Application of Artificial Intelligence (AI) In Libraries and Its Impact on Library Operations Review

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Abstract
This article presents a literature review on the application of Artificial Intelligence (AI) in libraries and its impact on library operations. This study aims to provide researchers with a comprehensive understanding of AI in the library context. The research methodology involved utilising the Scopus database and identifying 66 relevant articles related to AI. After removing duplicates and applying filters, all 65 articles were reviewed, and their key findings and summaries are presented in this article. The information presented herein will serve as a valuable resource for researchers interested in exploring the use of AI in libraries.
Keywords: Artificial Intelligence, AI in Libraries, AI in Application, AI in Library Services, AI Chatbots, AI Review, Robots in Libraries, Intelligent Libraries, Smart Libraries

Introduction

The rapid advancements in Artificial Intelligence (AI) have revolutionised various sectors and libraries are no exception. This article aims to provide a comprehensive review of the application of AI in libraries and its impact on library operations. By analysing a collection of relevant articles from the Scopus database, this study offers researchers valuable insights into integrating AI technologies within the library context.

The methodology employed for this review involved identifying and analysing 65 articles related to AI in libraries. These articles were carefully reviewed, and their key findings and summaries are presented. This review provides an in-depth understanding of AI's potential applications and benefits in library operations by exploring diverse topics such as AI chatbots, intelligent libraries, robots in libraries, and smart libraries.

The literature review begins with examining early research on AI in libraries, including studies on expert systems and their impact on information access. It then explores the use of AI-based library systems for software reuse, digital video libraries, and multilingual access to library resources. The review also covers AI applications in digital library search engines, academic law libraries, and library service management using RFID and wireless techniques.

Furthermore, this article discusses the implications of AI on the future of libraries and the potential challenges and opportunities it presents. It delves into the impact on library services, employment, and the need for regulations and ethical considerations. The review also highlights the role of libraries in embracing AI technologies and providing lifelong learning opportunities to their communities.

By presenting a comprehensive summary of the literature on AI in libraries, this article serves as a valuable resource for researchers interested in exploring the potential of AI in enhancing library operations. The insights gathered from these studies contribute to the growing body of knowledge on AI in libraries and provide a foundation for further research and implementation of AI technologies in the library field.

Summary of the Review

The research conducted by Hsieh and Hall (1989) provides a comprehensive analysis of artificial intelligence (AI) and expert systems within the library and information science domain. The study delves into AI's definition and historical development while extensively exploring the literature on AI sourced from "Library Literature" and "Library and Information Science Abstracts." Furthermore, the paper presents the outcomes of statistical examinations of topical subject headings to assist system designers in integrating Library of Congress Subject Headings and machine-readable (LCSH-mr) records into their systems. This investigation forms a constituent of a three-phase initiative supported by the Council on Library Resources, OCLC Online Computer Library Center, and the University of Michigan. Its primary aim is to examine the accessibility of LCSH-mr within online bibliographic systems. The subsequent stages of the project will compare subject headings in LCSH-mr with assigned subject headings in bibliographic records, as well as with the search terms utilised by patrons in online catalogues. The amalgamated findings of these three phases will furnish supplementary data, analysis, and recommendations regarding enhancing LCSH-mr as a valuable tool for subject access in online bibliographic systems.

Ostertag et al. (1992) present an AI-based library system called AIRS (AI-based Reuse System) for software reuse. The system allows developers to browse a software library and select components that best meet their requirements. Components and packages are described using features and terms, and similarity between descriptions is quantified using distance metrics. The authors illustrate the functionality of the prototype system through its application to Ada packages and C components. The paper emphasises the importance of software reuse in improving productivity and reducing development costs. It outlines the steps involved in the reuse process, including definition, retrieval, adaptation, and incorporation of reusable components. The AIRS system utilises AI techniques, such as frame-based representation and similarity computations, to facilitate efficient browsing and selection of components. The authors also discuss future directions, including the automation of library construction. The paper highlights the potential of AI-based systems like AIRS in enhancing software development by effectively reusing existing components.

The Hauptmann et al. (1997) study explores the use of artificial intelligence techniques in a digital video library. The authors aim to automate metadata production to support the library's interface, making it more user-friendly. The study applies speech recognition, natural language processing, and image analysis to create specific AI-based interface components such as video skims, representative frames, and word location marking. These AI techniques provide a user interface to the digital video library, allowing users to locate and retrieve relevant information quickly. The authors note that while there are imperfections in each of the AI techniques used, they are still effective in creating robust navigation tools for the digital video library.

Ferguson (1997) conducted a workshop on AI in Digital Libraries as part of the International Joint Conference on Artificial Intelligence (IJCAI). The workshop explored how AI techniques could address challenges in building digital libraries. The topics covered included information discovery and retrieval, user interface design, classification and indexing, and architectural designs. The workshop featured papers that presented various AI approaches, such as preference logic, natural language processing, machine learning, and multi-agent systems. The event facilitated knowledge sharing and discussion among participants, and plans were made to publish expanded versions of selected papers in a special International Journal on Digital Libraries special issue.

