ARTIFICIAL INTELLIGENCE AND THE TRANSFORMATION OF DIGITAL SEARCH ECOSYSTEMS: A BIBLIOMETRIC REVIEW OF INFORMATION LITERACY AND USER BEHAVIOR

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Abstract
This study aims to analyze the development and impact of artificial intelligence (AI) in digital search ecosystems and its influence on information literacy and user behavior. The problem addressed is how AI affects the way users search for, access, and assess information within search systems influenced by algorithms, and how digital and AI literacy affect the quality of the information obtained. The research method used is bibliometric analysis with a quantitative approach, utilizing Biblioshiny and VOSviewer tools to analyze data retrieved from the Scopus database. The data includes scholarly articles published between 2014 and 2024 related to AI, information literacy, and user behavior in digital search ecosystems. The main findings of this study show a sharp increase in publications related to AI and information literacy since 2020, with key findings highlighting the importance of Machine Learning and Deep Learning in enhancing user experience in search systems. This research also identified a significant gap in studies linking information literacy with user interactions in AI-powered search environments. In conclusion, this study contributes theoretically by clarifying the importance of AI literacy as a core component of information literacy in addressing challenges posed by AI in digital search systems. Practically, the findings suggest the need for the development of AI literacy programs and policies that support equitable access, especially in developing countries like Indonesia.

Keywords: Artificial Intelligence, Bibliometric analysis, Digital literacy, Information literacy, User behavior

INTRODUCTION

In recent years, the proliferation of artificial intelligence (AI) technologies has brought about significant changes in how individuals seek, process, and interact with information. Globally, digital search ecosystems are evolving from passive repositories into dynamic, AI-powered environments that shape information accessibility, relevance, and user experience

(Adewojo et al., 2025; Alzahrani et al., 2025; Meesad & Mingkhwan, 2024). The rise of large language models (LLMs), intelligent recommendation systems, and automated retrieval tools has transformed the way search functions, blurring the traditional boundaries between user queries and system intelligence. This transformation represents a paradigm shift in information systems, where algorithmic mediation increasingly influences what information is presented and how users engage with it (Komara & Widjaya, 2024).

In countries like Indonesia, undergoing rapid digital transitions, users with limited digital literacy struggle to navigate AI-powered search systems, exacerbating the information literacy deficit. Insufficient digital literacy impairs users' ability to critically assess AI-driven search results, contributing to the widening information gap, particularly in educational settings and among the general public (Widjaya & Komara, 2023). This gap is of particular concern in educational institutions, libraries, and among general users. If not addressed, this could widen the disparity between those who have the skills to navigate AI-driven environments and those who do not.

Furthermore, the integration of AI into digital search and retrieval practices is reshaping user behavior. It is affecting how people search for information, their trust in automated outputs, and their reliance on algorithmic suggestions (Shin, 2023; Virvou, 2023). For instance, user acceptance of AI-based reference services in libraries has been closely linked to digital literacy and AI literacy, affecting how critically users approach information consumption. Understanding these behavioral shifts is crucial for evaluating the long-term impact of AI on the way we seek and use information.

The social and educational implications of these developments are substantial. If left unexamined, the transformation could exacerbate existing inequalities by privileging individuals who already possess strong digital literacy, while marginalizing those who lack these skills. On the other hand, AI-enhanced search ecosystems have the potential to democratize access to knowledge, improve discoverability, and foster lifelong learning (Veerakannan, 2025). This presents an opportunity to create more inclusive digital environments, but it requires careful examination of the factors that contribute to both digital and AI literacy among users.

Despite the growing importance of these issues, existing literature remains fragmented. Although some bibliometric studies have examined AI's role in digital literacy, they tend to be broad and lack a focused exploration of how AI specifically transforms search ecosystems and affects user behavior in information-seeking contexts (Komara, Rohman, et al., 2025). There is a scarcity of studies that integrate information literacy and user behavior as core elements within AI-mediated search systems (Baptista et al., 2025; Krakowska & Zych, 2025). Moreover, while bibliometric reviews of AI in information systems or AI in education exist, they rarely highlight the intersection of AI, information literacy, and user behavior as critical variables.

This gap is significant. Current research does not adequately explore how users, with varying levels of information literacy, interact with AI-driven search environments. Nor does it examine how these interactions influence the quality, credibility, and consumption of information. As a result, there is limited understanding of the cognitive and social processes that shape user experiences and outcomes in AI-driven search contexts.

