

Bibliometric analysis of technological innovations in Indonesian libraries: trends, challenges, and future directions

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DOI: <https://doi.org/10.65881/integration.v1i1.33>

ARTICLE INFO

History:

Received: 02-11-2026

Revised: 02-15-2026

Accepted: 02-16-2026

Published: 02-18-2026

Keywords:

technological innovation;
technology implementation;
policy strengthening;
library technology.

ABSTRACT

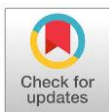
Purpose: to map the development of technological innovation in Indonesian libraries through bibliometric analysis, identify trends, challenges, and patterns of collaboration, and provide strategic guidance for the development of libraries that are adaptive, inclusive, and sustainable.

Method: using a bibliometric approach with the PRISMA framework to analyze Scopus-indexed articles (2015–2025) on technological innovation in Indonesian libraries, examining publication trends, subject areas, document types, geographic distribution, and thematic relationships.

Findings: indicate a growing trend in publications on technological innovation in Indonesian libraries, primarily in Computer Science and Social Sciences. Most publications are journal articles, with international contributions dominating, especially from China, the United States, and India. Thematic analysis reveals strong links between technological innovation, knowledge management, service efficiency, and the evolving role of libraries in digital transformation.

Implications: provides strategic guidance for policymakers and library managers to develop adaptive and inclusive technologies, enhance human resource competencies, and promote cross-disciplinary and international collaboration for sustainable digital transformation of libraries in Indonesia.

Originality: applying a bibliometric approach to map technological innovation in Indonesian libraries comprehensively, a perspective rarely explored in the local context, while integrating analyses of trends, institutional collaboration, and implementation challenges.



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Introduction

The article on bibliometric analysis of technological innovations is motivated by the rapid development of information and communication technology (ICT), which has

transformed various sectors, including the library sector. Technological innovations in libraries, such as digital library management systems, e-book services, and internet-based borrowing applications, have become increasingly popular in Indonesia. However, their implementation in certain regions, particularly outside major urban areas, remains limited. Therefore, it is essential to examine trends in technological innovation in Indonesian libraries to understand the extent to which these technologies have been adopted, their impact on library services, and identify opportunities for future development. Previous studies have highlighted several relevant aspects, including the mediating role of student learning engagement (Chang, 2025), the importance of fostering technological innovation and addressing communication gaps (Violet & Sri, 2025), and the need for stakeholders to integrate technology effectively into library services (Anisha et al., 2025).

Research on technological innovation in Indonesian libraries indicates that adopting information and communication technology (ICT) can enhance the accessibility and efficiency of library services (Purnamasari et al., 2025; Riady et al., 2023). Despite this progress, several challenges persist, particularly regarding disparities in technological access between urban and rural areas. Furthermore, librarians lack adequate training to manage continuously evolving digital systems effectively. This study aims to provide insights into the extent to which technology has been implemented in Indonesian libraries and to examine how research in this field contributes to improving the quality of library services across Indonesia, from urban centers to remote regions. Previous studies have offered valuable perspectives on digital transformation and innovation. For instance, research by Żywiołek et al. (2025) emphasizes the importance of accelerating digital transformation in the resource sector and strengthening digital innovation capacity. In contrast, Cheng et al. (2025) highlights the critical role of knowledge management and digital technology innovation in organizational development. Additionally, Ayyaswamy et al. (2025) underline the need for libraries to understand technical aspects, ensure data security, and provide staff training in the use of technology, while Xie & Zhang (2025) stress the importance of digital feasibility and system stability. Moreover, Adeyemi et al. (2025) suggest that academic libraries should prioritize fostering a culture of innovation and enhancing staff literacy skills to support sustainable technological advancement.

Although the application of technology in libraries offers significant potential benefits, the existing challenges cannot be overlooked. One of the primary issues is the disparity in access to technology, which hampers the implementation of such innovations in certain regions. Furthermore, the limited capacity of library staff represents a substantial obstacle, as not all librarians possess the necessary competencies to operate and manage emerging technologies effectively. Therefore, this study also seeks to explore potential solutions to address these challenges, including enhancing professional training programs and providing equitable technological infrastructure. These efforts are essential to ensure that libraries across Indonesia can optimally utilize technology in delivering services to the community. Previous research has highlighted several important aspects of library technology development. For example, Asim et al. (2023) discuss the integration of digital collections in libraries. Ishola et al. (2025) emphasize the importance of developing local technologies to support digital libraries and electronic services. Similarly, Jianing et al. (2024) identify priority opportunities for technological advancement and innovation in digitization. Meanwhile, Martzoukou (2021) argue that library digitization initiatives aim to enhance institutional websites and advance academic disciplines.

