

## A review of artificial intelligence implementation in academic library services

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*Artificial intelligence (AI) has emerged as a transformative force across various sectors, including academic libraries, offering potential paradigm shifts in operations and patron services. The imperative need for AI in educational library services stems from its myriad advantages in enhancing efficiency and service quality. Despite its promise, the integration of AI within academic libraries faces hurdles such as expertise shortages, infrastructure limitations, financial constraints, and employment concerns. This paper critically seeks to assess AI implementation in academic library services. The aim is to uncover adoption drivers and challenges in AI implementation in academic libraries. This paper conducts a comprehensive literature review to explore implementation of AI in academic libraries. The findings of the study indicate that AI implementation heralds an era of enhanced service delivery, albeit accompanied by challenges, notably in developing countries like South Africa. It also indicates that success hinges on meticulous planning, collaborative teamwork, adequate funding, and proactive promotion. Furthermore, the paper's findings offer librarians and top management insights into navigating the adoption of AI projects within academic library settings efficiently.*

**Keywords:** Artificial intelligence, academic libraries, implementation, library services, service efficiency

### 1 Introduction

Academic libraries are pivotal contributors to the academic success of universities, fostering intellectual growth, facilitating research endeavours, and enhancing overall excellence by providing a diverse range of resources and promoting information literacy (Hotsonyame 2023). These libraries serve as indispensable technological hubs that cater for the academic community, playing a vital role in advancing scholarly pursuits and educational excellence (Rodrigues & Mandrekar 2020). The global evolution of technological advancements has significantly reshaped and revolutionised various sectors, including academia. The integration of artificial intelligence (AI) technology into the educational landscape has elicited both commendation for its streamlining of traditional processes and criticism for its limitations (Gillespie et al. 2023).

Over the years, academic libraries, mirroring other sectors, have undergone substantial transformations, transitioning from manual operations to embracing cutting-edge technologies to enhance library utilisation and streamline service access. Notable advancements include the transition from traditional card catalogues to Online Public Access Catalogues (OPAC), simplifying information retrieval and eliminating the need for exhaustive manual searches (Eserada & Okolo 2019). Additionally, the accessibility of library services has significantly improved, enabling remote subject assistance without

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physical presence (Adetayo 2023). These technological strides have been instrumental in fostering improved library utilisation, particularly pertinent in the context of the fourth and fifth industrial revolutions (Oke & Fernandes 2020).

Despite proactive adoption, particularly of AI, by academic libraries to reshape service paradigms, there remains an observable gap in comprehensive implementation (Wheatley & Hervieux 2019; Farag, Mahfouz & Alhajri 2021). While AI is being harnessed to leverage big data and data analytics for operational and service-oriented purposes, bridging this implementation gap remains crucial to fully exploit these technological advancements (Garoufallou & Gaitanou 2021; Luca, Narayan & Cox 2022).

Recognising the significance of integrating cutting-edge technologies like AI into academic libraries, scholars have emphasised its potential to enhance service accessibility, both on site and online, and optimise operational efficiency, leading to increased engagement among staff and patrons (Ogar & Dushu 2018; Pierce 2022). However, despite the acknowledged necessity and potential advantages, a gap in the realisation of AI in libraries persists, calling for urgent measures to promote wider implementation (Wheatley & Hervieux 2019; Farag et al. 2021).

The aim of this paper was to uncover adoption drivers and challenges in AI implementation in academic libraries. Addressing three fundamental questions:

- Why is AI needed in academic libraries?
- Why is its implementation advantageous?
- How can its usage be effectively implemented?

This exploration sought to optimise academic library services by leveraging AI's potential to enhance quality and efficiency. The structure entails a presentation of the methodology, a comprehensive literature review aligned with the objectives, the ensuing findings, discussions, and a concluding summary.

## 2 Methodology

This paper adopted a comprehensive literature review, delving into the rich repository of scholarly works orbiting crucial keywords such as "artificial intelligence", "AI", "academic libraries", "implementation", "library services" and "service efficiency". The objective was to glean comprehensive insights from a broad spectrum of academic discourse, necessitating the exploration of diverse research avenues.

To navigate this vast information landscape, Scopus was used as an indexing tool to select journal articles and books on the context of research, thus the implementation of artificial intelligence in academic libraries. Access to the full text of these journal articles and books was facilitated by Google Scholar. The selection of these databases was deliberate, rooted in their unparalleled capacity to encompass a wide array of academic fields, ensuring access to a diverse range of literature sources. These platforms are well regarded for their robust search functionalities and advanced search options, allowing for nuanced and precise article discovery amid the expansive pool of scholarly publications. Notably, the hallmark of both Google Scholar and Scopus lies in their commitment to upholding quality standards by predominantly indexing peer-reviewed journals, thereby ensuring the inclusion of credible and validated research sources within our review.

