

Artificial Intelligence in Library Information Systems: A Systematic Review of Applications, Challenges, and Future Directions

Shinta Nur Hasanah^{1*)}, Hendro Mragono¹

¹Department of Information and Library Science, Faculty of Social and Political Science, Universitas Airlangga, Indonesia

*)Correspondence: shinta.nur.hasanah-2024@fisip.unair.ac.id

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Abstract

This study examines the integration of Artificial Intelligence (AI) into modern Library Information Systems (LIS) through a Systematic Review. The study aims to synthesize evidence on the applications, challenges, and future implications of AI adoption in academic and public libraries. Following the PRISMA framework, 26 peer-reviewed articles published between 2019 and 2025 were identified from Scopus, Web of Science, and Google Scholar, of which 10 studies met the predefined inclusion and exclusion criteria and were included in the final analysis. The selected studies were analyzed thematically through systematic coding and grouping of relevant findings according to three themes corresponding to the research questions: AI applications on modern library systems, challenges to AI adoption, and implications for LIS education and professional practice. The synthesis shows that AI technologies, including machine learning, natural language processing, chatbots, and predictive analytics, support a wide range of library functions, including automated cataloging and classification, personalized information services, digital preservation, and data-driven decision-making. However, AI adoption is constrained by algorithmic bias, data privacy and ethical concerns, limited AI literacy among library professionals, inadequate infrastructure, and high implementation costs. The findings further indicate that the growing adoption of AI requires LIS education and professional practice to strengthen AI literacy, technical competencies, ethical awareness, and human-AI collaboration. The study concludes that AI is not merely a technological tool for improving library operations but also a driver of organizational and professional transformation. Sustainable and inclusive AI adoption therefore requires institutional readiness, continuous competency development, ethical governance, and collaboration among librarians, educators, policymakers, and technology developers.

Keywords: artificial intelligence; library information systems; systematic review; AI adoption; library services

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1. Introduction

Libraries have long served as institutions for preserving knowledge, facilitating access to information, and supporting learning and research. Digital transformation has changed the scale, speed, and diversity of information production and has increased expectations for responsive and personalized library services. These changes require libraries to reconsider conventional workflows and explore technologies that can improve both operational efficiency and user experience (Islam & Guangwei, 2025; Cox & Mazumdar, 2024).

Artificial Intelligence (AI) has consequently become an important component of contemporary Library and Information Science (LIS). In the library context, AI encompasses a range of computational capabilities and technologies that support tasks involving learning, pattern recognition, language processing, prediction, recommendation, and decision support (Cox & Mazumdar, 2024). Library

applications include machine learning, natural language processing, expert systems, computer vision, intelligent agents, and robotics (Asemi et al., 2021; Cox & Mazumdar, 2024). Rather than representing a single technology, AI should therefore be understood as a family of capabilities that can be integrated into different library information processes.

AI applications are increasingly visible in both front-end services and back-end operations. Chatbots and virtual assistants can provide reference support and facilitate access to information, while recommendation and discovery systems can help users identify relevant resources (Cox et al., 2019; Narendra et al., 2025). On the operational side, AI can support automated metadata creation, cataloging, classification, collection analysis, and other data-intensive activities (Asemi et al., 2021; Narendra et al., 2025). Reviews of AI in libraries consequently identify service efficiency, resource discovery, personalization, and data-informed management as important areas of application (Narendra et al., 2025).

At the same time, AI adoption introduces organizational and ethical challenges. Library systems process information about users and their information behavior, making, privacy, data governance, transparency, and algorithmic bias important concerns (Ibrahim, 2025; Nathania et al., 2025). Recent literature also identifies limitations in infrastructure, funding, technical expertise, and staff preparedness, particularly in developing-country contexts (Hasrisanty et al., 2024; Orubebe et al., 2025). These challenges indicate that technological capability alone is insufficient; successful adoption also depends on institutional readiness, professional competencies, and governance (Harissanty et al., 2024; Lund et al., 2020).