Therefore, this study aims to conduct a systematic bibliometric review of the scholarly literature on artificial intelligence, digital search ecosystems, information literacy, and user behavior. The research will map publication trends, identify thematic focuses, explore geographical and disciplinary distributions, and uncover underexplored areas regarding user literacy and behavioral adaptation in AI-mediated search. By doing so, this research seeks to

make both theoretical and practical contributions. Theoretically, it will clarify how the scholarly discourse has addressed or neglected the convergence of AI, information literacy, and user behavior. Practically, it will inform educators, librarians, system designers, and policymakers about the critical competencies needed to navigate this evolving landscape and help ensure equitable access to information.

RESEARCH METHOD

This study adopts a descriptive quantitative research approach, utilizing bibliometric analysis to explore trends and patterns in AI, information literacy, and user behavior in digital search ecosystems. selected Scopus as our data source due to its comprehensive indexing of peer-reviewed scholarly literature, ensuring a high-quality dataset for bibliometric analysis. The Biblioshiny and VOSviewer tools were employed to analyze the data, providing performance analysis and science mapping through co-authorship, co-word, and citation analysis. These tools facilitate a detailed examination of the relationships between key themes, authors, and publications within the field. Bibliometric analysis is a quantitative method employed to uncover new insights into research trends by analyzing existing scientific publication data (Komara et al., 2025). A well-executed bibliometric study can significantly contribute to the advancement of a scientific discipline, providing researchers with an in-depth understanding of the field's development, identifying knowledge gaps, and generating new research ideas (Aria & Cuccurullo, 2017; Donthu et al., 2021).

For this study, data was harvested from the Scopus database in December 2025, selected for its comprehensive coverage of high-quality scientific literature across multiple fields of study. Scopus provides metadata that is compatible with bibliometric analysis tools such as Biblioshiny. It is also recognized for its broad coverage of social sciences and technology, with a more user-friendly interface for large-scale bibliometric data extraction than other databases like Google Scholar, and sometimes offers more extensive journal coverage than Web of Science (WoS) for the specific topics addressed in this research. However, it is important to acknowledge the potential limitations of Scopus, including its language bias, as it predominantly indexes English-language publications, and its coverage bias, as not all global publications are indexed by this database.

The search for research data related to "Artificial Intelligence," "Machine Learning," "Deep Learning," "Information Literacy," "Search Strategy," "User Satisfaction," and "Information Seeking Behavior" was conducted using a combination of these keywords in the Scopus database. The query was refined with the following parameters: TITLE-ABS-KEY (("Artificial Intelligence" OR "AI" OR "Machine Learning" OR "Deep Learning") AND ("Information Literacy" OR "Search Strategy" OR "User Satisfaction" OR "Information Seeking Behavior")) AND (LIMIT-TO (PUBYEAR, 2014–2024)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")). The keywords "Information Seeking Behavior" and "User Satisfaction" were incorporated to capture the full scope of the topic. This inclusion criterion targeted English-language articles published between 2014 and 2024, ensuring relevance to recent advancements in AI and information systems. While TITLE-ABS-KEY is a common and effective method for retrieving relevant articles, we acknowledge the limitation that this criterion may miss articles where the key terms appear in other sections (e.g., abstract or keywords). Further research could expand the query to test its sensitivity by including these sections, improving the comprehensiveness of the search.

The article selection process, as illustrated in the PRISMA flow diagram (Figure 1), involved several stages. Initially, articles were retrieved based on the specified search criteria. Duplicate records were then eliminated using Scopus' automatic deduplication feature, followed by a manual check to confirm accuracy. The inclusion criteria required that articles be scientific publications that directly addressed the topics of interest. Articles that did not meet this criterion, including non-peer-reviewed works or those that merely mentioned the keywords without a primary focus on the research themes, were excluded. Articles that passed the screening were then exported in CSV format, facilitating data analysis using Biblioshiny and VOSviewer programs.