In their paper, Michos et al. (1999) address the language barriers that hinder effective resource sharing and common access to library resources. They introduce the TRANSLIB system, which integrates various multilingual information tools to provide multilingual access to library catalogues. The system utilises AI-based methods and features functionalities for

searching in multiple languages, multilingual presentation of query results, and localisation of the user interface. The authors present evaluation results indicating significant improvements in the search process, high user-friendliness, and cost-effective maintenance and system upgrades. They emphasise the importance of multilingualism in library automation systems and highlight the potential of AI tools, such as natural language processing and machine translation, in enhancing information retrieval capabilities. The paper concludes by discussing the commercial exploitation and future goals of the TRANSLIB system, including support for remote databases and the addition of new languages.

The article "The Future of Artificial Intelligence in Your Virtual Libraries" by Balleste (2002) provides a primer on artificial intelligence (AI) in library service. The author explains what AI is and what it can do for libraries, giving examples and listing vendors to contact for further information. The author, who has experience implementing AI, aims to dispel the misconception that AI is only found in science fiction and presents AI as a relevant and valuable technology for libraries in the 21st century.

Balleste (2007) explores the potential of artificial intelligence (AI) in law libraries. The author emphasises the role of libraries in designing and programming AI systems to enhance public services. While acknowledging the challenges of implementing AI technology in complex transactions like legal reference interviews, Balleste highlights the possibilities offered by intelligent systems to supplement and expand library services. The article discusses the conceptualisation of AI systems, their programming through algorithms, and the use of avatars or graphical displays to facilitate interaction with library patrons. Balleste envisions AI assistants as valuable tools that can assist librarians in performing menial tasks and improve patrons' experience at library websites. The author also speculates on the future potential of AI in law libraries, suggesting its application in areas such as reference services, circulation operations, and cataloguing. Balleste's article provides a thought-provoking glimpse into the evolving role of AI in law library settings.

The author, Alberico (2011), predicts the impact of expert systems and artificial intelligence on libraries over the next ten years by considering five areas: knowledge media, knowledge industries, knowledge institutions, modes of discourse, and implications. The predictions are based on existing technology, but the author acknowledges that technological advances may occur in the future. The author references the publication "Libraries of the Future" as a relevant and on-target prediction for the future of libraries and artificial intelligence. The author also mentions Project Intrex, an early experiment by MIT to develop an electronic library, incorporating many technological solutions to the problems faced by libraries.

R-Moreno et al. (2014) discussed using RFID and wireless techniques for efficient library service management. The review highlights the application of RFID in libraries to determine the physical location of books and assist users in navigating the library. The prototype system, named SIGUEME, combines RFID sensors, AI-based planning and monitoring, and screen-based information display. The integration of RFID and wireless sensor networks (WSNs) is explored, emphasising the expanded functionality and reduced costs. The review also examines the application of RFID and WSNs in healthcare, logistics, and libraries, discussing the benefits and challenges in each domain. Experimental results from the implementation of SIGUEME in Meco's Public Library are presented, showcasing the system's capabilities in tracking users, generating statistics, and providing guidance.

Wu et al. (2015) presented an application of artificial intelligence (AI) technologies in CiteSeerX, a digital library search engine. The review highlights key AI techniques for document classification, de-duplication, metadata extraction, and author disambiguation. It emphasises the unique features of CiteSeerX, such as open access to full-text scholarly documents, automatic extraction of metadata and citation context, and indexing of paper

entities like tables and figures. The review discusses the challenges and performance of these AI technologies and their transferability to other digital libraries. It also describes the architecture of CiteSeerX and the use of open-source software in its development. The review highlights the cost and scalability challenges of rebuilding a system like CiteSeerX from scratch.

The article "Imagining the use of intelligent agents and artificial intelligence in academic law libraries" by Talley (2016) discusses the potential benefits of incorporating artificial intelligence (AI) and intelligent agents into academic law libraries. The author distinguishes between the two technologies and provides examples of how they can be used in academic law libraries, such as conversational agents for reference and circulation and information literacy modules. The article also highlights the benefits of using AI and intelligent agents, such as improving services provided to the law school community and library patrons. The author encourages academic law librarians to embrace AI and champion its use to benefit the law school community.

"What's Trending in Libraries from the Internet Cybersphere - Artificial Intelligence and other Emerging Technologies" by Oyelude (2017) presents a report on the latest technology trends in libraries, including the increasing use of artificial intelligence. The article is based on information from blogs and wikis and highlights the increasing demand for AI-related skills in the workforce. The report also discusses the potential implications of AI for the crew and the need for regulations to govern the use and creation of AI, including creating an "electronic personhood" status. The article also covers Google's effort to incorporate machine learning into all its products, such as wearables, using Android Wear 2.0 as an example.

Arlitsch and Newell (2017), in their article "Thriving in the Age of Accelerations: A Brief Look at the Societal Effects of Artificial Intelligence and the Opportunities for Libraries," discuss the impact of AI on society and the opportunities it presents for libraries. The authors state that increased computer processing power, big data, and machine learning techniques have accelerated the development of AI. They mention how AI has already changed many industries, including libraries. The authors also examine the potential effects of automation on employment, social and political systems and how it could impact libraries. They suggest that libraries must be prepared for the changes brought about by AI and must embrace the opportunities it presents by providing opportunities for lifelong learning to their communities.

