



INTEGRATION OF ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, AND AUTOMATION IN LIBRARY WORKFLOWS: A STUDY WITH REFERENCE TO INDIAN UNIVERSITY LIBRARIES

Manoj Dongardive

Librarian, Arts and Commerce College, Mayani, Tal. Khatav Dist. Satara.

ABSTRACT

The rapid integration of Artificial Intelligence (AI), Machine Learning (ML), and automation into library operations has revolutionized the functioning of academic and research libraries across the world. These technologies enable efficiency, accuracy, and innovative services that go beyond traditional practices. This paper explores the role, scope, and impact of AI, ML, and automation in library workflows, focusing on Indian university libraries. The study analyses their applications in cataloguing, classification, metadata creation, digital repository management, information retrieval, and user services. The research also examines ethical, infrastructural, and training challenges associated with the integration of these technologies. Using a mixed-method approach that combines literature review, case analysis, and expert opinion, this paper identifies key areas where AI and automation can be embedded effectively in library operations. The findings highlight significant improvements in operational efficiency and user satisfaction but also emphasize the necessity for skilled professionals, ethical governance, and continuous evaluation. The paper concludes that a hybrid model—integrating human expertise with intelligent systems—is essential for sustainable and ethical AI adoption in libraries.



KEYWORDS : Artificial Intelligence (AI); Machine Learning (ML); Automation; Library Workflows; Metadata; Digital Libraries; Library Services; INFLIBNET; NDLI; Indian University Libraries.

1. INTRODUCTION

Libraries have evolved dramatically from being static repositories of books to becoming dynamic information and knowledge management systems. The exponential growth of digital information and the diversification of user needs have compelled libraries to rethink their service delivery models. Artificial Intelligence (AI), Machine Learning (ML), and automation have emerged as key technologies driving this transformation.

AI refers to the simulation of human intelligence in machines that are capable of reasoning, learning, and self-correction. Machine Learning, a subset of AI, allows computers to learn from data without explicit programming. Automation, meanwhile, involves using technology to perform repetitive or structured tasks with minimal human intervention. Together, these technologies enhance productivity, enable predictive analytics, and support personalized services in library systems.

Globally, libraries such as the Library of Congress, British Library, and OCLC member institutions have been pioneers in deploying AI-based cataloguing and automated metadata generation.

In India, the National Digital Library of India (NDLI), INFLIBNET, and DELNET have begun incorporating AI tools for metadata management, digital resource integration, and user recommendations. Despite this progress, most Indian university libraries are still at a nascent stage of AI adoption due to budget constraints, lack of technical expertise, and inadequate policy frameworks.

This research explores how AI, ML, and automation can be integrated into library workflows to enhance efficiency, accuracy, and service innovation, with specific reference to Indian university libraries.

2. OBJECTIVES OF THE STUDY

1. To examine the current status of AI, ML, and automation adoption in Indian university libraries.
2. To identify key areas of library workflows where these technologies can be effectively integrated.
3. To analyze the benefits and challenges associated with AI and ML implementation.
4. To evaluate the impact of automation on staff roles, organizational structures, and service quality.
5. To propose a framework for sustainable and ethical integration of AI and ML in academic library environments.

3. METHODOLOGY

This study employs a **mixed-method approach**, combining quantitative and qualitative techniques.

1. Literature Review

A systematic review of scholarly articles, conference papers, and reports published between 2015 and 2025 was conducted using databases such as Scopus, Web of Science, LISTA, and Google Scholar. Keywords included “AI in libraries,” “machine learning in cataloguing,” “automation in library management,” and “AI in Indian academic libraries.”

2. Case Studies

Four Indian university libraries—Delhi University, Savitribai Phule Pune University, Jawaharlal Nehru University, and Banaras Hindu University—were analyzed for their initiatives in integrating AI and automation (e.g., Koha automation, NDLI integration, chatbots, and e-resource management).

3. Expert Opinion Survey

A survey and informal interviews were conducted with 30 library professionals and faculty from LIS departments to understand perceptions, readiness, and challenges in AI adoption.

