



Application of Artificial Intelligence in Academic Libraries: A Comprehensive Study

Shrikrishan Thapliyal and Dheeraj Singh Negi

¹Maharaja Agrasen Himalayan Garhwal University, Pokhra Pauri Gahrwal Uttarakhand, India

²Lingaya's Vidyapeeth Deemed University, Faridabad, Haryana India

*Corresponding E- mail: dheerajnegi3@gmail.com; krishanlibrarian@gmail.com

Abstract

The 21st century Artificial Intelligence (AI) has role a transformative technology of the, influencing various sectors like a many sectors Research & Education, Medical sector, industry sector and information sector etc. Academic libraries are an Information hub of higher education institutions, are increasingly adopting AI-related tools to enhance operational efficiency, improve the library user engagement in and support new research activities and provide the 24/7 hours services to user's perspective in different sector. This research paper explores the application of AI in academic libraries, feature & function its technologies, Implication benefits, different types of challenges facing by the users & Library staff time to time, ethical implications, and future prospects. The study highlights how AI-driven systems such as machine learning, natural language processing, chatbots, and predictive analytics are reshaping cataloguing, reference services, collection development, and research analytics feature of AI and Advantage role of AI in Academic Libraries. In today's era, AI plays a pivotal role in modernizing agricultural academic libraries; it ensures immediate access for students, researchers, and faculty members to digital repositories containing agricultural research publications, crop science data, climate-resilient agricultural research, and sustainable farming techniques. AI Provide a significant advantage in personalization, automation, and data-driven decision-making; it also presents challenges related to cost, infrastructure, Data privacy, and skill development progrmm. The paper concludes that the strategic and ethical integration of AI can strengthen academic libraries and redefine the role of librarians in the digital era.

Keywords: *Artificial Intelligence, Academic Libraries, Machine Learning, Chatbots, Digital Transformation, Library Automation, Research Support etc.*

Introduction

Academic libraries have always been very important for helping with teaching and learning at universities and colleges. For a time, libraries were just physical spaces that had a lot of printed books, journals and other materials that people could use for reference. As technology got better libraries started to change and now they have both printed and digital things. The arrival of Artificial Intelligence is a step in this change. Artificial Intelligence is also really helping with education and research in agriculture. Libraries that use Artificial Intelligence are making it much easier for people to manage data do research and get the information they need. Artificial Intelligence gives computers the ability to do things that normally require a human to be smart, like thinking, learning, understanding language and making decisions. In libraries Artificial Intelligence is being used in the

systems that keep track of books the tools that help people find things the services that answer questions online and the platforms that analyze research. This change is a move from using computers to do simple tasks to using computers that can learn and get better at helping people. The fact that there is much digital information now and people expect more from libraries and libraries need to manage their resources well has made libraries start to use Artificial Intelligence. This paper is, about how Artificial Intelligence's changing academic libraries and what this means for the people who work in libraries and the people who use them.

Literature Review

Artificial Intelligence and Its Emerging Role in Libraries

Artificial Intelligence (AI) has emerged as an important technological development with significant implications for library and information services. The

integration of AI into libraries has created new opportunities for automating routine activities, improving information retrieval, providing personalized services, supporting reference assistance, and enhancing user experiences. The literature indicates that academic libraries are gradually moving from traditional automation toward intelligent and data-driven service environments. Wang (2019) explained that AI encompasses technologies capable of performing tasks that traditionally require human intelligence, including learning, reasoning, problem-solving, perception, and language processing. In the library context, these capabilities can be applied to information discovery, recommendation systems, chatbots, classification, metadata generation, predictive analytics, and user support.

Noh (2015), through the concept of Library 4.0, discussed the transformation of libraries into technologically advanced environments capable of providing more personalized and intelligent services. The development of smart and intelligent libraries is closely associated with emerging technologies such as AI, machine learning, natural language processing, big data, and the Internet of Things. Gul and Bano (2019) highlighted the emergence of smart libraries and identified AI as an important technological component for transforming conventional library operations and services. Their work suggests that AI can help libraries become more responsive to changing information needs while improving the efficiency of professional activities.

AI Applications in Academic Libraries

Several studies have specifically examined the application of AI in academic libraries. Asemi, Ko, and Nowkarizi (2021) reviewed the applications of AI in academic libraries and identified a broad range of possible applications, including information retrieval, reference services, recommendation systems, cataloguing, classification, and user-oriented services. Their review demonstrates that AI can support both technical and public-service functions. The authors also emphasized that the adoption of intelligent technologies requires libraries to consider organizational readiness, staff competencies, infrastructure, and ethical considerations.

