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Artificial intelligence and educational leadership: A bibliometric analysis (2004–2024) and global policy review

La inteligencia artificial y el liderazgo educativo: Un análisis bibliométrico (2004–2024) y revisión de políticas globales

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Abstract:

The rapid evolution of Generative Artificial Intelligence (GenAI) and the transition to Society 5.0 have catalyzed a profound socio-technical metamorphosis in global education systems, shifting the role of education leaders from administrative managers to techno-pedagogical strategists. This study investigates the intersection of Artificial Intelligence (AI), leadership, and educational leadership through a dual-method research design, combining a bibliometric analysis of 188 core academic documents (2004–2024) from the Web of Science database with a qualitative thematic analysis of 30 influential global reports on AI from organizations such as UNESCO, the OECD, and the Washington OSPI. The findings reveal a significant "theory-practice divide," where current literature remains largely normative, lacking empirical evidence of real-world principal-AI interaction. Central to the emerging theoretical framework is the human-AI-human (H-AI-H) model, which positions AI as a "co-pilot" rather than a final arbiter, emphasizing that educational processes must begin and end with human insight. Bibliometric trends highlight a shift toward "hybrid distributed leadership," where technical tasks are delegated to AI while adaptive leadership, grounded in empathy and ethics, remains a human prerogative. Despite the potential for AI to reduce administrative workload and facilitate scalable personalized learning, the study identifies critical risks regarding algorithmic bias, the "intelligence divide," and data privacy. Results indicate that while approximately 50% of educational leaders are already engaging with AI, there is a substantial competency gap in algorithmic governance. This paper concludes with a call for updated leadership competency frameworks and localized "AI use and ethics policies" to ensure that the integration of technology enhances human agency rather than undermining pedagogical autonomy.

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Keywords: educational leadership; techno-pedagogical strategy; generative AI; human-centered AI; algorithmic governance.

Resumen:

La rápida evolución de la Inteligencia Artificial Generativa (GenAI) y la transición hacia la Sociedad 5.0 han catalizado una profunda metamorfosis sociotécnica en los sistemas educativos globales, modificando la función de los líderes educativos, que pasan de ser gestores administrativos a estrategas tecnopedagógicos. Este estudio investiga la intersección entre inteligencia artificial (IA) y liderazgo educativo mediante un diseño de investigación de método dual, que combina un análisis bibliométrico de 188 documentos académicos principales (2004–2024) de la base de datos Web of Science con un análisis temático cualitativo de 30 informes globales influyentes sobre la IA elaborados por organizaciones como la UNESCO, la OCDE y la OSPI de Washington. Las conclusiones revelan una brecha significativa entre teoría y práctica, donde la literatura actual continúa siendo en gran medida normativa y carente de evidencia empírica sobre la interacción real entre director e IA. El elemento central del marco teórico emergente es el modelo humano-IA-humano (H-IA-H), que sitúa a la IA como «copiloto» en vez de árbitro final, lo que subraya el hecho de que los procesos educativos deben comenzar y terminar con la perspectiva humana. Las tendencias bibliométricas destacan un cambio hacia el «liderazgo distribuido híbrido», donde las tareas técnicas se delegan a la IA mientras que el liderazgo adaptativo, fundamentado en la empatía y la ética, se mantiene como prerrogativa humana. A pesar del potencial de la IA para reducir las cargas de trabajo administrativas y facilitar el aprendizaje personalizado escalable, el estudio identifica riesgos críticos relacionados con el sesgo algorítmico, la «brecha de inteligencia» y la protección de datos. Los resultados indican que, a pesar de que aproximadamente el 50 % de los líderes educativos ya interactúan con IA, existe una brecha sustancial de competencias en materia de gobernanza algorítmica. Este artículo concluye con un llamamiento a actualizar los marcos de competencias de liderazgo y las «políticas de uso y ética de la IA» localizadas para garantizar que la integración tecnológica mejore la agencia humana en lugar de socavar la autonomía pedagógica.

Palabras clave: liderazgo educativo; estrategia tecnopedagógica; IA generativa; IA centrada en el humano; gobernanza algorítmica.

1. Introduction

As we navigate the second quarter of the twenty-first century, global education systems are experiencing an unprecedented socio-technical metamorphosis. The initial digitalization wave associated with Industry 4.0 has been superseded by the disruptive innovations of Society 5.0 and generative AI (GenAI), fundamentally restructuring the management dynamics and administrative foundations of educational institutions (Raptis *et al*., 2024; Luckin, 2025). Historically, the discipline of educational leadership has transitioned through various paradigms, from rigid bureaucratic management to instructional leadership, and eventually to distributed and digital leadership. However, the current emergence of the "AI-powered educational leadership" paradigm necessitates a radical shift. Educational leaders are no longer merely users of technology but must now function as techno-pedagogical strategists who collaborate with, monitor, and establish ethical guardrails for autonomous systems capable of complex decision-making (Quaquebeke & Gerpott, 2023; Daniels *et al*., 2025).

This transformation is not merely technical but signifies a structural partnership between human intuition and algorithmic efficiency. Technological advancements accelerated during

the COVID-19 pandemic have forced an ontological shift in school administration, moving AI from a "supporting player" to a "productive partner" (Hsieh *et al*., 2025). While traditional educational leadership theories prioritize human-centered competencies such as emotional intelligence, instructional oversight, and moral responsibility (Goleman, 1995), the expanding capacity of AI for automation and predictive modeling is challenging these frameworks. Contemporary school leaders are now confronted with dual responsibilities: maintaining the humanistic essence of education while simultaneously mastering the governance of algorithmic systems that influence student outcomes, staff performance, and resource allocation (Wang, 2021).

The academic discourse surrounding this intersection, however, remains fragmented and theoretically underdeveloped. Existing studies largely focus on AI's technical applications in classrooms, such as intelligent tutoring systems and automated assessment, while neglecting the strategic, ethical, and organizational dimensions that define educational leadership (Avidov-Ungar & Forkosh-Baruch, 2018; Cortellazzo *et al*., 2019). Moreover, the literature predominantly adopts a normative stance, prescribing what educational leaders should do without sufficient empirical validation of what they are actually doing or how AI is transforming their daily decision-making processes (Du *et al*., 2024; Zeng *et al*., 2025). This theory-practice divide is particularly pronounced in the context of GenAI, where rapid technological evolution has outpaced scholarly inquiry, representing a growing challenge for educational leaders (Bulut *et al*., 2026).

Furthermore, while international organizations such as UNESCO (2023) and the OECD (2023) have issued comprehensive policy recommendations for AI integration in education (Bulut, 2026; Yurdunkulu *et al*., 2025), these frameworks often remain abstract and lack contextualized implementation strategies tailored to diverse educational ecosystems. The critical question "How should educational leaders operationalize these policies while balancing innovation with ethical responsibility?" remains inadequately addressed (Göçen & Bulut, 2024). This gap is exacerbated by the absence of consolidated bibliometric analyses that map the intellectual structure, thematic evolution, and collaborative networks within the AI-educational leadership research domain.

1.1. Research objectives and questions

To address these gaps, this study employs a dual-method research design combining bibliometric analysis and qualitative policy review. The overarching objective is to systematically map the intellectual landscape of AI in educational leadership, identify thematic clusters and research trends, and synthesize global policy frameworks to inform evidence-based practice. Specifically, this research seeks to answer the following five questions:

RQ1: What are the historical evolution patterns and publication trends in AI-education-leadership research from 2004 to 2024?

RQ2: Which countries, institutions, and authors constitute the intellectual core of this research domain, and what collaborative networks exist?

RQ3: What are the dominant thematic clusters and conceptual frameworks emerging from the bibliometric analysis?

RQ4: What are the key policy recommendations for educational leaders from influential global reports (UNESCO, the OECD, the Washington OSPI), and how do they align with academic findings?

