



REVIEW OF ARTIFICIAL INTELLIGENCE IN EDUCATION

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ARTICLE

ARTIFICIAL INTELLIGENCE IN RESEARCH FUNDING: A BIBLIOMETRIC ANALYSIS OF GRANT DISCOVERY, GRANT MATCHING, PROPOSAL DEVELOPMENT, AND FUNDING ECOSYSTEMS

Inteligência Artificial no Financiamento à
Pesquisa: uma Análise Bibliométrica da
Identificação de Oportunidades de Fomento,
Compatibilização de Editais, Desenvolvimento de
Propostas e Ecossistemas de Financiamento

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ABSTRACT | Background: AI is increasingly reshaping how research funding is discovered, pursued, and awarded, yet the fragmented literature on this emerging domain lacks a systematic synthesis of its intellectual structure and an integrative model connecting its diverse applications. This study addresses that gap by examining research trends and developing a conceptual framework for AI in research funding. **Objectives:** The objectives of the study is to identify and characterize research trends relating to AI-assisted research funding and to develop a conceptual framework synthesizing these applications into an integrated model. **Method:** Bibliographic data were extracted from the Scopus database, resulting in a final dataset of 3,267 journal articles, which were subsequently analyzed using Biblioshiny (Bibliometrix package in R) and VOSviewer. **Findings:** The results reveal a rapidly expanding field, with a 40.22% annual growth rate and publications rising from 22 in 2017 to 826 in 2025, concentrated among a core set of journals and prolific authors, and dominated by research-intensive economies led by the United States, China, and the United Kingdom. Thematic analysis shows a shift from foundational AI and data-centric themes toward funding- and method-centric applications, reflecting the field's transition from technical novelty toward operational implementation. Building on these findings, a five-stage conceptual framework, grant discovery, grant matching, proposal development, proposal evaluation, and funding ecosystem, is proposed to guide the responsible integration of AI across the research funding lifecycle. **Conclusion:** AI is reshaping the research funding lifecycle by creating opportunities for more efficient, accessible, and data-driven funding processes. The





proposed five-stage framework provides a foundation for understanding and guiding the responsible integration of AI in research funding while emphasizing human oversight, transparency, fairness, and accountability.

Keywords | Artificial Intelligence; Grant Discovery; Research Funding; Grant Matching; Proposal Development; Proposal Evaluation; Bibliometric Analysis; Funding Ecosystem

RESUMO | Contexto: A inteligência artificial (IA) vem transformando cada vez mais a forma como as oportunidades de financiamento à pesquisa são identificadas, buscadas e concedidas. Entretanto, a literatura fragmentada sobre esse domínio emergente ainda carece de uma síntese sistemática de sua estrutura intelectual e de um modelo integrador que articule suas diferentes aplicações. Este estudo busca preencher essa lacuna por meio da análise das tendências de pesquisa e do desenvolvimento de um framework conceitual sobre a aplicação da IA ao financiamento à pesquisa. **Objetivos:** Este estudo tem como objetivos identificar e caracterizar as tendências de pesquisa relacionadas ao financiamento à pesquisa assistido por IA e desenvolver um framework conceitual que sintetize essas aplicações em um modelo integrador. **Método:** Os dados bibliográficos foram extraídos da base Scopus, resultando em um conjunto final de 3.267 artigos científicos, posteriormente analisados por meio do Biblioshiny (pacote Bibliometrix, em R) e do VOSviewer. **Resultados:** Os resultados revelam um campo em rápida expansão, com taxa de crescimento anual de **40,22%** e aumento do número de publicações de **22, em 2017, para 826, em 2025**. A produção científica concentra-se em um conjunto central de periódicos e autores altamente produtivos, com predominância de economias intensivas em pesquisa, lideradas pelos Estados Unidos, China e Reino Unido. A análise temática evidencia uma transição de temas fundamentais relacionados à IA e centrados em dados para aplicações voltadas ao financiamento e aos métodos, refletindo a passagem do campo da novidade tecnológica para a implementação operacional. Com base nesses achados, propõe-se um framework conceitual composto por cinco etapas: **identificação de oportunidades de fomento, compatibilização de editais, desenvolvimento de propostas, avaliação de propostas e ecossistema de financiamento**, destinado a orientar a integração responsável da IA ao longo do ciclo de financiamento à pesquisa. **Conclusão:** A IA está transformando o ciclo de financiamento à pesquisa ao criar oportunidades para processos de fomento mais eficientes, acessíveis e orientados por dados. O framework de cinco etapas proposto oferece uma base para compreender e orientar a integração responsável da IA no financiamento à pesquisa, enfatizando, simultaneamente, a supervisão humana, a transparência, a equidade e a responsabilização.

Palavras-chave | Inteligência Artificial; Identificação de Oportunidades de Fomento; Financiamento à Pesquisa; Compatibilização de Editais; Desenvolvimento de Propostas; Avaliação de Propostas; Análise Bibliométrica; Ecossistema de Financiamento.

INTRODUCTION

Artificial intelligence (AI) is transforming education and academic research, with research funding emerging as a promising area of application. Recent advances in AI have created new opportunities to transform these conventional research funding processes. AI has evolved from a specialized computational discipline into a general-purpose technology that supports data-driven decision-making across numerous sectors, including healthcare, education, finance, manufacturing, and scientific research (Burger et al., 2023; Carobene et al., 2024). Powered by machine learning, deep learning, natural language processing, and more recently generative AI and large language models (LLMs), AI systems are increasingly capable of analysing large volumes of structured and unstructured information, recognizing complex patterns, generating human-like text, and supporting sophisticated decision-making tasks (Lawaju et al., 2024; Zahra & Rautela, 2024). These capabilities have accelerated the integration of AI into research administration and funding management, where intelligent systems are beginning to support researchers, research institutions, and funding agencies throughout the funding lifecycle (Filetti et al., 2024).



Within the research funding domain, AI applications have expanded rapidly across multiple stages of the funding process. Intelligent grant recommendation systems employ machine learning and semantic matching algorithms to identify funding opportunities that align with a researcher's expertise, publication history, institutional profile, and research interests, thereby reducing the time and effort required to locate relevant funding calls (Gardner et al., 2022; Munagandla et al., 2024). Natural language processing and generative AI tools assist applicants during proposal development by improving language quality, enhancing document structure, checking compliance with funding guidelines, summarizing literature, and supporting proposal refinement (Cortés et al., 2024; Rahmawati et al., 2026). At the organizational level, funding agencies are increasingly exploring AI-assisted systems for reviewer assignment, proposal screening, evaluation support, portfolio analysis, and strategic resource allocation (Neema & Chandrashekar, 2021; Spyroglou et al., 2022). Together, these developments suggest the emergence of an AI-enabled research funding ecosystem in which algorithmic intelligence increasingly complements human expertise across grant discovery, proposal preparation, proposal assessment, funding prioritization, and post-award management.

Although these developments present significant opportunities, they also introduce important scientific, ethical, and governance challenges (Bloch & Sørensen, 2015; Mahajan, 2025). The rapid adoption of AI has generated concerns regarding transparency, explainability, accountability, fairness, and responsible decision-making within research funding (Devkota et al., 2026; Farid, 2024). AI-based grant recommendation systems may unintentionally reinforce existing inequalities if recommendations are influenced by historical funding patterns that favour established researchers or well-resourced institutions (Gardner et al., 2022; Munagandla et al., 2024). Similarly, AI-supported proposal evaluation systems may reproduce biases embedded within training data, potentially disadvantaging interdisciplinary research, early-career scholars, or applicants from underrepresented regions and institutions (Cortés et al., 2024; Rahmawati et al., 2026). The increasing use of generative AI for proposal development has also stimulated extensive debate regarding originality, authorship, academic integrity, and the appropriate balance between machine-assisted writing and genuine scholarly contribution (Neema & Chandrashekar, 2021; Spyroglou et al., 2022). These issues have attracted growing attention from researchers, funding organizations, and policymakers seeking to ensure that AI enhances rather than undermines fairness, transparency, and trust in research funding systems.