Similarly, Cox, Pinfield, and Rutter (2019) investigated the likely impact of AI on academic libraries through the perspectives of thought leaders. Their study indicated that AI could significantly influence professional roles, library workflows, and service delivery. Rather than simply replacing library

professionals, AI was viewed as a technology that could change the nature of librarians' work. Routine and repetitive activities may increasingly be automated, allowing professionals to devote greater attention to higher-level activities such as research support, information literacy, data management, and user engagement.

Wheatley and Hervieux (2019) conducted an environmental scan of AI in academic libraries and found that AI-related technologies were increasingly being explored for a variety of library functions. Their work demonstrates that AI adoption is not restricted to a single application but extends across discovery, reference, collection management, and other areas. The study also draws attention to the need for libraries to understand the technological, professional, and organizational consequences of AI implementation.

Kaushik and Verma (2020) discussed AI in academic libraries as an emerging area capable of supporting library automation and service improvement. Their work indicates that AI can complement existing library management systems and assist professionals in delivering faster and more efficient services. Lamba and Madhusudhan (2019) similarly examined AI tools in academic libraries and emphasized their potential for improving library operations and facilitating intelligent information services.

Madhusudhan (2021) examined the use of AI-based tools in university libraries and highlighted the growing importance of intelligent technologies in academic information environments. The increasing availability of AI tools provides opportunities for university libraries to improve information access and automate selected processes. However, effective implementation depends upon appropriate technological infrastructure, staff training, and institutional support.

Intelligent Information Retrieval and Discovery

One of the most important applications of AI in libraries is intelligent information retrieval. Traditional information retrieval systems depend largely on keyword matching and predefined metadata. AI-based systems can potentially understand user queries more effectively, identify relationships between concepts, and provide more relevant information.

Shiri (2019) discussed semantic search and linked data in academic libraries, emphasizing the importance of moving beyond traditional keyword-based discovery toward systems capable of understanding relationships among information resources. Semantic technologies can improve the

discoverability of library resources by connecting related concepts, authors, subjects, and documents.

AI can also support recommendation systems by analyzing users' information-seeking patterns and preferences. Such systems may recommend books, journal articles, databases, or other scholarly resources based on previous searches and usage patterns. This represents a shift from passive information provision toward personalized information services.

Li and Du (2020) examined AI applications and ethical issues in libraries and indicated that intelligent systems can improve information services while simultaneously creating challenges concerning privacy, transparency, accountability, and bias. Therefore, intelligent discovery systems need to balance personalization and efficiency with responsible management of user information.

Chatbots and AI-Based Reference Services

AI-powered chatbots represent another significant application of artificial intelligence in libraries. Chatbots can provide answers to frequently asked questions, guide users toward library resources, assist with database navigation, and provide basic reference support. Such systems can operate continuously and reduce the burden on library staff for repetitive enquiries.

Pathak (2022) discussed AI-enabled chatbots in academic libraries and highlighted their potential to enhance reference services. Chatbots can provide immediate responses to common user questions and improve the accessibility of library services. They can also serve as an initial point of contact before users are referred to professional librarians for more complex information needs.

The development of conversational AI and large language models has further expanded the possibilities for library reference services. Negi (2022) examined the use of ChatGPT in libraries and discussed its potential for optimizing language-model capabilities for library services. Generative AI can assist with question answering, summarization, drafting, information support, and communication. Nevertheless, AI-generated information requires verification because language models may produce inaccurate or misleading information.

Automation of Library Operations

AI has the potential to support several routine library housekeeping activities. These include cataloguing, classification, indexing, metadata generation, document processing, circulation management, and collection analysis. Baryshev et al. (2020) examined the implementation of AI technologies in library services and demonstrated the growing relevance of intelligent technologies in library operations.

AI-based automation can reduce repetitive manual work and improve operational efficiency. Machine learning techniques can be used to identify

patterns in bibliographic records, classify documents, extract metadata, and support collection-related decisions. Kim and Kim (2021) examined machine-learning applications in library services and demonstrated the potential of machine learning to support library activities through data-based analysis and prediction.

The application of AI should therefore be viewed as an extension of library automation rather than as an isolated technology. Conventional integrated library management systems provide the technological foundation for managing collections and circulation, while AI can introduce additional intelligence through prediction, learning, recommendation, and natural-language interaction.