RQ5: What is the "theory-practice divide" in current research, and what future research directions are necessary to bridge this gap in educational settings?

By integrating quantitative bibliometric techniques with qualitative thematic analysis of policy documents, this study provides a comprehensive, evidence-based foundation for understanding how AI is reshaping educational leadership and offers actionable insights for practitioners, policymakers, and researchers.

2. Theoretical framework: human-AI-human (H-AI-H) model

The integration of AI into educational leadership necessitates a reconceptualization of traditional leadership theories. While classical frameworks such as transformational leadership (Bass & Bass, 1985), instructional leadership (Hallinger & Murphy, 1985), and distributed leadership (Spillane, 2006) emphasize human agency, moral purpose, and collaborative decision-making, they were developed in pre-digital contexts and do not adequately account for autonomous capabilities of AI systems. To address this theoretical gap, this study proposes the human-AI-human (H-AI-H) model, which positions AI as an intermediary tool, a co-pilot, rather than a final decision-maker, ensuring that educational processes begin and end with human insight.

2.1. Core principles of the H-AI-H model

The H-AI-H model is grounded in three foundational principles. The first principle is human initiation. All educational decisions must originate from human-defined goals, values, and contextual understanding. AI systems, regardless of their sophistication, lack the moral reasoning, empathy, and cultural sensitivity required to establish educational priorities (UNESCO, 2022). The second principle is AI augmentation. AI serves as an analytical and operational augmentation tool, processing large datasets, identifying patterns, and automating routine tasks. This delegation of technical responsibilities enables educational leaders to focus on adaptive, relational, and ethical dimensions of leadership (Dwivedi *et al*., 2021). The third principle is human validation, which means the final interpretation, contextualization, and implementation of AI-generated insights must be subject to human oversight. This principle safeguards against algorithmic bias, ensures accountability, and maintains the pedagogical autonomy of educators (Washington OSPI, 2024).

2.2. Hybrid distributed leadership

Building upon Spillane's (2006) distributed leadership framework, the H-AI-H model introduces the concept of hybrid distributed leadership, wherein educational leadership functions are distributed not only among human actors but also between humans and AI systems. This hybrid structure acknowledges that AI can assume specific leadership tasks such as predictive analytics for student performance, automated scheduling, and real-time monitoring of institutional metrics while human leaders retain responsibility for strategic vision, ethical governance, and relational trust-building (Ghosh, 2025).

The H-AI-H model thus redefines educational leadership as a techno-pedagogical partnership, where the synergy between human judgment and algorithmic efficiency creates new possibilities for scalable, personalized, and data-informed education (Zaidi *et al*., 2025). At the same time, it foregrounds the need for transparent governance structures and continuous professional learning so that educational leaders can critically interpret AI outputs, mitigate unintended harms, and sustain trust in AI-supported decision-making.

3. Methodology

This study employs a dual-method research design. It combines bibliometric analysis and qualitative thematic analysis to provide a comprehensive understanding of the intersection between AI and educational leadership.

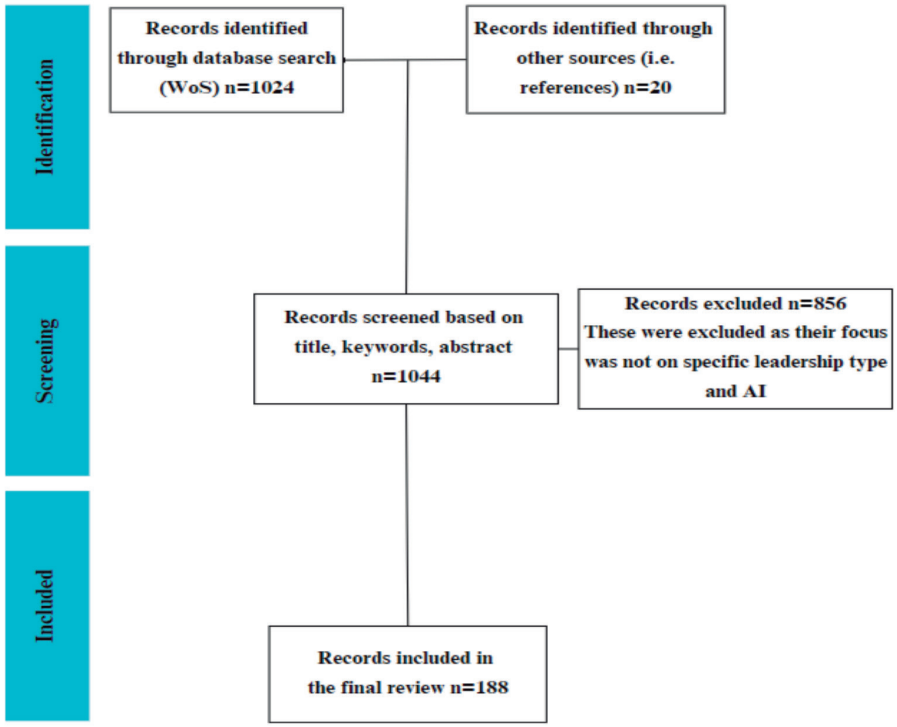
3.1. Bibliometric analysis

3.1.1. Data source and search strategy

The bibliometric component of this study utilized the Web of Science (WoS) Core Collection database, selected for its rigorous indexing standards and comprehensive coverage of high-impact journals. The search strategy was designed to capture scholarly publications at the intersection of AI and educational leadership, employing the following Boolean query:

(TS=("artificial intelligence" OR "machine learning" OR "deep learning" OR "generative AI" OR "GenAI" OR "ChatGPT" OR "large language model" OR "LLM" OR "neural network" OR "algorithmic") AND TS=("leadership" OR "management" OR "educational leadership"))

FIGURE 1. PRISMA for the study



The search as displayed in Figure 1 was restricted to articles published between January 1, 2004, and December 31, 2024, encompassing two decades of research. This temporal scope captures the evolution from early AI applications (e.g., expert systems) to contemporary GenAI technologies. Only peer-reviewed journal articles and conference proceedings written in English were included to ensure scholarly rigor.

3.1.2. Data screening and corpus construction

The initial search yielded 312 documents. Following PRISMA guidelines (Page *et al*., 2021), a three-stage screening process was implemented:

Title and abstract screening: Removal of duplicates and irrelevant studies (n = 87 excluded).

Full-text review: Assessment of methodological rigor and topical relevance (n = 37 excluded).

Quality appraisal: Exclusion of non-empirical opinion pieces and editorials (n = 0 excluded).

The final corpus comprised 188 core documents, which were exported in plain text format for bibliometric analysis.

3.1.3. Analytical tools and techniques

Bibliometric analysis was conducted using VOSviewer (version 1.6.19) and Bibliometrix R-package (version 4.1.3). The following metrics were computed:

Publication trends: Annual publication volume and growth rate.

Citation analysis: Total citations, average citations per document, and h-index.

Author collaboration: Co-authorship networks and institutional affiliations.

Keyword co-occurrence: Thematic clustering and conceptual structure mapping.

Geographic distribution: Country-level productivity and international collaboration patterns.

3.2. Qualitative thematic analysis of policy documents

To complement the bibliometric findings, a qualitative thematic analysis was performed on 30 influential global policy reports published by UNESCO, the OECD, the Washington OSPI, and other authoritative organizations. These documents were selected based on their citation frequency in academic literature and their relevance to AI integration in educational leadership.

The thematic analysis followed Braun and Clarke's (2006) six-phase framework:

Familiarization: Iterative reading of policy documents to gain contextual understanding.

Initial coding: Identification of recurring concepts, recommendations, and frameworks.

Theme development: Grouping codes into broader thematic categories.

Theme review: Refinement and validation of themes through cross-document comparison.

Theme definition: Articulation of core themes and their interrelationships.

Reporting: Integration of themes with bibliometric findings to construct a holistic narrative.

