

Artificial Intelligence in Educational Leadership: A Two-Decade Bibliometric Analysis (2004–2024)

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ABSTRACT

This study presents a bibliometric analysis of Artificial Intelligence (AI) in leadership research, focusing on the intersection of AI technologies and leadership practices over the past two decades (2005–2023). Based on a dataset of 323 Scopus-indexed papers, the analysis identifies key trends, emerging themes, and the concentration of research in countries such as the United States, China, and Australia, and leading journals like Cogent Education. The study reveals the increasing prominence of AI ethics and generative AI in leadership research, reflecting a shift towards human-centered applications of AI in leadership contexts. The research gap addressed by this study lies in the limited exploration of how AI influences leadership practices across different sectors, particularly in educational leadership. While previous studies have focused on AI's role in educational technology, this work uniquely examines AI's broader implications for leadership competencies and decision-making. The novelty of this study is in its comprehensive bibliometric approach, offering a structured analysis of global research trends and the development of a conceptual framework for AI in leadership. Practical implications of the findings include recommendations for educational policymakers to integrate AI literacy into leadership development programs, leadership trainers to incorporate AI tools into their training methods, and researchers to continue exploring AI's role in leadership across various disciplines. The study underscores the importance of interdisciplinary collaboration to address ethical concerns related to AI and to foster responsible AI adoption in leadership practices. By providing insights into the current state of AI in leadership research, this study contributes to the development of more informed, ethical, and effective leadership strategies in both educational and organizational settings.

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1. Introduction

Artificial Intelligence (AI) has increasingly influenced leadership practices across various sectors, particularly in education [1], [2], [3]. Over the past two decades, AI's integration into

leadership has gained significant traction as both a tool and a strategic framework for enhancing decision-making processes. However, despite the growing interest and widespread use of AI technologies, there remain significant gaps in understanding how AI can effectively transform leadership across different contexts. Previous research has primarily focused on AI's application in education and technology without fully exploring its intersection with leadership and management practices in organizational settings. This study seeks to address these gaps by providing a comprehensive bibliometric analysis of AI in leadership, utilizing data from the Scopus database.

The research problem centers on the need for a systematic understanding of how AI influences leadership practices, particularly in educational leadership [4], [5], [6], [7], [8]. As AI continues to evolve, there is a growing need to explore its potential in enhancing leadership strategies, decision-making, and organizational learning. However, existing studies lack a comprehensive approach to mapping out the cumulative growth and evolving trends of AI in leadership. This gap is especially evident in the paucity of studies focused on how leadership competencies can be shaped by AI technologies. In addressing these challenges, this study draws on a bibliometric analysis to uncover patterns, trends, and key themes in AI leadership research over the last two decades.

The research paper by Gunawan [9] serves as a valuable contribution to the field by mapping global research trends on AI in educational leadership. This analysis, driven by the need for a systematic global overview, addresses gaps identified in previous works. This study emphasizes the role of AI in enhancing leadership through better decision making and managerial efficiency, drawing attention to the need for improved strategies in AI adoption despite challenges like digital literacy and infrastructure limitations. Building on these insights, the first paper explores emerging trends and collaborative networks to understand how AI can be effectively integrated into educational leadership. This motivation stems from the desire to fill the knowledge gap in how AI technologies, such as predictive modeling and learning analytics, are reshaping leadership practices across various educational institutions.

The research gap in AI leadership studies is clear: existing works have concentrated primarily on AI in education and technology without fully addressing how AI can enhance leadership practices. This study fills that gap by examining the evolving relationship between AI and leadership, highlighting trends and emerging themes that are key to understanding AI's impact on leadership development. This is especially important in light of the rapid advancement of AI technologies, which have introduced new possibilities for shaping leadership approaches in educational institutions and beyond. The objective of this study is to provide a comprehensive bibliometric analysis, mapping the trajectory of AI's role in leadership, and offering a conceptual framework to guide future research.

The research gap in AI leadership studies is clear: existing works have concentrated primarily on AI in education and technology without fully addressing how AI can enhance leadership practices. This study fills that gap by examining the evolving relationship between AI and leadership, highlighting trends and emerging themes that are key to understanding AI's impact on leadership development. This is especially important considering the rapid advancement of AI technologies, which have introduced new possibilities for shaping leadership approaches in educational institutions and beyond. The objective of this study is to provide a comprehensive bibliometric analysis, mapping the trajectory of AI's role in leadership, and offering a conceptual framework to guide future research.

The solution presented in this research is to map out the existing body of literature, identifying core themes, key sources, and emerging trends through bibliometric techniques [10], [11], [12], [13]. By analyzing publications indexed in the Scopus database from 2005 to 2023, this study aims to provide a clear picture of the academic landscape surrounding AI and leadership. Furthermore, this study proposes a framework for understanding how AI technologies can be leveraged to enhance leadership practices, particularly within educational institutions [14], [15], [16], [17]. The analysis also highlights the need for interdisciplinary collaboration between AI technologists, educators, and leadership experts to address challenges related to AI's ethical use and its role in leadership development.

The novelty of this research lies in its bibliometric approach to AI in leadership, which combines an analysis of keywords, co-citations, and global research trends. Unlike earlier works that primarily focus on specific sectors or technologies, this study provides an overarching analysis of AI's role in leadership across multiple domains, offering valuable insights for researchers, policymakers, and practitioners alike. The results of this analysis will be instrumental in shaping future research directions and understanding the evolving role of AI in leadership.

The contribution of this research is significant as it provides a structured overview of the development of AI in leadership studies, highlighting key trends, challenges, and opportunities for future research. By employing a robust bibliometric methodology, this study offers novel insights into the ways AI technologies are reshaping leadership, particularly in the context of educational leadership. Moreover, it contributes to the development of a conceptual framework that can guide future research and practice in AI leadership applications, offering a foundation for better decision-making, leadership development, and organizational transformation. This research also lays the groundwork for addressing ethical considerations surrounding AI in leadership, ensuring a holistic understanding of its impact across diverse sectors.

The structure of the manuscript is organized as follows: The next section outlines the methodology used in this study, including the scope, coverage, and data extraction procedures. Following that, the results and discussion section presents the findings from the bibliometric analysis, highlighting key trends, research gaps, and thematic clusters. Finally, the conclusions summarize the study's contributions, offering suggestions for future research and practical implications for AI in leadership.

