

Public Libraries in the AI Era: Leading Innovations, Opportunities, and Challenges

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Abstract

Purpose: This study presents an outline of how the integration of Artificial Intelligence (AI) in public libraries is reshaping traditional library services, offering novel opportunities to enhance users participation.

Design/methodology/approach: The study used the narrative review of relevant literature in the field of Artificial Intelligence and public the library, along with real-world examples from various smart libraries. The current study highlights several significant applications of AI in library environments, such as AI-powered chatbots, Virtual assistants, AI-integrated recommendation systems, smart security systems and robotics technologies.

Findings: The reviews of previous studies show that AI integration is crucial in transforming public libraries into dynamic, user-centred knowledge hubs. ChatGPT-like generative AI tools are improving automated cataloguing and classification, AI-powered search tools and natural language processing (NLP) enable users to find information more accurately. Multilingual chatbots and virtual assistants provide 24/7 guidance to users to locate the information. Moreover, AI can analyse user behaviour from their search queries and borrowing patterns to offer personalised recommendations, similar to commercial OTT platforms, showing that the AI systems have a high potential to improve public library services.

Limitations: This study pointed the integration of AI tools in public library settings from the existing literature and highlighted major real-world examples from the smart libraries around world.it also identified key challenges such as ethical concerns regarding seamless AI deployment in library settings, AI literacy of the public, Fund Allocation and Job Security.

Originality/value: This study offers a new perspective by reviewing published research papers in the field of Artificial Intelligence (AI) in public libraries across different countries and contexts. Unlike previous studies that focused on isolated case studies, this paper critically reviews and synthesises international examples.

Keywords: Artificial Intelligence, AI-powered technologies, Public Libraries, Smart Libraries,

Introduction

Artificial intelligence (AI) has been used in a number of sectors to increase productivity and working ef-

iciency. Especially in healthcare (Amisha et al., 2019; Becker, 2019; Jiang et al., 2017), agriculture (Bannerjee et al., 2018; Eli-Chukwu, 2019), academia (Abbas et al., 2023; Abbasi et al., 2025; Ahmed & Godiyal, 2021; Akgun & Greenhow, 2022), etc., libraries are not exempt from the widespread use of AI technologies in the digital era. Imagine a librarian who never sleeps - that's what AI can be for libraries. It helps organise books and resources automatically, making things quicker and easier for the library staff (Kumar & Jyoti, 2024). Libraries may improve their operations, customer satisfaction, and their ability to remain relevant in the digital world by implementing AI-powered technologies (Ahmed et al., 2024; Audunson et al., 2019; Chowdhury et al., 2006; Tai & Ghosh, 2024; Y. Chan, 2015). It is crucial that libraries embrace the newest technology; if they are aiming to remain current and prepared for the future, they must strategically integrate AI technologies (Rahmani, 2023).

The application of AI and AI powered technologies in the various sections of libraries, such as AI-powered recommendation systems for discovering library resources and personalised recommendations, automated metadata generation helps to reduce manual input, virtual assistance and chatbots facilitating active responses to the user queries, data analytics for collection management, digital preservation and access, text analyses and information extraction (Gajbhiye, 2024).

The advanced capabilities of AI can contribute to most of the sections of the library, especially in public libraries (Rahmani, 2023). In contrast to other types of libraries, such as academic libraries (Raju, 2014) and special libraries (Murray, 2013), Public libraries have a diverse range of patrons. As such, it is the duty of public libraries to be updated with the latest technologies available in the contemporary world in order to meet users' needs. A vast array of resources can be found at public libraries, which are constantly adding new materials. As a result, it is challenging to retain its resources and effectively distribute them to its users without the use of AI technology (Audunson et al., 2019; Chowdhury et al., 2006).

In the past, public libraries have been viewed as hubs for learning and knowledge. The initiative aims to raise the general standard of service delivery, increase accessibility, and make libraries more relevant to the needs of their communities. This technological advancement promises to significantly enhance the quality of library services in addition to revolutionising their operational elements of the user experience. Public Libraries can adopt AI-assisted cataloguing, classification, acquisition, reference, inventory checking, and also assistance from chatbots for user inquiries and personalised recommendations (Rahmani, 2023).