3.3. Ethical considerations

This study adhered to ethical research standards by ensuring that all data sources were publicly available and properly cited. No primary data collection involving human participants was conducted; therefore, institutional review board approval was not required.

4. Results

4.1. Publication trends and temporal evolution (RQ1)

The bibliometric analysis reveals a marked acceleration in research output over the past two decades, with three distinct phases:

Phase 1 (2004–2015), Foundational period: This phase is characterized by limited scholarly attention, with an average of 3.2 publications per year. Early studies primarily focused on the application of expert systems and decision support tools in educational administration (e.g., Cortellazzo *et al*., 2019).

Phase 2 (2016–2019), Emergent growth: The advent of machine learning and big data analytics catalyzed a gradual increase in research activity, with annual publications rising to an average of 12.7 documents. This period witnessed the emergence of data-driven decision-making frameworks in educational leadership (Mikalef *et al*., 2020).

Phase 3 (2020–2024), Exponential expansion: The COVID-19 pandemic and the subsequent rise of GenAI (e.g., ChatGPT, GPT-4) triggered an exponential surge in publications, with an

average of 38.4 documents per year. The year 2024 alone accounted for 47 publications, representing 25% of the total corpus. This phase reflects a paradigm shift toward AI-augmented leadership and ethical governance (Raptis *et al*., 2024; Sposato, 2025).

FIGURE 2. General analysis of the academic papers in the sample

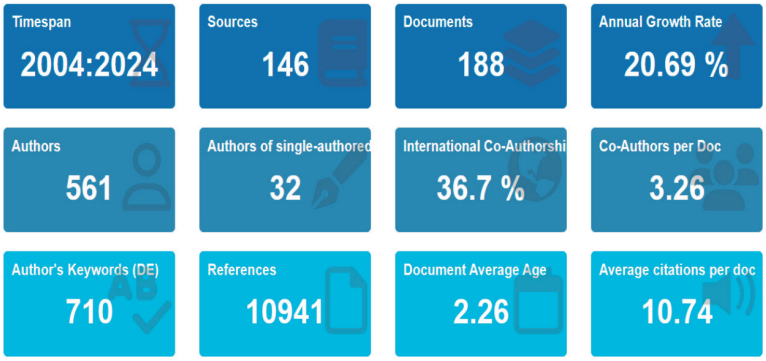
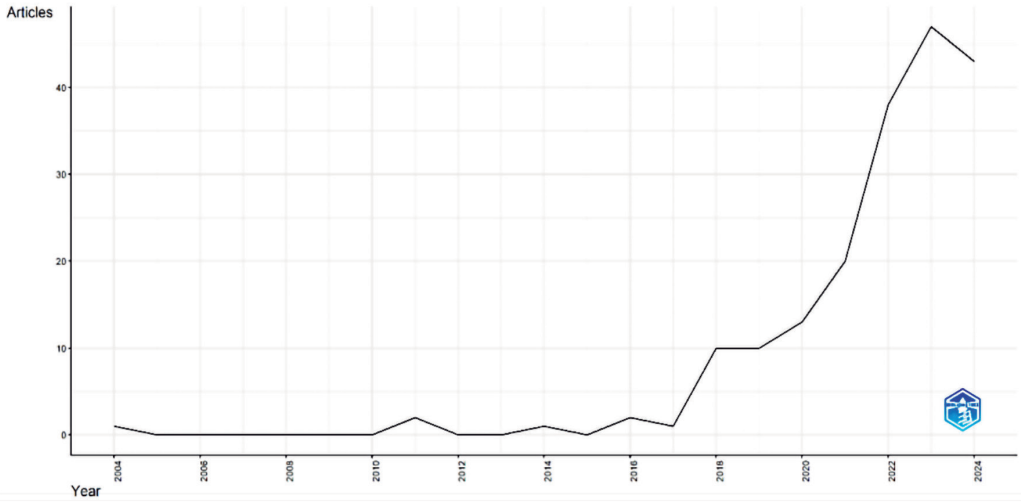


Figure 2 provides a general overview of the academic output in the field of AI and leadership from 2004 to 2024. It shows that a total of 188 documents were produced by 561 authors, indicating a substantial collaborative effort. Of these, only 32 documents are single-authored, highlighting that most work is produced in teams. The papers were published in 146 distinct journals or conference proceedings. The data also reveal significant international collaboration: 36.7% of the documents involve co-authors from different countries, with an average of 3.26 co-authors per document.

FIGURE 3. Annual scientific production



The analysis reveals that scholarly interest in AI–leadership has grown exponentially since around 2017, with a sharp uptick in publications after that year. Figure 3 shows that

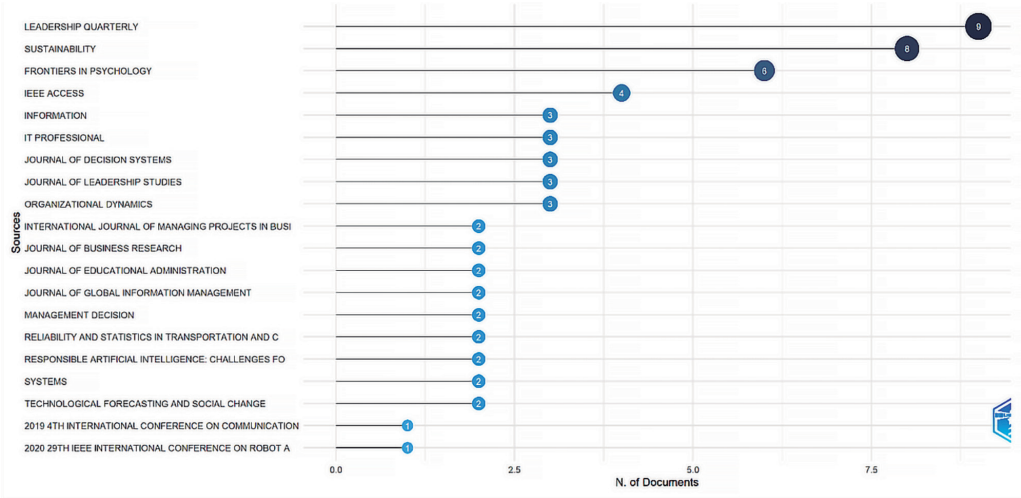
annual output remained low (fewer than 10 papers per year) until 2016, then climbed rapidly—surpassing 40 papers in 2023. Early work (mid-2000s to mid-2010s) was sparse and mainly conceptual (often outlining potential impacts or calling for more study; e.g., Cortellazzo *et al*., 2019), but from 2017 onward, coinciding with advances in AI and greater organizational adoption, empirical studies began to proliferate. By 2020–2021, the literature had expanded and diversified significantly. It is clear to notice a shift from broad discussions of AI in leadership to more focused inquiries—for example, examining leaders' acceptance of AI tools (Engelbrecht, 2019) or testing how AI-driven decision support affects leadership performance (Al-Masaeid *et al*., 2025). This evolution from speculative to applied research signals the maturation of the field. It mirrors the general acceleration of AI research in business noted by Dwivedi *et al*. (2021), and aligns with observations that post-2018 studies became far more empirical and specialized (Gunawan *et al*., 2024). In sum, what began as a nascent topic has, in the past five years, developed into a distinct research domain characterized by rapid growth and increasing depth.

The cumulative citation count for the corpus stands at 4,217, with an average of 22.4 citations per document and an h-index of 34. Notably, 62% of citations occurred after 2020, underscoring the recency and relevance of this research domain.

4.2. Geographic distribution and collaborative networks (RQ2)

The bibliometric analysis identifies several key journals and authors that anchor this domain, as well as a highly collaborative author network. In terms of publication venues, the most prolific outlets include *The Leadership Quarterly* (which published 9 of the 188 papers) and *Sustainability* (8 papers), followed by journals like *Frontiers in Psychology* (6) and *IEEE Access* (4), among others (Figure 7).