The novelty of this study, in comparison with previous research, lies in its specific focus on technological innovation in Indonesian libraries through a bibliometric approach. Most prior studies have examined technological developments within a global context or in developed countries. In contrast, the adoption of technology in Indonesian libraries remains in a developmental stage and is unevenly distributed, particularly in remote areas. Furthermore, earlier research has generally concentrated on specific technological applications, such as library management systems or e-book services, without comprehensively analyzing the broader development of research trends in this field. By employing bibliometric analysis, this study seeks to provide a more holistic perspective on research trends, patterns of institutional collaboration, and the overall impact of technological innovation on the enhancement of library services in Indonesia.

The diversity and novelty of this study are reflected in its approach to identifying research trends in technological innovation within the Indonesian context, which has often been overlooked in previous studies. By employing a bibliometric analysis that integrates multiple variables, such as the number of publications, institutional contributions, and the impact of technology on improving access and service efficiency, this research offers a more comprehensive understanding of the developments and challenges libraries in Indonesia face. Moreover, this study addresses a gap in the existing literature, which has largely focused on global perspectives or specific technological applications, by providing a detailed mapping of technology implementation within the local Indonesian context. The novelty of this research lies not only in the object of study but also in the methodological approach adopted, thereby generating new insights for library managers and policymakers in formulating strategies for sustainable technological development. Previous studies have also contributed important perspectives. For instance, Yuhan et al. (2024) evaluate science and technology innovation policies in the context of libraries. Cabanes et al. (2024) highlight challenges related to resources, funding, labor, time constraints, and strategic positioning in advancing educational technology innovation. Meanwhile, Gupta & Gupta (2024) demonstrate the use of the Connected Papers platform (connectedpapers.com) to collect and analyze data from scientific literature.

The urgency of this research is considerable, given libraries' crucial role in Indonesia's educational and information systems, particularly amid the rapid advancement of technology. Libraries no longer function solely as repositories for printed materials; rather, they serve as centers of information access that significantly influence educational quality and the development of community knowledge. Despite technological progress in this sector, many libraries in Indonesia have not yet optimally utilized technological innovations. Disparities in access to technology between urban and rural areas, along with the limited availability of skilled human resources to manage digital systems, constitute substantial challenges. Therefore, this study is essential for mapping developments and identifying the challenges Indonesian libraries face in implementing technological innovations. The findings are expected to provide practical recommendations for library managers and policymakers in designing more equitable and effective strategies for technological development across Indonesia. Previous research supports the relevance of this study. Tinmaz & Ivanovici (2024) argue that the era of technological innovation significantly influences library development. Furthermore, Gaitanou et al. (2024) note that libraries are undergoing continuous transformation. Adam et al. (2024) emphasize the importance of policy development to foster partnerships and enhance educational curricula, while Khalil et al. (2024) examine the impact of information technology media within library contexts.

The problem formulation of this study focuses on analyzing the development of research on technological innovation in Indonesian libraries through several key aspects. First, it examines the trends in the number of publications and the factors influencing their growth. Second, it identifies the journals that publish the most articles on this research theme and analyzes their contributions to knowledge dissemination. In addition, the study examines the subject areas of these journals to determine the disciplinary scope of the topic. Furthermore, this research aims to identify subject areas closely related to technological innovation in libraries and to explore the main topics that frequently emerge through cluster analysis. The study also examines document types and the geographical distribution of publications by country. Finally, it seeks to identify potential future research topics in the field of technological innovation in libraries, thereby providing direction and guidance for subsequent research and development.

Method

This study employs the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to systematically identify, screen, and select articles relevant to the research theme of technological innovation in libraries in Indonesia (see Figure 1).