The integration of AI technologies into the public library landscape is crucial and highly recommended in the digital era. It contributes to improving the user experience, optimising library operations, expanding swift access to huge quantities of information, lowering human labour, and, lastly, establishing libraries as creative and flexible community resources in the modern world.

Review of Literature

Application of artificial intelligence technologies in public libraries has been explored by some scholars (Ahmed et al., 2024; Audunson et al., 2019; Chowdhury et al., 2006; Li, 2024; Rahmani, 2023; Tella & Ajani, 2022; Y. Chan, 2015). The major implementation of AI technologies in the various sections of libraries, including classification and cataloguing, reference service, information retrieval, translation, etc. The adoption of AI technologies exclusively used in certain tasks in public libraries, such as automated cataloguing, virtual reference services, and data analytics, has been studied by (Ahmed et al., 2024), and its use in public libraries

In the study of Mahmud (2024); Moulaison-Sandy and Coble (2024) explored the use of artificial intelligence applications for cataloguing in the library; this section requires a lot of time and human resources to finish the cataloguing work. The use of AI technologies that help to leverage the cataloguing process with the AI support, such as automated metadata generation, subject heading assignment, authority control and name disambiguation, multilingual cataloguing support, enhanced classification, content analysis and summarisation (Mahmud, 2024). The study by Tella and Ajani (2022) explored the various uses of robotics technology in libraries, specifically used in shelving and locating library materials, security, real-time reference services, automated storage and retrieval systems, etc., which will help to save the time and effort of library staff.

To explore the perspective of librarians, IT professionals, Library managers, and library users towards the integration of AI in public library services, Rahmani (2023) interviewed 29 participants. It's found that AI in libraries can enhance library operations and user experiences by enhancing information retrieval, automating repetitive tasks, and delivering personalised services.

As well as the advantages, the challenges and limitations of incorporating AI technologies in libraries have been studied by (Alala et al., 2024; Hussain, 2023; Li, 2024). These studies addressed the major hindrances faced by libraries, such as a lack of budget, a lack of technical staff, integration with existing systems, and weak networks (Alala et al., 2024; Hussain, 2023; Li, 2024).

Emerging Applications of AI in Public Libraries

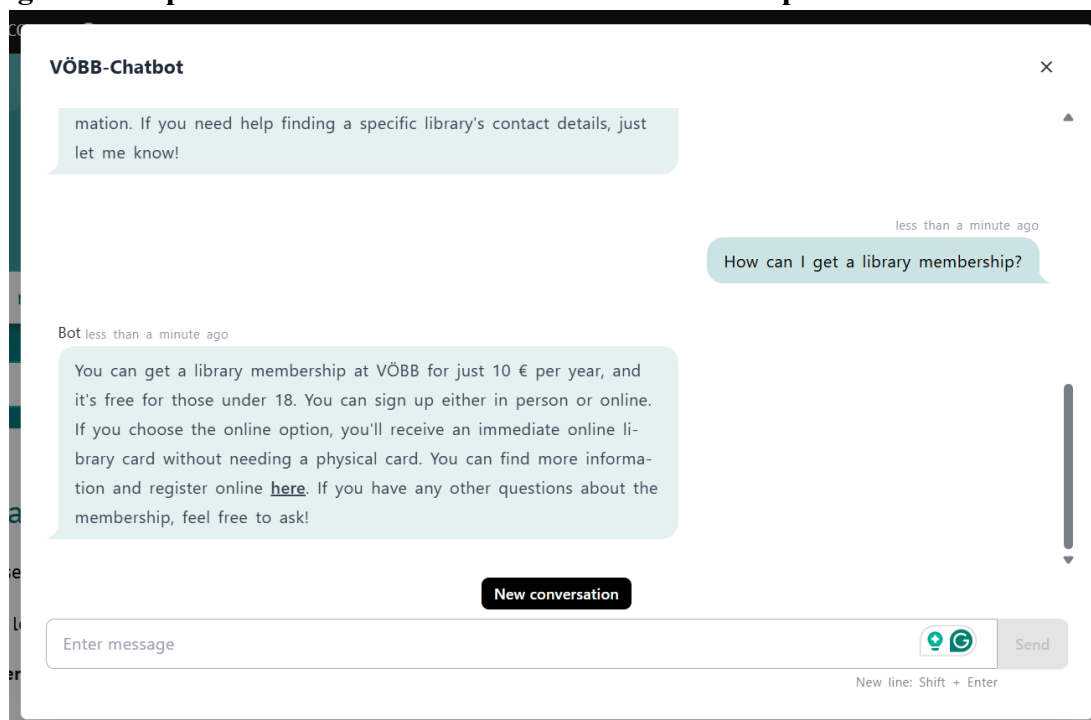
The capabilities of AI and allied technologies facilitate its use for generating sophisticated data-driven services such as personalised recommendations, intelligent chatbots, automated shelving and user behaviour analytics, thereby transforming the way information is accessed and delivered. Here is a list of some innovative AI-driven technologies progressing in public library settings in a global scenario.