By synthesizing the findings from this study, future research can further explore the integration of AI in leadership across different databases and interdisciplinary fields. Expanding the scope of this research to include other databases such as Web of Science (WoS) and PubMed will provide a broader perspective, especially in areas such as healthcare leadership. This broader exploration will enhance the understanding of AI's application in leadership, offering a richer foundation for future studies on this rapidly evolving topic.

2. Method

This study employs a bibliometric analysis (Fig. 1) to explore the intersection of Artificial Intelligence (AI) and leadership, focusing on trends, themes, and research trajectories over the past two decades (2005-2023). The data for this analysis was retrieved from the Scopus database, which was chosen for its comprehensive coverage of interdisciplinary academic journals, conference proceedings, and books, providing a robust and reliable source for citation and bibliometric analysis. While other databases such as Web of Science (WoS) and Dimensions could have been used, Scopus was selected due to its extensive representation of publications related to AI, education, and leadership. One limitation of using Scopus exclusively is that it might miss some studies published in other prominent journals that are indexed in WoS or Dimensions. However, Scopus remains one of the most widely used databases in bibliometric research, and its use provides a consistent and reliable dataset for this study.

Scopus was selected for this study due to its extensive collection of peer-reviewed academic journals, conference papers, and books. It provides a comprehensive source of metadata for bibliometric analysis across multiple disciplines. While combining multiple databases such as WoS or Dimensions could provide a broader perspective, Scopus was considered sufficient for this analysis, given its wide coverage of interdisciplinary topics such as AI, education, and leadership. Nevertheless, future studies could benefit from incorporating additional databases to overcome the potential limitations of Scopus in capturing all relevant publications.

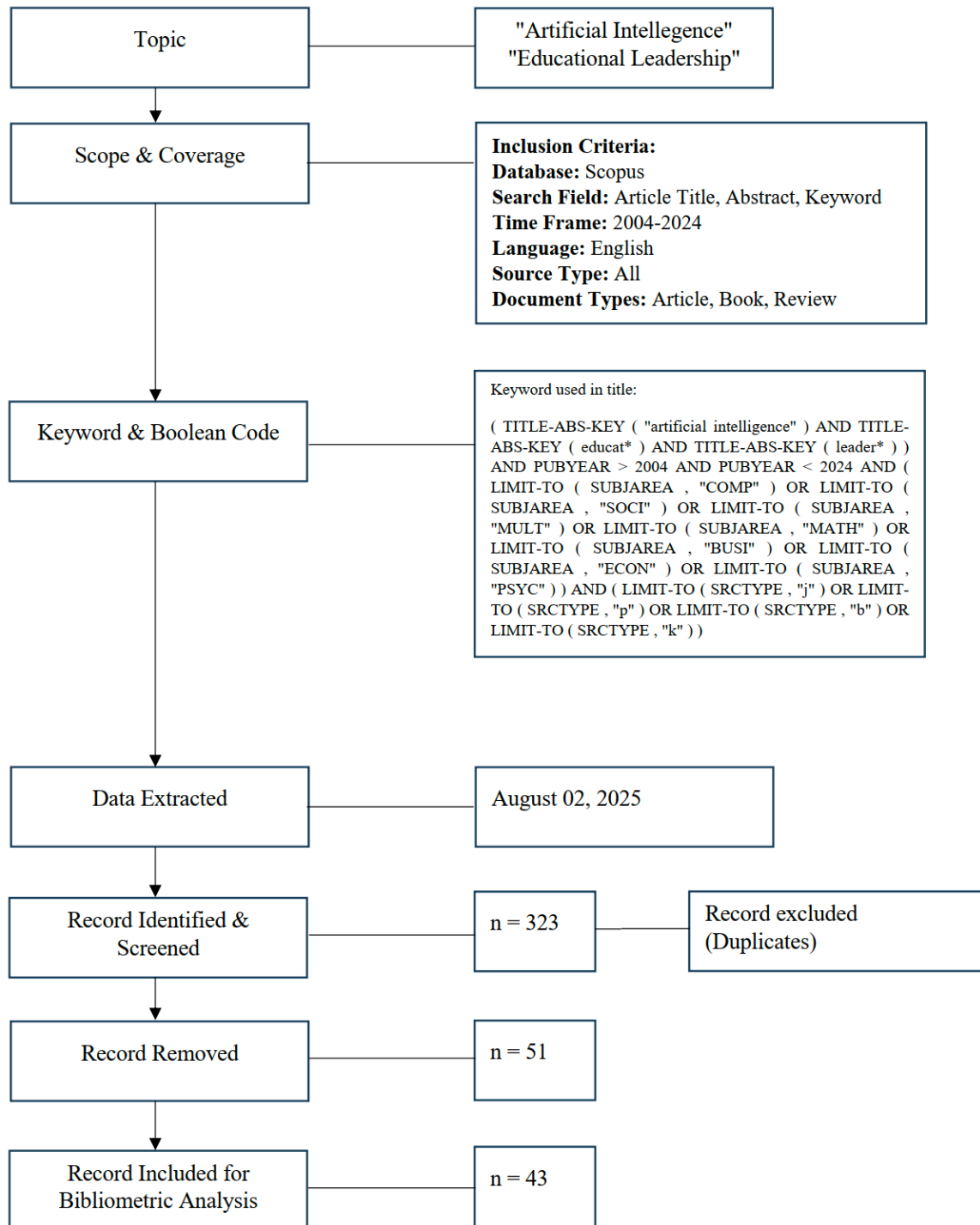


Fig. 1. Flow diagram of the bibliometric analysis process (adapted from Zakaria [18])

2.1. Scope & Coverage

This study defines its scope as peer-reviewed literature on artificial intelligence (AI) within leadership educational contexts over the last two decades and modified methodology research by Gunawan [9]. The coverage is restricted to records indexed in the Scopus database to ensure consistent metadata and robust citation analytics. The temporal window follows the query constraint `PUBYEAR > 2004 AND < 2024`, which effectively captures publications from 2005–2023. Only English-language records are retained to maintain comparability of text mining and keyword analyses. Subject

areas are limited to COMP, SOCI, MULT, MATH, BUSI, ECON, PSYC to keep the corpus aligned with technical, social, and managerial facets of AI and leadership. Source types include journals (j), proceedings (p), books (b), and book series (k) to reflect both archival and emergent venues. Document types retained for analysis are articles, reviews, and books, matching the inclusion criteria.