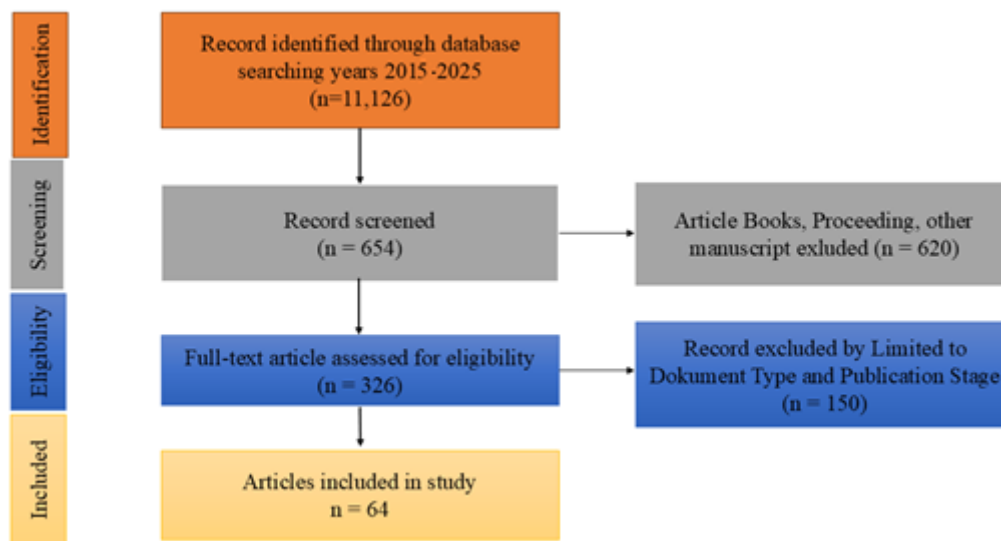


Figure 1 PRISMA method

At the identification stage, a comprehensive search was conducted using the Scopus database with the keywords “Technology Innovation,” “Library,” and “Indonesia.” The search was limited to publications from 2015 to 2025 and initially yielded 11,126 articles related to the research theme. This stage aimed to identify all potentially relevant articles, thereby ensuring a broad scope for subsequent screening and analysis.

Following the identification stage, a screening process was conducted to ensure that only articles meeting the established research criteria proceeded to the next phase. Publications in the form of books, conference proceedings, and unpublished manuscripts were excluded. Of the 11,126 records initially identified, 654 articles underwent further screening, and 620 were excluded for failing to meet the relevance criteria. This screening stage is crucial to ensure that the selected articles demonstrate sufficient

quality and direct relevance to the theme of technological innovation in libraries in Indonesia.

At the feasibility evaluation stage, the filtered articles were further assessed to ensure alignment with the research objectives. Only articles that met the feasibility criteria were included in the subsequent analysis. Of the 654 screened articles, 326 were deemed feasible and considered for further review. After a final evaluation, 64 articles that satisfied all inclusion criteria were selected for bibliometric analysis. The PRISMA method provides a systematic framework that ensures only relevant and high-quality articles are included, thereby enabling a comprehensive and valid analysis of technological innovation in libraries in Indonesia.

Results and discussion

Number of publications per year

Figure 2, which illustrates the number of publications per year on library information technology in Indonesia, can be described as follows:

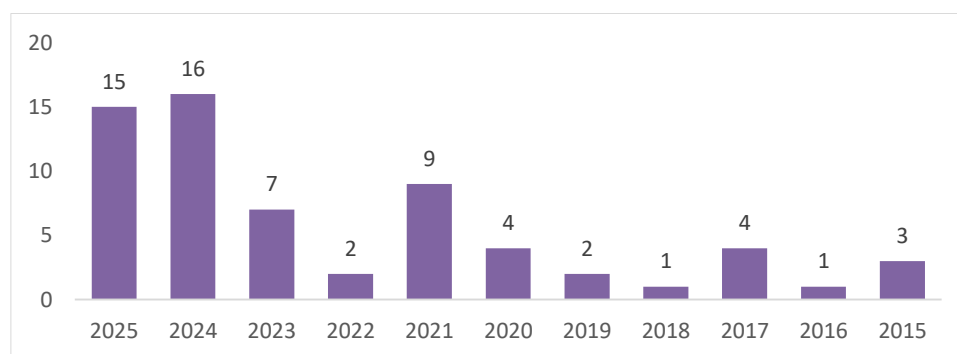


Figure 2 number of publications per year
Source: Scopus, 2026

Figure 2 shows a trend of increasing publications related to technological innovation in Indonesian libraries, particularly in recent years. In 2025, 15 articles were published, while in 2024, the number was slightly higher at 16 articles. This trend reflects a growing interest in the topic, with increasing attention to the development and application of technological innovations in library services. The observed increase may indicate greater awareness of the role of technology in enhancing the efficiency and quality of library services, both nationally and internationally. Additionally, the rise in publications suggests progress in research on integrating technology into library management, including the development of digital library systems and the adoption of new technological solutions in Indonesia.