1. AI Chatbot: an intelligent tool for libraries

Chatbots can be broadly classified into two types: AI chatbots and rule-based chatbots. AI chatbots represent a modern advancement in AI systems, designed to generate responses according to the queries. To make these bots interact more naturally, extensive training is necessary so they can mimic human conversation patterns. On the other hand, rule-based chatbots operate on predefined sets of questions and responses, requiring little training and are limited to answering only within those predefined boundaries. (Supreetha, 2022). Implementing chatbots can lead to cost savings for libraries. By automating routine tasks and reducing the need for additional human resources, libraries can optimise their operational costs over time (Khandagale et al., 2023). Chatbots can handle routine, predictable, and frequently asked questions, offering users immediate assistance. They can also provide general to more complex queries. Essential details about library services can be communicated through various formats such as brief chat sessions, computer-assisted calls, FAQs, virtual library tours, and librarian assistance requests. In reference services, the chatbots can answer frequently asked questions and give general guidance for expert answers to required questions, 24/7, even when the library is closed (McNeal & Newyear, 2013; Panda & Chakravarty, 2022; Wang, 2024). Several libraries around the world have integrated chatbots to improve user experience. Emma, the Mentor Public Library Chatbot, is the MPL's virtual reference librarian. Emma helps the patrons by answering their questions about the library and directing them to other online resources. Emma was initially introduced on November 19, 2009, with the capability to respond to a small set of predefined frequently asked questions (Iglesias, 2013). Within six weeks, the chatbot was upgraded to an AI-driven model. Over time, its functionality expanded significantly and

became able to provide information on library services, rules, operating hours, navigation support, and links to tutorials and external websites or databases (Lun, 2009). The VÖBB AI chatbot is launched by the Verbund der Öffentlichen Bibliotheken Berlins (VÖBB)- the Association of Public Libraries in Berlin. It's designed to help people interact conversationally with a library's vast catalogue rather than relying solely on traditional search tools. It's considered one of the first AI systems deployed specifically to make a large public library collection searchable by natural language conversation; here, users can ask questions in natural language rather than keywords (AboutSomethinK, 2024).

Figure 1- AI-powered chatbot service of the association of public libraries in Berlin



<https://www.voebb.de/aDISWeb/app>

Figure 1 shows the interface of the Association of Public Libraries in Berlin Chatbot, where the researcher asked, 'How can I get a library membership?' The chatbot responded with full details about the library's membership policy. Here, this chatbot can answer many queries from library patrons 24*7 and will help both library users and library workers save time and manage multiple requests simultaneously.

In the context of public libraries, these AI communication systems are becoming essential tools. They enhance user engagement by providing 24/7 assistance, simplifying access to resources, supporting multilingual communication, and improving the overall efficiency of library services. As libraries transform into smart learning environments, integrating AI chatbots will be indispensable in improving service delivery and making information access more inclusive, interactive, and user-centric.