2.2. Keyword & Boolean Code

The search strategy employs a Boolean string that targets AI within education-leadership contexts while remaining generalizable to leadership scholarship. The representative query is TITLE-ABS-KEY("artificial intelligence") AND TITLE-ABS-KEY(educat) AND TITLE-ABS-KEY(leader)** , coupled with the scope filters above. Truncation operators (e.g., educat*, leader*) broaden recall to capture lexical variants such as "education/educational" and "leader/leadership." Field scoping to TITLE-ABS-KEY balances precision and coverage for bibliometric purposes. The year and subject-area limits are embedded directly in the string to standardize retrieval. Source-type and document-type filters are added to minimize noise from non-scholarly or peripheral materials. This coded query is reused reproducibly for reruns and sensitivity checks.

2.3. Records Identified & Screened

Executing the coded query yields an initial pool of records that are exported with complete bibliographic fields. The screening step includes automated checks for missing essentials (title, authors, source, year) to ensure viability for analysis. Records outside the year, language, subject-area, or document-type limits are flagged at this stage. Titles and abstracts are skim-screened to verify topical relevance to AI and leadership in educational or organizational settings. Any obviously off-topic items (e.g., unrelated engineering leadership without AI) are marked for removal. Screening decisions are logged to preserve a transparent audit trail. The count at this stage is reported as Records Identified & Screened (n) in the flow.

2.4. Records Excluded (Duplicates)

Duplicate detection is performed using combinations of DOI, title similarity, author lists, and year to avoid double-counting. When DOIs are absent, fuzzy matching on titles and venues is applied conservatively. Conference versions and extended journal versions are retained as distinct items only if they provide substantively different bibliographic identities. Detected duplicates are removed and the number is reported as Record Excluded (Duplicates) (n). This step prevents inflation of citation counts and co-occurrence frequencies. It also improves the stability of network metrics such as degree and centrality. A deduped corpus proceeds to topical relevance checks.

2.5. Records Removed (Out of Scope/Quality Filters)

After deduplication, remaining items undergo a relevance review to ensure a substantive link to AI and leadership rather than tangential mentions. Items are removed if leadership is absent, if AI is nominally cited without methodological or conceptual substance, or if the focus is unrelated to the defined domains. Additional removals occur for incomplete metadata or non-English full texts where analysis integrity would be compromised. Proceedings abstract without full papers may be excluded if bibliographic fields are insufficient for reliable mapping. This step also harmonizes document types to the declared inclusion set. Decisions and rationales are documented to keep the process reproducible. The resulting tally is summarized under Record Removed (n) in the flow.

2.6. Records Included for Bibliometric Analysis

The curated set that passes all filters forms the analytic corpus. This corpus is treated as the gold-standard input for performance indicators (e.g., annual growth) and science-mapping (e.g., co-occurrence, co-citation). Its stability is essential for valid longitudinal inference across the two-decade window. Descriptive statistics (counts by year, source, country, and subject area) are computed first. Then, standardized thesaurus cleaning is applied to author keywords to merge lexical variants and plurals. The final inclusion count is reported as Record Included for Bibliometric Analysis (n) in the protocol. This corpus anchors all subsequent visualizations and network measures.

2.7. Data Extracted

From each included record, structured fields are extracted: authors, affiliations, year, source title, document type, keywords, references, and citations. These fields enable construction of co-authorship, co-citation, and keyword co-occurrence matrices. Normalization steps (e.g., fractional counting for collaborations) are applied where appropriate. Keyword cleaning consolidates near-synonyms and stemmed variants to reduce fragmentation in concept maps. Reference lists are parsed to build the cited-side networks used in intellectual-structure analyses. All extraction and cleaning scripts are parameterized so the pipeline can be rerun on future updates. The Data Extracted stage concludes the methodology and hands the dataset to the analysis modules.

3. Results and Discussion

3.1. Bibliometric Analysis: Core Sources, Keywords, and Document Distribution

Fig. 2 presents the distribution of articles across sources, illustrating Bradford's Law of scattering, which reveals that a small number of journals dominate the field of AI and leadership research. This hierarchical distribution highlights the core sources Cogent Education and Sustainability (Switzerland) as the primary contributors, housing most AI-focused leadership articles. The steep drop-off in contributions from other journals after these core sources indicates that the field is highly concentrated in a few journals, with most of the research being funneled into these high-impact sources. This is reflective of a trend seen in other rapidly growing fields, where leading journals and publishers establish themselves as central hubs of scholarly output, guiding the direction of research and setting the thematic tone for future studies.

As shown in Fig. 2, certain journals, particularly Cogent Education, lead the AI-leadership research field. This is indicative of the journal's focus on both AI and educational leadership, which makes it a central hub for the dissemination of AI-related leadership research. The prominence of these journals highlights the concentration of AI leadership studies in a few select academic venues, suggesting that the field is still in its early stages of development, with research largely funneled into a limited number of high-impact sources. The dominance of Cogent Education also reflects the increasing importance of interdisciplinary journals that bridge the gap between AI and leadership. As AI's applications in leadership become more recognized, journals like Cogent Education serve as critical platforms for scholars seeking to publish cutting-edge research on the intersection of AI and leadership practices.

When compared to a previous bibliometric study by Pslyakov [19], Mertala P [20], and Ma J [21] on AI and education technology, which found a similar concentration in core journals like Computers & Education and Educational Technology & Society, the findings in Fig. 2 corroborate the notion of publication centralization in high-impact sources. However, the AI in leadership field, as seen in this analysis, appears to be even more concentrated in a few journals like Cogent Education, suggesting that while AI's integration into educational leadership is growing, it remains a relatively niche area compared to broader educational technology research. This comparison emphasizes the emerging nature of AI leadership studies, indicating that while the volume of research is increasing, the academic community's focus is still heavily dependent on select, high-visibility journals. This pattern could suggest that the field is in an early phase of development, where foundational research is concentrated in core sources, with broader dissemination expected as the field matures.