The primary bibliometric techniques applied in this study include performance analysis and science mapping. Performance analysis measured several metrics, such as publication frequency, author productivity, and citation impact. Science mapping was conducted using co-authorship, citation, and co-word analyses, with the aim of mapping publication trends, co-authorship networks, and thematic development over time.
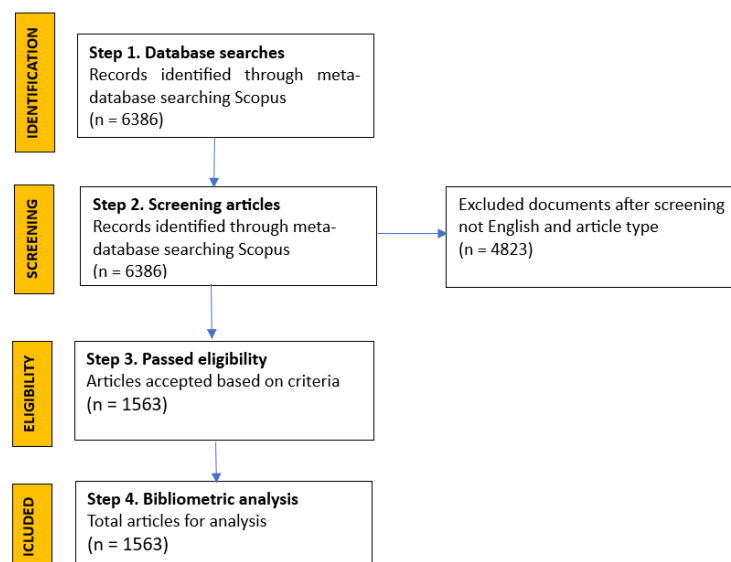

Figure 1. PRISMA flow diagram

The PRISMA flow diagram (Figure 1) outlines the screening process used to select articles. A total of 6,386 records were retrieved based on the query criteria. After removing duplicates and non-peer-reviewed works, 1,563 articles were included. During the screening phase, semantic relevance was assessed manually by evaluating the abstract and full text of each publication against the inclusion criteria. Articles that did not focus on AI-mediated search systems or lacked a clear connection to information literacy or user behavior were excluded. This step is essential to mitigate potential bias from irrelevant publications and ensure that only studies pertinent to the research question were included. Given the reliance on English-language documents in Scopus, potential language bias may have excluded valuable non-English literature, which is a limitation of the study.

To ensure rigorous interpretation, we employed standard bibliometric techniques to operationalize co-authorship, co-word, and citation analysis. Co-authorship analysis was used to identify collaborative research networks and the most productive authors in the field, while co-word analysis mapped the thematic development of AI-related topics over time. Citation

analysis was used to evaluate the impact and influence of specific articles. The science mapping method, focusing on density (the number of publications in a specific topic) and centrality (the relevance of a topic within the network), helped to identify the dominant research themes and their interconnections.

The density and centrality of thematic clusters were interpreted based on standard bibliometric frameworks, with density reflecting the level of research activity and centrality indicating the importance of themes within the scholarly discourse. The clearer identification of these clusters provided insights into how different subfields within AI, such as machine learning, deep learning, and information literacy, are interconnected and evolving.

RESULT AND DISCUSSION

Publication Growth

Based on the data presented in Table 1, the annual scientific production has experienced a substantial increase over the years, particularly since 2019. The graph indicates a rapid acceleration in the number of published articles from a modest number in the earlier years to a sharp increase in recent years. This trend demonstrates a clear upward trajectory in the field of study, highlighting an increase in research output, particularly from 2020 onward, as reflected by the data in Table 1.

Table 1. Annual scientific production

Year	Articles
2014	22
2015	23
2016	31
2017	33
2018	49
2019	76
2020	104
2021	160
2022	222
2023	300
2024	543

From 2014 to 2018, the number of articles published grew steadily but modestly. In 2014, there were only 22 articles, and this number slowly increased to 49 articles in 2018. This slower growth can be attributed to early stages of research development or perhaps the emergence of the subject matter in scientific communities. During this period, the research field may have still been gaining traction, with fewer researchers focusing on this particular area of study. The increase during this period, although positive, shows a relatively modest growth rate.

The years 2019 to 2021 represent a more pronounced shift in the scientific production of articles. The number of articles grew from 76 articles in 2019 to 160 in 2021, indicating a sharp acceleration. This could be attributed to several factors, such as a growing interest in the subject matter, increased funding and support for research, or perhaps the rise of new technologies and methodologies that have made research more efficient. Additionally, 2020 marked a year when global disruptions, like the COVID-19 pandemic, may have played a role in

encouraging a shift towards digital and remote research efforts, leading to greater collaboration and faster publication processes.