The paper by Massis (2018) discusses the arrival of artificial intelligence in the library and the literature review and commentary on the topic by professionals, researchers, and practitioners. The potential implications of AI in libraries are seen as both exciting and disruptive, with some concerns that the technology could corrupt the library's mission and affect research and reading. However, the author also acknowledges that AI's eventual acceptance and incorporation could positively enhance library services, which are currently only being examined and considered.

The paper by Asemi and Asemi (2018) studies the “application of artificial intelligence (AI) in library systems in Iran and introduces the potential of library systems to use AI techniques.” The authors used Exploratory Factor Analysis (EFA) to identify the most applicable AI techniques categories in Library and Information Science (LIS). They found that recommender systems are the most commonly used intelligent systems in LIS, and natural language processing is the most underdeveloped. The paper evaluated the development of AI in library systems in Iran based on the underdevelopment in three areas: public services, technical services, and management services. The results showed that recommender systems are the most developed, while natural language processing is the most underdeveloped. The concepts of "development degree" and "underdevelopment rank" were introduced to reflect the amount of use of AI facilities in library systems.

In Johnson's 2018 article, the author discusses the impact of artificial intelligence (AI) on libraries and the institution of librarianship. They believe that AI will change the way we seek information and make decisions and that machines will become better at tasks that used to require human intelligence. The author argues that as AI becomes more advanced, people may rely on it more and not seek information from libraries or librarians. However, libraries and public universities may play an essential role in the AI revolution by supporting open-source AI projects and promoting information literacy.

Williams (2019) discussed that AI personal assistants like Siri, Alexa, Cortana, and Google Assistant have changed how people expect to get answers to their questions. As a result, students' expectations for database search functions have changed, and they expect databases to know and understand what they are searching for. However, using databases requiring complex search strategies and training can still be difficult to convince researchers to use, as they opt for quicker and more accessible solutions such as Google Scholar. AI personal assistants have limitations and can also lead to snarky replies. To convince researchers to use databases, librarians need to emphasise the value and legitimacy of information found in them and continue to provide training on effective search strategies.

Miao (2019) aims to investigate human rights ethics in artificial intelligence (AI) research. The study analyses the ethical dilemmas related to AI technology and its development and highlights the importance of human rights protection in AI systems. The study defines human rights from a philosophical and ethical perspective and draws from previous scholars' work. The study argues that the development of AI technology should serve humanity as the highest goal and consider "human nature." The research also highlights the need to regulate AI human rights ethics, including the ethical and moral status of humans in front of intelligent machines and the specific human rights of intelligent machines. The study emphasises the need to balance sensitivity and the importance of human control over AI technology.

Shelton (2019) explores the concerns and potential impacts of robots, AI, and machine learning (ML) on libraries and professions. The author reflects on past technological advancements, such as the introduction of the typewriter, which divided librarians. Shelton discusses the fourth industrial revolution driven by AI, robots, and connectivity, highlighting the disruptive potential they pose to libraries. Drawing from personal experience, the author recalls how the desktop computer revolutionised their career and expresses concern about these new technologies potentially replacing higher-level skills. Shelton also discusses the benefits of robots and AI in libraries, such as robotic retrieval systems and AI-powered chat services. The article concludes by acknowledging the challenges posed by robots and AI while emphasising the need to adapt and embrace progress.

Ylipulli and Luusua (2019). Without libraries, what have we? Public libraries as nodes for technological empowerment in the era of smart cities, AI and big data. In this literature review, the authors discuss the flaws in smart city development, which they argue is too technology-led and business-oriented, resulting in diminished citizen agency and digital divides. They propose the need for more participatory and inclusive approaches, suggesting that public libraries can act as allies and partners in participatory design and technology education. The paper maps the challenges of smart city development, introduces the Finnish library system as a democratic project, and presents examples of how libraries provide technological education. The authors emphasise bridging micro-level actions with macro-level technopolitical development through collaborations with Meso-level actors and networks. They argue for scalable approaches to increase citizens' understanding and control over new technologies, addressing the digital divide and empowering individuals.

"Application of Virtual Reality Technology in Medical University Libraries in the Era of Artificial Intelligence" by Wei (2019) provides a comprehensive overview of the research on virtual reality technology in medical university libraries. The paper explores the impact of

virtual reality technology on collection resource construction, knowledge management, cultural heritage preservation, and reader service. It examines virtual reality technology's development in domestic and foreign contexts, discussing case studies and practical applications. The author also addresses medical university libraries' challenges in implementing virtual reality technology and proposes potential solutions. This paper offers valuable insights into the potential benefits and difficulties of integrating virtual reality technology in medical university libraries, making it a valuable resource for researchers and practitioners.