The implications extend to the professional preparation of librarians. Tait and Pierson (2022) identified opportunities to strengthen AI and robotics content within LIS curricula, while Saeidnia and Keshavarz (2024) emphasized approaches for improving learning and retention of AI-related concepts. Research on Indonesia academic libraries also indicates generally favorable AI awareness while highlighting the importance of infrastructure, competencies, and leadership for implementation (Harisanty et al., 2024).

Although previous studies have discussed particular AI applications, ethical concerns, professional competencies, and adoption barriers, the evidence remains dispersed across technological, organizational, and educational perspectives. This study therefore conducts a systematic review to synthesize these dimensions within a single analytical framework. The review addresses three research questions: (1) How is AI currently implemented in modern library systems? (2) What challenges hinder the effective adoption of AI? and (3) What are the implications of AI adoption for LIS education and the professional practice of librarians?

2. Literature Review

2.1 Artificial Intelligence in Library Information Systems

AI is understood in this study as a set of computational capabilities that can perform or support activities involving learning, pattern recognition, language processing, prediction, recommendation, and decision support. Cox and Mazumdar (2024) emphasize that AI is an umbrella covering multiple technologies and library use cases rather than a single technology. In library environments, its significance therefore lies in how these capabilities are embedded in information processes, including back-end processing, user services, data and AI literacy, data-science activities, and user management (Cox & Mazumdar, 2024).

The literature shows that AI can extend existing library information systems by automating repetitive and data-intensive activities. Asemi et al., (2021) review applications involving expert systems, AI, and robotics in technical and public library services, while Narendra et al., (2025) identify machine learning, natural language processing, and other data-driven techniques as important directions in contemporary LIS. The theoretical implication is that AI can increase the capability of information systems to classify, recommend, retrieve, predict, and interact with users (Asemi et al., 2021; Narendra et al., 2025)

2.2 Smart Libraries

The concept of the smart library extends the idea of a digital library by emphasizing interconnected technologies, intelligent services, data-driven decision-making, and user-centered environments. A smart library is not defined simply by the presence of digital resources; it depends on the integration of technological, service, human, governance, and physical dimensions that enable the library to respond dynamically to user needs (Yunus et al., 2025). The systematic review by Yunus et al., (2025) identifies six major smart-library themes: smart technology, smart service, smart people, smart governance, smart places, and smart buildings.

From this perspective, AI can function as one of the technologies that enables smart-library capabilities through intelligent discovery, recommendation, automation, conversational interfaces, and analytics (Yunus et al., 2025; Narendra et al., 2025). These capabilities can make library services more adaptive and data-informed, but smart-library development also requires supporting infrastructure, appropriate governance, competent staff, and user-centered service design (Yunus et al., 2025). Thus, AI adoption should be evaluated as part of a broader smart-library transformation rather than as an isolated technical upgrade.

2.3 Digital Transformation in Libraries

Digital transformation refers to organizational change enabled by digital technologies rather than the simple conversion of analogue resources into digital formats (Vial, 2019). Vial (2019) conceptualizes digital transformation as a process in which digital technologies trigger disruptions and

organizational responses that alter value-creation paths while also creating structural and organizational challenges. Applied to libraries, this perspective means that AI adoption can affect workflows, service models, professional roles, decision-making, and the ways libraries create value for their communities (Vial, 2019; Islam & Guangwei, 2025).

The relationship between digital transformation and AI is therefore reciprocal. AI can accelerate organizational transformation by automating processes and enabling new forms of service, while the broader digital environment provides data, infrastructure, and organizational conditions that shape AI implementation (Vial, 2019). Library research similarly connects AI and digital transformation with the movement toward more intelligent, flexible, and user-centered library environments (Islam & Guangwei, 2025).

2.4 Human-AI Collaboration

Human-AI Collaboration provides a complementary perspective to automation. The concept of hybrid intelligence emphasizes systems in which human and artificial intelligence capabilities are combined so that each contributes different strength to a shared task (Dellermann et al., 2019). In libraries, AI can process large datasets, detect patterns, generate recommendations, and automate routine work, while librarians contribute contextual knowledge, ethical judgment, professional standards, and sensitivity to user needs (Cox & Mazumdar, 2024; Dellermann et al., 2019).