However, before 2024, the number of publications declined sharply, with only 7 articles in 2023, 2 in 2022, and even fewer in earlier years. This decrease may suggest that, despite the initial growth in interest, research in this field is entering a phase of refinement and consolidation. Other contributing factors could include limited funding, inadequate research infrastructure, or challenges in conducting in-depth studies, which may affect both the volume and continuity of publications. Furthermore, as emerging research becomes increasingly specialized, the number of articles meeting specific publication criteria may also decrease. Nevertheless, this trend offers valuable insights into the dynamics of research development in this area, indicating that, despite these

challenges, technological innovation in Indonesian libraries remains a promising and relevant field for scholarly investigation.

Subject area

Table 1, which presents the subject areas of articles related to library information technology in Indonesia, can be described as follows:

Table 1 journal subject area

Nu.	Field of study	Amount	Nu.	Field of study	Amount
1	Computer science	24	12	Biochemistry, genetics and molecular biology	2
2	Social sciences	23	13	Agricultural and biological sciences	2
3	Engineering	12	14	Physics and astronomy	1
4	Medicine	9	15	Pharmacology, toxicology and pharmaceuticals	1
5	Business, management and accounting	4	16	Nursing	1
6	Arts and humanities	4	17	Multidisciplinary	1
7	Environmental science	3	18	Immunology and microbiology	1
8	Energy	3	19	Health professions	1
9	Mathematics	2	20	Decision sciences	1
10	Economics, econometrics and finance	2	21	Chemistry	1
11	Earth and planetary sciences	2	22	Chemical engineering	1

Source: Scopus, 2026

Based on data on journal subject areas, most publications on technological innovation in Indonesian libraries are concentrated in Computer Science and Social Sciences. Specifically, 24 articles were published in Computer Science and 23 in Social Sciences, indicating that research in these areas frequently addresses the development of information systems and technology-based library data management. Additionally, the presence of 9 articles in the field of Engineering highlights the link between technological development and its practical application in library service innovation.

Other subject areas, such as Medicine, Business, Management and Accounting, and Environmental Science, show minimal representation in this topic, with 12, 4, and 3 articles, respectively. This suggests that research on technological innovation in libraries is primarily situated within technical and social contexts, while its connections to other fields, such as medical or managerial disciplines, remain limited. Furthermore, some less represented subjects, such as Physics and Astronomy, Pharmacology, and Immunology and Microbiology, each have only one article, indicating very low or negligible relevance to the study of technological innovation in libraries.

Types of document

Figure 3, which presents the types of documents related to library information technology in Indonesia, can be described as follows:



Figure 3 types of documents

Source: Scopus, 2026

Based on Figure 3, which presents the types of documents, the majority of publications related to technological innovation in libraries are journal articles, totaling 35. This suggests that research in this field is primarily disseminated through articles that emphasize empirical studies and the practical application of technology in libraries. The second most common type of document is conference papers, with 12 publications, indicating that a substantial portion of research is shared at conferences, likely highlighting the latest developments and ongoing discussions in library technology. Review articles account for 7 publications, reflecting comprehensive analyses or literature reviews on technological innovations in libraries. Other document types, such as book chapters (5), conference reviews (4), and errata (1), make a smaller contribution, demonstrating that the primary channels for scholarly communication in this area remain journal articles and conference proceedings.