The period from 2022 to 2024 represents an explosive growth phase in the field, with the number of published articles jumping significantly. In 2022, 222 articles were published, and in 2023, this number increased further to 300 articles. The most dramatic increase occurred in 2024, with 543 articles published. This surge can be attributed to the accumulation of years of prior research activity, the maturation of the field, and perhaps the heightened availability of resources and support for research. The rapid acceleration in 2024 indicates that the field is now well-established and that the volume of research is scaling up at an exponential rate.

Author Analysis

Figure 3 displays a list of the most relevant authors in the field, with each having contributed five documents to the body of research. This chart highlights the individuals who have played a significant role in advancing research within the specified area, suggesting that these authors are key contributors and possibly recognized thought leaders. Their publications may have had a notable influence in shaping the direction of studies related to artificial intelligence, information literacy, and user behavior in digital search ecosystems. Given the equal contribution from each author, this list underlines the diversity of expertise in the field, spanning across various academic disciplines and institutional backgrounds.
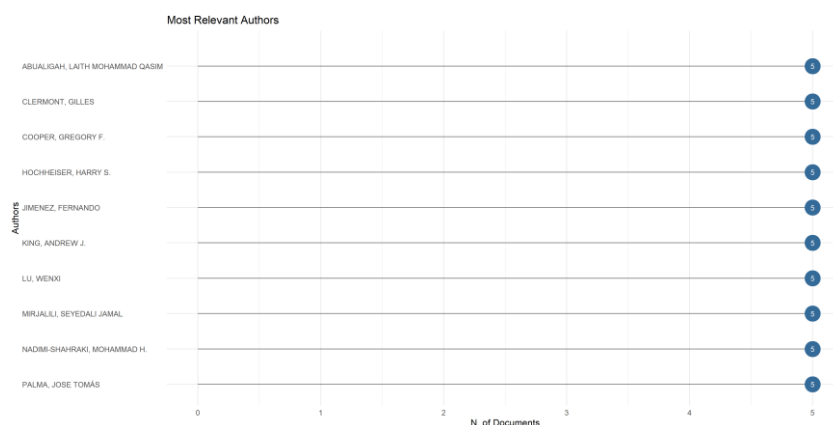

Figure 3. Most Relevant Authors

The equal representation of each author, with five publications each, signals that the research domain is highly collaborative, with multiple scholars contributing equally. This could suggest a trend where the body of work on the topic is being developed through joint efforts rather than being dominated by a few leading individuals. It may also reflect an emerging interdisciplinary approach, where authors from diverse fields such as computer science, information systems, and behavioral studies are contributing to a more integrated understanding of how AI is transforming digital search ecosystems. This growing diversity of contributors is essential for fostering innovation and advancing research methodologies, as it encourages a wider range of perspectives and theoretical frameworks in addressing the challenges and opportunities presented by AI in information retrieval systems.

Co-Word and Topic Analysis

The network visualization in Figure 5 represents key thematic areas in AI research, revealing the relationships between core concepts, keywords, and research fields. It displays a clear division between three primary areas: Artificial Intelligence (AI), User Satisfaction, and Algorithms/Search Strategy. These areas are interconnected through various keywords and show a multidimensional approach to AI research. Each node in the network corresponds to a keyword, with larger nodes indicating more frequently occurring terms, and the lines between them signify connections or co-occurrences in the literature. This layout allows for an understanding of how different research domains and methodologies within AI are intertwined, highlighting areas of overlap and focus.

Figure 5. Network visualization of co-occurrence analysis

The Artificial Intelligence area, as expected, forms a central hub in the network, with strong links to terms like research, impact, satisfaction, and AI technology. This suggests that AI is a dominant and foundational field in current research. The term health emerges as a notable focus, as AI is increasingly applied in health-related fields such as diagnosis, health information, and nurses. The substantial connection between chatbot and student emphasizes the growing research into AI-powered conversational agents for educational purposes, particularly in the context of student learning and user interaction (Labadze et al., 2023). This cluster reflects the broad applicability of AI across various sectors, including education, healthcare, and customer satisfaction, demonstrating its cross-disciplinary relevance.