Despite the rapid growth of research on AI in research funding, the literature remains fragmented. Most studies examine isolated applications, such as grant discovery, proposal development, evaluation, or funding management, without considering how these technologies collectively reshape the entire research funding ecosystem. As a result, the intellectual structure of the field, its major research themes, collaboration networks, and temporal evolution remain insufficiently understood. The recent emergence of generative AI has further accelerated research activity, making it increasingly challenging to identify influential contributors, emerging topics, and future research directions (Burger et al., 2023; Devkota et al., 2026; Lawaju et al., 2024; Siddique et al., 2026b). Moreover, the field lacks a comprehensive conceptual framework that integrates AI applications across the research funding lifecycle. Rather than representing independent innovations, AI-enabled grant recommendation systems, proposal-writing tools, evaluation algorithms, and funding management platforms function as interconnected elements of a broader digital transformation. Developing an integrated perspective is therefore essential to synthesize



existing knowledge, reveal research gaps, guide responsible AI adoption, and establish a coherent foundation for future research and policy.

To address these gaps, this study conducts a bibliometric analysis of the literature on AI in research funding to systematically examine the evolution, intellectual structure, and thematic development of this emerging field. Specifically, the study pursues two objectives. First, it identifies and characterizes research trends relating to AI-assisted grant matching, proposal development, proposal evaluation, and the broader research funding ecosystem by examining publication growth, influential authors, institutions, countries, collaboration networks, citation structures, and thematic evolution. Second, it develops a conceptual framework that synthesizes these findings into an integrated model of AI-enabled research funding, illustrating how AI technologies interact across different stages of the funding lifecycle while identifying emerging research directions and governance considerations.

LITERATURE REVIEW

AI shaping global education

AI in education has evolved from early computer-assisted learning and rule-based intelligent tutoring systems to sophisticated generative AI (GenAI) applications. Burger et al. (2023) noted that early educational AI primarily emphasized automated feedback and limited personalization, whereas Lawaju et al. (2024) highlighted its expansion into teaching, learning, assessment, and academic practice. The emergence of ChatGPT in November 2022 further accelerated GenAI adoption within educational institutions (Baber et al., 2024), particularly through its capacity to generate human-like content, explain complex concepts, and support individualized learning (Zahra & Rautela, 2024). Recent studies have documented applications across personalized learning, academic writing, automated assessment, instructional support, and knowledge creation, while identifying concerns related to accuracy, academic integrity, bias, privacy, and human oversight (Lawaju et al., 2024; Song & Song, 2023; Siddique et al., 2026b; Zhai et al., 2021). Evidence from a 35-country survey of over 45,000 respondents further indicates widespread adoption, with AI reportedly used by 88% of students and 77% of faculty (Digital Education Council, 2026). Within higher education, these developments extend beyond classroom applications to influence academic research, researcher development, institutional research capacity, and the broader processes through which universities generate and sustain knowledge (Crompton & Burke, 2023; Lee et al., 2024). Collectively, these developments position AI as an integral component of the academic ecosystem and provide a foundation for examining its emerging applications in academic research.

AI in educational research journey

Academic research, a major domain of the education system, has increasingly become embedded with AI, which now supports multiple stages of the research lifecycle. In the early stages, AI-powered tools facilitate topic selection, literature discovery, and research gap identification by processing large volumes of scholarly literature and identifying semantically relevant studies (Abdullaev et al.,



2023; Devkota et al., 2026). Researchers have also begun using AI for questionnaire development, including generating, refining, and aligning survey items with research objectives. As research progresses, AI supports data analysis, pattern recognition and experimental design, particularly when handling large and complex datasets (Alonso-Arroyo et al., 2019; Filetti et al., 2024). The emergence of generative AI and LLMs has further expanded its application to scholarly writing, assisting with drafting, language refinement, synthesis, and manuscript structuring (Carobene et al., 2024). AI is also increasingly supporting publication-related activities, including journal selection, formatting, editorial compliance, and aspects of peer review. These applications are particularly consequential within the context of academic research, where faculty researchers and graduate students rely on research skills, institutional support, and external funding to develop and disseminate scholarly work (Chikwari & Alexander, 2023; Denny et al., 2019). As AI becomes integrated across the research lifecycle, it may also reshape how researchers identify funding opportunities, develop competitive proposals, and engage with increasingly digitalized research administration systems (Ebadi & Schiffauerova, 2015). Therefore, the progression from AI-assisted research discovery to publication establishes a direct conceptual link between AI in educational research and the emerging role of AI in research funding within higher education.

AI in research funding: From grant discovery to proposal development

Research funding is a fundamental driver of scientific discovery, technological innovation, and socioeconomic development, enabling researchers to generate knowledge, address societal challenges, and translate scientific advances into practical applications (Neema & Chandrashekar, 2021; Thelwall et al., 2023). However, increasing global investment in research and development has intensified competition for limited funding opportunities, requiring researchers to navigate an increasingly diverse landscape of government agencies, private foundations, international organizations, and industry partners (Alonso-Arroyo et al., 2019; Ebadi & Schiffauerova, 2015). Within this context, AI is emerging as a means of reducing information asymmetry and improving efficiency across the funding lifecycle. AI-powered systems can process large volumes of funding calls, eligibility criteria, thematic priorities, and researcher profiles to identify relevant opportunities more efficiently than conventional search approaches (Batista et al., 2024). Recent developments in intelligent funding discovery and recommendation systems further employ semantic similarity, knowledge graphs, recommender algorithms, and predictive analytics to connect researchers with potentially suitable funding opportunities (Bloch & Sørensen, 2015; Rothwell, 2026). Thus, AI is increasingly shifting grant discovery from manual searching toward more intelligent and personalized opportunity identification.

Beyond grant discovery, AI is increasingly being applied to grant matching, where the objective extends from identifying available funding calls to determining the degree of alignment between a researcher's expertise, research interests, previous outputs, and the requirements of specific funding schemes (Abdullaev et al., 2023; Sangwa et al., 2025). Traditional funding searches often depend on keywords, institutional networks, and researchers' prior knowledge, which may overlook relevant opportunities because of differences in terminology or disciplinary boundaries (Devkota et al., 2026). AI-based semantic matching can address this limitation by analysing the conceptual



similarity between researcher profiles and funding requirements, while knowledge graphs can connect researchers, institutions, topics, funders, and previous awards within a common information structure (Bloch & Sørensen, 2015). Such systems can potentially identify interdisciplinary funding opportunities that may remain difficult to detect through conventional searches. Predictive analytics may further support funding intelligence by analysing historical awards, institutional characteristics, thematic priorities, and previous funding patterns (Barrientos et al., 2026; Rothwell, 2026). Consequently, the literature suggests a gradual transition from simple funding databases toward intelligent recommendation environments capable of supporting researchers throughout the opportunity-identification and grant-matching stages.

The role of AI subsequently extends into proposal development, where researchers must translate research ideas into coherent, competitive, and funder-compliant applications. Natural language processing and generative AI have created new opportunities to support this stage by assisting with proposal drafting, restructuring, language refinement, summarization, and alignment with funding-call requirements (Barrientos et al., 2026; Cortés et al., 2024; Gardner et al., 2022). Recent studies suggest that generative AI can reduce the time required for preparing funding documents while improving readability, coherence, and consistency across proposal sections (Munagandla et al., 2024). AI can also assist researchers in analysing call documents, identifying required components, checking compliance with eligibility and formatting requirements, and refining research objectives or methodological descriptions (Tuffaha et al., 2019). These applications are particularly relevant given the administrative complexity and time pressures associated with competitive grant preparation. Nevertheless, the literature also raises concerns regarding factual accuracy, originality, intellectual property, confidentiality, and the potential homogenization of scholarly proposals (Naganuma et al., 2026). Accordingly, AI-assisted proposal development is increasingly conceptualized not as a replacement for researchers' expertise but as a decision-support and writing-assistance mechanism requiring substantive human verification and scholarly judgment.