Country/territory

Figure 4, which illustrates the distribution of countries publishing on library information technology in Indonesia, can be described as follows:

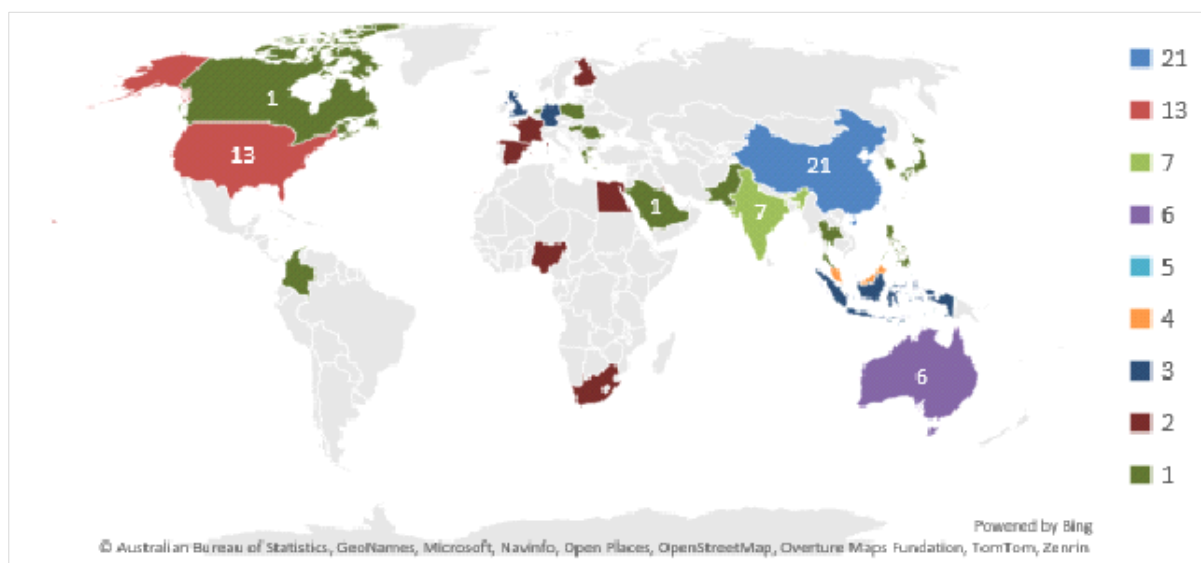


Figure 4 contribution of countries to the article

Source: Scopus, 2026

Based on Figure 4, which presents the countries and territories of publication, it is evident that research on technological innovation in libraries in Indonesia receives significant contributions from other countries. China leads with 21 articles, followed by the United States with 13 and India with 7. This pattern indicates that countries with advanced technological innovation and information system development strongly influence research in library technology. Although Indonesia itself has only 3 publications in this category, countries such as Malaysia (5 articles) and Australia (6 articles) contribute more, highlighting the potential for growth and collaboration in the Asia-Pacific region. Several other countries contributed fewer publications: France, Finland, Egypt, and Thailand each had 2 articles, while Colombia, Canada, and Bahrain each had 1. These findings demonstrate that while technological innovation in libraries is not limited to major countries, it is increasingly gaining attention worldwide. Nevertheless, Indonesia, with its considerable potential in the digital library sector, needs to enhance its research and publication efforts to remain competitive with other countries in applying technology to library services.

The relationship between research themes

Figure 5, which illustrates the relationship between research themes and library information technology in Indonesia, can be described as follows:

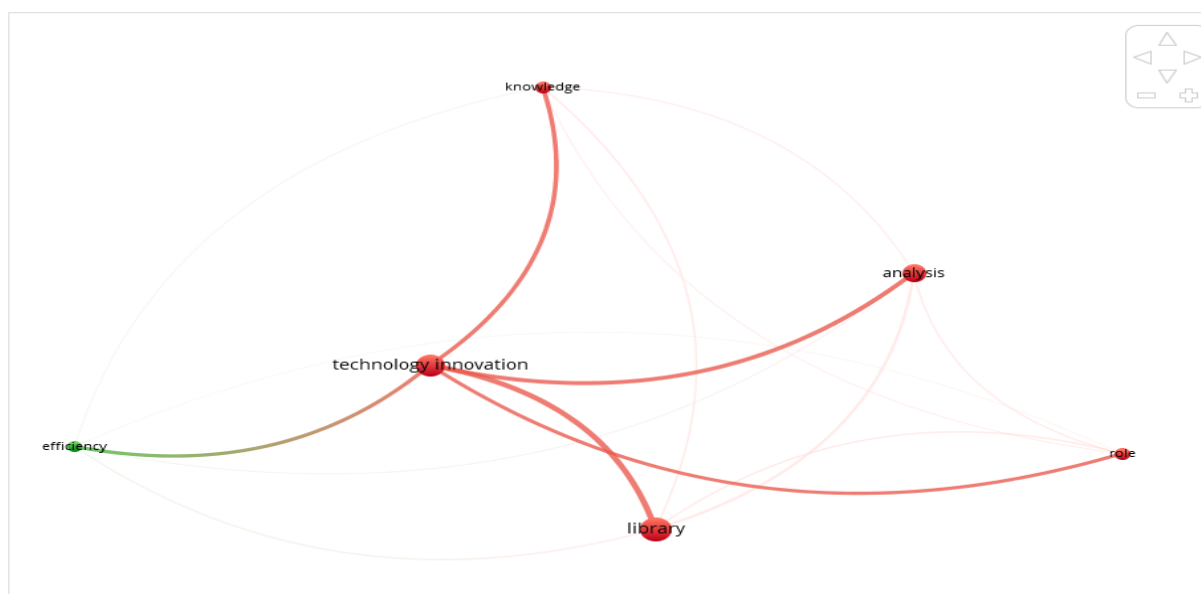


Figure 5 relationship between research themes

Source: Scopus, 2026

Figure 5 presents a network visualization of the relationships among key concepts in research on technological innovation in libraries. The analysis shows that “technology innovation” serves as the central hub, connecting to several other concepts, including “knowledge,” “analysis,” “efficiency,” and “library.” The strong linkage between “technology innovation” and “library” indicates that the primary focus of these studies is on applying technological innovations within the library context to improve knowledge management and operational efficiency. This suggests that research in this area aims to explore how technology can enhance library services and advance library information systems in Indonesia.

Moreover, the concept of “knowledge” is closely linked to “analysis,” indicating that many studies focus on how technology influences the dissemination and management of knowledge within libraries. This relationship also reflects research examining the role of technology in enhancing the efficiency of library services. The connection with “role” emphasizes how technological innovation contributes to transforming the functions of libraries. In other words, the network illustrates a dynamic interplay between technology, efficiency, knowledge analysis, and the evolving role of libraries in the modern context. It provides insights into how innovative technologies can reshape the library ecosystem to achieve improved services and outcomes.

Research trends

Research trends indicate a shift in focus from merely adopting technology toward a more strategic and systematic understanding of library transformation. Studies are no longer limited to the implementation of specific devices or systems; instead, they increasingly position technological innovation as part of broader changes in service ecosystems, governance structures, and organizational culture within libraries. This development suggests that research is moving toward a more conceptual, holistic approach. In addition, research trends demonstrate a strengthening of interdisciplinary approaches. Technological innovation in libraries is examined not only from a technical perspective but also in relation to social, managerial, and policy dimensions. In other words, research increasingly views technology as an instrument integrated with user behavior, librarians’ competencies, digital literacy, and institutional strategies. This approach underscores that digital transformation in libraries is understood as a multidimensional process rather than merely an infrastructure upgrade.

The theme of technological innovation in libraries in Indonesia is very relevant and crucial in the current era of digitalization. Libraries, as institutions responsible for distributing knowledge, need to transform to keep up with the times. Technology offers many opportunities to improve operational efficiency and expand community access to information. The use of digital-based library management systems, online borrowing services, and the application of artificial intelligence in collection management are examples of innovations that can help libraries face modern challenges. Therefore, research exploring the application of technology in libraries is crucial for understanding how technology can enhance service quality and the relevance of libraries in an increasingly digitally connected society. Research can strengthen studies that examine the innovative application of artificial intelligence technology in library and information science research (Quan et al., 2024) and the interactive development of innovation and technology standards (Chen & Fu, 2023).

Research has also increasingly addressed issues of sustainability and equitable access. The focus of scholarly inquiry extends beyond technological advancements in urban centers to highlight capacity gaps and implementation challenges in less developed regions. Consequently, research trends reflect a growing concern for equity in information access and for strengthening human resource capacity as a key determinant of successful innovation. From a methodological perspective, the growing use of bibliometric analysis indicates a tendency to map the development of knowledge in a more systematic and data-driven manner. This approach enables researchers to identify patterns of collaboration, thematic trajectories, and future research opportunities in a more structured way. Thus, research trends are evolving not only at the substantive

level but also through increasingly comprehensive and evidence-based analytical approaches.