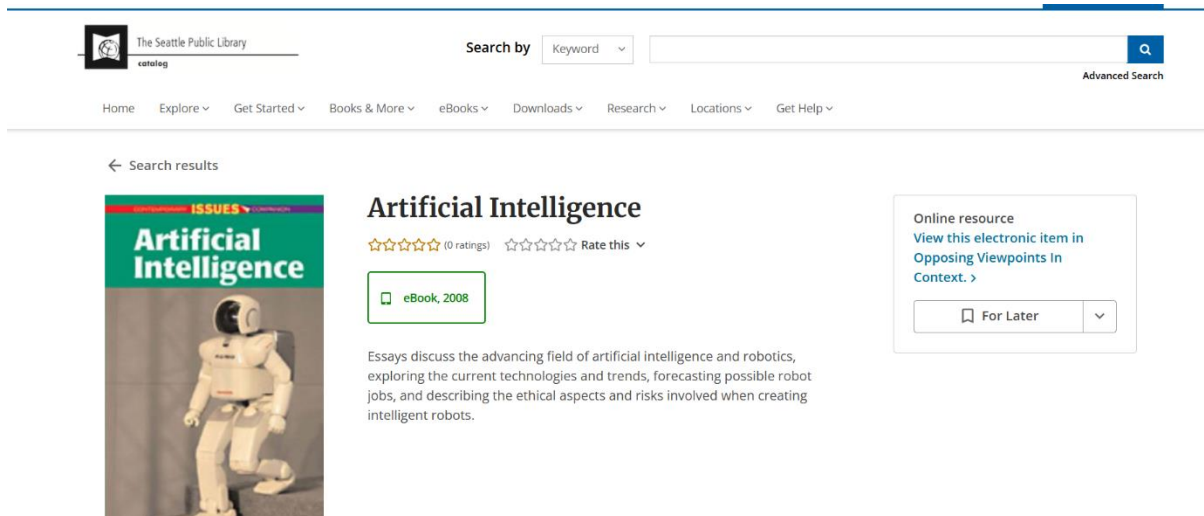
2. AI-Powered Personalized Recommendation systems

AI algorithms can analyse users' search queries and reading patterns to identify their interests and provide personalised recommendations (Balasubramanian & Tamilselvan, 2023). AI-enabled library systems' personalised recommendations make your library visit more enjoyable, and it's not just about books; it's about creating a smarter and more useful library environment (Kumar & Jyoti, 2024). An early

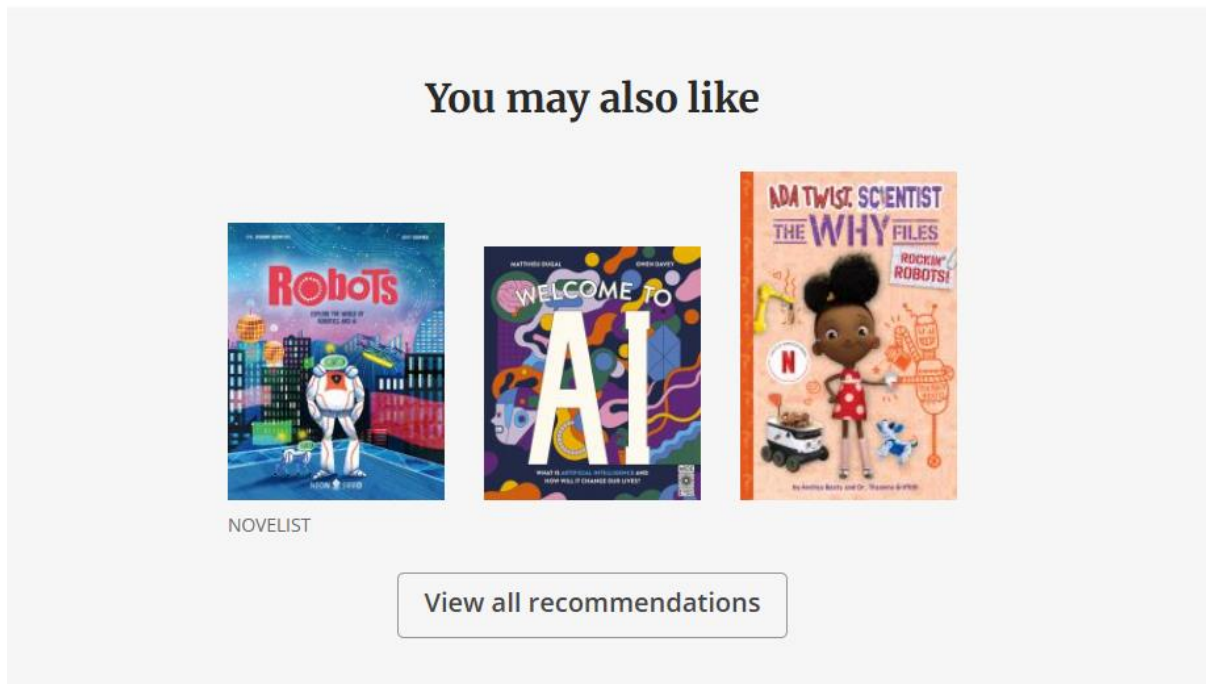
recommender system, referred to as Grundy, recommended books based on a library of manually assembled stereotypes (Aggarwal, 2016). According to Balabanović and Shoham (1997), recommender systems are typically categorised according to the methodology used to generate suggestions for the users.