The User Satisfaction area, marked by green nodes, links closely to terms such as satisfaction, trust, and user experience. This cluster emphasizes the growing importance of understanding user interaction with AI systems, particularly regarding user trust and satisfaction. Keywords like intention, user experience, and e-government service suggest a focus on how users engage with AI systems in real-world applications, including public services. The mention of continuance intention reflects interest in how users' ongoing interactions with AI systems are influenced by their satisfaction and trust. This highlights the critical need for research that not only improves the technical performance of AI systems but also ensures they meet user needs and expectations effectively. Overall, the network emphasizes that the

development of AI technologies should go hand-in-hand with research into human-computer interaction, satisfaction, and usability to ensure widespread acceptance and positive outcomes.
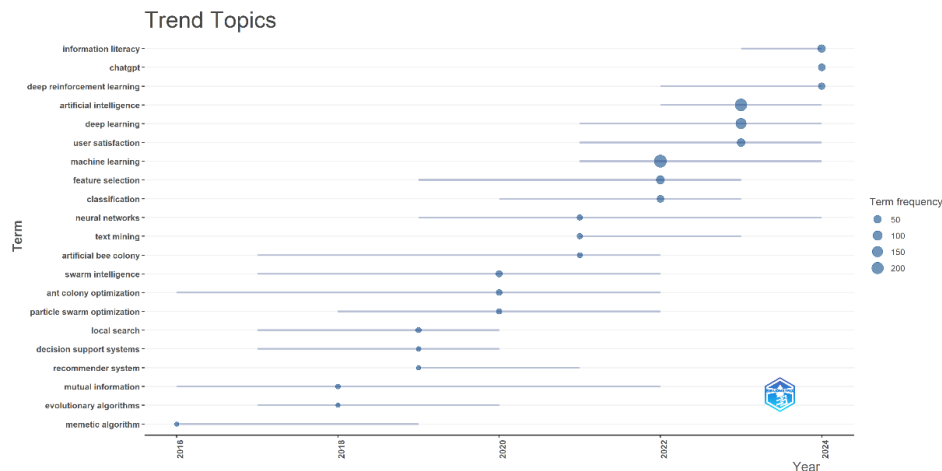

Figure 6. Research topic trends 2003-2024

The trend topics presented in Figure 6 show the evolution of key research terms in the field of Artificial Intelligence (AI) and related areas from 2016 to 2024. The graph highlights a substantial increase in the frequency of terms such as Information Literacy, ChatGPT, Deep Reinforcement Learning, and Artificial Intelligence. These terms reflect the rapidly expanding focus on AI technologies, their application across various sectors, and the growing interest in how AI influences digital search and user behavior. Notably, Information Literacy emerged as a key topic early in the timeline and has seen steady growth, indicating a continuous recognition of the importance of understanding how users interact with AI systems and the information they provide (Komara & Widjaya, 2024).

The period from 2020 to 2024 marks the sharpest rise in the frequency of terms related to AI and Machine Learning, particularly with terms such as Deep Learning, Artificial Intelligence, and User Satisfaction gaining prominence. This shift can be attributed to the increasing real-world applications of AI technologies, particularly in fields like healthcare, business, and education, where these technologies are now integral to decision-making and information retrieval (Liao et al., 2023; Yin et al., 2021). The rapid development and deployment of systems like ChatGPT and other conversational AI technologies in recent years further fueled this rise. These advancements have sparked discussions around the ethical use of AI, user interaction, and the overall impact of AI on user satisfaction and engagement, which are key areas reflected in this research trend.

Machine Learning and Feature Selection are also gaining increasing attention, indicating a focus on optimizing AI models to make them more efficient and effective. The rise of these terms suggests that researchers are not only concerned with the development of AI but are also focused on improving how AI systems handle large datasets, select relevant features, and adapt to user behavior in real-time. This trend aligns with broader technological shifts, where improving AI's performance and its ability to make informed, accurate decisions in complex environments is a priority (Ekundayo, 2024; Kovari, 2024). As AI applications expand, the focus on optimization techniques like Swarm Intelligence, Ant Colony Optimization, and Particle Swarm Optimization reflects a growing interest in finding innovative ways to make AI systems smarter and more adaptable.

