

Artificial Intelligence for Next-Generation Academic Library Circulation

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Abstract: Artificial Intelligence (AI) is transforming academic libraries by enabling intelligent, efficient, and user-centred services. Although technologies such as Radio Frequency Identification (RFID), mobile applications, recommendation systems, predictive analytics, and conversational agents have been adopted in many libraries, their implementation often remains fragmented. This conceptual paper proposes an AI-Informed Intelligent Library Circulation Concept (AI-ILC) that integrates these technologies into a unified service-oriented framework. Unlike technology-driven approaches, the proposed concept positions AI as a decision-support tool that complements librarians' expertise while enhancing user experience, operational efficiency, and evidence-based management. The model consists of five interconnected components: intelligent user access, intelligent circulation services, decision support, personalized user engagement, and continuous service improvement. The paper contributes to the growing discourse on AI-enabled academic libraries by providing a strategic conceptual framework for modernizing circulation services while preserving the professional values of librarianship, including privacy, accessibility, transparency, and equitable access. It further identifies future research opportunities for empirical validation and practical implementation in higher education institutions.

Keywords: Artificial Intelligence, Academic Libraries, Library Circulation, Smart Libraries, Intelligent Library Services, User-Centred Services.

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I. INTRODUCTION

Academic libraries are undergoing significant transformation as digital technologies reshape information access, learning environments, and user expectations. Traditional circulation systems, once centred on manual transactions and later enhanced through barcode and RFID technologies, have improved operational efficiency but remain largely transactional. These systems automate routine processes without providing intelligent, integrated, and personalized services that modern library users increasingly expect.

Artificial Intelligence (AI) offers an opportunity to redefine library circulation as a strategic service rather than merely an operational function. Recent advances in AI—including predictive analytics, recommendation systems, conversational agents, and intelligent authentication—can improve resource discovery, personalize user services, and support evidence-based decision-making.

This paper addresses this gap by proposing an AI-Informed Intelligent Library Circulation Concept (AI-ILC). The paper introduces a service-oriented conceptual model demonstrating how AI can strengthen circulation services

while supporting librarians' professional roles. The proposed concept aims to enhance user experience, improve operational effectiveness, and facilitate strategic library management while preserving the ethical principles of privacy, accessibility, and intellectual freedom. (Cox et al., 2019).

II. REVIEW OF RELATED LITERATURE

The application of AI in academic libraries has expanded considerably over the past decade. Studies have examined RFID-enabled automation, Internet of Things (IoT) technologies, recommendation systems, predictive analytics, and AI-powered conversational agents as mechanisms for improving library operations and user services (Asim et al., 2022; Cox et al., 2019).

RFID has become one of the most widely adopted technologies for circulation management because it enables faster borrowing and returning, efficient inventory control, and enhanced collection security (Butters, 2008; Chelliah et al., 2015). Similarly, smart library initiatives integrating IoT technologies have demonstrated potential for creating responsive and technology-enabled learning environments (Asim et al., 2022).

AI applications have further expanded library capabilities. Recommendation systems improve information discovery by suggesting relevant resources based on user preferences (Ekstrand, 2018), while predictive analytics assists libraries in forecasting collection demand and supporting evidence-based management (Das & Islam, 2021). AI-powered chatbots also enhance reference and circulation services by providing immediate responses to routine enquiries (Reinsfelder & O'Hara-Krebs, 2023).

Despite these advances, current implementations remain fragmented. Most libraries adopt individual technologies independently, resulting in disconnected services that limit the strategic potential of AI. Furthermore, ethical concerns relating to privacy, transparency, informed consent, and algorithmic bias continue to influence AI adoption in libraries (American Library Association, n.d.; Wang et al., 2024).

III. AI-INFORMED INTELLIGENT LIBRARY CIRCULATION CONCEPT

The proposed AI-Informed Intelligent Library Circulation Concept (AI-ILC) reimagines circulation as an intelligent service ecosystem rather than a sequence of isolated transactions. The model consists of five interconnected components that collectively improve library services.

The first component, Intelligent User Access, enables secure and flexible authentication through RFID cards, QR codes, mobile applications, and institutionally approved identification methods. Biometric authentication may be incorporated where institutional policies and user consent permit, thereby balancing enhanced security with privacy and ethical considerations (Kharat et al., 2023).

The second component, Intelligent Circulation Services, supports borrowing, returning, renewal, reservations, and automated notifications. Artificial Intelligence enhances these routine services by providing personalized reminders, context-aware assistance, and simplified self-service options while complementing rather than replacing existing Integrated Library Management Systems (ILMS), thereby improving service efficiency and user experience (Almulla et al., 2026).

The third component, Intelligent Decision Support, utilizes circulation data to identify borrowing trends, predict resource demand, optimize collection development, and support evidence-based administrative decisions. By transforming circulation data into actionable insights, libraries can improve strategic planning, collection management, and resource allocation (Ayinde et al., 2026).