- Content-based recommendation: Recommendations are made by analysing the user's previous preferences and suggesting items that share similar attributes.
- Collaborative recommendation: This approach suggests items based on the preferences of other users who have shown similar interests or behaviour.
- Hybrid recommendation methods: These systems integrate both content-based and collaborative techniques to enhance recommendation accuracy and overcome the limitations of individual approaches.

These methods help build smart systems, which can offer more personalised and useful suggestions to users. Integrating artificial intelligence (AI) into library services significantly enhances personalised information retrieval, thereby improving user engagement and satisfaction. AI-powered recommender systems can analyse huge amounts of user data, such as borrowing history, search queries, and reading patterns, to generate suggestions that align with individual user reading preferences. The University of Huddersfield Library in the UK implemented a recommender tool integrated with its OPAC to suggest books based on students' borrowing patterns, resulting in increased user engagement and higher circulation (Wakeling et al., 2012).



The screenshot shows the search results for 'Artificial Intelligence' on the Seattle Public Library catalog. The search bar at the top contains the text 'Artificial Intelligence'. The results page features a book cover for 'Artificial Intelligence' (ISSUES) with a robot illustration. The title 'Artificial Intelligence' is prominently displayed. Below the title, there are star ratings and a 'Rate this' option. A green box indicates it is an 'eBook, 2008'. A descriptive paragraph follows: 'Essays discuss the advancing field of artificial intelligence and robotics, exploring the current technologies and trends, forecasting possible robot jobs, and describing the ethical aspects and risks involved when creating intelligent robots.' To the right, there is an 'Online resource' section with a link to 'View this electronic item in Opposing Viewpoints In Context.' and a 'For Later' button.



<https://seattle.bibliocommons.com/search>

Figure 2- The Seattle Public Library (USA) – Biblio Core Library OPAC recommends books based on students’ search patterns.

The researcher typed a book named ‘Artificial Intelligence’. The personalised recommendation system enabled the OPAC to display recommendations related to the query, such as various books on Artificial Intelligence. The BiblioCore System works based on users' search patterns, called “Search Expansion.” For example, if a student consistently searches for specific genres, the OPAC begins to prioritise those genres in the auto-suggest dropdown menu.

In public library settings, these systems assist different age groups by suggesting relevant books and digital resources based on their specific interests and search behaviour, thereby facilitating more efficient access to personalised information (Lu, 2012). Despite these advances, the current generation of recommender systems still requires further improvements to make recommendation methods more effective and applicable to an even broader range of real-world applications (Adomavicius & Tuzhilin, 2005).

3. Role of Artificial Intelligence in Cataloguing and Classification

The integration of Artificial Intelligence (AI) into classification and cataloguing is transforming traditional cataloguing practices into new streamlined methodologies. Traditionally, these classification and cataloguing processes relied on manual processes and predefined classification schemes, such as the Dewey Decimal Classification (DDC) or Library of Congress Classification (LCC), carried out by trained and qualified librarians and information professionals (Balasubramanian & Tamilselvan, 2023). Manual cataloguing processes involve creating bibliographic records that include various aspects of the library materials, including title, author, subject and physical description of the materials. To guarantee precision and accuracy, this process calls for a great deal of time and experience (Mahmud, 2024). AI-enabled cataloguing revolutionises library management by automating metadata generation, subject classification, and keyword tagging, leading to increased accuracy and efficiency (Li, 2024). Generative AI tools have

enhanced cataloguing by enabling better extraction of information from unstructured data (Roy et al., 2024).