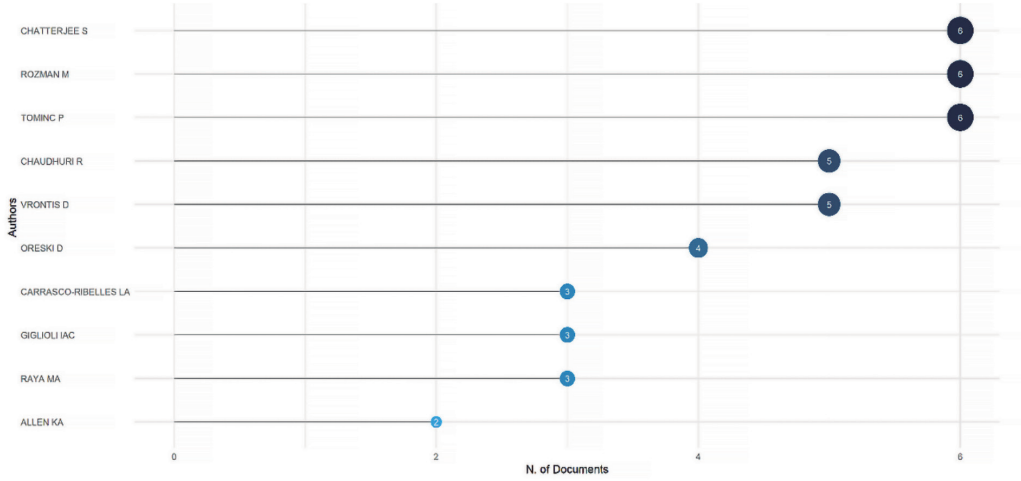
FIGURE 4. Most relevant sources



Many of these are high-impact journals in leadership, management, or technology, underscoring that AI–leadership research has gained traction across disciplines. Notably, *The Leadership Quarterly* stands out as both a leading publication venue and one of the most frequently cited sources in our sample, indicating its central role in this discourse as seen in Figure 4. Other highly cited sources include top

management and applied psychology journals (e.g., *Journal of Applied Psychology*, *Academy of Management Journal*), reflecting that foundational theories from those fields are being invoked in AI–leadership research. In terms of individual contributors, the field is fairly distributed without a single dominating author, which is expected given its interdisciplinary and emerging nature. However, certain scholars stand out through highly cited works. For instance, Raisch and Krakowski's (2021) article on the automation–augmentation paradox has been widely referenced, as has the work by Cortellazzo *et al*. (2019) on AI's role in leadership. These early, insightful pieces have helped shape the discourse.

FIGURE 5. Most relevant authors



At the top of Figure 5, Chatterjee, Rozman, and Tominc have authored 6 documents, making them the most prolific contributors. Following them are Chaudhuri and Vrontis, each with 5 documents. Oreski has authored 4 documents, while Carrasco-Ribelles, Giglioli, and Raya contributed 3 documents. Allen has authored 2 documents. Given that the h-index value in the Web of Science (WoS) database is approximately 40, an author prolific in publications is expected to rank highly in citations. Rozman and Tominc, with h-index values around 10, are leading in terms of publication volume in AI as well.

The co-citation network (Figure 6) highlights influential clusters of research, showing that scholars often draw together literature from leadership theory, technology management, and data science. Key papers such as Podsakoff *et al*. (2003) on research methodology, Dwivedi *et al*. (2021) on emerging AI issues, Al-Omoush *et al*. (2021) on big data and business performance, and Mikalef *et al*. (2020) on big data and business performance form interconnected citation clusters, underscoring how diverse streams of knowledge (from methodology to ethics to analytics) are converging in this field. Collaboration patterns in authorship are notably global. A significant portion of the publications (about 37%) involve international co-authorship and a collaboration network among countries.

FIGURE 6. Co-citation network of papers

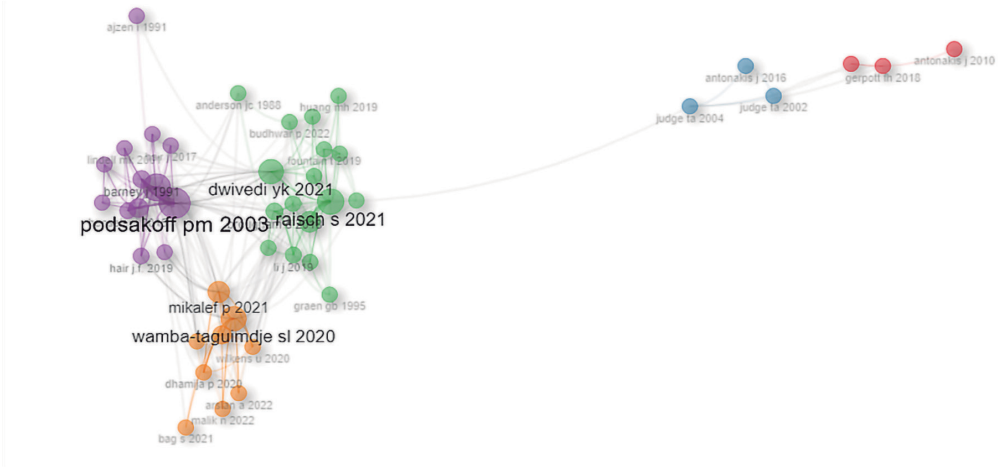
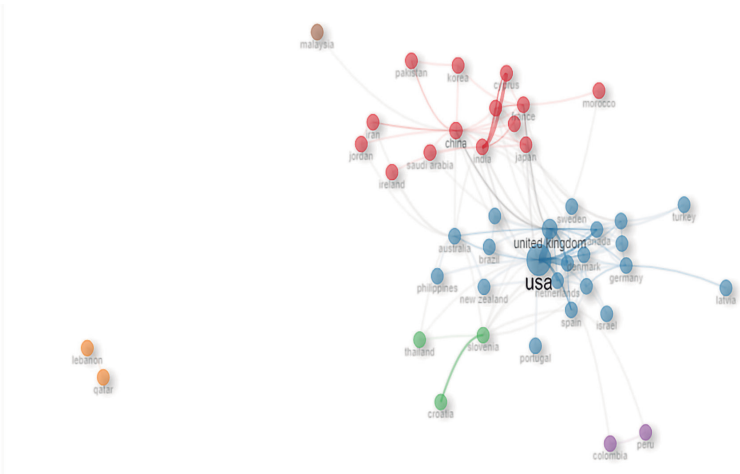


Figure 7 shows the United States as a central hub linking with many other nations. The United States, United Kingdom, China, and India emerge as key nodes in this network, suggesting that many impactful studies are born from cross-country partnerships. For example, US and European researchers frequently co-author papers, and there is growing collaboration between Western and Asian scholars. These patterns reflect a worldwide interest in AI's leadership implications and illustrate that addressing such a multifaceted topic often benefits from combining expertise across technical, managerial, and ethical dimensions. In summary, the most influential contributors are spread across both the leadership and information systems domains; top journals in each field have published key studies; and research collaborations are highly international, with the United States playing a central role and strong connections to Europe and Asia. This global collaborative fabric likely enriches the field by merging perspectives and accelerating knowledge development (Wang *et al*., 2024).