The fourth component, Personalized User Engagement, focuses on enriching users' interactions with library resources. By analysing borrowing patterns and academic interests within appropriate ethical and privacy safeguards, Artificial Intelligence can recommend relevant books, journals, databases, institutional repositories, and other learning resources. Intelligent chatbots and virtual assistants

can also provide real-time responses to routine circulation enquiries, enabling librarians to devote greater attention to research support, information literacy, and scholarly communication. Such personalized services improve resource discovery and strengthen users' overall library experience (Almulla et al., 2026; Cox et al., 2019).

The fifth component, Continuous Service Improvement, emphasizes that intelligent circulation should evolve through continuous assessment and feedback. Circulation statistics, user feedback, and service performance indicators enable libraries to evaluate operational effectiveness and refine services over time. This adaptive approach supports strategic planning while ensuring that technological innovations remain aligned with institutional objectives and the core values of librarianship (Oakleaf, 2010; Ayinde et al., 2026).

Importantly, the proposed concept recognizes that AI should function as a decision-support tool rather than a replacement for professional librarians. Ethical considerations—including privacy protection, informed consent, transparency, equitable access, and accountability—must guide every stage of AI implementation. Consequently, the AI-ILC offers a balanced approach in which intelligent technologies enhance library services while preserving the human-centred philosophy of academic librarianship.

IV. APPLICATIONS AND IMPLICATIONS

The proposed AI-Informed Intelligent Library Circulation Concept offers practical guidance for academic libraries seeking to modernize circulation services. By integrating AI-enabled technologies within a unified service framework, libraries can transform circulation from a routine operational function into an intelligent, user-oriented service. One significant application is the enhancement of user experience. Intelligent authentication, mobile-enabled services, automated notifications, and personalized recommendations simplify access to library resources and reduce the time required for routine circulation transactions. These improvements contribute to greater user satisfaction and encourage increased utilization of both physical and digital collections (Almulla et al., 2026; Cox et al., 2019).

The concept also strengthens evidence-based library management. Data generated through circulation activities can support collection development, identify emerging information needs, forecast demand for resources, and assist administrators in making informed decisions regarding budgeting and service planning. Consequently, circulation data becomes an important strategic resource rather than merely an operational record (Sengar et al., 2024; Oakleaf, 2010).

Furthermore, AI-enabled circulation supports teaching, learning, and research by improving information discovery and facilitating timely access to relevant scholarly resources. Intelligent recommendation services, virtual assistants, and predictive analytics complement librarians' expertise, allowing professionals to focus on advanced academic

support, research consultation, and information literacy programmes (Almulla et al., 2026; Cox et al., 2019).

The model additionally provides a practical pathway for libraries to adopt AI incrementally. Instead of replacing existing Integrated Library Management Systems (ILMS), libraries can integrate intelligent technologies with their current infrastructure, making implementation more feasible for institutions with varying technological and financial capacities (Asemi et al., 2021; Ayinde et al., 2026).

Almulla, A., Alharbi, F., & Alshammari, M. (2026). AI-driven personalization in library and information services:

V. CONCLUSION

Artificial Intelligence presents significant opportunities for reimagining circulation services in academic libraries. Although technologies such as RFID, predictive analytics, recommendation systems, and conversational agents have individually demonstrated considerable value, their implementation remains fragmented across many institutions. The absence of an integrated service perspective limits the strategic benefits that AI can offer to library users and administrators.

This paper has proposed the AI-Informed Intelligent Library Circulation Concept (AI-ILC) as a service-oriented conceptual model that integrates intelligent technologies into five interconnected components: intelligent user access, intelligent circulation services, intelligent decision support, personalized user engagement, and continuous service improvement. The proposed concept emphasizes user-centred services, evidence-based management, and ethical governance while recognizing librarians as indispensable professionals within the AI-enabled library ecosystem.

The proposed model contributes to the emerging literature on AI-enabled academic libraries by providing a concise conceptual framework that bridges existing technological innovations with practical library services. It encourages academic libraries to adopt AI strategically to improve operational efficiency, enhance user experience, and support institutional decision-making without compromising the profession's commitment to privacy, accessibility, intellectual freedom, and equitable access.

As a conceptual study, this paper does not present empirical validation. Future research should therefore examine the practical implementation of the AI-ILC through pilot projects, expert evaluation, and user-centred assessment in different academic library contexts. Comparative studies across institutions, usability evaluations, and investigations into ethical and organizational challenges will further strengthen the applicability of the model. Such research will help determine how AI can best support intelligent, sustainable, and inclusive circulation services within contemporary academic libraries.



Fig 1. AI-Informed Intelligent Library Circulation Concept

Fig 1. Conceptual representation of the AI-Informed Intelligent Library Circulation Concept illustrating the integration of intelligent user access, circulation services, decision support, personalized engagement, and continuous service improvement.

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