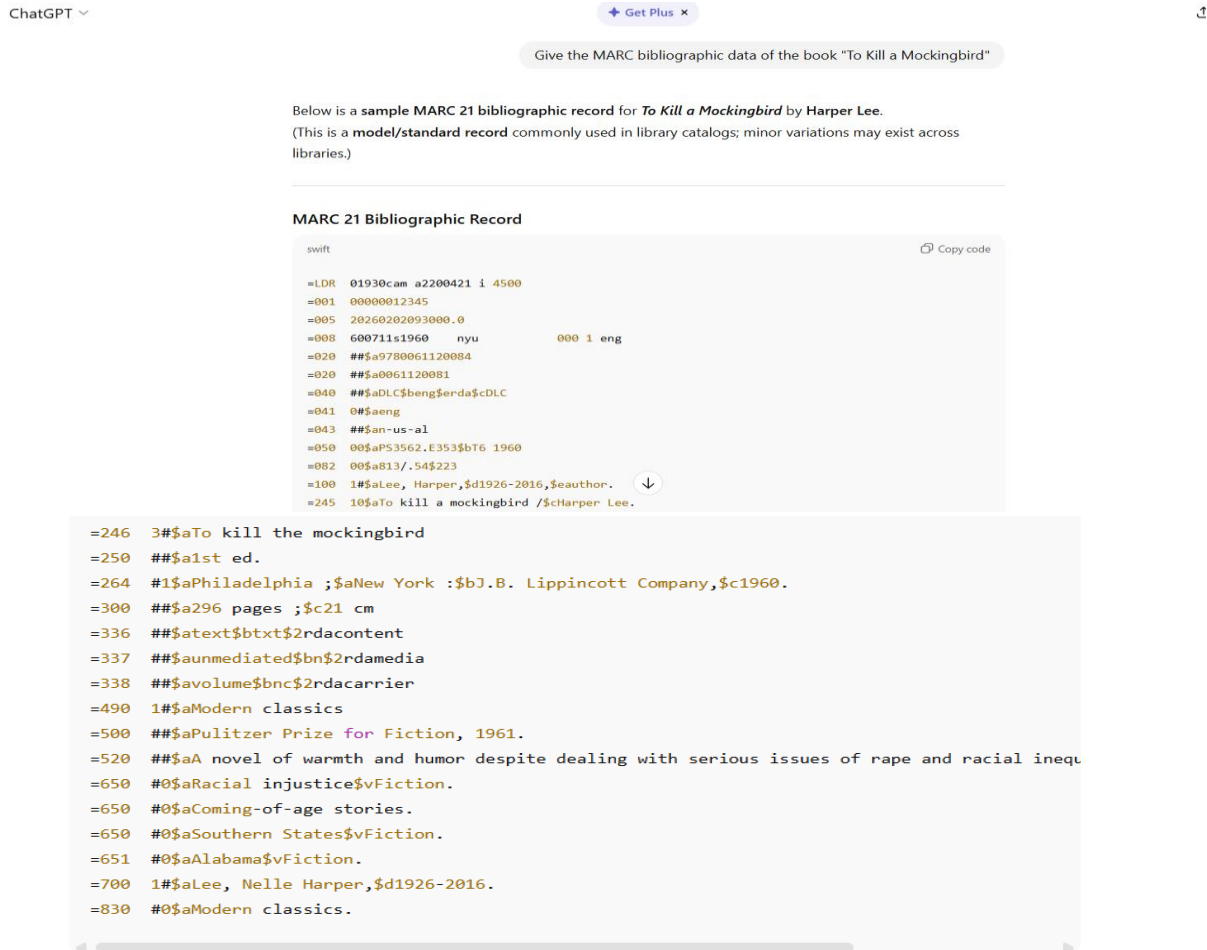


Figure 3- MARC bibliographic records using generative AI (ChatGPT)

Figure 3 demonstrates that the author simply inputs the book's title, 'To Kill a Mockingbird', with the prompt "Give the MARC bibliographic data of the book", and the system automatically retrieves the authoritative bibliographic metadata, including all the MARC fields. With the support of generative tools, creating and managing bibliographic data is easier and time-saving, helping library staff reduce cataloguing work.

The ability to create metadata and other bibliographic records using AI tools could reduce the time and resources required for the cataloguing process; this could free up library workers to focus on other important tasks (Brzustowicz, 2023). These innovations streamline information management, making it more effective. The shift from traditional practices to automated systems paves the way for future advancements in library operations.