The application of AI further extends to the evaluation and management of research funding, creating a broader AI-enabled funding ecosystem. Funding organizations receive substantial volumes of applications and must identify appropriate reviewers, assess proposal quality, prioritize competing projects, and allocate finite resources while maintaining fairness and transparency (Mocanuet al., 2024; Tuffaha et al., 2019). AI-supported systems can assist with reviewer selection, proposal classification, similarity detection, funding prioritization, and decision support by analysing large volumes of textual and bibliometric information (Neema & Chandrashekar, 2021; Spyroglou et al., 2022; Rahmawati et al., 2026). Beyond individual evaluation tasks, emerging research examines AI-enabled research management, funding intelligence, analytics, and policy support, suggesting a transition toward more integrated digital funding ecosystems (Devkota et al., 2026; Siddique et al., 2026b). However, algorithmic bias, explainability, data privacy, accountability, and human oversight remain critical considerations in automated or AI-assisted funding decisions (Filipovic, 2025). Overall, the literature indicates a progressive expansion of AI from grant discovery and matching to proposal development, evaluation, and ecosystem-level funding management, establishing research funding as an emerging domain of AI-enabled transformation.



Gap in existing literature

Despite the growing application of AI across education and academic research, two specific gaps remain in the literature on AI-enabled research funding. First, existing studies largely examine individual applications, such as grant matching, proposal development, and proposal evaluation, while lacking a comprehensive mapping of publication growth, influential authors and institutions, country contributions, collaboration networks, citation structures, and thematic evolution across the broader research funding ecosystem. Second, the literature provides limited conceptual integration of these fragmented applications into a unified framework. Specifically, insufficient attention has been given to how AI technologies interact across interconnected stages of the funding lifecycle, from grant discovery and matching to proposal development, evaluation, and funding decision-making. Addressing these gaps, this study first characterizes the intellectual and thematic landscape of AI-assisted research funding and, second, develops a conceptual framework that integrates AI applications across the funding lifecycle while identifying emerging research directions and key governance considerations.

METHODOLOGY

This study employed bibliometric analysis. Bibliometric analysis is a quantitative research method used to systematically examine the structure, evolution, and knowledge dynamics of a scientific field through the analysis of publication metadata, citation patterns, collaboration networks, and thematic relationships (Donthu et al., 2021; Passas, 2024). The bibliographic data were retrieved exclusively from the Scopus database due to its comprehensive coverage of high-quality, peer-reviewed literature across multiple disciplines and its widespread use in bibliometric research (Lowar et al., 2025; Khanal et al., 2025). A structured search strategy was developed using the search string presented in Table 1, which targeted literature related to artificial intelligence, research funding, grant matching, proposal development, and funding ecosystems.

Table 1. Database and Search String

Database	Search String
Scopus	("artificial intelligence" OR AI OR "machine learning" OR "deep learning" OR "generative AI" OR "large language model*" OR "ChatGPT" OR "ClaudeAI" OR "Gemini" OR "natural language processing") AND (grant* OR funding OR "research funding" OR "research grant*" OR "grant application*" OR "grant proposal*" OR "funding opportunit*" OR "funding landscape*" OR "grant matching" OR "grant recommendation" OR "funding recommendation" OR "research funding ecosystem*" OR "research education" OR "research funding management" OR "proposal development" OR "proposal writing" OR "grant writing" OR "proposal generation" OR "proposal automation" OR "automated proposal*" OR "proposal assistant" OR "proposal evaluation" OR "proposal review" OR "proposal preparation" OR "research proposal*")

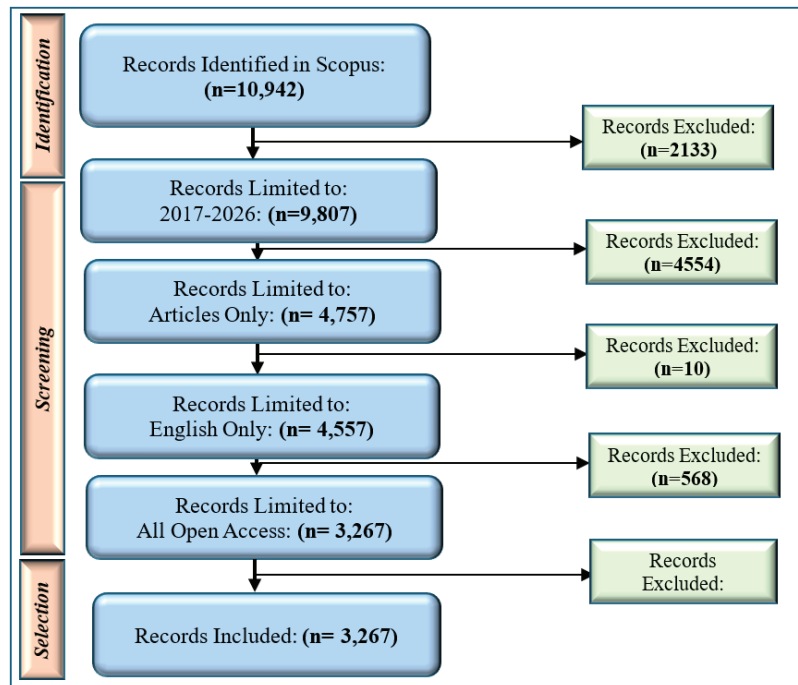


Figure 1. Data Selection Process

The data collection process followed a three-stage procedure comprising identification, screening, and selection (Figure 1). The literature searches initially identified 10,942 documents. During the screening stage, predefined inclusion criteria were sequentially applied to ensure the relevance and quality of the dataset. First, the publication period was limited to 2017-2026, reducing the dataset to 9,807 records. The search was then restricted to journal articles, resulting in 4,757 documents, followed by the inclusion of English-language publications only, yielding 4,557 records. Finally, only Open Access (OA) articles were retained, producing a final dataset of 3,267 publications for analysis. The selected records were subsequently analysed using Biblioshiny (R package Bibliometrix) and VOSviewer, two widely adopted software packages for bibliometric studies (Siddique et al., 2026a). Biblioshiny was employed to examine publication performance, citation patterns, productivity, and thematic evolution, whereas VOSviewer was used to visualize collaboration networks, keyword co-occurrence, citation relationships, and the intellectual structure of the field (Khanal et al., 2025; Mondal, 2026).

RESULTS

This section presents the findings of the bibliometric analysis across four subsections: descriptive overview of the dataset, performance analysis, collaboration structure, and conceptual and thematic analysis.



Descriptive Overview

This part of the study presents the characteristics of the bibliometric dataset and analyzes annual scientific production and annual average citations, offering insights into the publication trends and citation performance of the research domain. The bibliometric dataset comprises 3,267 journal articles published between 2017 and 2026 (Table 2), indexed across 1,376 sources, providing a comprehensive representation of the rapidly evolving field of artificial intelligence in research funding. The literature exhibits a strong annual growth rate of 40.22%, reflecting increasing scholarly interest in AI-assisted grant matching, proposal development, and funding ecosystems. The documents have an average age of 2.54 years and an average of 27.36 citations per document, indicating that the field is both recent and influential. The dataset includes 27,178 authors, with an average of 10.6 co-authors per document and 38.54% international co-authorship, highlighting the collaborative and interdisciplinary nature of this research domain. In this regard, these characteristics demonstrate a rapidly expanding and globally connected knowledge base suitable for mapping the intellectual landscape of AI in research funding.