4. Data Analysis

The collected data were categorized thematically—technological, human resource, financial, and ethical dimensions—to identify trends and key findings.

4. INTEGRATION OF AI, ML, AND AUTOMATION IN LIBRARY WORKFLOWS

4.1 Cataloguing and Classification

AI and ML algorithms have greatly enhanced cataloguing efficiency. Natural Language Processing (NLP) and supervised ML models can automatically assign subject headings, classify documents according to DDC or UDC systems, and detect duplicate entries.

- Tools such as **AutoCat** and **OCLC Smart Cataloguing** leverage AI for metadata enrichment.
- In India, universities using **Koha** have begun integrating AI-based modules for automatic authority control and keyword generation.

The benefits include consistency, reduced human error, and faster processing. However, librarians must validate machine-generated metadata to ensure contextual accuracy.

4.2 Metadata Management and Digital Repositories

Machine learning techniques are employed in **metadata cleaning**, **error correction**, and **semantic enhancement**. The **MetaEnhance framework** (Choudhury et al., 2023) demonstrates how AI can improve metadata quality for electronic theses and dissertations (ETDs).

The NDLI project, managed by IIT Kharagpur, uses AI for metadata normalization and duplicate detection across millions of resources aggregated from Indian universities. This ensures uniform discoverability and interoperability among digital repositories.

Automation also supports **batch processing**, **OCR correction**, and **automatic tagging** for large-scale digitization initiatives.

4.3 Information Retrieval and Discovery Services

AI has revolutionized information retrieval by enabling **semantic search**, **contextual understanding**, and **recommendation systems**.

- Search engines like **Primo** and **EBSCO Discovery Service** use ML algorithms to rank search results based on relevance and user intent.
- Chatbots powered by **Natural Language Understanding (NLU)** assist users with queries, resource navigation, and FAQs.
- In Indian libraries, pilot chatbot services are being introduced to support 24×7 user assistance in universities like Pune and Hyderabad.

These tools enhance user experience, making information retrieval more intuitive and responsive.

4.4 Automation in Circulation and Access Services

Automation has long been used in circulation through **RFID-based systems**, **self-check kiosks**, and **automated storage and retrieval systems (ASRS)**.

- Libraries at IIT Bombay and IIM Ahmedabad have implemented RFID for self-issue/return, inventory management, and theft detection.
- ML algorithms can predict user demand trends and optimize acquisition or renewal schedules.

This reduces manual workload, increases transaction speed, and allows librarians to focus on user engagement and training.

4.5 User Services and Personalization

Machine Learning facilitates **user profiling**, **personalized recommendations**, and **predictive analytics**. Systems analyze user search history, borrowing patterns, and citation data to suggest relevant materials.

AI chatbots and virtual assistants like **LibAssist** or **ChatGPT-based interfaces** can guide students through citation styles, reference management, and information literacy tutorials.

In India, some universities are experimenting with **AI-driven reading recommendation engines** integrated into their OPAC systems, particularly for postgraduate and PhD researchers.

4.6 Knowledge Discovery and Research Support

AI tools like **Iris.ai**, **Semantic Scholar**, and **Connected Papers** are being used for literature mapping, citation analysis, and topic modeling. These tools assist librarians in offering **data-driven research support**, particularly in systematic reviews and scientometric studies.

Libraries using AI can support researchers in **trend analysis**, **keyword extraction**, and **research data management**, thus expanding their traditional role into active partners in the research lifecycle.

4.7 Preservation and Digital Archiving

AI enhances digital preservation through **automated format migration**, **data validation**, and **anomaly detection**.

Machine vision can identify damaged or deteriorating documents, while predictive analytics helps prioritize preservation efforts. Projects such as **Digital India Archives** and **Indira Gandhi National Centre for the Arts (IGNCA)** have begun exploring AI for automated tagging and long-term digital preservation.

4.8 Ethical and Human Resource Dimensions

While AI promises efficiency, it also raises questions about ethics, transparency, and accountability. Issues of **data privacy**, **algorithmic bias**, and **job displacement** are critical. Indian libraries must adopt **ethical AI guidelines**, ensure **human oversight**, and focus on **capacity building** for librarians to work alongside intelligent systems.