4. AI-Powered Face Recognition: Library Security and Access

Traditional biometric or facial recognition technologies often rely on external credentials like ID cards, passwords, or PINs. In contrast, a Face recognition system examines an individual's physiological and

behavioural characteristics in order to determine an individual's identity instead of authenticating people and granting them access to physical domains by using passwords, PINS, smart cards, plastic cards, tokens or keys (Hassaballah & Aly, 2015). This method includes the analysis of unique features such as fingerprints, irises, facial patterns, voice, and even gait (Kumar Singha et al., 2016). With the advancement of AI technology, biometric systems, particularly facial recognition, are increasingly being used to enhance user convenience and security.

The facial recognition component can be divided into two main components: face presence recognition and facial feature recognition. Once a face has been located, the next step is to extract the individuality or uniqueness associated with that face. A face recognition system compares the detected face with stored templates to compute a similarity measure, which helps identify the exact individual (Balasubramaniam et al., 2025). These developments in AI-driven facial recognition make the technology highly suitable for environments that require both security and user convenience, such as public libraries. A major issue in public libraries is lines at the entry points and queues in the circulation section. Moreover, adding personal details and carrying the library card can sometimes be inconvenient for the public (Bangdiwala et al., 2023). By replacing physical entry cards with Facial recognition access, libraries can streamline entry processes, reduce administrative burdens, and enhance the overall user experience.

5. Robotic Assistance

Libraries using robotics technology are no longer news (Shubha, 2023). We can imagine a situation in which a patron enters the library and is greeted by a humanoid robot at the entrance. The robot provided a brief orientation and assisted with locating resources. These AI-powered technologies have significant potential to completely transform the role of libraries in the digital age by streamlining routine processes, improving information retrieval, and offering personalised user experiences (Indraji et al., 2024).



Figure 4- Pepper is interacting with patrons in the library.

In Figure 4, a robot named “Pepper” is interacting with the library users; it is a semi-humanoid robot developed by Softbank Robotics in Japan. Pepper is a 120 cm tall, 29 kg humanoid robot with a 12-hour battery life, equipped with various sensors, a camera, a microphone, and a chest-mounted touch display. It moves using omni wheels, allowing free rotation, rather than walking on legs (Harada, 2019).



Figure 5- Libby, a humanoid at the University of Pretoria Libraries, interacts with users

Libraries around the world are increasingly exploring the use of social robots to enhance user experience and improve service delivery. One common feature is employing these humanoids to greet visitors as they enter the library, provide a welcoming environment, and assist with basic directional inquiries. Libby, a humanoid at the University of Pretoria Libraries in South Africa, performs such welcoming services. In the future, the role of robotics in libraries is expected to be more extensive than its current functions. Possible Future developments may include the use of AI humanoid robots with natural language processing capabilities that can handle complex multilingual user queries, recommend resources, and support learning activities (University of Pretoria, 2019). Moreover, autonomous robotic systems could monitor user query patterns, predict book demand, minimise the staff effort and support dynamic space management.

Challenges of adopting AI applications in public libraries

Keeping up with the latest technological advancements is essential for any organisation. Public libraries must incorporate the newest technologies into their everyday operations because of their strong public relations ties (Olayode, 2022). Technology based on artificial intelligence, such as robots, machine learning, deep learning, natural language processing, etc., has become essential in this era. Adopting smart services to meet and address consumers' sophisticated needs demands smart librarians with a variety of cutting-edge skills (Rahmani, 2023). To guarantee ethical, fair, and efficient services to society, public libraries must overcome several significant challenges.

1. Ethical Dilemmas in Public Library

Ethical issues should be taken into account when integrating AI into public libraries' everyday operations. A diverse range of people use the services provided by public libraries. The accountability of AI-driven outcomes or judgments is still debatable, and the recommendations, suggestions, and decisions made by

these tools should not be based on a person's gender, race, or religion (Nathania et al., 2025). Moreover, libraries handle patrons' personal information, and AI-driven services often depend on it to improve their operations. AI systems may violate privacy by monitoring users' browsing habits and search histories, and by saving geolocation data for customised services. Additionally, the algorithmic and transparency issues should be taken into consideration (Saeidnia, 2023).

Regulations governing the usage, process, and results of AI tools should be framed by libraries in order to meet ethical concerns. And also demand transparency and accountability from AI vendors. Regularly audit the AI systems for fairness and accuracy (UDO-OKON & Ebenezer, 2024).