Table 2. Dataset Summary

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2017:2026
Sources (Journals, Books, etc)	1376
Documents	3267
Annual Growth Rate %	40.22
Document Average Age	2.54
Average citations per doc	27.36
References	147370
DOCUMENT CONTENTS	
Keywords Plus (ID)	16850
Author's Keywords (DE)	9289
AUTHORS	
Authors	27178
Authors of single-authored docs	229
AUTHORS COLLABORATION	
Single-authored docs	236
Co-Authors per Doc	10.6
International co-authorships %	38.54
DOCUMENT TYPES	
article	3267

The annual scientific production demonstrates a substantial increase in research on AI in research funding over the study period. Publications increased markedly from 22 articles in 2017



to 826 articles in 2025, demonstrating sustained and rapidly growing scholarly interest in artificial intelligence in research funding. Although only 461 articles were indexed for 2026, this lower count reflects the incomplete coverage of the publication year rather than a decline in research activity. This analysis is evidenced by the linear forecast line as shown in Figure 2. Conversely, the average citations per year declined from 123.32 in 2017 to 0.66 in 2026 (Figure 2). The declining average citations per year primarily reflect the citation time-lag effect, as recently published studies have had less time to accumulate citations than earlier publications, rather than indicating a reduction in their scholarly impact (Donthu et al., 2021; Hassan & Duarte, 2024). Therefore, these findings indicate that AI-assisted grant matching, proposal development, and funding ecosystems constitute a rapidly expanding research domain that continues to attract increasing academic attention.

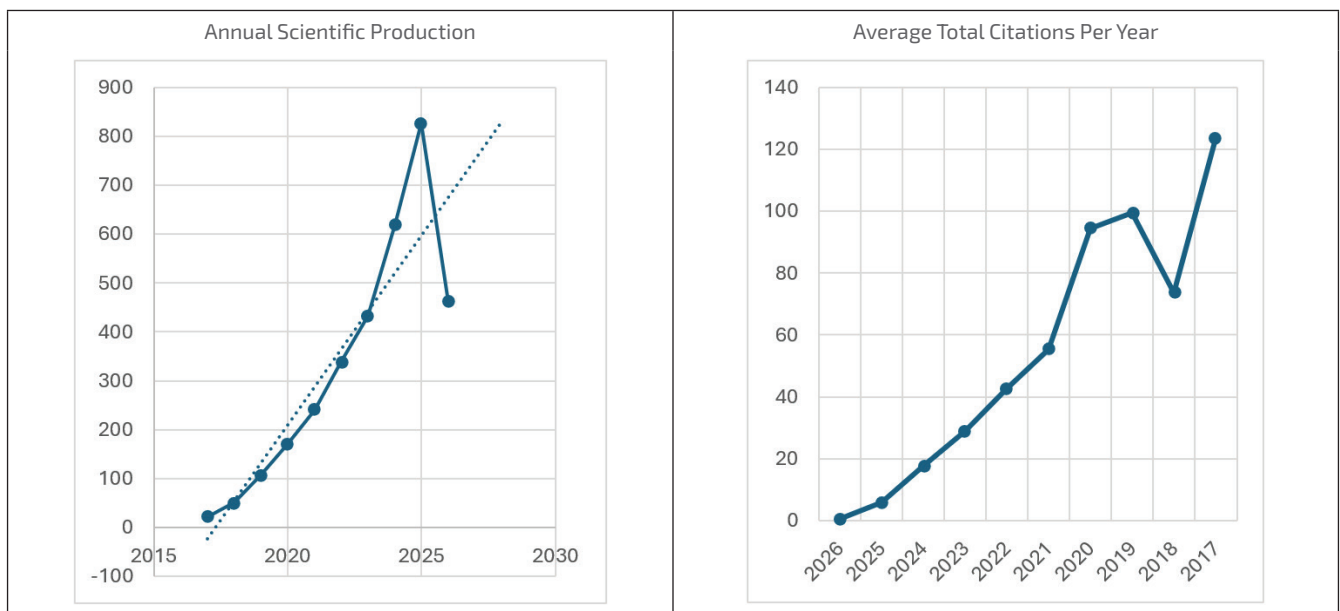


Figure 2. Annual Scientific Production and Annual Average Total Citations Per Year

Performance Analysis

This part of the study includes the most productive sources, authors, countries, and documents. Bradford's Law identifies the core sources that contribute the largest share of publications within a research field. As shown in Figure 3, the literature is distributed across 1,376 sources and follows the classical Bradford distribution, comprising a core of 16 highly productive sources, followed by 318 sources in Zone 2 and 1,042 sources in Zone 3 (Figure 3). This concentration indicates that a relatively small number of journals account for a substantial proportion of publications on AI in research funding (Subedi et al., 2026). The high goodness-of-fit ($R^2 = 0.9368$) demonstrates that the observed source distribution closely follows Bradford's theoretical model. Moreover, the Bradford multiplier ($k = 11.58$) and the significant KS p-value ($< 2 \times 10^{-16}$) further confirm a highly unequal yet statistically robust distribution of scholarly output across journals.

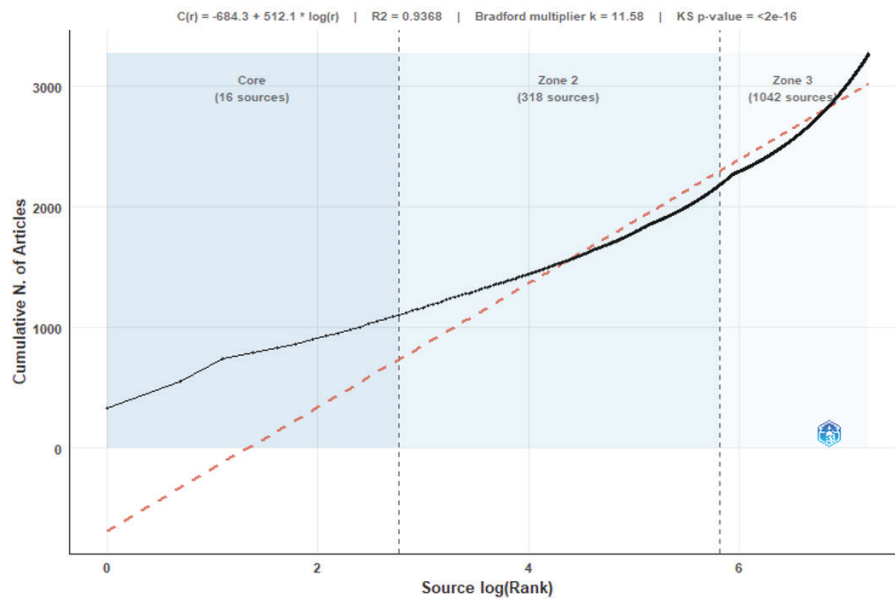


Figure 3. Bradford's Law

Similarly, Lotka's Law describes the distribution of author productivity, suggesting that a large proportion of authors publish only a single article, while relatively few authors contribute multiple publications (Donthu et al., 2021; Passas, 2024). As illustrated in Figure 4, the observed author productivity closely follows Lotka's distribution, with an estimated β value of 2.17, which is consistent with the theoretical expectation (Figure 4). The high coefficient of determination ($R^2 = 0.8932$) indicates that the fitted model explains approximately 89.3% of the variation in author productivity. Furthermore, the Kolmogorov–Smirnov (KS) p-values for both the theoretical model (9.74×10^{-7}) and the fitted model (2.59×10^{-5}) confirm the statistical robustness of the observed distribution. These findings suggest that the field is characterized by a large number of occasional contributors and a relatively small group of highly productive authors who drive its intellectual development (Alonso-Arroyo et al., 2019; Devkota et al., 2026).