Predictive Analytics and Data-Driven Library Services

Another emerging area is the application of predictive analytics. Libraries generate large quantities of data through circulation transactions, database usage, searches, downloads, gate entries, and other user interactions. AI and machine learning can analyze these data to identify patterns and predict future needs.

Tella and Olasina (2014) discussed predictive analytics as a new frontier for libraries. Predictive techniques can potentially support collection development, resource allocation, user-service planning, and identification of changing information needs. By analyzing historical patterns, libraries can make more evidence-based decisions concerning acquisitions and services.

Ransbotham, *et al.*, (2018), although focusing on AI in business, demonstrated the wider organizational significance of AI and the transition from experimentation toward practical implementation. This perspective is relevant to libraries because AI adoption similarly requires organizations to move beyond technological experimentation and develop strategies for integrating AI into routine institutional processes.

AI and Library and Information Science Education

The emergence of AI also has implications for library and information science education. Ocholla and Ocholla (2020) examined AI and its implications for library and information science education and highlighted the need to prepare future professionals for an increasingly technology-driven information environment. Library professionals require not only traditional competencies in information organization and retrieval but also awareness of AI technologies, data management, algorithmic systems, ethics, and digital literacy.

The increasing use of AI therefore requires professional development and continuous training. Librarians need to understand how AI systems operate, evaluate their outputs, identify biases and inaccuracies, and guide users in responsible AI use. This is particularly important in academic libraries, where information literacy and research support are central professional responsibilities.

AI in Indian Academic Libraries

The literature also indicates increasing interest in AI applications within the Indian academic library environment. Sharma and Shukla (2021) examined AI applications in Indian academic libraries and emphasized the potential of intelligent technologies to improve library services. Indian academic libraries are increasingly adopting digital technologies, automated library management systems, online discovery tools, and electronic information resources, creating a foundation for the subsequent adoption of AI.

Kaushik and Verma (2020) and Lamba and Madhusudhan (2019) similarly identified AI as an emerging component of academic library services. However, implementation in developing institutional contexts may be affected by infrastructure, funding, technical expertise, staff competencies, and institutional support. These factors are particularly important when assessing the actual status of AI adoption rather than merely examining its theoretical possibilities.

The work of Negi and colleagues also demonstrates the expanding use of digital technologies in Indian library and information environments. Studies concerning mobile technologies, open-source library software, bibliometric analysis, plagiarism-detection technologies, and AI-based tools indicate that library professionals are increasingly engaging with emerging digital technologies. Negi (2014) examined the use of mobile technologies in libraries and information centres, while Singh Negi (2014) discussed the implementation of New GenLib in a library context. These studies demonstrate the broader technological transformation of library services that provides a foundation for more advanced AI-based applications.

AI, Ethics, and Professional Challenges

Although AI provides substantial opportunities, the literature also emphasizes several challenges. Li and Du (2020) identified ethical issues associated with AI in libraries, including privacy, transparency, accountability, and potential bias. Academic libraries manage sensitive information

concerning users' searches, borrowing patterns, research interests, and resource usage. Consequently, AI implementation must ensure appropriate protection of personal and usage data.

Another concern is the reliability of AI-generated information. Generative AI systems can produce plausible but inaccurate information, making human verification essential. This is particularly important in academic libraries, where users depend on information for research, teaching, and scholarly communication.

The introduction of AI may also alter professional roles. Cox et al. (2019) suggested that AI could transform rather than simply eliminate library work. Professionals may increasingly become responsible for AI-supported information services, data stewardship, digital literacy, algorithmic awareness, and evaluation of AI-generated content. Consequently, continuous professional development is essential.

Bibliometric and Digital Information Studies

Bibliometric studies provide another perspective on the development of library and information science research. Negi (2019) investigated Library and Information Science journals indexed in the Directory of Open Access Journals (DOAJ), while Negi (2021) conducted a bibliometric study of the DESIDOC Journal of Library and Information Technology. These studies demonstrate the importance of bibliometric techniques for understanding scholarly communication, publication patterns, and research trends.

The increasing use of AI in bibliometric analysis can further improve the ability of researchers and librarians to analyze large scholarly datasets. AI-supported bibliometric systems can assist in identifying research trends, influential publications, collaboration patterns, and emerging research areas. Thus, bibliometrics represents an area where AI and library science intersect significantly.