In addition, titles not accessible on Google Scholar were searched on Google to identify accessible databases, including Harvard Business Review, ResearchGate, University of Western Cape Thesis Repository, LJ Library Journal, International Journal of Advanced and Applied Research, IFLA website and Perlego.

Employing Boolean operators such as "OR" facilitated a comprehensive exploration by broadening the search parameters, enabling a thorough examination of pertinent literature encompassing various facets of AI implementation in academic libraries. To maintain a contemporary perspective, the focus remained on scrutinising journal articles and books published between 2017 and 2024. This deliberate temporal focus ensured that our synthesis and analysis were firmly rooted in the most current and relevant research findings, offering an up-to-date understanding of the evolving landscape of AI implementation within academic library services.

## 3 Literature review

The contemporary landscape witnesses a notable trend across various organisations, including academic libraries, gravitating towards the integration of advanced computer systems capable of executing tasks traditionally associated with human cognition (Cardon 2018). This paradigm shift stems from the advent of AI, a technology that humans have adeptly harnessed to accomplish a diverse spectrum of tasks through AI-driven devices (Gupta & Mangla 2020). The surge in its usage signifies a pivotal transformation, indicating that AI has outgrown its nascent stage and is no longer considered a novel or unconventional concept.

AI's historical roots can be traced back to the 1950s, marking its inception and subsequent evolution over the decades (Marr 2019). Lowe and Lawless (2021) shed light on the mid-1950s to early 1960s as the period witnessing the emergence of 'Game AI,' which has evolved into a substantial industry today, boasting a multi-billion-dollar valuation. Smith (2018) argues that the evolution of AI technology is closely linked to the development of new hardware and the availability of increasingly massive datasets.

The term "artificial intelligence (AI)", coined by John McCarthy in 1956, signifies the field's inception, yet its definition remains a subject of ongoing debate among scholars and researchers (Gupta & Mangla 2020; Mökander et al. 2023). Diverse interpretations exist, defining AI as the creation of intelligent computer systems mirroring human-like behaviours (Gupta & Mangla 2020), the manifestation of human-like intelligent behaviours in machines (Marr 2019) or the capability of machines to exhibit intelligence distinct from human natural intelligence (Lowe & Lawless 2021). However, the crux of these definitions converges on programming machines to emulate human intelligence and behaviours.

The overarching objective of AI remains consistent: to create systems capable of exhibiting intelligent behaviours, learning, reasoning, and providing advice, significantly impacting various domains (Qamar 2022). AI's prowess lies in enabling computers to replicate human-like intelligence, perception, and decision-making, yielding benefits such as automation and insightful analytics (Zhao et al. 2021). These systems' adaptability, informed decision-making, and seamless interaction with humans' underscore AI's profound potential to tackle complex problems and perform tasks at or beyond human capacities (Chen, Sun & Wang 2022; Haque 2023).

In the realm of academic libraries, AI's integration has sparked transformative changes, heralding a new era of managing and accessing information (Echedom & Okuonghae 2021). AI's emergence in academia has significant potential and intriguing applications in many areas, especially in library contexts (Omame & Alex-Nmecha 2020). The applications of AI within library contexts encompass a wide spectrum, including expert systems for reference services, robotic systems for tasks like book reading and shelf management, and virtual reality for immersive learning experiences in technical assistance (Omame & Alex-Nmecha 2020). This infusion of AI not only reshapes the landscape of library services, but also signifies a paradigm shift in technical and patron services, promising innovative solutions that transcend traditional boundaries (Omame & Alex-Nmecha 2020; Banerjee 2022). AI's potential within academic libraries reflects its capacity to revolutionise information management and service delivery, fostering a dynamic and enriched learning environment for patrons and staff alike.

### 3.1 The need for AI academic libraries

The integration of AI in academic libraries serves as a transformative force that addresses various challenges such as resource constraints, improves information retrieval, streamlines knowledge organisation, personalises user services and enhances resource management, thereby significantly improving library services (Barsha & Munshi 2023). The diverse capabilities of AI, ranging from natural language processing to classifying books to enriching metadata, are redefining traditional library operations (Ali, Naeem & Bhatti 2020; Cox & Mazumdar 2022). By using modern technologies such as natural language processing and machine learning algorithms to automate the indexing and accurate classification of library collections, AI also enables the creation of customised recommendation systems that significantly improve the discoverability and accessibility of resources for library patrons (Suryawanshi 2024).