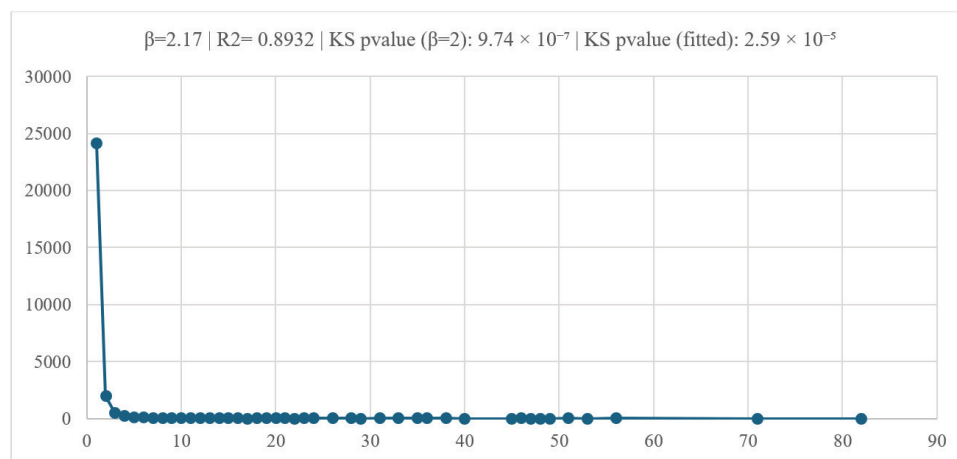


Figure 4. Lotka's Law



Collaboration Structure

This part of the study comprises co-authorship analysis based on countries, co-citation analysis based on sources, and bibliographic coupling based on documents. Co-authorship analysis examines collaborative relationships among countries to reveal the global research network within a scientific field (Abdullaev et al., 2023; Donthu et al., 2021). As shown in Figure 5, the analysis, based on a minimum threshold of 2 documents and 2 citations, reveals a highly interconnected international collaboration network. The United States occupies the central position with the largest node, contributing 1,018 documents, 41,496 citations, and the highest total link strength (1,656), underscoring its dominant role in global knowledge production and international collaboration. Strong collaborative relationships are also evident among China, Spain, the Netherlands, Australia, and Belgium, forming several major research clusters. This is consistent with the study of Devkota et al. (2026). The dense connections among these countries demonstrate that research on AI-assisted grant matching, proposal development, and research funding ecosystems is sustained through extensive international collaboration, with leading research-intensive nations serving as key hubs for knowledge exchange and interdisciplinary scientific advancement.

Similarly, co-citation analysis examines how frequently two sources are cited together, thereby revealing the intellectual structure and foundational knowledge base of a research field (Passas, 2024). Figure 6 presents the source co-citation network using a minimum threshold of 30 citations. The analysis identifies several prominent knowledge clusters, with PLOS ONE emerging as the most influential source (1,175 citations; total link strength = 24,258), followed by The Lancet (801 citations; total link strength = 18,272). Other highly connected journals include IEEE Access, Scientometrics, and Science, reflecting the multidisciplinary nature of the field. The strong interconnections among these sources indicate that research on AI-assisted grant matching, proposal development, and research funding ecosystems is underpinned by interdisciplinary scholarship spanning artificial intelligence, scientometrics, healthcare, and multidisciplinary scientific research.

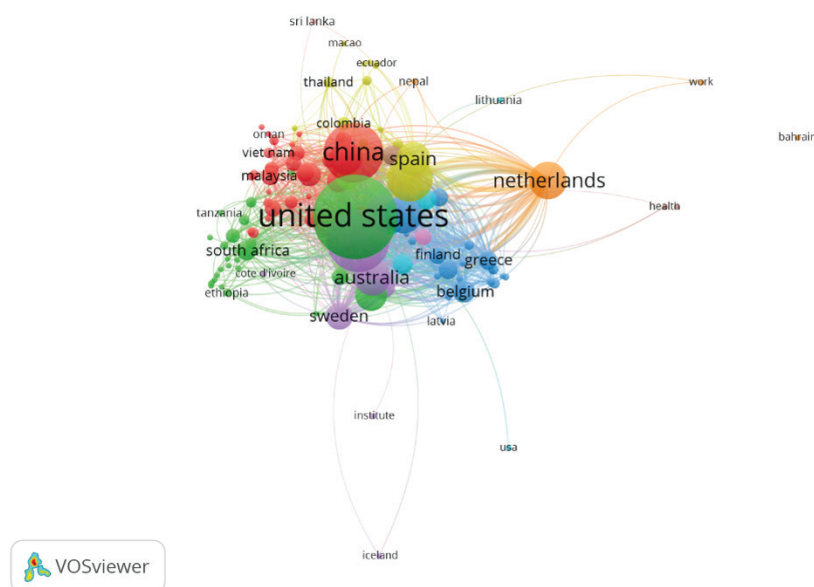


Figure 5. Co-authorship Analysis



Furthermore, bibliographic coupling measures the similarity between documents based on the references they share, thereby revealing contemporary research streams and intellectual connections within a field (Donthu et al., 2020; Mukherjee et al., 2022). Figure 7 presents the bibliographic coupling network for documents with a minimum threshold of 30 citations. The analysis identifies several distinct clusters, with Liu et al. (2020) emerging as the most strongly connected document (total link strength = 127), followed by Denny (2019) (TLS = 112). Bulten (2020) and Coley (2017) also occupy central positions, reflecting their strong intellectual relationships with other publications. The dense coupling among these studies indicates that the field is built upon a cohesive body of contemporary research spanning artificial intelligence, healthcare, and research evaluation. These influential publications collectively underpin the evolving knowledge base of AI-assisted grant matching, proposal development, and research funding ecosystems.

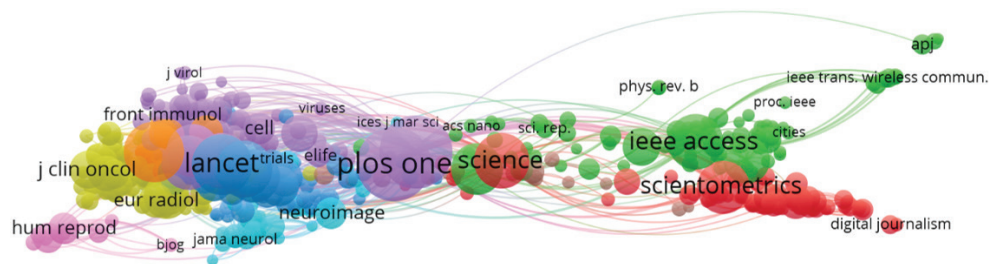


Figure 6. Co-citation Analysis

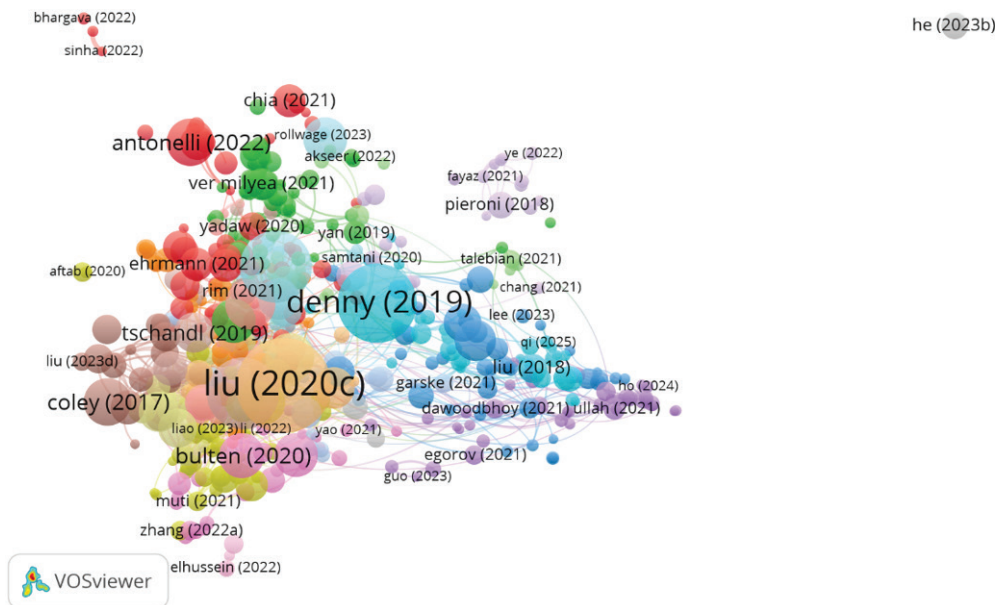


Figure 7. Bibliographic Coupling

Conceptual and Thematic Structure

This section includes keyword analysis, thematic evolution, and thematic mapping. Keyword analysis is conducted using a tree-map, as shown in Figure 8, to identify the most frequently occurring research themes. The tree-map reveals that research (4,368 occurrences), data (4,054), AI (3,498), study (3,681),