Concept Mapping

Figure 6 below illustrates a thematic mapping of AI research, highlighting the development degree (density) and relevance degree (centrality) of various research topics. This visualization effectively categorizes topics into Motor Themes, Basic Themes, Niche Themes, and Declining Themes, offering insight into how various AI-related fields are positioned in terms of their research intensity and centrality in the broader AI landscape.
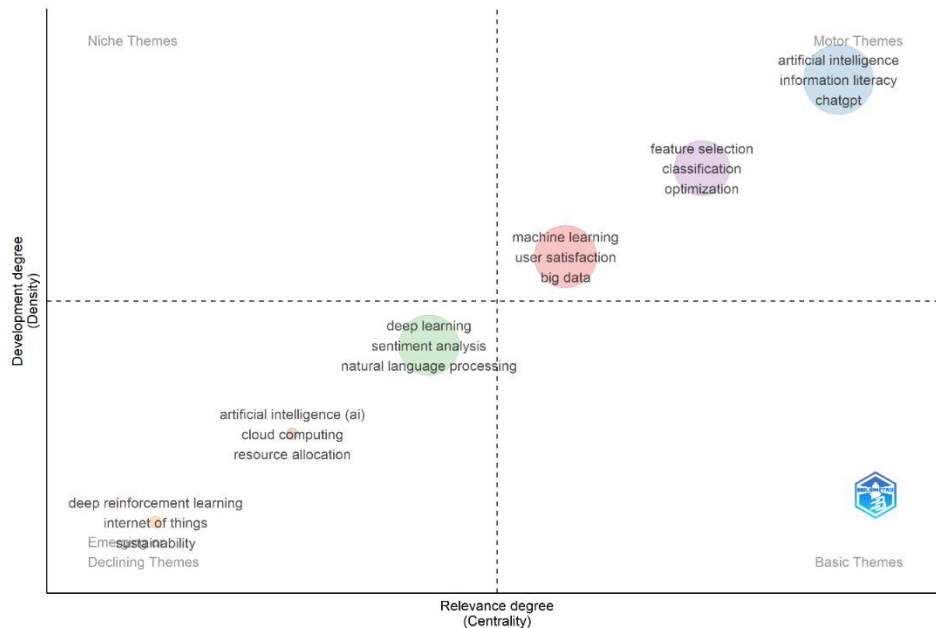

Figure 6. Thematic concept mapping

The Motor Themes comprising Machine Learning, User Satisfaction, Big Data, and Feature Selection occupy the top right quadrant of the chart. These topics are highly developed (high density) and centrally relevant (high centrality). This suggests that these fields are at the forefront of AI research, with substantial research output and a direct impact on various AI applications across industries. The prominence of Machine Learning and Big Data in this quadrant emphasizes the foundational role of these technologies in the ongoing development of AI. As data volumes continue to grow, machine learning algorithms and techniques for processing and analyzing large datasets are becoming increasingly vital for advancements in AI.

In the top left quadrant, the Niche Themes such as Deep Learning, Sentiment Analysis, and Natural Language Processing (NLP) are represented. These fields, while showing high development density, occupy a more specialized or niche position in AI research. They are actively evolving but are not as central to the AI discourse as the Motor Themes. Deep Learning in particular continues to show remarkable growth, especially in areas like NLP and Computer Vision, but its application is often domain-specific, indicating that these are more advanced sub-fields within AI. The rise of deep learning and its use in specialized tasks like language translation or facial recognition is indicative of how AI is becoming increasingly sophisticated and capable of performing complex, human-like tasks.

The Basic Themes category, which includes fundamental AI concepts like Artificial Intelligence (AI), Cloud Computing, and Resource Allocation, falls into the bottom right quadrant. These topics are highly relevant to the field, but they are relatively underdeveloped compared to the Motor Themes. This placement suggests that while these themes are widely

acknowledged and central to AI discourse, they are still in the foundational or exploratory stages of research. For example, AI itself, as a concept, is central to all AI-related research, but much of the foundational work on AI technologies and infrastructure (like cloud computing) is still being developed to support more advanced applications such as Machine Learning and Deep Learning.

Moving to the bottom left quadrant, we observe the Declining Themes, such as Deep Reinforcement Learning, Internet of Things (IoT), and Sustainability. These areas show lower development density and relevance degree, indicating that while they were once considered cutting-edge, their research activity has plateaued or declined in comparison to the other fields. Deep Reinforcement Learning, for instance, has faced challenges in terms of its practical application due to the complexity and high computational cost involved in training such models. Likewise, IoT, despite its early promise in connecting devices and enabling smart systems, may have been overshadowed by more pressing AI advancements in areas like Machine Learning and Big Data.

Sustainability as a declining theme suggests that while there has been significant interest in applying AI to environmental and sustainability challenges, it may have become less central in AI research compared to more technical areas like Deep Learning or Optimization. As the research landscape matures, these declining themes may be overshadowed by more emergent technologies, or they could be integrated into more focused sub-disciplines within the broader AI field, particularly those centered on sustainable AI and green computing.