The impact of AI goes beyond mere automation; it frees librarians from mundane tasks, as chatbots serve as a simple platform to reach out to target users such as students and researchers and can help them access the library's databases, allowing librarians to focus on more complex tasks (Kaushal & Yadav 2022; Aithal & Aithal 2023). By using AI systems based on radio frequency identification (RFID), libraries optimise the location of resources and work intelligently, enabling autonomous functions (Chhetri & Thakur 2019; Okunlaya, Syed Abdullah & Alias 2022). For users, AI simplifies the search for relevant research materials by using generative AI to streamline search procedures and save valuable time (IFLA 2023a). Librarians are freed from repetitive tasks and can spend their time getting to know and serve their clientele better (Chakarova & Trabert 2017)

Innovation through AI extends further, transforming library operations such as self-checkout systems and enabling 24-hour services (IFLA 2023b). The tireless nature of AI systems ensures continuous library operation, freeing librarians from round-the-clock responsibilities (Omame & Alex-Nmecha 2020). AI-driven virtual reference assistants like Pixel or chatbots constructed using Hypertext Pre-processor (PHP) prove instrumental in delivering consistent and efficient 24/7 services, catering for users' need for instant and personalised information (Gujral, Shivarama & Choukimath 2019; Omame & Alex-Nmecha 2020). Libraries in developed countries, such as the University of Oklahoma Library in North America, Monash University Library in Australia, and San Jose State University Library in North America, are already successfully using these AI chatbots (De Sarkar 2023). However, in developing countries such as India, there are obstacles such as a lack of financial support and infrastructure that hinder the adoption of chatbots in libraries (Kaushal & Yadav 2022).

In an era characterised by information overload, the role of AI in academic libraries becomes indispensable (Hussain 2023). AI technology's ability to analyse extensive metadata associated with scientific collections elevates indexing, reference services and information retrieval (Allal 2022). Ultimately, the integration of AI not only ensures accessibility and availability of library resources, but also equips library staff to adeptly navigate and harness AI's capabilities to address user inquiries (Abayomi et al. 2021).

### **3.2 Academic libraries AI implementation advantages**

The motivation behind the widespread adoption of AI lies in its transformative potential across various sectors, particularly in academic libraries aiming to enhance learning and research processes (Okunlaya et al. 2022). The promise of intelligent decision-making for information retrieval and sharing positions AI as an asset, yet challenges persist, especially in African academic libraries. Specific obstacles, such as unstable power supply, skills shortages, job displacement concerns, inadequate infrastructure, resistance to change, competencies, security issues and erratic power supply, hinder the seamless integration of AI (Echedom & Okuonghae 2021; Yusuf et al. 2022). Barsha and Munshi (2023) highlight the potential benefits and problems associated with AI adoption in developing countries, citing issues like infrastructure, a lack of experienced staff, privacy concerns, the digital divide, and high costs.

To effectively harness AI services, academic libraries require not only physical equipment, software and supporting infrastructure, but also qualified human resources (Srikanth & Kumar 2023). However, the substantial costs associated with upgrading and maintaining AI technology pose a significant hurdle (Barsha & Munshi 2023). Financial constraints, inadequate infrastructure, resistance to change, negative perceptions and a lack of expertise are common challenges faced by libraries in adopting innovative technology solutions (Kaushal & Yadav 2022). Research in Pakistani university libraries by Ali et al. (2022) highlights the limitations of existing IT infrastructure in handling advanced AI products. Similarly, a study in Southern Nigeria by Emiri (2023) reveals low AI adoption rates due to insufficient ICT infrastructure to meet global standards. The expenses related to staff training and consulting investments further weigh heavily on AI adoption (Dorhetso & Quarshie 2023), and Farag et al.'s (2021) study in Saudi academic libraries identified a lack of AI training as a significant barrier. Similarly, a lack of funding for staff training and limited time for workshops hinder the use of chatbots for digital library capabilities among librarians (Kaushal & Yadav 2022).

Concerns about job displacement due to AI advancements have been raised in developing countries, reflecting fears that AI and robotics may jeopardise librarians' careers (Ajani et al. 2022). Job security is a significant concern, with worries that AI technology could replace human roles, leading to job losses and reduced employment opportunities (Ajani et al. 2022). However, contrary perspectives suggest that AI adoption may not necessarily result in significant job losses, as libraries could assume additional roles related to content acquisition, data exploration, user assistance and content evaluation (Cox, Pinfield & Rutter 2019). This is corroborated by research conducted by Huang (2022) in Taiwan, a developed country, indicating that librarians in that context do not foresee being replaced by AI.