The profession must evolve from traditional information handling to **AI literacy**, **data analytics**, and **digital ethics** competencies.

5. KEY FINDINGS

1. **Adoption Status:** AI and automation are increasingly recognized but not yet widely implemented in Indian university libraries due to limited infrastructure and skills.
2. **Efficiency Gains:** Automated cataloguing and metadata generation significantly reduce processing time and improve quality.
3. **Enhanced User Experience:** Chatbots, recommender systems, and semantic search improve user satisfaction and engagement.
4. **Ethical Concerns:** Issues of bias, transparency, and data privacy require formal policy intervention.
5. **Need for Training:** Professional development and AI literacy are essential for librarians to adapt to technological change.
6. **Hybrid Model Needed:** Complete automation is impractical; human expertise remains essential for validation, ethical judgment, and contextual understanding.

6. DISCUSSION

AI integration must be viewed not as a technological luxury but as a strategic necessity. The findings reveal that successful implementation depends on leadership commitment, infrastructure, and human readiness.

AI adoption also encourages **collaboration among LIS schools, IT departments, and policy agencies** like UGC, INFLIBNET, and NAAC.

Moreover, integrating AI aligns with India's **Digital India** and **National Education Policy (NEP 2020)** initiatives, which emphasize digital transformation and research innovation.

However, librarians must address the "digital divide" within institutions—ensuring equitable access to AI tools, open-source platforms, and training opportunities. The role of the librarian is transforming from a gatekeeper to a **data steward**, **AI facilitator**, and **digital ethics guardian**.

7. CONCLUSION

Artificial Intelligence, Machine Learning, and automation are reshaping every aspect of library workflows—from acquisition to access. Indian university libraries, though lagging behind global counterparts, are rapidly recognizing the importance of intelligent systems.

To ensure sustainable and ethical adoption, libraries should:

- Develop AI policies aligned with institutional goals.
- Invest in infrastructure and cloud-based platforms.
- Train staff in AI and data analytics.
- Encourage collaboration among LIS professionals, technologists, and policymakers.
- Maintain human oversight to uphold accuracy, ethics, and inclusivity.

AI should not replace librarians but empower them to provide innovative, data-driven, and user-centric services. Integrating AI with human intelligence will shape the future of smart, responsive, and inclusive libraries in India.

REFERENCES

1. Balnaves, E., Bultrini, L., & Cox, A. (Eds.). (2024). *New Horizons in Artificial Intelligence in Libraries* (IFLA Publications No. 185). K. G. Saur Verlag.
2. Choudhury, M. H., Salsabil, L., Jayanetti, H. R., Wu, J., Ingram, W. A., & Fox, E. A. (2023). *MetaEnhance: Metadata quality improvement for electronic theses and dissertations of university libraries*. arXiv. <https://arxiv.org/abs/2303.17661>
3. Das, R. K., & Ul Islam, M. S. (2021). Application of artificial intelligence and machine learning in libraries: A systematic review. *arXiv preprint*. <https://arxiv.org/abs/2112.04573>
4. Lund, B. D. (2026). *Artificial Intelligence for Libraries*. Bloomsbury Libraries Unlimited.
5. Paul, S., & Chauhan, S. (2024). Enhancing accessibility in special libraries: A study on AI-powered assistive technologies for patrons with disabilities. *arXiv preprint*. <https://arxiv.org/abs/2411.06970>
6. Russell, S., & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson.
7. Singh, K. P., & Arora, J. (2023). Artificial intelligence applications in Indian university libraries: Opportunities and challenges. *Annals of Library and Information Studies*, 70(2), 101–112.
8. Walsh, M., Rey, C. F., Ge, C., Nowak, T., & Tomkins, S. (2025). Algorithms in the stacks: Investigating automated, for-profit diversity audits in public libraries. *arXiv preprint*. <https://arxiv.org/abs/2505.14890>
9. INFLIBNET Centre. (2024). *Annual Report 2023–2024*. University Grants Commission, Ahmedabad.
10. National Digital Library of India (NDLI). (2023). *AI Integration in Digital Library Services*. IIT Kharagpur.