Fig. 3 provides a visual representation of the most relevant keywords in the intersection of AI and leadership research, showcasing that terms like "artificial intelligence," "leadership," "learning," and "e-learning" dominate the literature. This suggests that the core focus of AI leadership research centers around understanding how AI technologies can enhance leadership practices, particularly in educational settings. The prominence of "learning" and "e-learning" reflects the increasing integration of AI into educational leadership, where AI is not just viewed as a tool for enhancing teaching methods, but also as a framework for shaping leadership competencies. The frequency of these

keywords indicates that scholars are increasingly exploring AI's potential to improve organizational learning, adapt leadership strategies, and foster innovative learning environments.

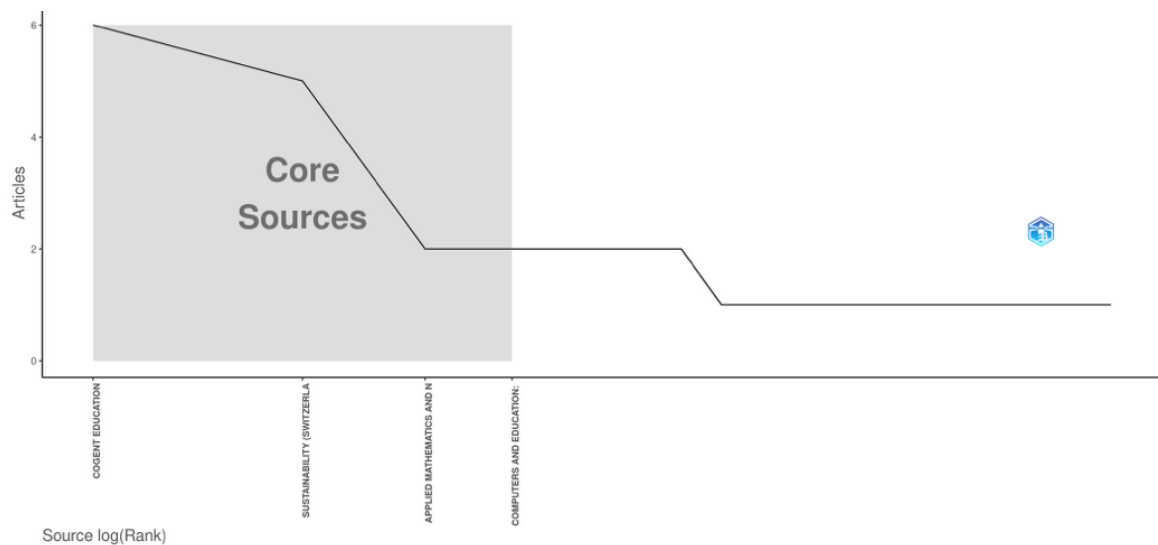


Fig. 2. Core sources identified by Bradford's Law from the bibliometric analysis of AI in leadership literature

When compared to the findings from Halkiopoulos C [22] and Mohd Amin M [23] which examined AI's role in education and identified "personalized learning" and "educational technologies" as key themes, there is a noticeable overlap with the results in Fig. 3, especially in terms of AI's application in learning environments. However, Halkiopoulos C and Mohd Amin M emphasized personalized learning as a focal point, this study highlights "leadership" as an equally significant theme, suggesting that the leadership dimension of AI in education is emerging as a more prominent research area. This contrast indicates a shift in focus towards the strategic and managerial roles that AI can play in leadership, while Holmes et al. emphasized its impact on pedagogical strategies. These differences suggest that while AI's applications in education continue to evolve, there is a growing body of research dedicated to exploring its influence not only on teaching but also on leading and managing educational institutions.

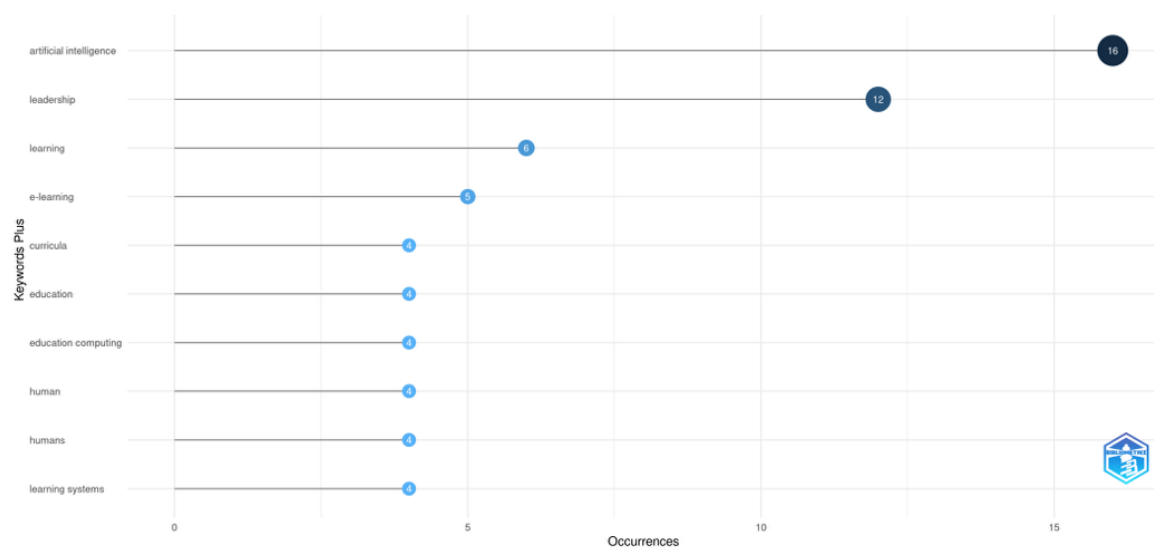


Fig. 3. Most relevant keywords identified in AI leadership research based on occurrence frequency

Fig. 4 presents a detailed examination of the document counts per year for various sources in the AI and leadership research field from 2022 to 2024. The graph highlights a steady decline in publications from journals like Sustainability Switzerland and Heliyon, while journals such as Cogent Education and Applied Mathematics and Nonlinear Sciences demonstrate consistent publication rates over the same period. This decline in certain sources may reflect a shift in focus or diminishing interest in AI and leadership within broader interdisciplinary journals, potentially due to saturation or a shift to more specialized publications. On the other hand, the stability seen in Cogent Education and Applied Mathematics and Nonlinear Sciences suggests these sources have become central to the discourse in AI leadership, offering a more dedicated platform for this niche research area. This trend may also reflect broader journal impact, where high-impact journals maintain their output even as emerging topics in the field fluctuate.