The satisfaction of stakeholders plays a pivotal role in AI adoption, influencing the human environment within libraries. While libraries traditionally prioritise information literacy, educating users about AI has often been neglected (Wheatley & Hervieux 2019). Few library users engage with knowledge-based systems, primarily because they are usually not user-friendly enough for the average library user (Misau 2021). This underscores the importance of enhancing user-friendly interfaces and conducting targeted outreach initiatives to bridge the gap between users and AI technologies in library settings.

Insufficient power supply poses a notable hindrance to the successful adoption and utilisation of AI technologies in libraries (Owolabi et al. 2022). Librarians grapple with substantial obstacles in embracing robotics technology, including limited budgets and an unreliable power supply (Sambo & Oyovwe-Tinuoye 2023; Tella 2023). Ensuring a consistent power supply is imperative for the effective functioning of AI systems, as highlighted in the findings of Owolabi et al. (2022), revealing that students may encounter difficulties when using AI technology without a reliable power source.

### **3.3 Ways to foster AI implemented and usage in academic libraries**

In addressing the evolving needs of their users, librarians are encouraged to stay abreast of technological advancements and cultivate an experimental culture that embraces data-driven technologies (Gupta & Gupta 2023). Recognising the critical importance of AI literacy, librarians can utilise this knowledge to comprehend AI tools, enhance library services, address ethical concerns, safeguard students from potential risks and promote innovative applications (Lo 2023). Sambo & Oyovwe-Tinuoye (2023) advocate for comprehensive training programmes prioritised by library management to equip researchers and librarians with the skills to effectively use robotic technologies within library environments. Ongoing training for both library staff and users plays a pivotal role in enhancing operational efficiency, improving user experiences, and introducing new services to a broader academic audience (Echedom & Okuonghae 2021).

The appropriation of responsibility and ownership of AI within library spaces is crucial for increased efficiency in library services. In the contemporary era, librarians are positioned to educate library users about modern technologies, ensuring users are well-informed about new technologies and conducting regular orientation programmes to foster appreciation and utilisation of these technologies (Kaushal & Yadav 2022; Srikanth & Kumar 2023). Embracing this responsibility by stakeholders enhances AI implementation in libraries.

While budget considerations are vital for sustaining resources and services, the cost presents a significant obstacle to AI implementation in libraries (Lo 2023; Srikanth & Kumar 2023). The pursuit of enhanced technology, services and user experiences necessitates libraries to seek additional funding, prompting the need for strategic investments (Onwueme & Nyemezue 2017). Practical solutions for developing countries to implement AI in library services include partnerships and infrastructure investments (Barsha & Munshi 2023). To address this financial challenge, libraries can explore diverse funding opportunities, such as technology grants and establishing partnerships with technology companies. Collaborative endeavours of this nature may present the prospect of reduced or cost-free access to AI tools in exchange for data sharing and cooperation (Lo 2023). Ajani et al. (2022) advocate that funding should ideally originate from government sources or the parent institutions of academic libraries, to prevent the misallocation of funds.

Moreover, the adoption of alternative power sources incorporating green technology concepts is essential to enhance AI implementation and library usage. Library management plays a pivotal role in ensuring a consistent power supply using alternative sources such as solar energy and generators (Owolabi et al. 2022). Ajani et al. (2022) highlight the challenges developing countries face related to technologies such as electricity supply and recommend that academic libraries tackle this issue by deploying alternative power generation systems like solar energy and biofuels. By collectively addressing challenges associated with AI implementation, such as finance, power and training, there would be a substantial increase in its overall efficacy within academic libraries.

#### 4 Discussion

The dynamic and evolving intersection of emerging technology and libraries is unmistakably evident in the transformative journey libraries have undertaken. As custodians of knowledge, libraries have consistently embraced emerging technologies to enhance their operations and services, evident in transitions from card catalogues to OPACs and from traditional reference desk services to 24/7 online and virtual reference services (Kim 2020; Hotsonyame 2023). The core mission of academic library services, centred on organising information resources for easy access, aligns seamlessly with the implementation of innovative technologies that accelerate information retrieval (Chakarova & Trabert 2017).