Research challenge

The research challenges discussed in this article primarily concern the complexity of digital transformation in libraries, which is not merely technical but also structural and cultural. Research in this field encounters difficulties in integrating multiple dimensions, technology, human resources, policy, and user needs into a single comprehensive analytical framework. The rapid pace of technological change further requires researchers to continuously update their perspectives and analytical indicators to remain relevant to evolving field dynamics. Moreover, there are challenges in obtaining representative and evenly distributed data. The highly diverse conditions of libraries in Indonesia, regarding infrastructure, funding, and human resource capacity, make generalizing findings particularly difficult (Winata et al., 2021). Research must account for variations in local contexts to avoid bias toward institutions that are already more technologically advanced. This situation calls for methodological approaches that are sensitive to regional differences and institutional characteristics.

Another challenge relates to the limitations of research collaboration and networking. The development of technological innovation in libraries ideally requires cross-disciplinary and cross-institutional collaboration, including partnerships among academics, library practitioners, and policymakers. However, building such synergy is not always straightforward due to differences in priorities, capacities, and institutional orientations. Without strong collaboration, research risks becoming fragmented and may fail to generate strategic impact. This research is crucial for formulating policies and strategies that enable technology to be accessed and utilized evenly across Indonesia, with a focus on enhancing human resources and supporting infrastructure. The research can reinforce Zhang et al. (2023) findings, which identified five aspects of intelligent management systems: retrieval systems, recommendation systems, question-and-answer systems, and search engines. This paper presents several suggestions for using GPT to integrate library services and promote innovation (Zhang et al., 2023). Meanwhile, Jiang & Shan (2023) findings indicate a long-term equilibrium relationship between the science and technology innovation system and public libraries, with both influencing each other and developing synergistically.

Future research directions

Future research should strengthen more contextual and locally grounded approaches. Subsequent studies need to explore in greater depth how technological innovation can be adapted to the characteristics of libraries across various regions of Indonesia, including remote areas and institutions with limited resources. The emphasis should extend beyond technology adoption to encompass adaptive, inclusive, and sustainable implementation models that align with local social conditions and infrastructure. In addition, future research may place greater emphasis on the development of human resource capacity as a key determinant of successful digital transformation. More in-depth studies on librarians' digital competencies, continuous training strategies, and the enhancement of technological literacy among library users are essential to ensure that innovation does not remain confined to technical aspects alone. Such an approach would help create a library ecosystem that is not only technologically modern but also institutionally and culturally prepared. Furthermore, future research could expand cross-disciplinary and international collaboration. Given

the global nature of technological development, comparative and collaborative studies can provide valuable insights into best practices in digital library management. Such research has the potential to develop more effective policy models and implementation strategies, while also strengthening Indonesia's position in the international research landscape on technological innovation in libraries.

Conclusions

Research trends in Indonesian libraries are moving toward more strategic, holistic, and interdisciplinary approaches, focusing on transforming service ecosystems, improving efficiency, and ensuring equitable access to information. However, research faces significant challenges, including the complexity of integrating technology with structural, cultural, and human resource dimensions, as well as limitations in collaboration and the availability of representative data across regions. Future research is directed toward the development of adaptive, inclusive, and sustainable technology implementation models, the strengthening of librarians' digital competencies, the enhancement of user literacy, and the expansion of cross-disciplinary and international collaboration to produce policy strategies and best practices that are both contextually relevant and widely impactful for libraries throughout Indonesia.

This research makes a significant contribution by providing a comprehensive mapping of technological innovation in Indonesian libraries through a bibliometric approach, a rare approach in the local context. The study not only identifies publication trends, academic fields, and patterns of institutional collaboration but also highlights major challenges such as disparities in technological access and limitations in librarian capacity. Furthermore, this research offers strategic directions for future development, including the implementation of adaptive and inclusive technology models, the enhancement of human resource competencies, and the strengthening of cross-disciplinary and international collaboration, making its findings a practical guide for policymakers, library managers, and researchers in promoting a sustainable and equitable digital transformation of libraries across Indonesia.

The limitation of this research lies in its reliance on publications indexed in the Scopus database, which may mean that local literature or publications that have not been digitized are not represented, and in its focus on bibliometric analysis rather than direct empirical investigation in the field. Future research should combine bibliometric approaches with qualitative methods or case studies in Indonesian libraries, including those in remote areas, to gain richer contextual insights into technology implementation, service effectiveness, and the capacities of librarians and users, so that the research findings can provide a more holistic and relevant practical guide for strategies in developing library technology in Indonesia.

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