and model (3,268) are the dominant keywords, reflecting the strong emphasis on AI-driven research methodologies and data-centric applications. Other prominent terms, including patients, funding, learning, health, methods, and clinical, indicate the interdisciplinary nature of the field, with substantial contributions from healthcare and medical research. Thus, the keyword distribution demonstrates that AI applications in research funding are closely associated with broader advances in data analytics, machine learning, and scientific research (Alonso-Arroyo et al., 2019; Devkota et al., 2026).

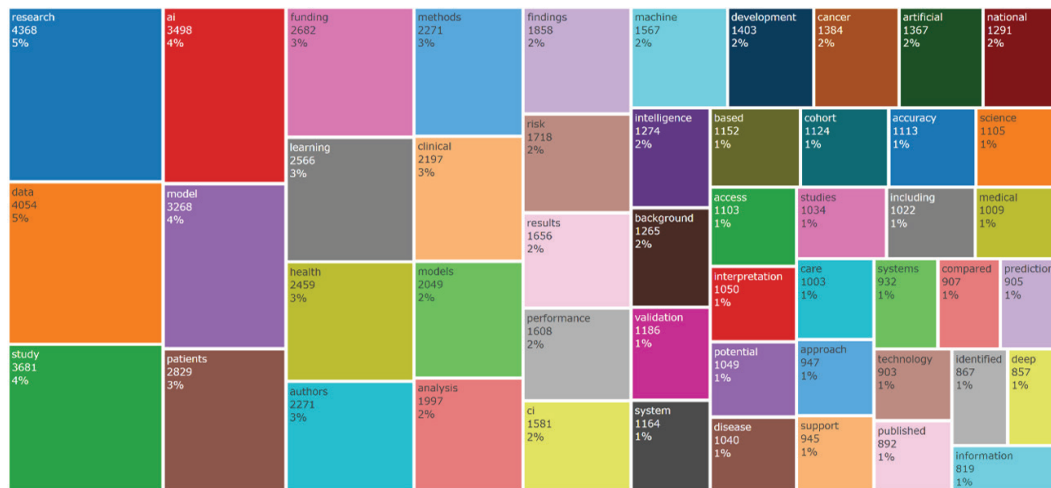


Figure 8. Keyword Analysis

Thematic evolution, in the same way, illustrates how the research focus has shifted over time, revealing the continuity and emergence of major themes across different periods (Donthu et al., 2020). As shown in Figure 9, the period 2017-2020 was dominated by data, learning, and methods. During 2021-2023, the emphasis shifted towards funding, methods, and health, reflecting the expanding application of AI in research funding and healthcare. In the most recent period (2024-2026), methods emerged as the dominant theme, followed by funding and published, indicating a transition from foundational AI research toward methodological advancement and practical implementation within research funding ecosystems.

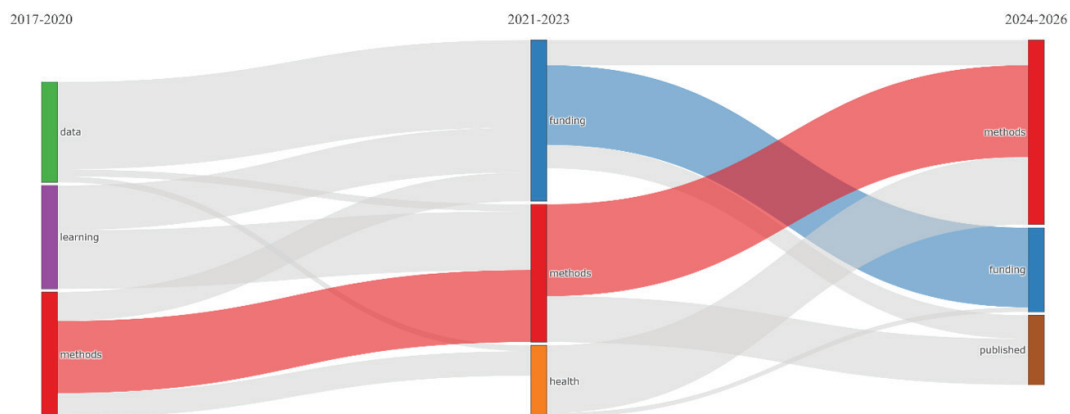


Figure 9. Thematic Evolution



Thematic mapping provides insight into the maturity, relevance, and developmental stage of research themes within the field (Donthu et al., 2020; Mukherjee et al., 2022). As illustrated in Figure 10, methods, findings, and background are positioned in the motor themes quadrant, indicating that methodological innovation is both highly developed and central to advancing research on AI-assisted grant matching, proposal development, and research funding ecosystems. The artificial intelligence, intelligence, and analysis cluster appears within the basic themes, suggesting that these concepts constitute the foundational knowledge underpinning the field while offering opportunities for further development. The funding, authors, and study cluster occupies a transitional position near the centre, reflecting its broad relevance but relatively moderate thematic development. Conversely, learning, machine, and algorithms are located in the declining themes quadrant, indicating that foundational AI techniques are gradually giving way to more application-oriented research focused on AI-enabled research funding processes and methodological advancement.

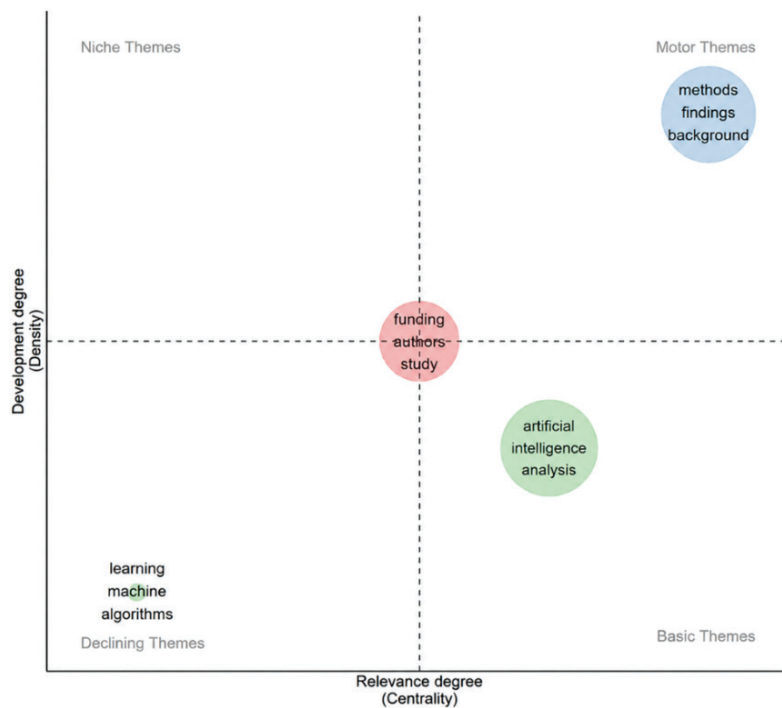


Figure 10. Thematic Map

LESSON LEARNED FROM BIBLIOMETRIC ANALYSIS

The bibliometric findings offer several critical insights into how AI is being positioned to guide and reshape research funding processes. The steady annual growth rate of 40.22%, alongside the sharp rise in publications from 22 in 2017 to 826 in 2025, signals that AI's role in research funding is not a marginal or speculative trend but a rapidly consolidating area of scholarly and practical interest. This growth trajectory, however, must be read alongside the declining average citations per year for recent publications, which, while partly explained by the citation time-lag effect, still suggests that the field is in an early maturation phase where ideas are proliferating faster than they