The perspective is particularly relevant because library services involve decisions that cannot be evaluated solely through computational efficiency. AI-generated recommendations, classifications, or answers may require professional review to ensure relevance, fairness, privacy, and alignment with institutional policies (Ibrahim, 2025; Nathania et al., 2025). Human-AI collaboration therefore provides a theoretical basis for interpreting AI as an augmentation or professional practice rather than as an inevitable replacement for librarians (Dellermann et al., 2019; Cox & Mazumdar, 2014).

2.5 Technology Adoption through Diffusion of Innovations

The Diffusion of Innovations (DOI) theory developed by Rogers provides a framework for explaining how new technologies spread within a social system. Rogers (2003) describes an innovation-decision process involving knowledge, persuasion, decision, implementation, and confirmation, and distinguishes adopter categories ranging from innovators and early adopters to the early majority, late majority, and laggards. Adoption influenced by how potential adopters perceive an innovation and by the social and organizational environment in which adoption occurs (Rogers, 2003).

DOI is relevant to AI adoption in libraries because libraries differ in readiness, resources, leadership support, staff competencies, and perceptions of technological value. Lund et al., (2020) explicitly applied Rogers' adopter categories to academic library employees and examined how adopter-category identification related to knowledge and perceptions of AI. Harisanty et al., (2024) similarly examined AI awareness, adoption, competencies, facilities, and organizational factors among Indonesia

academic-library stakeholders. DOI therefore helps explain why the availability of AI technology does not automatically result in uniform adoption across libraries (Lund et al., 2020; Rogers, 2003).

2.6 Theoretical Synthesis and Analytical Framework

The theories above are complementary rather than competing. The AI perspective explains the technological capabilities introduced into LIS; smart-library theory explains the service and organizational environment in which those capabilities operate; digital transformation explains broader organizational change associated with technology adoption; human-AI collaboration explains how professional expertise and AI capabilities can be combined; and Diffusion of Innovations explains differences in adoption and readiness across social and organizational contexts (Cox & Mazumdar, 2024; Yunus et al., 2025; Vial, 2019; Dellemann et al., 2019; Rogers, 2003). Together, these perspectives provide the theoretical foundation for synthesizing the reviewed literature.

Based on this framework, the review analyzes the literature through connected dimensions corresponding to the research questions. First, AI applications are examined in relation to smart-library services and digital transformation. Second, adoption challenges are interpreted through organizational readiness, ethical governance, professional competencies, and diffusion factors. Third, implications for LIS education and professional practice are examined through the human-AI collaboration perspective. This framework enables the results to move beyond article-by-article description toward an integrated interpretation of technological, organizational, and professional change.

3. Methods

This study employed a Systematic Literature Review (SLR) to identify, assess, and synthesize research on AI in Library Information Systems. The review followed the PRISMA 2020 reporting guideline to make the identification, screening, eligibility, and inclusion process transparent and reproducible (Page et al., 2021). PRISMA 2020 provides updated reporting guidance for systematic review, including recommendations for transparent reporting of study identification, selection, and synthesis (Page et al., 2021). The method was selected because the research questions require an integrated synthesis of evidence distributed across studies with different designs and emphases.

3.1 Search Strategy

The literature search was conducted in Scopus, Web of Science, and Google Scholar. The search strategy combined terms related to the technology and the library context, including “Artificial Intelligence,” “AI in Libraries,” “Library Information,” “Machine Learning Libraries,” “Digital Transformation Library,” “Natural Language Processing Library,” and “Chatbot Library.” The search was restricted to publications dated 2019-2025. Retrieved records were consolidated before screening, and duplicate or otherwise ineligible records were removed according to the predefined criteria.

3.2 Study Selection and Eligibility

Study selection followed the four PRISMA stages. During identification, 26 potentially relevant records were retrieved from the three databases. During screening, titles and abstracts were examined for topical relevance and eight records were excluded. During eligibility assessment, the full texts of the remaining 18 records were examined against the inclusion and exclusion criteria, and a further eight records were excluded because they lacked accessible full text or only marginally addressed AI in the library context. Ten studies therefore met all criteria and were included in the final synthesis. Table 1 presents the predefined eligibility criteria, while Figure 1 presents the study-selection flow.