Mobile Technologies, Digital Services, and the Transformation of Libraries

The development of AI should also be understood within the broader transformation of libraries through mobile and web technologies. Singh Negi (2014) discussed mobile technologies in libraries and information centres, illustrating the movement of library services beyond physical spaces. Digital services have progressively changed how users discover, access, and interact with library resources.

The evolution from automated libraries to digital libraries, smart libraries, and intelligent libraries

represents a gradual technological progression. Earlier technologies primarily focused on automating repetitive activities, whereas contemporary AI systems increasingly provide analytical, predictive, conversational, and personalized capabilities. Consequently, AI can be viewed as the next stage in the technological development of library services.

Research Gap

The reviewed literature establishes that AI has considerable potential for improving academic library services. Existing studies have addressed AI applications in information retrieval, reference services, chatbots, machine learning, automation, predictive analytics, recommendation systems, and professional education. However, several gaps remain.

First, much of the existing literature is conceptual, exploratory, or based on environmental scans and reviews. There is a need for more empirical studies examining the actual implementation and use of AI in academic libraries. Second, comparatively limited research systematically examines the perspectives of both library professionals and users. Third, the literature indicates the importance of infrastructure, funding, training, organizational support, and ethical considerations, but these factors require further empirical investigation in specific institutional contexts.

Fourth, there is a need to examine the actual level of AI readiness among academic libraries rather than focusing only on the potential applications of AI. Research should consider the availability of AI-enabled systems, staff competencies, institutional policies, user awareness, perceived usefulness, barriers to adoption, and satisfaction with AI-supported services. Finally, the rapid development of generative AI and tools such as ChatGPT creates a need for updated research concerning responsible AI use, information accuracy, academic integrity, privacy, and the changing role of library professionals.

Concept of AI in Academic Libraries

Artificial Intelligence

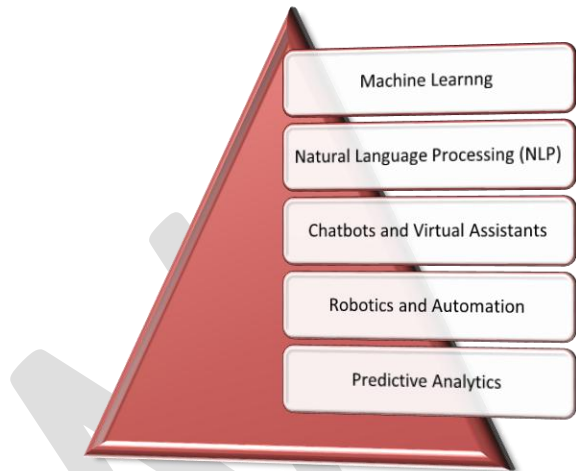
Artificial Intelligence encompasses various subfields, including machine learning (ML), natural language processing (NLP), robotics, expert systems, and data mining. These technologies allow systems to analyze data, recognize patterns, and make informed decisions without constant human intervention.

Library Automation to Intelligent Systems

Library automation began with computerized catalogues and integrated library management systems (ILMS). These systems automated circulation,

cataloguing, and acquisitions. However, they operated based on predefined rules. AI-based systems differ because they learn from user interactions and adapt accordingly.

Core AI Technologies Used in Academic Libraries



Machine Learning (ML)

The Machine learning algorithms analyze large datasets to detect patterns and predict outcomes. In libraries, Machine Learning used in libraries ML enhances decision-making by identifying trends in resource utilization.

- i. Recommendation systems
- ii. Predictive acquisition planning
- iii. Usage pattern analysis
- iv. Classification and indexing

Natural Language Processing (NLP)

NLP enables machines to understand and interpret human language. In academic libraries, NLP provide the different types services to library and information centre.

- Voice-based search systems
- Automatic summarization
- Sentiment analysis of user feedback
- NLP improves communication between users and library systems.

Chatbots and Virtual Assistants

AI-powered chatbots provide 24/7 assistance, answering frequently asked questions and guiding users in accessing resources. They reduce response time and staff workload.

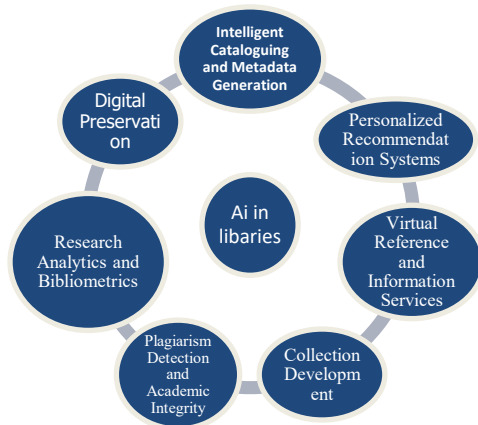
Robotics and Automation

Few advanced academic libraries use robotic systems for automated storage and retrieval. Robots assist in inventory management and shelf reading.