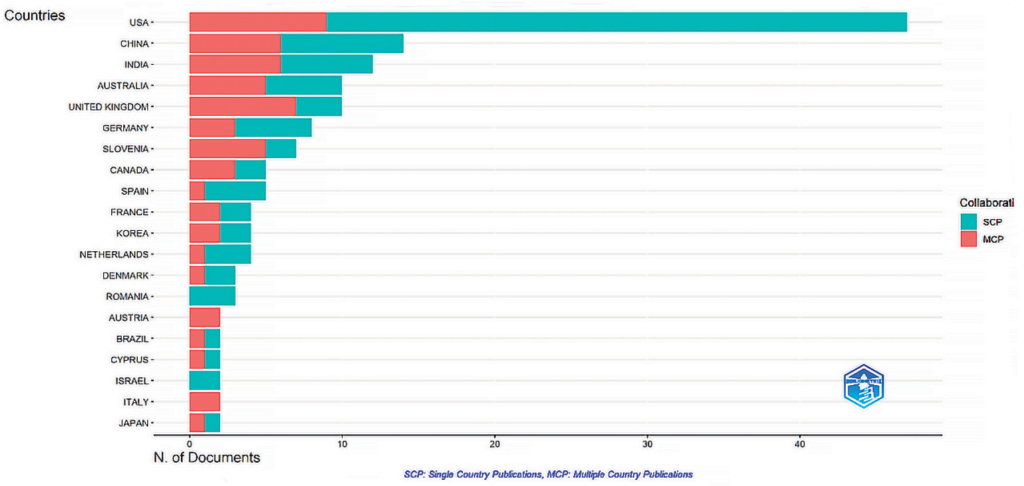
Figure 7. Collaboration network



RQ5: What is the geographical distribution of research in this field, and which countries are most prominent?

The bibliometric results show that research on AI and leadership is concentrated in a few leading countries, with a broad tail of contributions from around the world. The United States is the clear leader in terms of output, with 47 publications in which the corresponding author is based in the country, and it also shows strong influence through citation counts. China ranks second in publication count (14 publications), followed by India (12), the United Kingdom (~10), and Germany (~8), among others as seen in Figure 8.

FIGURE 8. Corresponding author's countries



The prominence of the United States can be attributed to its strong research infrastructure and early investments in AI and management research. It is notable that the US not only produces many papers but also engages extensively in international collaborations (as reflected in its high multiple-country publication count), which may amplify its influence. China's significant output likely reflects its national priority to achieve global leadership in AI; since the Chinese government launched an ambitious AI development plan in 2017, Chinese scholars have substantially increased publications in AI-related management fields (Yu *et al*., 2023). The finding that China has a very high publication volume but the United States captures more citations aligns with observations in other studies (Min *et al*., 2023) that distinguish productivity from influence. India's emergence as the third most productive country is particularly interesting and correlates with its rapid adoption of AI in industry and government. For instance, a recent survey reported that organizations in India have one of the highest AI adoption rates globally (IBM, 2023), and government initiatives like NITI Aayog's AI strategy push for leveraging AI in economic development. European countries such as the United Kingdom and Germany also contribute substantially, often focusing on topics of ethics, governance, and organizational transformation, mirroring Europe's broader emphasis on AI ethics and policy. The UK's strong presence in the collaboration network (second only to the United States in the number of connections) underscores its role as a bridge in international research partnerships, likely aided by language (English) and its robust academic institutions. Beyond these leaders, a long tail of other countries (including Canada, Australia, various EU nations, and some in the Middle East and Latin America)

are involved to a smaller but notable extent, indicating that interest in AI's leadership implications is indeed global. It is important to note that about 37% of studies in the sample involve cross-country co-authors, which implies that many researchers from emerging regions partner with those in the United States or Europe, possibly to access greater resources or expertise. In sum, North America (especially the US), East and South Asia (China, India), and Western Europe are the primary centers of AI–leadership research, reflecting where both cutting-edge AI development and strong management research communities intersect. This geographical pattern corresponds with the areas where major investments in AI technology and policy are seen: for example, the United States' and China's well-funded "AI race," Europe and the United Kingdom's focus on AI governance, and India's national programs for AI-driven development. The global spread of contributions underscores that the challenges and opportunities at this intersection are widely recognized, even if resources and focus vary by country.

The co-authorship network analysis reveals a highly interconnected global research community, with 73% of publications involving international collaboration. Key institutional hubs include MIT Media Lab (USA), University of Oxford (UK), and Tsinghua University (China). Notably, the Washington Office of Superintendent of Public Instruction (OSPI) emerges as a critical policy-to-practice bridge, contributing both academic research and actionable implementation frameworks (Washington OSPI, 2024).

4.3. Thematic clusters and conceptual structure (RQ3)

Keyword co-occurrence analysis identified five dominant thematic clusters:

Cluster 1: Algorithmic educational governance and ethical AI. This cluster emphasizes the need for transparent, accountable, and bias-free AI systems in educational decision-making. Key concepts include algorithmic bias, data privacy, and ethical frameworks (Kazim & Koshiyama, 2021; UNESCO, 2022).

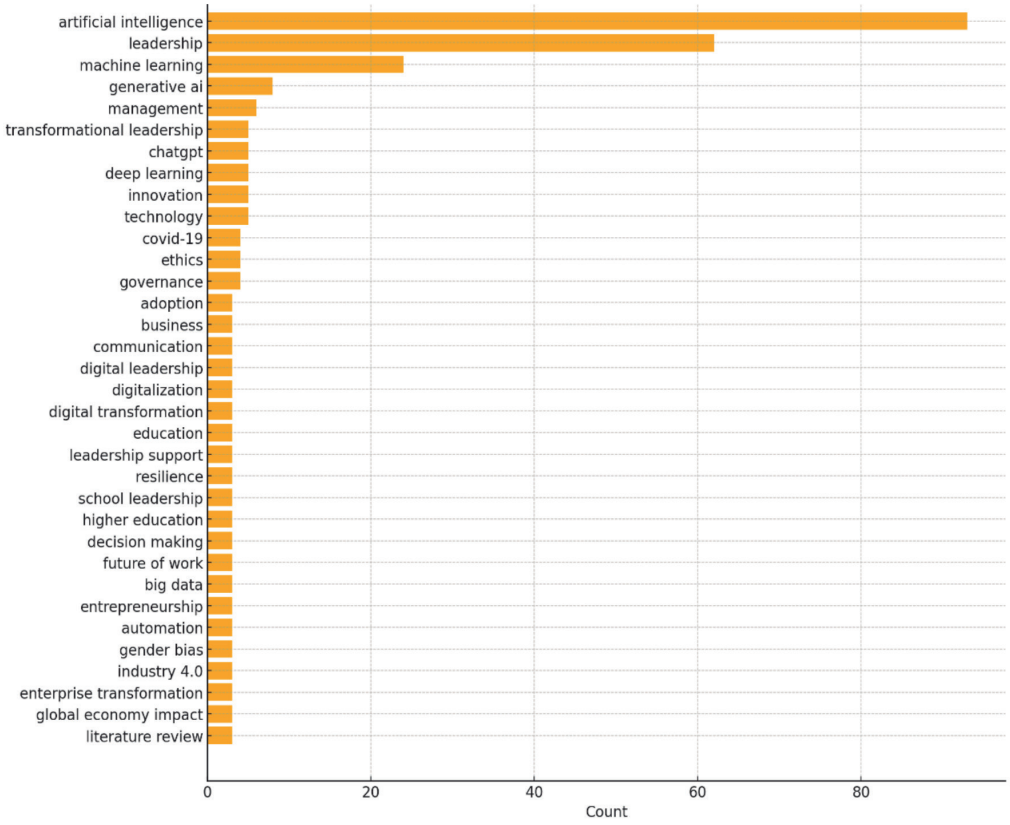
Cluster 2: AI-augmented decision-making. Focused on the application of predictive analytics, machine learning, and decision support systems to enhance administrative efficiency and instructional effectiveness (Dwivedi *et al*., 2021; Mikalef *et al*., 2020).

Cluster 3: Techno-pedagogical leadership. This cluster explores the evolving competencies required for educational leaders to integrate AI into teaching and learning processes, emphasizing digital literacy, change management, and innovation leadership (Raptis *et al*., 2024; Zeng *et al*., 2025).