2. Job Security Concerns Among Library Staff

People have been afraid that artificial intelligence (AI) will eventually replace humans in every industry (Nathania et al., 2025; UDO-OKON & Ebenezer, 2024). Numerous library functions, including cataloguing, categorisation, inventory checking, circulation, reference services, and recommendation systems, can be completed quickly and more efficiently by AI-driven tools than by humans. The number of staff needed by the library may decrease as AI increasingly automates routine and repetitive tasks. Artificial intelligence (AI) technologies' superior ability to manage massive amounts of data and other capabilities increases acceptability in every industry, which will increase human concerns of losing their jobs (UDO-OKON & Ebenezer, 2024).

However, AI should be emphasised by libraries as a tool to increase output rather than as a replacement for human library staff. To stay ahead of the trend, library professionals should develop new skills that enable them to engage with AI systems. Libraries should fund reskilling and upskilling initiatives for their staff, including seminars, workshops, and training. By equipping employees with skills that are fit for the future, libraries make sure that professionals evolve alongside technology rather than being replaced by it.

3. Funding Gaps for AI Adoption

It is difficult to raise additional funding for the adoption of new technologies since they are expensive, and public libraries already raise funds for their daily operations from governments, library patrons, and philanthropists. Public libraries can modernise their services with the help of AI, but widespread and equal adoption is still greatly hindered by cost (Jha, 2023; Orubebe et al., 2024). Without long-term funding plans, many public libraries risk becoming technologically obsolete and widening the digital divide between communities.

To address this, policymakers, library committees, and funding bodies must prioritise long-term investment in digital infrastructure, recognising libraries as essential public technology hubs and not optional service providers. Strategic planning, collaborative purchasing models, prioritising budget allocation for AI development and maintenance to ensure long-term sustainability.

4. Lack of AI literacy and skilled employees

Imagine a library that has the latest technology for its patrons, but neither the patrons nor the staff know how to use it. Will the technology be useful, and what is the library's purpose? This emphasises how crucial AI literacy is for both library employees and patrons (Hussain, 2023). In order for the public to benefit from the most recent services offered by the library, they must be aware of when and how to use this technology appropriately. Since library employees are the main pillars of the institution, they must be familiar with how each technology works (Nathania et al., 2025). Additionally, the vast majority of people who utilise public libraries are local residents; their ages and educational backgrounds vary. Hence, there will be a gap in technological expertise among the various library users (Mushtaq & Arshad, 2022).

Libraries can address these issues by publishing a pamphlet outlining the practical use of the newest technology, offering extension programs to patrons regarding their use, and raising awareness on social media and other platforms (Hussain, 2023). In the case of library professionals, encourage them to take certificate courses to gain new skills, promote them according to their skills, and implement job rotation to help them become knowledgeable about all areas of the library (Jha, 2023).

Implementing AI technology in public libraries is not a straightforward procedure; several obstacles make it take longer than expected. Lack of technological infrastructure, including integrated systems, high-speed networks, internet access issues, outdated infrastructure, and interoperability issues, is an additional significant obstacle. Furthermore, most of the libraries are still using outdated technology and are incompatible with artificial intelligence (Orubebe et al., 2024). Therefore, the only way to integrate AI technology is to completely replace outdated technology, which may raise questions regarding libraries' budgetary capacity (Pence, 2022). Despite these challenges, AI technology offers significant improvements in efficiency for the daily operations of the public library. Therefore, if the majority of the challenges are surmounted, libraries, with the help of AI, will ultimately become centres for technological development and digital literacy (Echedom & Okuonghae, 2021).

Conclusion

Public libraries with advanced AI technologies are setting a new level of efficient and effective library service delivery to their patrons. Implementing AI chatbots, recommendation systems, robotics, and adopting AI features for cataloguing, classification, and securities aligns with the fourth and fifth laws of library science, such as 'save the time of the reader' and 'library is a growing organisation'. However, successfully implementing this technology will take time and may pose many hurdles for libraries. Given ethical concerns, financial issues, and a lack of skilled employees, it's essential for public libraries to take positive actions and strategic measures to adopt AI technology, minimising associated challenges to ensure effective and equitable implementation.

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