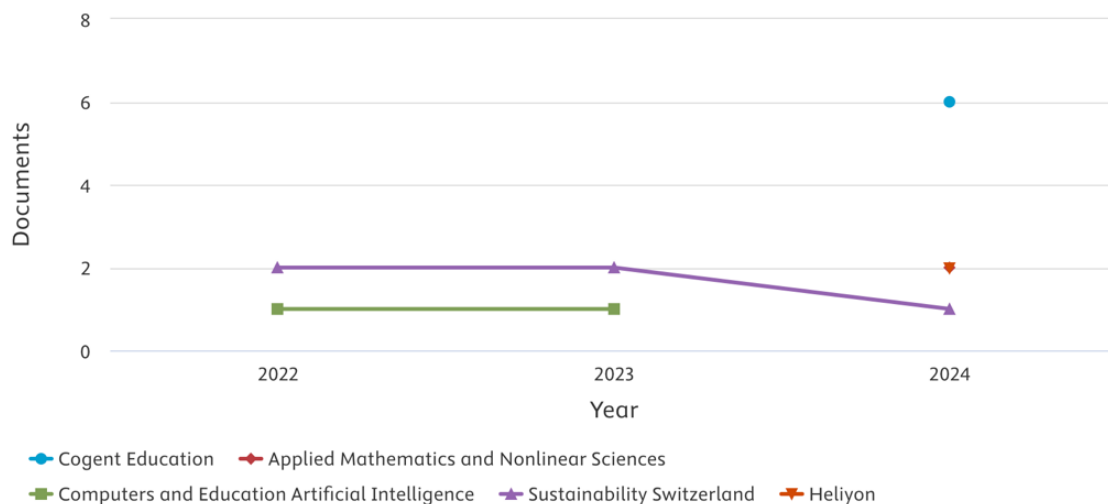


Fig. 4. Documents per year by source in the field of AI and leadership research

When compared to research by Jia F [24] which explored AI in education technology, a similar publication pattern was observed where certain core journals such as Computers & Education and Educational Technology & Society exhibited steady output, while others experienced periodic surges or declines. However, AI in leadership appears to have a slightly more volatile trajectory, particularly in newer journals like Sustainability Switzerland and Heliyon, possibly because AI in leadership is still developing compared to AI in education technology, which has been more established for a longer period. This comparison highlights that AI's application in leadership remains a growing but unstable field, which may experience fluctuations as the research community solidifies its focus and core venues for dissemination.

Fig. 5 highlights the global distribution of AI and leadership research, revealing that the United States leads in the number of publications, followed by China and Australia. This suggests a strong academic and research-driven engagement in AI leadership in these countries, reflecting their established technological ecosystems and research infrastructures. The dominance of the United States aligns with its historical leadership in both AI research and educational innovations, which likely translates into a higher volume of published works in AI leadership. China's significant presence in the field indicates its rapidly growing emphasis on AI as a central component of national policy and technological development. Meanwhile, Australia's position underscores its active contribution to global AI discourse, particularly within educational leadership.

When compared to the results in Rahimi M [25], Kumara U [26], Sigh A [27], and Yumnam G [28] which mapped the global distribution of AI-related research in education technologies, a similar trend emerges with the United States taking the lead, followed by countries such as China and United

Kingdom. However, in their study, Europe and Canada appeared to have a more substantial presence than in the AI leadership field. This difference could be attributed to the interdisciplinary nature of AI in education, which attracts broader participation from educational technology experts, while AI in leadership remains more specialized and concentrated in countries with strong leadership and management studies traditions. The comparison further emphasizes the global nature of AI research but also highlights varying national emphases, with AI leadership research in countries like the United States and China likely benefiting from substantial governmental and institutional support, which might not be as pronounced in other regions.

The U.S., China, and Australia dominate the field of AI and leadership research, as illustrated in Fig. 5. This trend is driven by the strong academic infrastructure and technological advancements in these countries. The United States has long been at the forefront of AI research and innovation, with its leading universities, research institutions, and technology companies driving both academic and applied research in AI. This dominance is reflected in the substantial volume of publications and citations originating from U.S.-based authors and institutions.

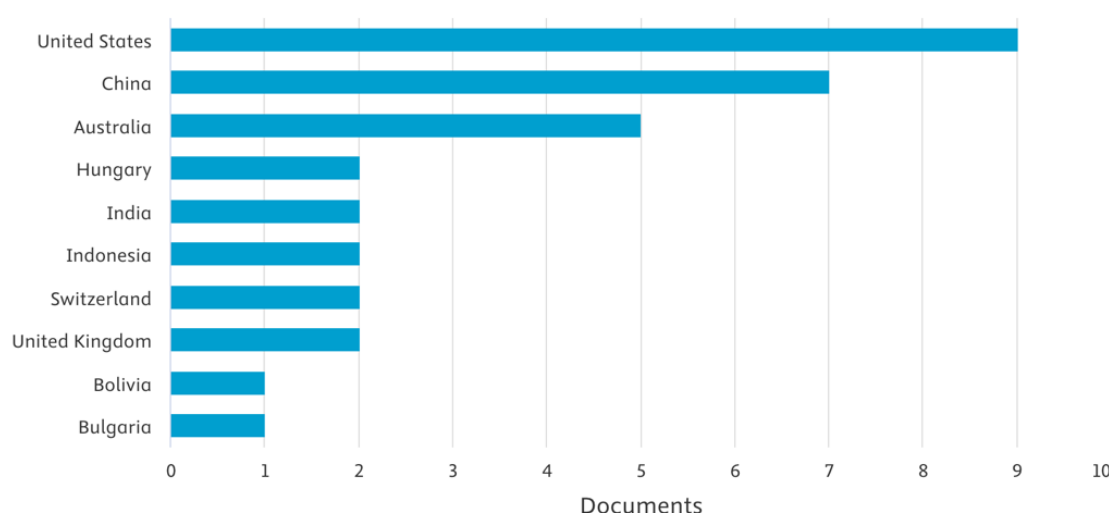


Fig. 5. Documents by country or territory in AI leadership research

China's significant presence in the field can be attributed to its aggressive national policies promoting AI as a core element of its technological and economic development. The government's emphasis on AI, coupled with substantial investment in research and development, has propelled China into a leadership position in various areas of AI research, including its application in leadership contexts. Australia's position, while slightly lower than that of the U.S. and China, highlights its strong academic contributions to global AI research, particularly within educational leadership. The country's focus on AI in education and leadership development reflects its commitment to improving leadership practices through technology, underscoring its growing role in the field.