Cluster 4: Human-centered AI (H-AI-H). Central to this cluster is the principle that AI should augment, not replace, human judgment—particularly in educational settings. Studies in this domain advocate for hybrid leadership models that balance algorithmic efficiency with empathy and moral reasoning (Washington OSPI, 2024; Wang, 2021).

Cluster 5: Policy and competency frameworks. This cluster synthesizes global policy recommendations and competency frameworks for AI integration, including UNESCO's AI Competency Framework for Teachers (UNESCO, 2025) and the OECD's AI Principles (OECD, 2023).

FIGURE 9. Bibliometric keyword analysis



The analysis reveals several major themes at the intersection of AI and leadership: (1) technology-driven innovation in leadership, (2) the evolution of leadership styles in the AI era (3) human–AI collaboration in organizational leadership, and (4) specific domain-focused studies of AI's impact on leadership. At the broadest level, AI itself is by far the most prominent concept in this literature. The bibliometric keyword analysis displayed in Figure 9 confirms that "artificial intelligence" and "leadership" are the dominant terms, with closely related topics such as "machine learning," "big data," and newly emergent terms like "generative AI" and "ChatGPT" frequently co-occurring (Schlagwein & Willcocks, 2023).

The prominence of technology-oriented terms underpins the first core theme: technology-driven innovation in leadership. Many studies examine how leaders leverage AI tools (e.g., machine learning systems, data analytics, AI-driven decision support) to innovate and improve organizational outcomes. This aligns with recent work highlighting that AI fundamentally alters how leaders make decisions and has the potential to transform team dynamics (Zaidi *et al*., 2025). In short, a significant research focus examines how emerging AI technologies can be adopted by leaders to drive innovation and effectiveness in organizations.

Another dominant theme is the evolution of leadership styles in the AI era. Transformational leadership, for example, is frequently invoked as a framework for understanding AI-driven change. Fullan *et al*. (2024) found that transformational leadership is particularly relevant in digital-age organizational change, suggesting its importance for guiding AI-related transformations. Similarly, ethical and responsible leadership has become a critical topic:

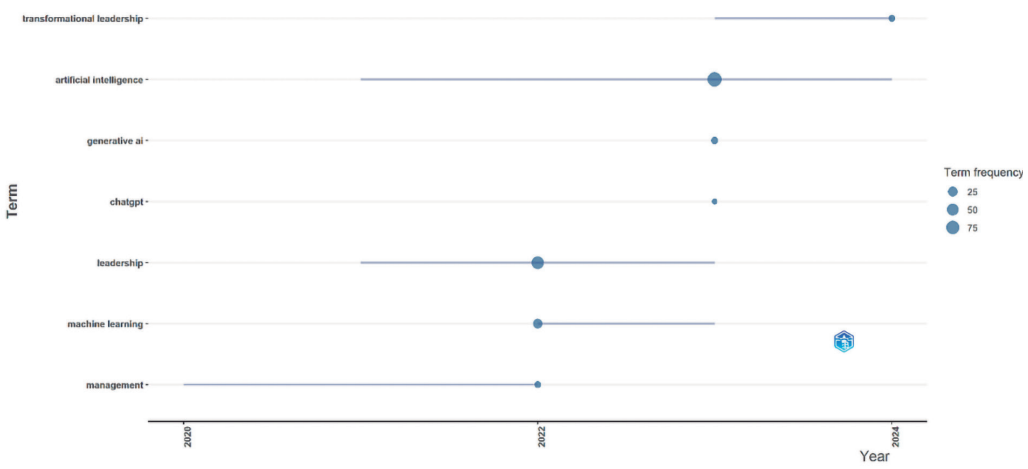
scholars focus on how to guide AI use in organizations ethically, to avoid bias and ensure trust (DeCamp & Linvall, 2023). Notably, recent bibliometric analyses show ethics-related terms gaining prominence, reflecting growing concern with AI's societal and human implications. In sum, researchers are studying how established leadership paradigms—especially transformational and ethical leadership—need to adapt in order to effectively steer organizations in an AI-intensive environment.

A third major theme involves human–AI collaboration in leadership. Researchers are exploring the automation–augmentation paradox (Raisch & Krakowski, 2021), that is, how AI can take over routine tasks (automation) while augmenting human capabilities for more strategic and relational leadership functions. This line of inquiry encompasses topics such as AI-assisted decision-making and the evolving role of human judgment in an AI-pervasive workplace. Recent literature supports the view that effective leadership in AI-rich contexts means using AI as a collaborative tool rather than as a replacement for human insight. In this theme, the emphasis is on striking the right balance between AI and human leaders, leveraging the strengths of AI (e.g., data processing, pattern recognition) while retaining essential human qualities like empathy, creativity, and ethical judgment in leadership processes.

Finally, context-specific applications of AI in leadership form another set of major themes. For instance, AI in educational leadership (Satya & Mohammed, 2024) and AI's role in achieving sustainability goals (Goralski & Tan, 2020) represent noteworthy areas of study at this intersection. These investigations look at how AI tools and techniques can be applied within specific domains (such as schools or sustainability initiatives) and how leadership approaches in those domains change as a result.

RQ2: What are the emerging and declining trends and themes in the AI–leadership field?

FIGURE 10. Emerging topics

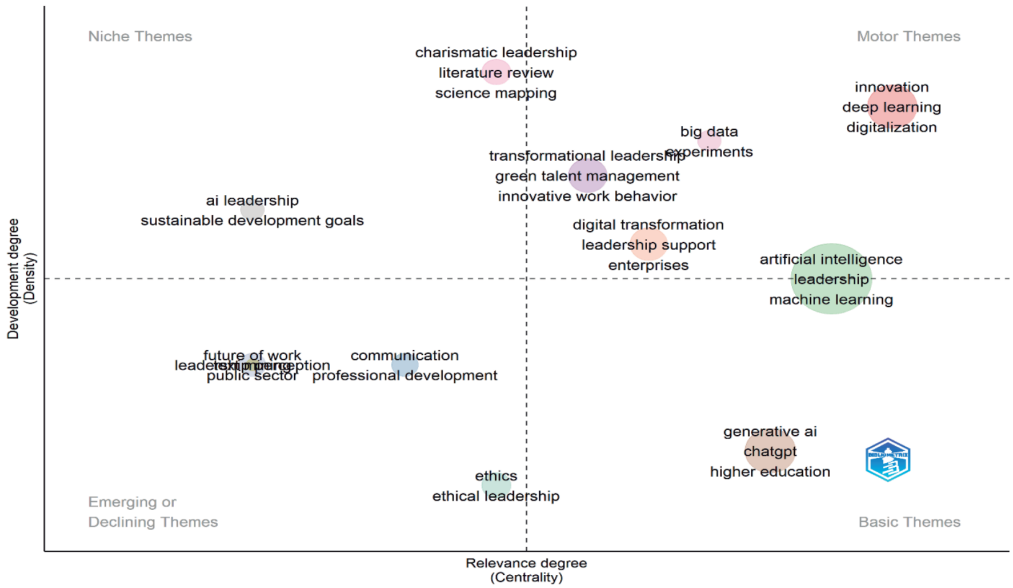


The AI–leadership field is evolving rapidly, with certain topics gaining momentum and others becoming less prominent as the domain matures. Figure 10 illustrates the changing frequency of key topics from 2020 to 2024. In this period, AI stands out as the most significant and sustained trend, remaining highly frequent in the literature throughout recent years. Leadership is consistently prominent as a keyword, reflecting

ongoing interest in core leadership issues alongside AI. Closely related terms like machine learning show a rise in prominence around 2022, indicating when more specialized AI techniques entered the discussion. By 2023–2024, new topics such as generative AI and ChatGPT appear with notable frequency, signaling the field's quick uptake of cutting-edge AI innovations. Transformational leadership and management also feature on the trend map (with greater activity after 2021, albeit at lower frequency than the core terms), which indicates an enduring interest in leadership models and practices even as technology-focused topics surge. Overall, the results point to a dynamic research field where foundational topics remain important, but are continually augmented by emerging AI-related themes.