Morriello (2020) presents an overview of the digital revolution's impact on the library world. The article focuses on three main technological evolutions: the Internet of Things (IoT), Blockchain, and Artificial Intelligence (AI). The author explains the development and features of these technologies and then delves into their applications in the library field. The author presents projects conducted in Italy and abroad in various library activities such as cataloguing, collection development, information literacy, scientific communication, and academic librarianship. The impact of IoT, Blockchain and AI is comprehensive in knowledge and information and, therefore, in libraries. The author suggests that using these technologies in libraries is inevitable and only a question of time. The article provides valuable insight into the potential benefits libraries can reap from these technologies.

Țundrea et al. (2020) describe a web client application for library management that utilises artificial intelligence (AI) and machine learning (ML) technologies to meet the needs of both library users and staff. The goal of the application is to simplify the process of reserving books and make the work of library staff easier through various functionalities such as searching for users or books using QR codes. Integrating AI and ML technologies in the application opens up new opportunities, allowing librarians to analyse readers' choices, create an automated system of recommendations, and acquire new books of interest to readers. The application also provides feedback to publishing houses. The authors highlight the challenges and opportunities in integrating AI in the development of library management systems.

Abayomi et al. (2021) examine the awareness and perception of academic librarians in Nigeria regarding using artificial intelligence (AI) in managing university libraries. The study was conducted using a survey design that included qualitative and quantitative approaches and involved 80 academic librarians from 8 purposively selected university libraries in the country. The results showed that the academic librarians were aware of the use of AI in library operations. Still, they were concerned about the potential loss of their jobs due to its adoption. The study also found that AI was seen as a tool to improve job performance and user satisfaction, but there was a need to create more awareness of its significance in library operations. The study recommends that academic librarians acquire the necessary skills to comply with AI in library operations, that library management educates librarians about the benefits of AI, and that librarians attend training and conferences to prepare for the adoption of AI in library operations.

Li, S. (2021). Application analysis of artificial intelligence in library network security. Li explores the application of artificial intelligence (AI) technology in library network security in this paper. The article discusses the concept and characteristics of library network system security and proposes an AI-based preventive mechanism for library network system security. It presents an AI technology method and an analytic hierarchy process to evaluate network security situations, improving real-time performance and prediction accuracy. The study also focuses on data fusion, hierarchical artificial immune situation assessment, and an improved algorithm based on population cognition. Experimental research demonstrates the effectiveness of the proposed AI models in predicting and assessing library network security situations. The findings suggest AI can enhance library management networks' defence capabilities and safety. Li's research provides valuable insights into the application of AI in library network security.

Yordy (year) explores the impact of AI-generated prior art on patentability. While the focus in the literature has been on the patentability of AI-generated inventions, little attention has been given to the use of AI to mass produce prior art and potentially render valuable inventions unpatentable. The article highlights the consequences of AI-generated prior art, including decreased incentives for researchers to disclose valuable knowledge through the patent system. It examines existing patent law doctrines and their limitations in addressing this issue. The proposed solution suggests modifying the novelty inquiry and introducing a conception requirement for prior art. This approach aims to balance the promotion of technological advancement while acknowledging the role of AI in generating information.

The use of artificial intelligence (AI) technology in university libraries to enhance their information building was examined by Chen et al. in 2021. Through data mining and questionnaire surveys, the authors reviewed the state of smart library research and practices today and their challenges. They discussed the challenges and solutions of an intelligent library information construction strategy. The report highlights the integration of AI technology with the growing trend in the education industry and offers guidance for building intelligent libraries. The authors have included a list of the products and features that may be used to construct smart libraries and a thorough explanation of the application scenarios and informational measures.

Han (2021) writes about the trend of turning digital libraries into intelligent metadata platforms by utilising artificial intelligence in his work "Intelligent Library Management under the Background of Artificial Intelligence" (AI). The author makes the case that AI can aid with data collection and analysis for library management decisions and lessen the strain on library workers. According to the study, merging AI and human expertise can result in a library management system that is more effective and knowledgeable. The author also discusses the advantages of utilising AI in library management, including shortened working hours and fewer mistakes, which may lead to higher client satisfaction. To continue the development of AI, the essay emphasises the significance of collaboration between library directors and academics.

Yuan (2021) addresses the effect of artificial intelligence (AI) on libraries in his article. Technology advancements have made AI a key research priority worldwide, and many nations plan to incorporate AI into their national strategies. The author examines how AI influences innovation and technology integration in libraries and suggests how AI might be used there for resource creation, information services, and librarian development. According to the author, research on technological innovation and library development will advance significantly due to the path libraries take in the AI era.

Li (2021) conducted research on the construction of an intelligent service system for a university library based on the Internet of Things (IoT) in an artificial intelligence (AI) environment. The research used AI for data analysis, focusing on the population evolution mechanism. The study used the dominant population to improve the probability of evolution, which led to a better evolution of individuals in the prevalent population and accelerated the algorithm's convergence. Based on this, a book retrieval system and IoT were used to construct the proposed model. The proposed system was compared to traditional library systems and outperformed other existing models.