Fig. 6 presents the funding landscape of AI and leadership research, showcasing the American College of Dentists and Carolinas HealthCare System as prominent sponsors, followed by other institutions such as the College of Dentistry, University of Kentucky. The involvement of these organizations, which are primarily rooted in healthcare and professional development, suggests a niche yet crucial intersection between AI, leadership, and healthcare management. The diversity of funding sources reflects the interdisciplinary nature of AI and leadership research, where both traditional academic funding and industry-related support converge. The presence of healthcare institutions as key sponsors also indicates a growing interest in AI applications in leadership, not just in educational contexts, but also in managing complex organizations and improving decision-making in healthcare leadership.

When compared to the findings in Dwivedi Y [29] which explored AI funding in educational technology research, the funding sponsors in that study were more heavily oriented toward educational foundations, government agencies, and major technology companies like Microsoft and Google. This contrast highlights the differing nature of funding sources across sectors; while AI in education technology benefits from significant corporate sponsorship and educational grants, AI in leadership research appears to be more aligned with professional organizations and sector-specific institutions, such as those found in healthcare management. This distinction underscores the applied focus of AI in leadership, which often has more direct, practical implications for organizational effectiveness and leadership strategies, especially in healthcare and similar sectors. The comparison further indicates that as AI leadership research continues to expand, the variety of funding sources is likely to broaden, encompassing both private industry and more specialized fields of leadership.

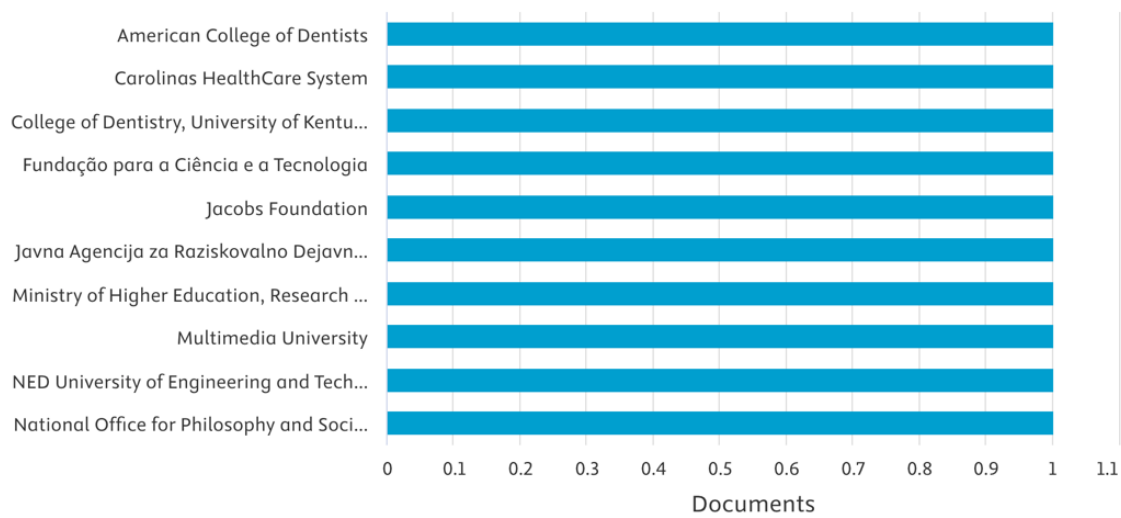


Fig. 6. Documents by funding sponsor in AI and leadership research

3.2. Visualizing the Intersection of Artificial Intelligence and Leadership: A Bibliometric Approach

The cumulative degree distribution shown in Fig. 7 provides a valuable insight into the structure of the co-citation network. This type of distribution is common in network analysis, particularly when studying bibliometric data. In this case, the figure reveals a clear decay in the cumulative degree as the node index increases, which indicates that most of the citations are concentrated around a smaller number of highly cited nodes. This trend is often observed in scientific networks where a small group of influential publications (or authors) receives most citations, while a larger set of publications contributes less significantly. The steep drop-off in the cumulative degree graph suggests that leadership and artificial intelligence research, while growing, still relies heavily on a core group of foundational studies.

The pattern observed in the cumulative degree distribution could also reflect the hierarchical nature of academic research in this domain. High-degree nodes, representing key studies, attract many citations due to their seminal contributions. Meanwhile, low-degree nodes indicate more recent or specialized research that has yet to gain broad recognition. This distribution also emphasizes the importance of identifying key publications that shape the field. Researchers looking to explore AI and leadership in the context of education might consider focusing on these highly cited nodes, as they likely represent critical milestones in the development of the field.

When comparing this result to another bibliometric study on AI in education, a similar pattern was found. In a study by Xie W [30] which analyzed co-citation patterns in AI in education, the cumulative degree distribution also demonstrated a steep drop off, with a small number of high-citation papers dominating the network. This reinforces the idea that the AI and leadership fields, like

AI in education, are concentrated around a core set of influential studies, but with significant contributions from emerging topics. The cumulative degree distribution serves as a useful tool for mapping out this centrality and identifying the key studies that anchor the research domain.