Table 1. Inclusion and Exclusion Criteria in Article Selection

No	Criteria	Information
1	Inclusion	Articles published between 2019-2025
2	Inclusion	Articles indexed in Scopus, Web of Science, or Google Scholar
3	Inclusion	Articles discussing the application of AI in the context of libraries or Library Information Systems (LIS)
4	Inclusion	Articles published in English or Indonesian and available in full text
5	Inclusion	Articles containing empirical research, systematic review, or relevant conceptual studies
6	Exclusion	Articles not directly related to libraries or LIS
7	Exclusion	Articles containing editorials, opinion pieces, or commentaries without research substance
8	Exclusion	Articles containing duplicate articles from different databases
9	Exclusion	Articles with unavailable full text

3.3 Data Extraction and Thematic Synthesis

After inclusion, the 10 studies were read in full and relevant findings were extracted in relation to the three research questions. The analysis proceeded through thematic synthesis. First, findings concerning AI uses, adoption barriers, competencies, ethical issues, and professional implications were identified within each study. Second, these findings were coded according to their substantive meaning and grouped into conceptually similar categories. Third, categories were compared across studies to identify recurring patterns, converging findings, and differences in emphasis. Finally, the categories were synthesized into three overarching themes corresponding to RQ1 (AI applications), RQ2 (challenges to AI adoption), and RQ3 (implications for LIS education and professional practice). The synthesis was interpretive and comparative rather than statistical; no meta-analysis or effect-size calculation was conducted.

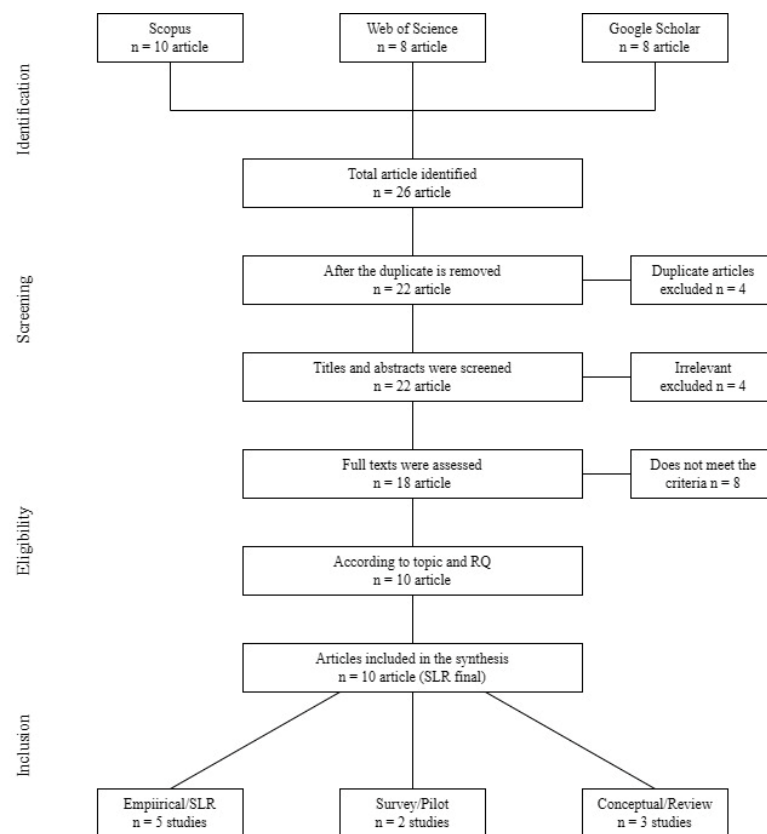


Figure 1. Article selection flow based on PRISMA guidelines

4. Results and Discussions

This section reports the synthesis of the 10 studies selected through the PRISMA process. Table 2 summarizes the scope and primary focus of the included studies. Sections 4.1.1-4.1.3 synthesize findings across studies according to the three research questions rather than presenting each article as an insolated case. The synthesis emphasizes recurring patterns, converging findings, and differences in emphasis across the included literature.