are being empirically tested, validated, or critically absorbed into established practice (Donthu et al., 2020; 2021). Similarly, the strong presence of Bradford's core sources and the highly skewed Lotka distribution of author productivity further reinforce this picture: a small set of journals and a small group of prolific authors are driving the intellectual agenda, while the majority of contributions remain occasional and exploratory. For higher education, where external research funding directly supports faculty research, graduate research training, institutional research capacity, and knowledge production, this rapid expansion has implications beyond technological adoption (Crompton & Burke, 2023; Lee et al., 2024; Song & Song, 2023). Universities may increasingly depend on AI-enabled funding tools to navigate competitive funding environments, making the maturity and reliability of the underlying evidence particularly important. Therefore, these patterns caution against the premature or uncritical adoption of AI-driven grant-matching, proposal-drafting, or evaluation tools by funding agencies and institutions, since the underlying evidence base, though expanding quickly, has not yet been thoroughly stress-tested for reliability, generalizability, or unintended consequences.

A second lesson emerges from the geographic and collaborative structure of the field. The concentration of scientific production in the United States, China, and the United Kingdom, reinforced by the centrality of the United States within the co-authorship network and its dominance in total link strength, indicates that the intellectual and technical infrastructure guiding AI in research funding is being shaped predominantly by a small number of research-intensive, well-resourced economies. The most influential and most tightly coupled publications, such as Denny et al. (2019), originate largely from these same knowledge hubs, meaning that the conceptual and methodological foundations of the field are disproportionately anchored in institutional contexts that may not reflect the funding norms, disciplinary priorities, or resource constraints of researchers elsewhere. This concentration is particularly relevant to higher education because universities differ substantially in research infrastructure, grant-management capacity, faculty resources, and access to AI technologies (Lawaju et al., 2024; Siddique et al., 2026b). AI funding systems developed primarily within well-resourced research universities may therefore have different implications when applied to teaching-intensive or resource-constrained institutions. This imbalance carries direct practical implications: AI systems designed for grant matching or proposal evaluation, if built on data and assumptions drawn from these dominant contexts, risk embedding rather than correcting existing structural inequities when deployed in more diverse or resource-constrained research funding environments (Abdullaev et al., 2023; Neema & Chandrashekar, 2021). The strong international co-authorship rate of 38.54% demonstrates that collaboration is occurring, but the network structure suggests it is organized around a few central hubs rather than distributed evenly, a pattern that has consequences for whose priorities and assumptions ultimately inform AI-guided funding practices globally (Siddique et al., 2026a).

A third lesson concerns the thematic trajectory of the field, which reveals a discipline in transition rather than one that has settled into a stable identity. The progression from data- and learning-centric themes in 2017-2020 toward funding- and method-centric themes in 2021-2026 indicates that scholarship is maturing from foundational technical development toward applied, process-oriented implementation within actual funding workflows. This is corroborated by the thematic map, where "learning," "machine," and "algorithms" appear as declining themes even as "methods" and



“findings” occupy the motor-theme quadrant, suggesting that the field's centre of gravity is shifting away from algorithmic novelty for its own sake and toward the practical integration of AI methods into grant matching, proposal development, and evaluation processes (Devkota et al., 2026; Zahra & Rautela, 2024). From a higher-education perspective, this shift also suggests that AI-enabled funding is becoming part of the wider digital transformation of academic research, potentially affecting how researchers develop funding competencies, how institutions support grant-seeking activities, and how research opportunities are accessed across academic communities (Baber et al., 2024; Burger et al., 2023; Zahra & Rautela, 2024). At the same time, the transitional positioning of the “funding, authors, study” cluster, neither fully peripheral nor fully established as a motor theme, indicates that AI applications specific to research funding have not yet crystallized into a mature, self-contained research niche with its own settled methodological conventions. Taken together, these three lessons, rapid but unevenly validated growth, geographically concentrated knowledge production, and an unresolved transition from technical novelty to operational maturity, underscore the need for an organizing structure capable of situating these diverse and still-developing strands of AI application within a single coherent model, a need that is addressed directly in the conceptual framework proposed in the following section.

CONCEPTUAL FRAMEWORK FOR AI-GUIDED RESEARCH FUNDING

Building on the bibliometric findings and the lessons identified above, this study proposes a five-stage conceptual framework that situates AI applications within the sequential logic of the research funding lifecycle, moving from opportunity discovery through to broader ecosystem-level communication and governance. The framework positions “AI in Research Funding” as the central organizing construct, around which five interconnected process stages operate: (1) grant discovery, (2) grant matching, (3) proposal development, (4) proposal evaluation, and (5) funding ecosystem (Figure 11). This structure mirrors the thematic clusters revealed in the keyword and thematic-map analysis, where funding, methods, and data-centric themes converge around a shared technical core, while also reflecting the sequential logic through which researchers and funding agencies actually experience the funding process, from first becoming aware of relevant opportunities to eventually operating within a transparent, well-governed funding environment.

The first two stages, grant discovery and grant matching, together correspond to the acceleration of the initial phase of the funding journey, though they represent analytically distinct functions (Bloch & Sørensen, 2015; Thelwall et al., 2023). Although grant discovery was not explicitly identified through the bibliometric analysis, it is retained as the first stage based on the foundational work of Gardner et al. (2022). They identify funding opportunity identification as the essential starting point of the research funding process, upon which all subsequent stages depend. According to Bloch and Sørensen (2015), grant discovery involves AI-enabled scanning and aggregation of dispersed funding calls across public agencies, private foundations, and international bodies, using natural language processing and web-scraping techniques to identify and structure funding information that would otherwise remain fragmented across disparate sources. Grant matching, as per Munagandla et al. (2024), then builds on this structured pool of opportunities, applying machine learning and semantic-



similarity algorithms to align specific calls with a researcher's expertise, publication history, and institutional profile, reducing search costs and information asymmetry. This conceptualization is supported by the bibliometric findings, where AI, data, learning, methods, and funding emerged as the dominant keywords, while methodological innovation and AI-driven funding processes constituted the core thematic structure of the field. Together, these two stages transform an unstructured funding landscape into an actionable, personalized set of opportunities, setting the stage for proposal development (Ebadi & Schiffauerova, 2015; Neema & Chandrashekar, 2021).