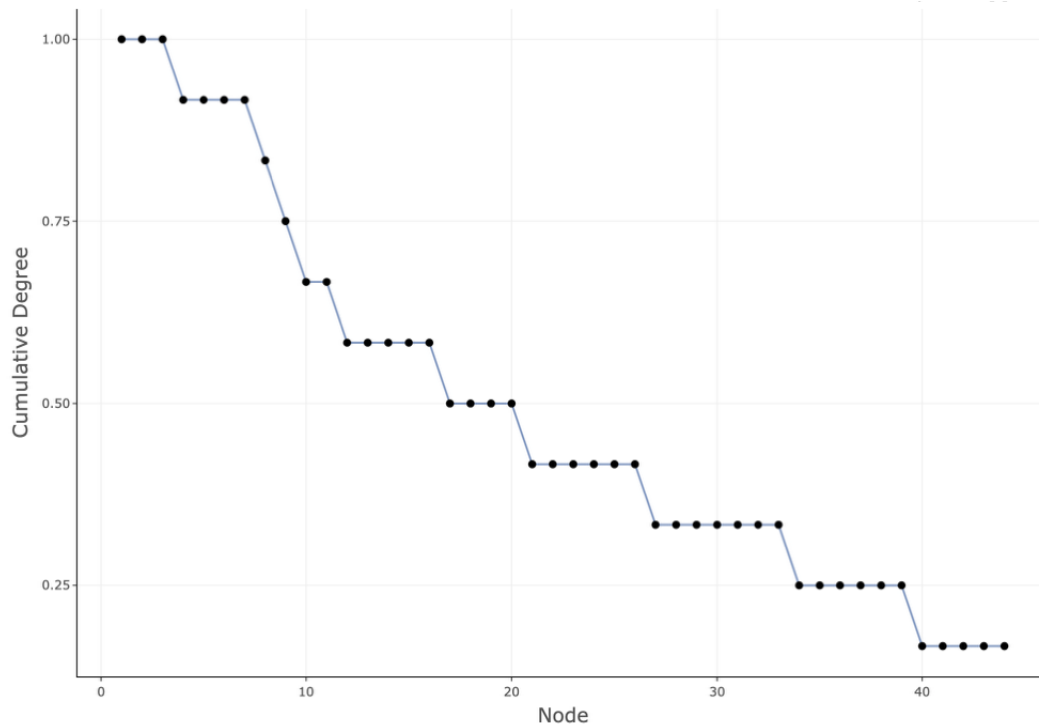


Fig. 7. Cumulative degree distribution of co-citation network nodes

Fig. 8 offers a detailed visualization of the co-occurrence network, highlighting how keywords related to artificial intelligence (AI) and leadership are interlinked within the academic literature. The network layout emphasizes key terms such as "education," "leadership," "human," and "training," which are strongly interconnected. These keywords are central to understanding the primary themes driving research in AI and leadership, particularly in the context of education. The tight clustering of terms such as "learning," "training," and "human" suggests an increasing focus on the human-centered applications of AI, highlighting the role of AI in enhancing leadership and decision-making processes within educational systems. This clustering can also indicate the growing importance of leadership in AI development, especially as AI technologies become more integrated into educational environments.

When comparing this result to another bibliometric study on AI in leadership (Table 1), a similar co-occurrence pattern was found in a study by Corbett F [31] and Keding C [32] which analyzed the intersection of AI and management. Their findings revealed a high degree of connection between leadership, training, and AI, reflecting the growing interest in using AI to improve organizational leadership. Both studies indicate that the role of AI in leadership is evolving, with an increasing emphasis on personalized learning, human interaction, and the ethical use of AI in decision-making processes. The consistency between the two studies highlights the cross-disciplinary impact of AI, demonstrating its expanding role in leadership across various domains.

The evolution of keyword novelty in AI and leadership research, as visualized in Fig. 9, demonstrates a significant shift in the focus of the field. As the co-occurrence network evolves, we can see the rise of new terms such as "generative AI", "AI ethics", and "leadership analytics". These terms reflect emerging research areas that have gained prominence in recent years. The novelty of these keywords indicates a pivot toward more nuanced and specialized topics in the intersection of AI and leadership. This shift suggests that scholars are increasingly exploring how AI technologies not

only support leadership but also raise ethical considerations, particularly in terms of data privacy, decision-making, and the role of human oversight in AI-driven leadership processes.

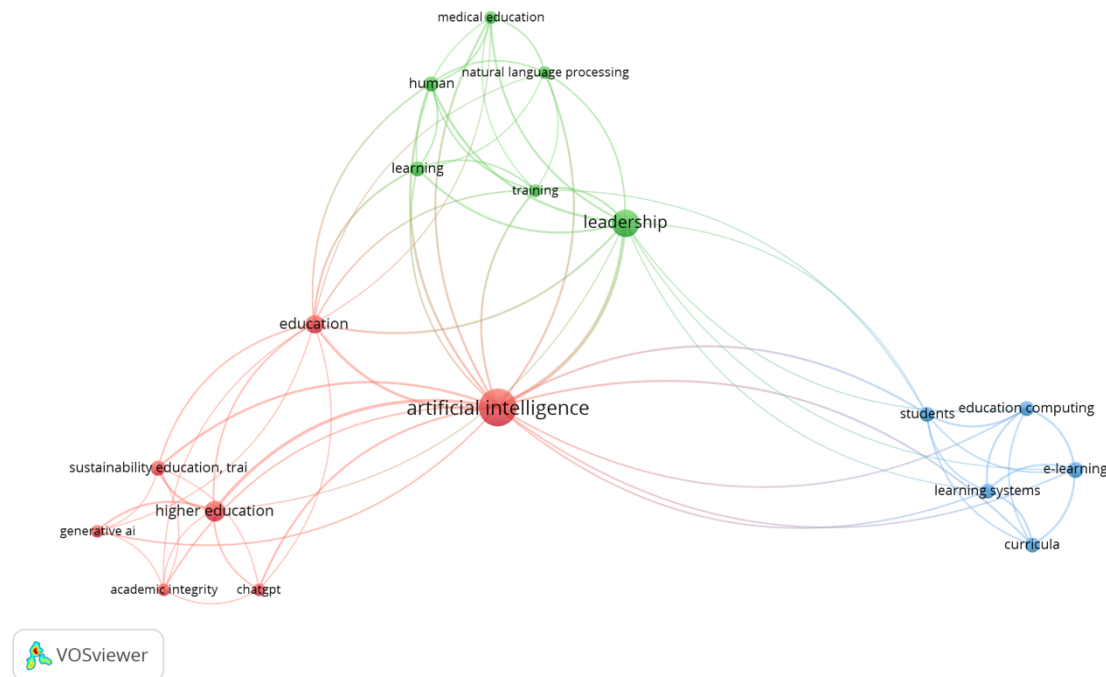


Fig. 8. Co-occurrence network of keywords in artificial intelligence and leadership research

The emergence of these keywords aligns with broader trends in the AI field. For instance, "generative AI" has gained traction in recent years due to its potential in content creation, personalization, and decision support. In the context of leadership, this technology is being explored for its ability to assist in strategy development, scenario planning, and leadership communication. Similarly, "AI ethics" has become a critical area of study as the implications of AI decision-making processes grow more complex. The novelty of this keyword signals that researchers are increasingly concerned with the moral and societal impact of AI in leadership, particularly in terms of fairness, accountability, and transparency in AI systems.