Table 2. Characteristics of Included Studies

No	Title	Year	Result
1	Narendra et al. - Artificial Intelligence Implementation in Library Information Systems	2025	AI applications, trends, methods, and implementation challenges in LIS
2	Asemi et al. - Intelligent Libraries: A Review on Expert Systems, Artificial Intelligence, and Robot	2021	Expert systems, AI, robotics, and intelligent library environments
3	Joshi - The Role of Artificial Intelligence	2025	Automation, chatbots, metadata, and AI-enabled library management

	in Modern Library Management Systems		
4	Tait & Pierson – Artificial Intelligence and Robots in Libraries	2022	AI, robotics, and competencies in LIS education
5	Harisanty et al. – Leaders, Practitioners and Scientists’ Awareness of Artificial Intelligence in Libraries	2024	AI awareness, readiness, competencies, infrastructure, and adoption factors
6	Cox et al. – The Intelligent Library	2019	Perceived impacts, opportunities, risks, and professional implications of AI
7	Saeidnia & Keshavarz – Artificial Intelligence for LIS Education	2024	Approaches to learning AI concepts and strengthening AI literacy
8	Lund et al. – Perceptions Toward Artificial Intelligence Among Academic Library Employees	2020	AI perceptions and Diffusion of Innovations adopter categories
9	Mohammed et al. – The Impact of Artificial Intelligence on Information Systems	2025	Operational benefits, decision-making, governance, bias, and ethics
10	Orubebe et al. – Adoption and Utilization of Artificial Intelligence in Academic Libraries	2025	Adoption opportunities, barriers, competencies, resources, and infrastructure

4.1 Results

4.1.1 Artificial Intelligence Application in Modern Library Systems (RQ1)

The thematic synthesis indicates that AI applications in libraries cluster into four interrelated functions: intelligent discovery and user support, automation of back-end information processing, data-driven management, and development of smart-library capabilities. Across the reviewed studies, AI is therefore not limited to one service point; it functions as an enabling layer that connects user-facing services with internal information workflows (Asemi et al., 2021; Cox et al., 2019; Narendra et al., 2025; Yunus et al., 2025).

First, intelligent discovery and user support include chatbots, virtual assistants, recommendation functions, and other conversational or personalized services that can expand access to reference and discovery support (Cox et al., 2019; Narendra et al., 2025). Second, back-end applications include automated cataloging, metadata generation, classification, indexing, and

collection processing; these functions are associated with reducing repetitive work and increasing processing capacity (Asemi et al., 2021; Narendra et al., 2025; Joshi, 2025). Third, predictive and analytical capabilities can support collection development, resource allocation, and decision-making by identifying patterns in circulation, usage, and other operational data (Narendra et al., 2025). Finally, the combination of AI with interconnected digital technologies contributes to smart-library development, in which services become more adaptive, data-informed, and user-centered (Yunus et al., 2025).

4.1.2 Challenges to Artificial Intelligence Adoption in Libraries (RQ2)

The synthesis identifies four interconnected categories of adoption barriers. The first is ethical and governance risk, including privacy, data security, algorithmic bias, transparency, accountability, job displacement, and the potential loss of human contact (Ibrahim, 2025; Nathania et al., 2025). The second category is institutional readiness, encompassing funding, infrastructure, data quality, leadership support, and the capacity to integrate AI with existing systems (Harisanty et al., 2024; Orubebe et al., 2025). Together, these findings indicate that AI adoption involves not only technical feasibility but also governance and organizational capacity.

The third category is human capacity. The reviewed literature indicates that positive attitudes toward AI do not necessarily translate into implementation because staff may lack technical knowledge, confidence, or opportunities for training (Harisanty et al., 2024; Tait & Pierson, 2022; Saeidnia & Keshavarz, 2024). This finding is consistent with Diffusion of Innovations because adoption depends not only on the characteristics of an innovation but also on adopter characteristics and the social system in which adoption occurs (Rogers, 2003; Lund et al., 2020). The fourth category is institutional inequality. Differences in funding, connectivity, infrastructure, and expertise can produce uneven AI adoption and may widen existing service disparities if implementation is not accompanied by inclusive policies and capacity development (Orubebe et al., 2025; Harisanty et al., 2024).