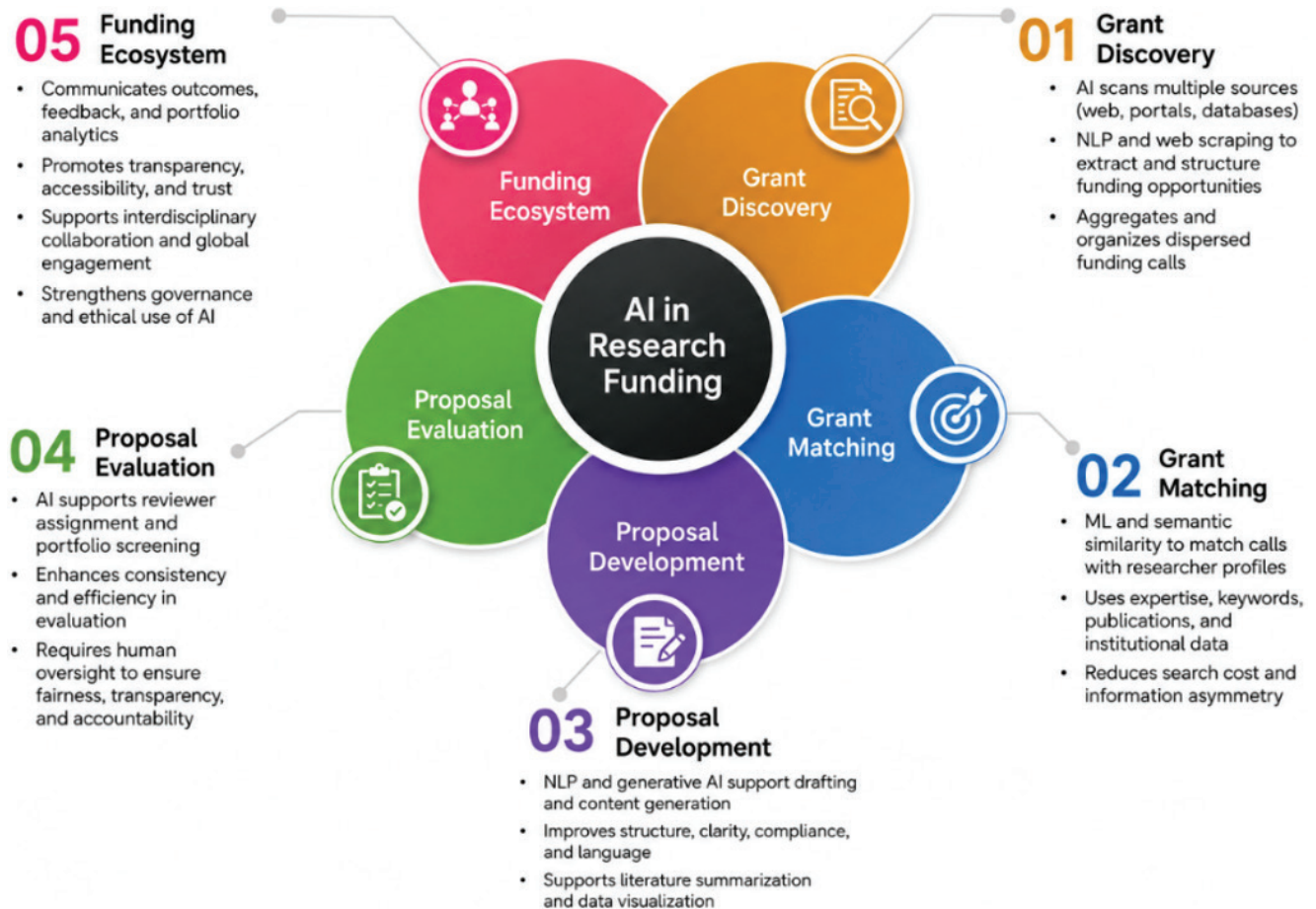


Figure 11. AI in Research Funding

The third stage, proposal development, draws on natural language processing and generative AI tools to support drafting, language refinement, structural compliance, and literature summarization, functions that parallel the broader “academic text writing” applications of AI and that were shown in the thematic evolution analysis to be gaining prominence between 2021 and 2026 (Barrientos et al., 2026; Munagandla et al., 2024; Naganuma et al., 2026). The resulting proposal then enters the fourth stage, proposal evaluation, where AI supports reviewer assignment, portfolio screening, and evaluation consistency in a manner analogous to AI-enabled optimization in data management, though this stage necessarily requires sustained human oversight to safeguard fairness and



accountability, a concern repeatedly surfaced in the literature on algorithmic bias in funding decisions (Chikwarti & Alexander, 2023; Filipovic, 2025). The fifth and final stage, funding ecosystem, closes the loop by addressing how AI-supported outcomes, funded projects, evaluation records, and portfolio-level analytics, are communicated back to researchers, institutions, and policymakers, and how transparency, accessibility, and interdisciplinary collaboration are maintained across an increasingly international funding landscape, consistent with the strong international co-authorship patterns observed in the collaboration network (Gardner et al., 2022; Mocanu et al., 2024; Munagandla et al., 2024; Naganuma et al., 2026). Rather than treating these five stages as isolated technical interventions, the framework emphasizes their interdependence: inefficiencies or biases introduced at the discovery or matching stage propagate through proposal development and evaluation, ultimately shaping the fairness and legitimacy of the broader funding ecosystem, thereby offering a foundation for understanding where AI adds value and where governance safeguards are most urgently needed.

CONCLUSION

This study examined the evolution of AI in research funding through a bibliometric analysis of 3,267 journal articles and proposed a conceptual framework that organizes AI applications in research funding. The findings demonstrate that this is a rapidly expanding yet still-emerging research domain, characterized by strong publication growth, increasing international collaboration, and an interdisciplinary knowledge base spanning artificial intelligence, scientometrics, healthcare, and research evaluation. The performance, collaboration, and conceptual analyses reveal that scholarly attention has progressively shifted from foundational AI technologies toward application-oriented research focused on improving funding discovery, proposal preparation, and decision-making processes. Building on these findings, the proposed framework consolidates fragmented research into an integrated lifecycle model that explains the role of AI across the five stages of the research funding process: grant discovery, grant matching, proposal development, proposal evaluation, and the funding ecosystem. Further, from a practical perspective, the framework offers guidance for funding agencies, research institutions, and policymakers in adopting AI technologies to enhance efficiency, accuracy, and accessibility while emphasizing the continued importance of human oversight to ensure fairness, transparency, accountability, and equity in funding decisions. For higher education, the framework highlights the potential of AI to strengthen university research capacity by supporting researchers and research administrators in accessing funding opportunities and developing competitive proposals.

LIMITATIONS

This study has several limitations that should be considered when interpreting its findings. First, the analysis is restricted to Scopus-indexed, English-language, and open-access journal articles, while the exclusion of other databases, such as Web of Science, may have omitted relevant interdisciplinary literature. Second, the keyword-based search strategy may have



captured healthcare and clinical AI studies that mention “funding” or “grants” without substantively examining AI-enabled research funding processes, potentially inflating the dataset and introducing thematic noise. Conversely, reliance on predefined keywords may have excluded relevant studies using alternative terminology to describe AI, research funding, grant management, or funding decision-making. Third, consistent with the nature of bibliometric research, the study does not undertake a formal quality appraisal of individual articles, which limits assessment of the methodological robustness of the underlying evidence compared with systematic reviews. Fourth, the concentration of self-citations from a single research group may influence citation patterns and the representativeness of the reference base.

AREA OF FURTHER STUDY

Future research should broaden the evidence base by integrating multiple bibliographic databases, refining search strategies, and applying systematic quality-assessment procedures. The proposed five-stage framework should be empirically validated through case studies of AI adoption within research funding agencies and comparative investigations across diverse geographic and institutional contexts. Longitudinal research could examine how AI-enabled grant-matching systems influence funding distribution and equity over time. Experimental studies should assess the effects of generative AI-assisted proposal writing on proposal quality and reviewer evaluations. Further research should investigate how AI-supported funding decisions affect research diversity, interdisciplinarity, and scientific innovation. Such evidence would strengthen understanding of the long-term implications, effectiveness, and responsible implementation of AI across the research funding ecosystem.

DECLARATIONS

Declaration of Ethics: Ethical approval was not required for this study as it is based solely on the analysis of published literature and does not involve human participants or animal subjects.

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Declaration of Funding: The authors received no financial support for the research, authorship, or publication of this article.

Declaration of Generative AI Use: Generative AI (ChatGPT-4.0) was used solely to assist with language improvement, including grammar, clarity, and readability. The authors remain fully responsible for the content, analysis, interpretation, and conclusions presented in this article.

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