Predictive Analytics

Predictive models help libraries anticipate user demands, optimize collections, and allocate resources effectively.

Applications of AI in Academic Libraries



Intelligent Cataloguing and Metadata Generation

AI tools automatically generate bibliographic information from documents and assign subject headings. Automated metadata generation reduces cataloguing time and enhances accuracy.

Personalized Recommendation Systems

AI analyzes user search history and borrowing patterns to recommend relevant resources. This improves user satisfaction and discovery efficiency.

Virtual Reference and Information Services

Chatbots help users in real-time by:

- Locating books and journals
- Explaining library policies
- Assisting with citation formatting
- Guiding database searches

These systems offer support all the time.

Collection Development

Artificial intelligence helps people make choices when they buy things for a library by looking at

- How often people use the books
- What people like to read
- What people are studying now
- This way the library has a good mix of books and they are all useful, to people.

Plagiarism Detection and Academic Integrity

AI-powered plagiarism detection systems compare submitted documents with vast databases to identify similarities. This promotes ethical research practices.

Research Analytics and Bibliometrics

AI assists in citation analysis, research impact measurement, and trend mapping. Libraries use AI tools to support faculty research evaluation.

Digital Preservation

Digitizing and preserving rare collections by automating image recognition, text extraction (OCR), and metadata tagging.

Advantage of Artificial intelligence in Academic Libraries

Enhanced Efficiency

AI automates repetitive tasks such as cataloguing, classification, and data entry, allowing librarians to focus on strategic activities.

Improved User Experience

Personalized services and faster response times enhance user satisfaction.

24/7 Service Availability

Virtual assistants ensure continuous support beyond physical library hours.

Data-Driven Decision Making

Libraries can analyze usage patterns and optimize services accordingly.

Challenges in Implementing AI

Financial Constraints

AI implementation requires significant investment in software, hardware, and training. Reliable internet connectivity and advanced IT infrastructure are essential.

Skill Gap between users and library staff

Library professionals need training in AI tools, data analytics, and digital technologies.

Data Privacy and Security

AI systems collect user data for personalization. Ensuring confidentiality and compliance with privacy regulations is critical.

Ethical Concerns

Algorithmic bias and lack of transparency in AI decision-making may affect fairness and inclusivity.

Role of Librarians in the AI-Driven Environment

Managing digital information resources is one of the most important roles of librarians in the AI era. The growth of digital collections, online databases, institutional repositories, and electronic journals has created a need for trained professionals to manage and maintain these resources. Librarians develop metadata standards, maintain the quality of digital records, and oversee the deployment of AI tools to aid in information retrieval. Librarians, by applying their professional knowledge and using the most advanced technologies, help to build well-structured digital information systems that improve knowledge access.

Impact on Teaching, Learning, and Research

AI improves academic support services by
Facilitating immediate access to scholarly resources
Enabling interdisciplinary research studies
Supporting systematic literature reviews
Assisting in research impact analysis.

Ethical and Social Implications

Libraries should responsible AI use by:

- I. User Privacy
- II. Guaranteeing algorithmic transparency
- III. Avoiding digital divide issues
- IV. Fostering equal opportunity
- V. Developing ethical frameworks is essential to maintain trust and integrity.

Future Trends in AI and Academic Libraries

Possible future developments: Voice based search engines, AI-enabled learning analytics Integration with Learning Management Systems (LMS), Advanced semantic search engines, Autonomous digital preservation tools, As AI evolves, academic libraries will evolve into intelligent knowledge ecosystems.

Recommendations

Define clear policies for AI implementation.
Invest in staff training and capacity building
Comply with data privacy. Collaborate with IT departments and technology vendors. Develop phased implementation strategies.

Conclusion

The Artificial Intelligence is choppy academic libraries into dynamic, user-focused knowledge spaces. Libraries can use AI technologies like machine learning, natural language processing, predictive analytics to increase operational efficiency, improve resource discovery, enhance research support services. But for successful adoption it requires careful planning, ethical considerations and ongoing professional development. Rather than displacing librarians, AI is enabling them to take on strategic roles in digital scholarship and information literacy. Used wisely, AI can greatly improve the quality and effectiveness of academic library services in today's educational setting.

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