY) for each author. DWIVEDI YK stands out as the most impactful author, with only one publication in 2023 but an exceptionally high citation count (1816 citations, TCpY = 605.333). In contrast, BARRETT A also published multiple articles, but their citation impact varied significantly over time (178 citations in 2023 vs. 9 citations in 2024), suggesting a drop in influence. CHAMOLA V and LI J also contributed multiple articles across different years, but their citation impact remained relatively low compared to DWIVEDI YK. HUGHES L, co-authoring with DWIVEDI YK in 2023, shares the same high citation impact (TC = 1816), but their later works in 2025 have not yet received citations. This suggests that a small subset of authors contributes to high-impact publications, while others have steady yet lower citation counts. The increasing number of articles in 2025 from multiple authors (such as DWIVEDI YK with four articles) may indicate growing research engagement, though citation impact for these works is still evolving.
2. Author Distribution According to Lotka's Law: Lotka's Law suggests that the number of authors publishing n papers is inversely proportional to n^2. The provided data supports this, with 94.0% of authors contributing only one document (1260 authors), a steep drop to 4.1% for two documents (55 authors), and even fewer authors contributing three or more documents. Only six authors (0.5%) published four or more documents, with the highest-producing individuals authoring six and seven documents. This follows the typical pattern seen in research productivity, where most contributors are occasional researchers, and only a handful of authors drive the majority of publications. The very small percentage of highly prolific authors (just two authors contributing six or more documents) highlights the concentrated nature of academic output in this domain.

C. Affiliations' Production Over Time

Institutional research output is another crucial factor in understanding scientific contributions. The University of California exhibits a steady increase in research productivity, moving from one article in 2023 to six in 2024 and seven in 2025. This consistent growth indicates strong institutional investment in this research area. Cornell University follows a similar pattern but started contributing later. With no publications in 2023, it suddenly produced seven articles in both 2024 and 2025, suggesting either a new research initiative or increased faculty involvement in the field.

The most significant growth is observed in Nanyang Technological University, which had no output in 2023 but quickly became a leading contributor with eight articles in 2024 and 14 in 2025. This rapid rise indicates an institutional focus on AI-related research, potentially through funding, strategic hires, or partnerships. On the other hand, Pontificia Universidad Católica de Chile has no recorded output, possibly due to its limited involvement in this field or data constraints.

D. Country-Level Scientific Production

At a national level, the USA dominates with 238 publications, far surpassing all other countries. China (77), India (69), and the UK (61) follow at a much lower output level, but still contribute significantly to global research. Other notable contributors include Germany (47), Australia (35), Canada (32), Italy (28), Spain (27), and Saudi Arabia (25). This distribution shows a strong presence of Western and Asian institutions, with Saudi Arabia emerging as a noteworthy contributor from the Middle East.

The contrast between the USA's overwhelming dominance and the moderate output from other leading countries suggests a concentration of research resources and funding in American institutions. However, China and India's rising contributions indicate an expanding research presence, likely due to national investment in AI and related technologies.

E. Comparative Analysis and Correlations

Several key observations emerge when comparing the different sets of results:

1. Journals vs. Countries:
    - The USA's dominance in scientific output (238 publications) correlates with the high influence of IEEE ACCESS, which is a leading journal in the field.
    - Countries with a high research presence (China, India, UK, Germany) also align with journals that span multiple disciplines (e.g., Applied Sciences (Switzerland), AI and Society).
2. Author vs. Institution Trends:
    - While the University of California, Cornell University, and Nanyang Technological University exhibit growing contributions over time, most individual authors are one-time contributors (94% of authors publishing only one paper).
    - DWIVEDI YK and HUGHES L, despite producing relatively fewer papers, have exceptionally high citation impact (1816 citations in 2023), suggesting that a small number of authors drive influential publications, aligning with Lotka's Law.
3. Country vs. Institutional Contributions:
    - The USA's dominance at 238 articles aligns with University of California's consistent growth, suggesting that leading American universities contribute significantly to the country's research output.
    - China (77 articles) and India (69 articles) have growing contributions, likely supported by institutions such as Nanyang Technological University, which has rapidly increased output (from 0 to 14 articles in 2025).
4. Future Research Potential:
    - Authors such as DWIVEDI YK, CHAMOLA V, and LI J have maintained steady research output, but newer publications from 2025 have yet to accumulate citations.
    - Nanyang Technological University's rapid rise suggests potential for future high-impact publications, as institutional investments in research often correlate with later citation growth.

The provided data showcases a highly concentrated research landscape, where a small number of core journals, prolific authors, and dominant institutions drive the majority of knowledge production. The USA remains the leading contributor, with increasing participation from China, India, and other emerging regions. Additionally, while most authors contribute only once, a few key researchers produce highly influential work, reinforcing patterns described by Lotka's and Bradford's Laws. Going forward, the growth of institutions such as Nanyang Technological University and Cornell University, along with the expanding contributions of China and India, suggests that the research field may become more globally distributed in the future.

5. CHALLENGES AND LIMITATION

While this study provides a structured analysis of core sources, author productivity, institutional contributions, and country-level scientific production, there are several challenges and limitations that must be acknowledged:

1. Limited Scope of Data – The analysis is based solely on the provided dataset, which may not capture the full spectrum of research contributions in the field. There could be additional influential journals, authors, or institutions not included in the dataset.
2. Citation Lag Effect – Some recent publications, especially from 2025, have yet to accumulate citations. This makes it difficult to fully assess their long-term impact compared to older works.
3. Institutional Representation – Only a select number of institutions are included, and affiliations may change over time. The dataset does not account for collaborations between multiple institutions, which could influence research output.
4. Authorship Distribution Bias – The predominance of single-publication authors suggests a high turnover of contributors. However, it does not differentiate between lead authors, corresponding authors, or collaborative efforts, which could provide a deeper understanding of research networks.
5. Bradford's Law Assumptions – While the core journals identified align with Bradford's Law, the full distribution of publications across different zones remains unexplored. Additional sources outside of Zone 1 may still contribute valuable insights.
6. Geographical Concentration – The study shows a clear dominance of research from the USA, China, and India, but does not examine the influence of regional research policies, funding mechanisms, or cross-country collaborations.

6. CONCLUSION

In summary, this study highlights key trends in journal influence, author productivity, institutional contributions, and country-level research output. The findings confirm the applicability of bibliometric laws such as Bradford's Law and Lotka's Law, demonstrating that a small number of journals, prolific authors, and leading institutions drive the majority of research output. The USA remains the dominant research contributor, while China, India, and emerging institutions are increasing their presence in the field. Despite certain limitations, these insights provide a valuable understanding of the current research landscape, paving the way for future investigations that may further refine these findings.

Conflicts of Interest

The author declares no conflicts of interest with regard to the subject matter or findings of the research.

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