The chart effectively maps the dynamic shifts in AI research, showing where the most active and relevant topics lie, and where the field might be headed. The rise of Motor Themes highlights the growing importance of Machine Learning and Big Data in shaping AI's future, while Niche Themes like Deep Learning continue to carve out specialized applications. The Basic Themes indicate the foundational work still being done to support AI, and the Declining Themes point to areas where interest may be waning, though they could still evolve or be absorbed into other areas. As the AI field progresses, the themes in the Motor and Niche quadrants are likely to remain at the forefront of innovation, driving new breakthroughs and applications across sectors

CONCLUSION

This bibliometric analysis of the intersection between artificial intelligence (AI), information literacy, and user behavior in digital search ecosystems has provided critical insights into the current state of research and its rapid development, particularly since 2020. The study found a sharp increase in AI-related publications, especially in machine learning, deep learning, and user satisfaction. These findings underline the growing importance of AI in transforming digital search systems, highlighting its pivotal role in reshaping information retrieval and enhancing user experience. This study's contributions reflect AI's potential to advance the accessibility and relevance of information in digital environments, making it a central focus of ongoing research.

A dominant theme in the research is the centrality of machine learning and deep learning, which have become foundational to AI's advancement. These technologies are now integral to complex tasks such as natural language processing and image recognition. However, a critical gap remains in addressing the role of information literacy in AI-driven environments. While AI technologies have progressed, user behavior and the effects of varying levels of digital literacy on interactions with AI-powered systems are still underexplored. The study emphasizes

the need for future research focused on understanding how users with differing levels of digital literacy engage with AI-driven search systems and how these interactions impact the quality and trustworthiness of the information retrieved. This gap signals the urgency of integrating AI literacy into educational frameworks and public policy.

Theoretical implications of this study contribute significantly to the understanding of how AI and information literacy intersect. The findings suggest a shift towards incorporating AI literacy as a core component of information literacy frameworks, which is necessary to ensure users can effectively navigate and critically assess AI-mediated search environments. Practically, the study highlights the need for targeted interventions to enhance both digital and AI literacy, particularly in developing countries like Indonesia. Policymakers, educators, and system designers are urged to consider these gaps when designing educational programs and AI systems to ensure equitable access and effective use of AI-powered technologies.

While this study provides valuable insights, it has certain limitations. First, the reliance on Scopus as the primary data source introduces potential bias, as it predominantly includes English-language publications and may exclude valuable contributions from non-English-speaking regions. Furthermore, while bibliometric analysis has proven effective in identifying trends, it inherently carries methodological constraints such as citation lag and database indexing bias. These factors may impact the comprehensiveness of the analysis, as some key studies could be omitted or delayed in citation metrics. Future research could address these limitations by incorporating a broader range of databases, including non-English sources, and extending the analysis to qualitative studies on user behavior in AI systems.

Additionally, the focus on bibliometric analysis, while useful for tracking research trends, does not fully capture the qualitative aspects of user experience with AI systems. Future studies could adopt mixed-methods approaches, combining quantitative bibliometric data with qualitative insights from user surveys and interviews. This would provide a more nuanced understanding of user interactions with AI systems and the factors that influence user trust, satisfaction, and engagement. Moreover, examining the socio-cultural dimensions of AI's impact in diverse global contexts, particularly in non-Western societies, could offer deeper insights into how AI affects user behavior in different regions.

This study makes an essential contribution to the field by mapping out the trends, gaps, and implications of AI's role in digital search ecosystems. It underscores the need for further research into the intersection of AI, information literacy, and user behavior. The rapid growth of AI-driven technologies calls for urgent attention to the development of AI literacy programs to ensure that users can critically engage with these systems. Future research should not only build on the findings of this study but also address its limitations by exploring diverse user demographics, non-English literature, and the broader socio-cultural factors that shape AI interactions. These efforts will contribute to the creation of more inclusive, equitable, and effective AI systems that meet the needs of all users.

SUGGESTION

Further research could explore the cultural and social dimensions of AI-mediated information retrieval, particularly in non-Western contexts. Additionally, studies examining the ethical implications of AI in shaping user behavior and information access, as well as the long-term effects on information literacy, would be valuable for developing more inclusive and equitable AI systems.

THANK YOU-NOTE

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