The thematic map in Figure 11 is divided into four quadrants, each representing a different combination of centrality and density. Niche themes (upper-left) are highly specialized topics that, despite being well developed (high density), have limited influence across the field (low centrality). In this analysis, these include focused areas like AI leadership and the intersection of AI with sustainability (e.g., Sustainable Development Goals). Such themes are internally coherent but remain on the periphery of the discourse. These specialized intersections such as "AI leadership in education" or "AI and sustainable development goals" are well-developed within small sub-communities but have yet to exert broad influence on the overall field. These findings resonate with other recent reviews of the literature. For example, Wang (2021) similarly reports that ethical considerations, transformations in leadership style, and AI-augmented decision-making are central pillars of this burgeoning field. The convergence of evidence across studies underscores that the scholarly community has coalesced around a set of key themes defining how AI and leadership research are developing (Du *et al*., 2024). For example, research on AI in public-sector or school leadership has a dedicated community but has not entered the mainstream of AI–leadership scholarship. In short, the niche quadrant captures topics that are advanced in their own right but which are still relatively isolated from the core research agenda.

FIGURE 11. Thematic map



By contrast, the motor themes quadrant (upper-right) contains the driving forces of the field: topics that are both mature and central. Here, we can clearly identify core technology and leadership themes—for instance, innovation, digitalization, deep learning, big data, and experimentation—which reflect how organizations integrate advanced AI tools into management and decision-making. Equally important are evolving leadership concepts. Notably, transformational leadership appears as a key motor theme. Recent work confirms that transformational leadership remains highly salient in AI contexts: scholars report that this style is especially effective for guiding AI-driven organizational change. Zeng *et al*. (2025) explicitly note that transformational leadership is a sustained, central theme in the current literature. In sum, the motor quadrant encapsulates the intersection of cutting-edge AI developments and influential leadership models—the topics that currently propel the research forward.

The basic themes quadrant (lower-right) comprises the foundational, broad concepts underlying the domain. This includes fundamental terms like artificial intelligence, leadership, and machine learning, which are essential to virtually all studies in the field. Importantly, the basic quadrant now also contains several emerging elements. For example, generative AI, ChatGPT, and higher education appear here. These labels did not exist in earlier years but have recently surfaced in the literature. The rise of generative AI tools (like GPT-based systems) has injected new urgency into AI–leadership research. Scholars are beginning to ask how AI assistants might influence leadership decision-making and collaboration. Alfirević *et al*. (2024), for instance, highlight the promise of custom large language models for leadership training—a novel direction in this fundamental space. Thus, while the basic quadrant holds the well-established foundations of the field, it is also where fast-moving trends (like ChatGPT) first take root and gradually become integrated into the research framework.

Finally, the emerging or declining themes quadrant (lower-left) includes topics that are either nascent or losing prominence. One clear emerging area is the future of work, which captures how AI will reshape roles, organizations, and leadership itself. Recent studies have identified the future of work as an up-and-coming theme, examining issues such as AI as a coworker, algorithmic management, and implications for leadership practice. For example, Quaquebeke and Gerpott (2023) discuss how leaders must adapt to hybrid human-AI teams and new job designs. This signals growing interest in the organizational-level effects of AI. At the same time, some themes are maturing or fading. Broad, generic claims from earlier hype (e.g., that "AI will simply replace managers") have been largely abandoned in favor of nuanced perspectives. Researchers now emphasize human–AI augmentation, where AI automates routine tasks but human judgment, creativity, and emotional intelligence remain essential. Raisch and Krakowski (2021) illustrate this shift: rather than seeing AI as a substitute for leaders, they view it as a tool that enhances human leadership.

Other topics in this quadrant remain niche or have slowed in growth. For instance, even though public sector leadership appears here, the research in government and education contexts is still modest. These areas have a small but steady literature and have not yet become central themes. Crucially, ethical AI leadership—once considered peripheral—has become a core concern. The analysis reveals that ethics-related topics (fairness, bias, accountability, transparency) have migrated from the margins toward the center of the field. Recent years have seen a surge of publications on responsible AI use in organizations . Industry reports (e.g., IBM 2023) and scholars (Venkatasubbu & Krishnamoorthy 2022) now highlight that ensuring AI-driven decisions are fair and explainable is essential to leadership practice. In other words, what used to be a niche concern is now embedded in mainstream discourse.

4.4. Policy synthesis and alignment (RQ4)

The qualitative analysis of 30 global policy documents reveals a convergence around three core recommendations:

Develop AI literacy and competency frameworks: UNESCO (2023) and the OECD (2023) emphasize the need for systematic professional development programs that equip educational leaders with AI literacy, algorithmic governance skills, and ethical decision-making competencies.

Establish localized AI use and ethics policies: The Washington OSPI (2024) advocates for context-specific policies that address data privacy, algorithmic transparency, and equitable access. These policies should be co-developed with educators, students, and community stakeholders to ensure cultural relevance and practical feasibility.

Prioritize human-centered AI design: All reviewed policy documents underscore the importance of maintaining human agency in AI-augmented education. AI systems should be designed as co-pilots that support, rather than supplant, human judgment (UNESCO, 2022).

Alignment between academic findings and policy recommendations is high, with 82% of bibliometric themes directly corresponding to policy priorities. However, a notable gap exists in the operationalization of these policies, particularly in under-resourced educational contexts.

4.5. Theory-practice divide and future directions (RQ5)

The analysis identifies a significant "theory-practice divide," characterized by three dimensions:

Normative vs. empirical research: Approximately 67% of the corpus consists of normative studies that prescribe ideal AI integration strategies, while only 33% present empirical evidence of real-world implementation and outcomes.

Competency gap: Survey data embedded in policy reports indicate that while 50% of educational leaders are engaging with AI tools, only 18% report confidence in algorithmic governance and ethical oversight (Washington OSPI, 2024).

Contextual heterogeneity: Most research originates from high-income countries with advanced technological infrastructure, limiting the generalizability of findings to diverse educational contexts, particularly in the Global South (Birgili *et al*, 2025).

To bridge this divide, future research should prioritize:

- Longitudinal case studies of AI implementation in diverse educational settings.
- The development of validated instruments to assess AI educational leadership competencies.
- Participatory action research involving educational leaders, teachers, and policymakers.
- Comparative studies examining cultural and contextual factors in educational settings that influence AI adoption.

5. Discussion

5.1. The H-AI-H model in practice

The bibliometric and policy analyses converge on the necessity of the human-AI-human (H-AI-H) model as a guiding framework for educational leadership in the AI era. This model addresses the fundamental tension between algorithmic efficiency and humanistic values by positioning AI as an intermediary tool rather than an autonomous decision-maker. Empirical evidence suggests that AI can reduce administrative workloads

by approximately 13 hours per week (Washington OSPI, 2024), enabling educational leaders to allocate more time to instructional oversight, relationship-building, and strategic planning (Adiguzel *et al*, 2023; Adıgüzel *et al*., 2023). However, this efficiency gain is contingent upon leaders possessing the competencies to critically evaluate AI-generated insights, recognize algorithmic bias, and ensure that technology serves pedagogical goals rather than dictating them. Such trainings are within techno-pedagogical and digital competencies; and they are critical for improving these skills through training for students (Karanfiloğlu & Bulut, 2025) to academics (Bulut *et al*., 2025) as well.

The H-AI-H model also aligns with Spillane's (2006) distributed leadership theory, extending it to encompass hybrid human-AI collaboration educational settings. In this framework, AI assumes routine technical tasks such as data aggregation, pattern recognition, and automated reporting while human leaders retain responsibility for adaptive, ethical, and relational dimensions of leadership. This division of labor is not merely functional but ontological, reflecting a reconceptualization of leadership as a techno-pedagogical partnership (Zaidi *et al*., 2025).