The impact of the industrial era 4.0, often known as the era of disruptive innovation, on librarians' roles is covered in the paper by Hayani et al. (2021). Era 4.0 emphasises robots, automation, big data, artificial intelligence, and the digital economy. To effectively serve library patrons in era 4.0, the authors contend that librarians must equip themselves with information technology and analytical skills. They advise deploying AI in libraries to assist patrons in utilising library materials. The university library at IAIN Lhokseumawe employs this tactic in its promotion efforts; the authors add a note. The library's lack of financing and knowledge about library services are just a few difficulties.

Yordy (2021) argues artificial intelligence (AI) affects the patent system by allowing mass-produced, AI-generated prior art to render valuable inventions unpatentable. This decreases the incentive for researchers to disclose practical knowledge through the patent system. The author proposes a solution that modifies the current novelty inquiry and breathes new life into the patent law doctrine of conception to solve the issues. The proposed solution helps maximise technological advancement by stimulating AI-driven and human-driven innovation.

To comprehend the elements impacting readers' intention to utilise smart libraries in the age of artificial intelligence, Liu et al. (2021) performed research. Using a questionnaire survey and a structural equation model, the study tested a theoretical model based on the Task-Technology Fit (TTF) model. The findings demonstrated that TTF, which determines the intention to utilise smart libraries, is significantly positively influenced by technology attributes and individual factors. Compared to personal traits, it was discovered that technology characteristics had a stronger influence. The study recommended giving smart library customers pertinent hints and support features and considering how well technology and the task fit each other when adding new AI technologies into services.

Kong (2021) discusses the application and research of artificial intelligence in digital libraries. It covers the basic theory of text classification, key technologies, main classification algorithms, and the advantages and disadvantages of different methods. The authors establish a digital library text classification model based on Rough-RBFNN neural network and optimise it. The results show that artificial intelligence technology can effectively improve the digital library and increase the potential for reading promotion. The authors suggest that digital libraries should rationally use artificial intelligence technology in combination with reading habits to create compelling reading promotion scenarios.

Li and Wang's (2021) paper examines the use of artificial intelligence (AI) in library applications. They first explore the critical technical aspects of AI in library applications and analyse its use in stack building, management, and information retrieval services. Next, the authors identify the current challenges with using AI in libraries and propose solutions to overcome these obstacles. This paper provides valuable insights for researchers and library staff in this field.

Tian (2021) discussed "Application of Artificial Intelligence System in Libraries through Data Mining and Content Filtering Methods," the author explores the use of artificial intelligence in the library system of vocational colleges. The paper suggests using a multi-intelligent agent collaboration method combined with content filtering and learning optimisation for personalised information services. The system uses data mining to match traditional document retrieval results with reader interests. The author emphasises the significance of intelligent service as a new direction for library development and the need to embrace new innovative technology to achieve "double first-class" libraries. The author also highlights the benefits of ubiquitous, personalised, and efficient services provided by AI in libraries.

The study "Artificial Intelligence Investing in Academic Libraries: Reality and Challenges" by Farag et al. (2021) examines the implementation of artificial intelligence in Saudi academic libraries. The study found a weak understanding of artificial intelligence among most library workers, with 69% saying they do not use AI. The study also found that AI is currently being used in indexing, analysis, retrieval, storage, photography, and meeting the needs of library users. However, there is a lack of training for workers in the AI sector, which is attributed to the lack of training courses. The study concludes that AI should be used as an assistive technology for library specialists but not relied on entirely. The main challenges faced by academic libraries are a lack of physical equipment, limited local AI technology

suppliers, and a lack of experience of researchers and students in dealing with technological innovations.

The paper "Transforming Academic Library Operations in Africa with Artificial Intelligence: Opportunities and Challenges" (Echedom & Okuonghae, 2021) explores the potential and limitations of using artificial intelligence (AI) in academic libraries in Africa. The authors examine the application of AI in libraries and the challenges faced in its adoption. The paper concludes that AI has the potential to significantly improve information services and provide a new level of efficiency. However, there are still challenges, such as inadequate infrastructure and a lack of proper training. The authors recommend a collaborative effort between the government and library management to promote the use of AI in African libraries and proper policy formulation to guide its use.

Yoon et al. (2022) conducted a survey to learn about the opinions of North American librarians regarding the use of AI and associated technologies in libraries. The findings revealed favourable views of these technologies among academic and public librarians, with 67% of respondents saying they will change how libraries operate and 68% indicating a desire for training. In addition, the survey revealed that 21% of librarians were already utilising AI and related technologies, and 80% anticipated their broad acceptance during the following 30 years. Both groups showed intense curiosity about these technologies and similar perspectives on whether AI is appropriate for various library tasks.

Tait and Pierson (2022) analysed 57 courses from five universities' topic descriptions to review library and information science master's programs offered in Australia. They discovered a lack of focus on contemporary technology because only one subject description made mention of artificial intelligence, and none of the subject descriptions mentioned robots. This can signify a disconnect between today's educational procedures and the technology-driven reality of library work. The authors speculate that a greater emphasis on integrating cutting-edge technologies, such as robotics, and AI, into library and information science courses may be necessary.