4.1.3 Implications for LIS Education and Professional Practice (RQ3)

The implications for LIS education and professional practice can be synthesized around three changes. First, AI literacy needs to become part of professional preparation, including understanding AI concepts, data, algorithms, information retrieval, evaluation of AI outputs, and ethical risks (Tait & Pierson, 2022; Saeidnia & Keshavarz, 2024). Second, professional roles are likely to become more hybrid, with librarians increasingly acting as data and digital curators, evaluators of algorithmic outputs, information-literacy educators, and mediators between users and intelligent systems (Cox & Mazumdar, 2024; Tait & Pierson, 2022). Third, the literature supports human–AI collaboration rather than a simple replacement model: AI can extend the scale and speed of routine processing, while

librarians retain responsibility for contextual interpretation, ethical judgment, user advocacy, and professional accountability (Dellermann et al., 2019; Cox & Mazumdar, 2024).

4.2 Discussions

The integrated findings show that AI adoption in libraries is best understood as a socio-technical transformation rather than a simple process of purchasing or installing new software. The AI and smart-library perspectives explain how intelligent capabilities can improve discovery, automation, personalization, and data-informed management, while the digital-transformation perspective explains why these applications can alter workflows, service models, and professional roles (Cox & Mazumdar, 2024; Yunus et al., 2025; Vial, 2019).

A central synthesis is the gap between technological potential and organizational readiness. The reviewed studies generally describe AI as beneficial for efficiency and service improvement, yet adoption remains uneven because libraries differ in infrastructure, funding, leadership, staff competencies, and readiness (Harisanty et al., 2024; Orubebe et al., 2025). This pattern is consistent with Diffusion of Innovations: adoption depends on adopter characteristics, social context, communication, and perceived consequences of an innovation (Rogers, 2003; Lund et al., 2020). Positive awareness among Indonesian library stakeholders is therefore an important starting point, but implementation also requires infrastructure, competency development, leadership support, and clear strategies (Harisanty et al., 2024).

The second major implication concerns responsible AI. Privacy, algorithmic bias, transparency, and accountability are not secondary technical issues because they directly affect the library's social mission (Ibrahim, 2025; Nathania et al., 2025). The reviewed literature supports ethical review, data-governance procedures, human oversight, and clear responsibilities for vendors and library staff as components of responsible implementation (Ibrahim, 2025; Nathania et al., 2025).

The third implication concerns human–AI collaboration. The evidence does not support a simple interpretation that AI will replace librarians. Instead, AI is more appropriately viewed as an augmentation technology that can perform high-volume computational tasks while librarians contribute professional judgment, contextual knowledge, empathy, and ethical accountability. This aligns with the hybrid-intelligence perspective, in which human and machine capabilities are deliberately combined to improve decision-making and task performance (Dellermann et al., 2019). The future direction of LIS practice is consequently likely to involve new combinations of technical, analytical, pedagogical, and ethical competencies.

5. Conclusion

This systematic review shows that AI is reshaping Library Information Systems across user services, information processing, collection management, digital preservation, and data-informed decision-making. The synthesis of 10 studies indicates that the main value of AI lies in expanding the

speed, scale, and adaptability of library services and workflows rather than in replacing the professional role of librarians (Asemi et al., 2021; Cox & Mazumdar, 2024; Narendra et al., 2025).

At the same time, sustainable adoption depends on more than technological availability. Privacy and data governance, algorithmic bias, infrastructure, funding, staff competencies, leadership, and institutional readiness remain significant conditions for responsible implementation (Ibrahim, 2025; Nathania et al., 2025; Harisanty et al., 2024; Orubebe et al., 2025). The findings therefore support a human-centered approach in which AI capabilities are combined with professional oversight and ethical governance (Dellermann et al., 2019).

For LIS education and professional practice, AI literacy should be integrated into curricula and continuing professional development, with emphasis on AI concepts, data literacy, evaluation of AI outputs, ethics, and human–AI collaboration (Tait & Pierson, 2022; Saeidnia & Keshavarz, 2024). Future research should prioritize empirical studies in Indonesian libraries, including comparative case studies of AI implementation, evaluations of user outcomes, assessments of librarian competencies, and longitudinal studies of organizational adoption. Such research can provide evidence for context-sensitive strategies that support inclusive and sustainable AI-enabled libraries.

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