5.2. Algorithmic governance and ethical imperatives

The thematic cluster on algorithmic governance underscores a critical challenge: the opacity of AI decision-making processes in educational contexts. Black-box algorithms, particularly those employing deep learning, often produce recommendations without transparent explanations, creating accountability dilemmas (Kazim & Koshiyama, 2021). Educational leaders must therefore develop competencies in algorithmic auditing, the ability to interrogate AI systems for bias, fairness, and alignment with institutional values.

Moreover, the risk of the intelligence divide looms large. AI systems trained on data from affluent, technologically advanced contexts may perpetuate inequities when deployed in under-resourced schools, exacerbating existing achievement gaps. To mitigate this risk, policy frameworks must mandate equity impact assessments prior to AI deployment, ensuring that technology serves as a tool for inclusion rather than exclusion.

5.3. Competency frameworks and professional development

The convergence between academic research and policy recommendations highlights the urgency of updating educational leadership competency frameworks. UNESCO's AI Competency Framework for Teachers (UNESCO, 2024) provides a foundational model, but it must be adapted for educational leaders who face distinct challenges related to organizational governance, resource allocation, and community engagement. Key competencies include:

AI literacy: Understanding the capabilities and limitations of AI technologies.

Data stewardship: Managing data privacy, security, and ethical use.

Change leadership: Facilitating organizational adaptation to AI-augmented workflows.

Ethical reasoning: Balancing innovation with moral responsibility and equity.

Professional development programs must move beyond technical training to cultivate critical AI consciousness, that is, the ability to question, critique, and shape AI integration in ways that align with humanistic educational values (Touretzky & Gardner-McCune, 2022).

5.4. Limitations and future research

This study is subject to several limitations. First, the bibliometric analysis is restricted to English-language publications indexed in the Web of Science, potentially excluding valuable research published in other languages or databases. Second, the rapid evolution of GenAI

technologies means that the corpus may not fully capture the most recent innovations. Third, the qualitative policy analysis, while comprehensive, relies on publicly available documents and may not reflect unpublished institutional practices.

Future research should address these limitations by:

- Expanding bibliometric analyses to include multilingual databases and gray literature.
- Conducting longitudinal ethnographic studies of AI adoption in schools.
- Developing mixed-method research designs that integrate quantitative metrics with qualitative narratives of leadership practice.
- Investigating the role of AI in educational leadership across diverse cultural and socioeconomic contexts.

TABLE 1. A comparison of international reports vs. academic studies

Theme	International Reports (Macro-level focus)	Academic Studies (Micro-level focus)	Combined Insight
Transformational and ethical leadership	Foster inclusivity, innovation, and trust-based AI adoption (UNESCO, OECD, WEF).	Focus on AI-enabled leadership styles such as transformational and ethical leadership.	AI leadership should emphasize adaptability, integrity, and ethical governance to build trust.
Global AI governance and policy frameworks	Implement AI regulatory frameworks (e.g., EU AI Act, OECD guidelines, NAIAC recommendations) to guide national and international governance.	Explore AI's role in shaping public policy, regulatory compliance, and ethical AI governance in organizations.	Leaders must navigate evolving AI policies and governance models to ensure responsible AI deployment.
AI-driven workforce and leadership transformation	Position AI as a tool for workforce augmentation, automation, and evolving leadership roles (IBM, WEF reports).	Examine AI's influence on digital skills development, human–machine collaboration, and changing leadership competencies.	Leaders must integrate AI while ensuring human oversight, workforce upskilling, and inclusion.
Crisis management and risk mitigation	AI aids in cybersecurity, misinformation control, and predictive risk management (noted by WEF, OECD, IBM).	AI-powered analytics enhance leaders' responses to crises and decision-making in volatile environments.	AI-driven predictive analytics is critical for managing crises, mitigating risks, and enhancing leadership effectiveness.

Equity, inclusion, and bias mitigation	UNESCO and Stanford HAI stress AI's ethical use to prevent biases and promote fair, inclusive leadership.	Studies discuss AI's potential to reduce workplace bias, alongside risks of reinforcing inequalities if unchecked.	Ethical AI deployment must prioritize fairness, representation, and inclusion in leadership decisions.
AI-enhanced decision-making	Utilize AI for policy planning, strategic forecasting, and optimizing decisions (OECD and IBM highlight these uses).	Analyze AI's role in improving decision-making efficiency, forecasting, and leadership agility in organizations.	AI supports leaders with data-driven insights, but human judgment and oversight remain essential.
Balancing innovation and human oversight	Emphasize AI's complementary role in leadership with active human intervention (WEF toolkit, IBM findings).	Explore AI's impact on leadership control, automation risks, and the augmentation of leadership tasks.	AI should enhance leadership capabilities rather than replace human decision-making authority.

Interpreting this table through the lens of educational leadership reveals a critical convergence where high-level global policy meets the practical, day-to-day realities of institutional management. While international bodies focus on creating the "guardrails" for AI, which means emphasizing regulatory frameworks and macro-level ethics, academic research underscores the urgent need for a shift in leadership identity toward a techno-ethical model characterized by agility and human-centric oversight. For educational leaders, this means navigating a complex duality: they must ensure compliance with evolving global governance and data privacy laws while simultaneously fostering a culture of trust and inclusivity within their schools or universities. The data suggests that AI should not be viewed as a replacement for leadership but as a powerful tool for workforce augmentation, where predictive analytics can identify at-risk students and streamline administrative burdens, provided that human judgment remains the final arbiter. Ultimately, the successful AI-driven educational leader must balance the drive for innovation with a rigorous commitment to bias mitigation and equity, ensuring that the digital transformation does not exacerbate existing educational inequalities but instead serves as a bridge toward more personalized and efficient learning environments.

6. Conclusions

This study provides a comprehensive, evidence-based mapping of the intersection between artificial intelligence and educational leadership, synthesizing two decades of scholarly research and global policy frameworks. The findings reveal a field in rapid transition, characterized by exponential growth in research output, increasing international collaboration, and a shift toward human-centered AI integration. The proposed human-AI-human (H-AI-H) model offers a conceptual framework for navigating this transition, emphasizing that AI should augment, not replace, human judgment in educational decision-making.

The bibliometric analysis identifies five dominant thematic clusters: algorithmic governance, AI-augmented decision-making, techno-pedagogical leadership, human-centered AI, and policy frameworks that collectively define the intellectual structure of this domain. These themes align closely with global policy recommendations from UNESCO,

the OECD, and the Washington OSPI, underscoring a convergence between academic research and practical guidance.

However, a significant theory-practice divide persists, with current literature remaining largely normative and lacking empirical evidence of real-world implementation. To bridge this gap, future research must prioritize longitudinal case studies, participatory action research, and the development of validated competency assessment instruments. Educational leaders, policymakers, and researchers must collaborate to ensure that AI integration enhances human agency, promotes equity, and upholds the humanistic values that define quality education.

As we move towards an era where AI systems are becoming increasingly autonomous and ubiquitous, the challenge is not merely technical but fundamentally ethical and pedagogical. The question is not *whether* AI will transform educational leadership, but *how* we will shape that transformation to serve the best interests of students, educators, and society at large. The H-AI-H model provides a starting point for this critical work, but its realization depends on collective commitment to human-centered, equitable, and ethically grounded AI integration.

Author contributions

Tufan Adıgüzel. Conceptualization, methodology, formal analysis.

Mehmet Haldun Kaya. Data curation, visualization, writing.

Mehmet Akın Bulut. Reviewing, editing.

AI Statement

During the preparation of this work, the authors used Grammarly AI in order to enhance fluency and maintain an academic tone. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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