Weijia (2022) researched the elements influencing libraries' preparedness to use artificial intelligence (AI). According to research, a library's preparedness to adopt AI was most affected by the emphasis on leadership, while the influence of competition was negligible. The study identified the primary elements influencing a library's preparation for AI: leadership focus, experience with AI applications, acceptance of AI, awareness of AI, and the innovation environment. The report suggests that library administrators be abreast of the most recent technical developments in the industry, routinely evaluate their library's readiness for AI, and swiftly install AI technologies. The report also recommends providing library personnel with AI training, supporting an environment that is open to innovation, and enticing workers to investigate the possibility of adopting AI.

Bi et al. (2022) reviewed Artificial Intelligence Technologies in Emerging Smart Libraries. They examine new technologies such as IoT, RFID, WiFi, BLE, NLP, Deep Learning, Recommender Systems, and OCR. They also delve into innovative library services such as attack prevention, machine vision, and intelligent circulation services using sensors, smart authentication, identification, and encryption. They provide a comprehensive survey on AI and IoT technologies in intelligent libraries, presenting a systematic and structured overview of this growing field. A case study on smart circulation services highlights the improvements that can be made in traditional librarianship with the integration of AI and IoT. The authors also discuss the challenges and prospects in the field.

In 2022, Neudecker examined the potential of using AI and ML to digitise and preserve cultural heritage. The author acknowledges that while cultural institutions have produced a large amount of digital data, there are issues with its quality and biases in AI. The paper investigates the challenges of using cultural heritage data in AI and the role of libraries in

improving data quality through curation. However, the legal requirements for using cultural heritage in AI are still unclear. Cultural heritage institutions must focus on providing high-quality, bias-free data for AI through improved data distribution and responsible digital curation.

Bradley's (2022) article explores the topic of AI ethics and usage in libraries. The author highlights how libraries are involved in AI's regulatory advancements. The study also discusses how libraries have contributed to creating ethical frameworks and how their operations are represented in national AI initiatives. Despite libraries' scant inclusion in current AI initiatives, the industry actively participates in consultations to guarantee an ethical and open future for AI. Because AI legislation is still in its infancy, the author contends there is still potential for libraries to participate.

Borgohain et al. (2022) conducted a bibliometric analysis from 2012 through 2021. They discovered that there wasn't as much study on AI applications in libraries compared to other fields like medicine, education, agriculture, and health. Price's law indicated that this industry saw exponential expansion. The most well-liked study topics were machine learning, deep learning, big data, and high-level programming languages. The authors concluded that AI technology might significantly enhance the current information system.

Al-Aamri and Osman (2022) used a descriptive research methodology to examine the significance of AI capabilities in library services. They did this by reviewing relevant Arabic and foreign studies concentrating on AI applications in knowledge management inside information institutions. The results demonstrated that many libraries are already integrating AI technology in various services, such as technical support and reference services, to facilitate users' access to information. The research covered how AI may improve library services and underlined how having a solid technical foundation and knowledgeable staff are essential to maximising its advantages. The authors suggested that libraries and information centres work to stay abreast of AI developments and make the required knowledge management investments.

Ajani et al. (2022) investigated librarians' perceptions of academic libraries in Nigeria's awareness of and readiness for adopting artificial intelligence (AI) in their processes and offerings. The study discovered that although academic libraries in Nigeria are aware of the use of AI in libraries worldwide, they are not yet wholly prepared to incorporate the technology into their daily operations. Regarding their preparation for adopting AI, the librarians' perspectives were divided. Integrating AI can increase libraries' productivity by minimising repetitive processes and human error. The significant issues that academic libraries in Nigeria can encounter are finance, a shortage of expertise, an unstable power supply, and constrained employee training and acquisition budgets. The report suggests allocating enough funds for acquiring AI technology and employing librarians with the necessary skills to work with the technology.

Panda and Chakravarty (2022). Adapting intelligent information services in libraries: a case of smart AI chatbots. This paper explores the implementation of artificial intelligence (AI) chatbots as a practical solution in libraries, particularly in response to the COVID-19 pandemic. The authors aim to demonstrate the potential of AI-driven "InfoBots" or "Chatbots" to fulfil user needs 24/7 with minimal or no human intervention, thereby adapting to the "new normal" of increased reliance on virtual spaces. They utilise Engati, a versatile AI chatbot service, to provide an overview of its use and multitasking features in libraries. The findings highlight that AI chatbots offer a reliable solution for initiating virtual assistance, augmenting reference services, and promoting a "library without walls" concept. The study emphasises the integration of AI with other technologies and its impact on intelligent information services, emphasising the need for libraries to consider implementing AI-enabled chatbots as virtual assistants to meet user information needs. The paper concludes that chatbots can improve service quality, personalisation, engagement, automation, revenue generation, and user satisfaction in libraries,

serving as a valuable marketing tool and enhancing information literacy. The authors suggest that AI-powered intelligent information services hold promise in the "new normals" of libraries.