Table 1. Clusters of keywords in the co-occurrence network of artificial intelligence and leadership

Cluster	Key Terms	Focus Area
Education Cluster (Red)	Education, Higher Education, Sustainability Education, Curricula	The integration of AI in educational settings, particularly in higher education and curricula design.
Leadership Cluster (Green)	Leadership, Training, Human, Learning	The role of AI in shaping leadership practices, enhancing leadership skills, and personalized learning for leaders.
Artificial Intelligence Cluster (Blue)	Artificial Intelligence, Generative AI, Natural Language Processing, Academic Integrity	Technical focus on AI technologies, their ethical considerations, and applications in leadership and education.
Computing & Technology Cluster (Light Blue)	Students Education Computing, E-learning, Learning Systems	The technological infrastructure supporting AI in education, such as digital tools and e-learning platforms.

In comparison, a similar study by Nozima Z [33] on keyword novelty in AI applications in education identified "adaptive learning" and "AI-driven personalized education" as emerging keywords. The novelty of these terms was seen as indicative of the growing interest in AI's potential to tailor educational experiences to individual needs, much like the leadership applications of AI explored in our study. The rise of such novel keywords in both education and leadership research

emphasizes the increasing focus on personalized and human centered AI systems. As both fields evolve, the novelty of keywords will continue to guide researchers toward new and innovative ways to integrate AI technologies while addressing emerging challenges in leadership and ethics.

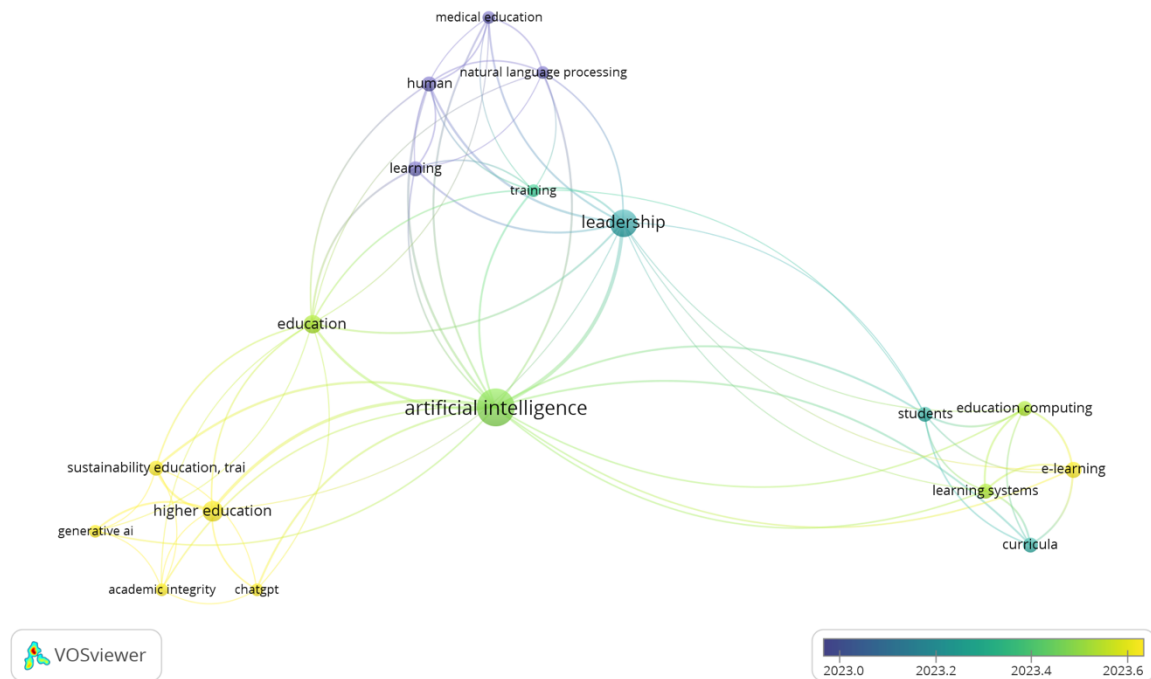


Fig. 9. Evolution of co-occurrence network by year (2023)

4. Conclusion

This study provides a comprehensive bibliometric analysis of the intersection between Artificial Intelligence (AI) and leadership, highlighting key trends, emerging themes, and the evolving role of AI in leadership practices. The main contributions of this research are:

1. The identification of the dominant role of countries like the United States, China, and Australia in AI-leadership research, highlighting the importance of academic infrastructure and government support in shaping the global landscape of AI and leadership.
2. The emergence of AI ethics and generative AI as critical themes in leadership research, signalling the increasing need for ethical frameworks in the use of AI technologies in leadership and decision-making.
3. The development of a conceptual framework that can guide future research and practice, addressing the gaps in understanding AI's impact on leadership competencies, organizational learning, and strategic decision-making.

For Educational Policymakers: It is essential to integrate AI literacy into leadership development programs. Policymakers should prioritize creating guidelines that address the ethical use of AI in leadership practices, particularly in educational settings, ensuring that AI technologies are used responsibly and for the greater good.

For Leadership Trainers: Leadership trainers should incorporate AI tools into their programs to enhance decision-making, improve learning environments, and foster innovative leadership practices. Emphasizing the human-centered applications of AI will be crucial in ensuring that AI supports, rather than replaces, effective leadership.

For Researchers: Future research should continue to explore the intersection of AI and leadership across different disciplines and regions. Expanding the scope to include other databases, such as Web

of Science and Dimensions, will provide a more comprehensive view of the global research landscape and deepen understanding of AI's role in leadership development.

AI-driven leadership is shifting towards human-centered and ethically guided frameworks. As AI technologies continue to evolve, the focus will likely shift from purely technical capabilities to ensuring that AI serves as a tool for enhancing leadership effectiveness, fostering collaboration, and making ethically informed decisions.

Declarations

Supplementary Materials: Supplementary materials of this study include the full dataset retrieved from Scopus and visualizations generated using VOS viewer.

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