In the midst of the digitalisation ushered in by the fourth and fifth industrial revolutions, academic libraries are increasingly integrating advanced technologies (Echedom & Okuonghae 2021); whereby the 4IR promotes the advancement of science and technology (Liao et al. 2018) while the Fifth Industrial Revolution (5IR) embraces the concept of harmonious collaboration between humans and machines, paving the way for a (r)evolution in thinking about human-machine collaboration and its use for greater societal well-being (Noble et al. 2022). At the forefront of these transformative technologies is AI, a pivotal force that libraries worldwide are implementing. This movement is fuelled by the recognition that AI enables computer systems to emulate complex human capabilities, automating processes, enhancing stakeholder satisfaction, and creating new avenues for communication and improved services (Marr 2019; Sheikh, Prins & Schrijvers 2023). This technological leap necessitates academic libraries to envision novel ways of disseminating information to meet evolving user needs requiring both management and staff motivation to effectively incorporate AI into academic library service (IFLA 2020).

The implementation of AI within academic libraries yields numerous benefits, foremost among them being heightened service efficiency (Oyetola et al. 2023). These advantages encompass round-the-clock service availability, precise cataloguing, and a reduced workload for librarians (Suryawanshi 2024; IFLA 2023b). AI systems have the capability to automate repetitive jobs like cataloguing, indexing and data management, enabling librarians to dedicate their time and skills to more intricate activities (Suryawanshi 2024). However, alongside these advantages, there are concerns and criticisms associated with AI implementation, including the potential for job loss and disruptions to service flow (Ali et al. 2022; Tamayo et al. 2023).

The successful integration of AI demands not only technological readiness, but also motivation and understanding from management and staff. In developed countries, studies Cox et al. (2019) and Huang (2022) suggest a positive outlook, with librarians comprehending the purpose of AI and embracing new roles such as content provision, data exploration and guiding users through the evolving information landscape. Interestingly, librarians in developed countries exhibit little concern regarding potential job losses attributed to AI replacing human roles.

Conversely, a different narrative unfolds in developing countries, where librarians harbour apprehensions about AI threatening job security due to a lack of understanding and necessary technological skills. Additionally, academic libraries in developing countries struggle with inadequate funding, infrastructure and technical skills related to their current

technologies, hindering the widespread implementation of digitisation and advanced technologies (Ali et al. 2022). This discrepancy in implementation means that academic libraries in developing countries lag, missing out on the benefits of technological advances.

Despite AI's potential to increase library services' efficiency, these challenges have caused academic libraries in developing countries to fall behind their counterparts in more developed countries. These findings align with similar research in developing countries, such as studies conducted by Ajani et al. (2022) in Nigeria and Adjei (2023) in Ghana and South Africa, revealing common challenges, including skills shortages, budget constraints, inadequate ICT infrastructure and a lack of government support.

This demonstrates that there is a great need for the integration of AI in academic libraries, as it improves service delivery and the efficiency of library operations and services. The implementation is beneficial, as it increases the efficiency of services by including 24/7 availability of services, accurate cataloguing, and reduced workload for librarians. However, to effectively implement the use of AI in academic libraries, many issues need to be resolved, such as job loss and skill shortages.

## 5 Conclusion

The integration of AI in academic libraries is a revolutionary change that is redefining the landscape of library services with unprecedented levels of efficiency. This adoption holds immense potential to improve accessibility, accuracy, and personalised user experience. However, the realisation of these promising prospects faces significant challenges, especially in underdeveloped countries where infrastructure, financial resources, expertise, and constant power supply are limited, posing major obstacles to the implementation of AI.

To advance the integration of AI into academic library services, a comprehensive approach that considers both the potential and the obstacles is essential. Addressing these challenges requires a concerted effort to bridge the technology gap and ensure that libraries in developing countries are not left behind. Strategic alliances and partnerships between libraries, technology experts, policy makers and funding agencies can serve as a catalyst for progress.

Crucially, the focus should be on knowledge sharing and capacity-building initiatives to equip library professionals with the skills they need to use AI effectively. In addition, developing adaptable and scalable AI models tailored to different resource environments is critical to promoting inclusivity and equitable access to technological advances. By fostering a collaborative ecosystem and prioritising adaptable strategies, the integration of AI into academic libraries becomes an achievable reality that enriches global scholarly work and ensures equitable access to transformative technological innovations in libraries worldwide.

The insights gained from this paper could prove helpful to librarians and managers in charting their course for the implementation of AI projects in academic libraries. By comprehensively addressing the challenges and opportunities associated with implementing AI in academic library services, this paper serves as an important insight for librarians, policy makers, technologists and stakeholders involved in shaping the future of academic libraries.

Future research could deepen the librarians' perspective on AI implementation while expanding the scope of studies to different developing countries. Currently, much of the research on AI in academic libraries focuses on a few developing countries. There is therefore a need to explore other geographical contexts to gain a comprehensive understanding of the challenges and opportunities in different settings. There is also a need to comprehensively explore the various AI services required by libraries so that future research directions aim to empirically investigate these services.

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