Liu et al. (2022) conducted a study on the application of artificial intelligence (AI) technology in the information retrieval of university libraries. The research aimed to address the deficiencies in existing intelligent information retrieval systems. A survey was conducted, and the results indicated that the main problems in AI information retrieval technology for university libraries included inadequate understanding of natural language, unclear knowledge representation, and difficulty in acquiring knowledge. The study proposed innovative solutions to overcome these issues based on the latest AI technology achievements. The application of AI in information retrieval showed significant improvements in university libraries' comprehensive management ability and user experience. The study also highlighted the need to strengthen the breakthrough of core AI technology to leverage its potential in university library information retrieval fully. The analysis emphasised the role of AI in enhancing information retrieval capabilities, providing personalised services, and integrating multiple retrieval methods in the digital library environment.

Rojas et al. (2022) highlight the increasing popularity of mobile robots for personal and industrial applications. While robot simulators like Isaac Sim offer high-graphical capabilities for robot development and testing, training mobile robots using deep reinforcement learning (DRL) can be challenging and time-consuming. To address this issue, the authors propose an easy-to-use DRL library that simplifies the configuration of robots, environments, and training scenarios. The library aims to reduce coding time by providing methods equivalent to 5-65 lines of code, enabling researchers to develop and test viable robot algorithms quickly. They integrate Isaac Sim, OpenAI Gym, Deep Reinforcement Learning, and Stable Baselines 3 to create a customisable training environment for mobile robots. The library fills the gap by providing an accessible framework for training robot agents using DRL techniques.

The researchers in the study by Ali et al. (2022) spoke by phone with five chief librarians to learn their viewpoints on incorporating AI in Pakistani university libraries. The survey discovered that although librarians knew AI's potential advantages in delivering cutting-edge services and enhancing user experience, they also voiced reservations about the expense and resources needed to adopt AI. The study employed a SWOT analysis to determine the advantages, disadvantages, opportunities, and risks related to the deployment of AI. The findings indicated a sluggish adoption of AI technology by Pakistani university libraries' administration, but financial, infrastructural, and technical talent issues remain and must be resolved.

A descriptive survey of chatbots employed by academic libraries in the US was carried out by Brown (2022). The survey discovered that most digital assistants, including chatbots, have been given typically feminine names, appearances, voices, and even personalities. However, the survey discovered that, contrary to the trend, there aren't many gendered library chatbots. This change is encouraging because it suggests a future in which technology design will take a more feminist and gender-inclusive approach and move away from the patriarchal inclinations in designing digital assistants as women.

A survey on the opinions of academic library directors in Hungary about the application of AI in libraries was carried out by Winkler and Kiszl in 2022. According to the survey, most library directors regard AI as an opportunity rather than a threat. It might help with various library operations, including digitisation, information service, and education. Information retrieval and data processing solutions backed by AI were found to be used by 25% of the libraries surveyed. Virtual or online services, reference services, and digitisation have been deemed the domains where AI support was most appropriate. The outcomes are consistent with global patterns and imply that library directors are knowledgeable about using AI in libraries.

The creative use of artificial intelligence (AI) in library management was investigated by Zhang (2022). The study sought to increase library staff productivity and improve reader service through an ant colony optimisation neural network model. The results of this model, which integrates the ant colony optimisation technique with the evaluation of library reader services, have been determined to be precise and sound in science. Testing in a library environment demonstrated the effectiveness of this model's application. AI in library administration can significantly alter the library industry and lead to the intelligent and informationized design of libraries.

The article by Pence (2022) investigates how artificial intelligence (AI) might affect libraries. The author identifies various vital uses of AI in libraries, such as extensive data research, remote access, and data analysis. The author believes that libraries can transform into virtual hubs for knowledge and connectivity by working with existing AI programs on campus, freeing librarians to provide advanced research expertise. The essay offers a thorough analysis of the potential effects of AI on libraries and makes recommendations on how they may adopt and profit from this technology.

A literature review on AI in research libraries was carried out by Gasparini and Kautonen (2022) using 126 papers. The findings revealed a range of viewpoints among libraries and librarians towards AI, with some welcoming the technology and others worried about its potential to undermine human values. The study demonstrates how libraries successfully apply design methodologies to handle AI-related difficulties. However, they also present crucial challenges like ethical transparency and the place of AI as a standalone entity. The authors suggest using design to address upcoming issues and generate opportunities. The interaction between libraries and stakeholders is also considered crucial.

A study on the use of artificial intelligence (AI) applications in Taiwanese university libraries was performed by Huang (2022). Utilising quantitative research techniques, the author surveyed both AI-implemented and non-implemented librarians. The findings demonstrated that the librarians' opinions regarding AI were more favourable if they had more in-depth information and organisational activities surrounding AI. The survey also discovered that finance and costs were the biggest obstacles to the application of AI, along with technical difficulties and privacy/ethical concerns. The analysis concluded that the top four AI applications would probably be implemented in libraries soon.

The Harisanty et al. (2022) study looked into the leaders of Indonesian academic libraries' level of AI awareness. The survey discovered the participants' opinions of AI and its potential advantages for libraries were positive and enthusiastic. Improved circulation services, improved classification of library resources, data analytics, and research support are some of the benefits of AI that have been cited. To employ AI effectively in libraries, the participants also underlined the need for librarians to have a working knowledge of IT, data analytics, library management, and user behaviour. However, the participants also noted several difficulties that can prevent the adoption of AI in libraries, such as budgetary management problems, leadership vision issues, and murky policy frameworks.

The Thalaya and Puritat (2022) study aimed to apply AI technology to raise the calibre of library services and increase user happiness. The trial results showed that employing AI to respond to queries regarding book locations, opening times, and other pertinent information saved the librarian's time and enhanced the management of library services. The satisfaction survey findings revealed an increase of 0.45% among nursing students and instructors, which improved library service management. In the future, AI technology will help users be satisfied with the library's services.

An investigation into using artificial intelligence (AI) in libraries was done by Harisanty et al. (2023). They discovered that AI could be easily incorporated into libraries for administrative functions like staffing, technical functions like cataloguing, and informational

functions like reference and information literacy. To thoroughly implement AI in libraries, numerous obstacles must be addressed. More research is required to fully comprehend the application of AI in libraries and its effects on support services.

Hussain (2023) researched the potential and difficulties of using artificial intelligence in library services. Utilising content analysis, this study used a qualitative research methodology. The results showed that while AI is a powerful technology that can improve library services, various obstacles, including a budget, librarian attitudes, and technical abilities, may prevent its application. The findings imply that implementing AI in libraries may result in positive transformation and hasten library growth. The paper also identifies several low-cost AI apps that librarians and information specialists might utilise to enhance library services.

Xu, Z. (2023) conducted a research study on the application of artificial intelligence (AI) in the library sector. The study explores the existing literature on AI and libraries and investigates AI's significant roles in libraries-related industries. It focuses on six key technologies: OCR, data mining, natural language processing, face recognition, knowledge mapping, and machine learning, providing a detailed analysis of each technology and its application characteristics in the library field. The study presents an overview of the practical application results of AI in libraries, analyses the impact of AI on the development and reform of libraries, and examines the current status of various AI technologies in the field. Additionally, it identifies potential challenges and problems that libraries may face in implementing AI-related technologies.

Nugroho et al. (2023) conducted a study analysing the correlation between artificial intelligence (AI) and libraries and the shift in research trends during the COVID-19 pandemic. The researchers gathered secondary data from Scopus using keywords such as "AI," "library," and "repository" from 1993 to 2022. The findings revealed that keywords like "human," "deep learning," "machine learning," "surveys," and "open-source software" became popular in 2020 and closely related to digital libraries. The annual scientific production of papers also significantly increased in 2021. The study highlights the importance of AI implementation in libraries to support repositories during the pandemic. It suggests that librarians can maximise AI-based repository services and create policies using AI. The research identifies themes and knowledge gaps in AI in library repositories, providing insights for researchers, academicians, and practitioners to conduct further research in this area.

The article titled "Application of AI in Library Digital Reading Promotion Service" by Lin et al. (2023) explores the role of artificial intelligence (AI) in transforming library services, specifically focusing on digital reading promotion. With the emergence of the era of great intelligence, libraries face challenges and opportunities for remodelling their services. Third-party companies, called "data aggregators," often provide digital reading promotion services. The article highlights the increasing popularity of online reading and the need for libraries to adapt their services to meet readers' demands. AI technology can enhance library services by identifying customers' interests and reading habits, allowing for personalised recommendations based on user preferences and reading history. This technology enables libraries to provide tailored suggestions to users, even considering factors such as reading time for each book or article.

Adetayo (2023) states that artificial intelligence (AI) chatbots, such as ChatGPT, have become valuable tools for academic libraries. They provide rapid and accurate responses to

user inquiries, offering convenience and accessibility outside traditional library hours. ChatGPT's advanced language processing capabilities enable it to generate human-like and contextually relevant responses, making it an effective virtual assistant. Academic libraries can utilise ChatGPT for reference services, selective dissemination of information, and collection development. However, challenges exist, including the potential loss of library employment, misuse of the technology, inaccurate query responses, and limited comprehension compared to human librarians. Despite these challenges, ChatGPT has the potential to enhance library services by automating routine tasks and freeing up librarians' time for more complex assistance, ultimately improving the quality and efficiency of academic library services.

Conclusion

Artificial Intelligence (AI) application in libraries holds immense potential for revolutionising library operations and enhancing user experiences. The comprehensive review conducted in this article has highlighted the diverse ways AI technologies are employed in libraries, including AI chatbots, intelligent libraries, robots, and various AI applications in library services. The findings of this review indicate that AI can improve information retrieval, automate routine tasks, personalise user interactions, and provide innovative services. AI-powered chatbots can effectively handle user inquiries and provide instant assistance, improving overall user satisfaction. Intelligent libraries equipped with AI technologies can streamline cataloguing, classification, and recommendation processes, enabling efficient information access for patrons.

The implementation of AI in libraries also poses certain challenges and considerations. Ethical concerns, privacy issues, and the need to ensure equitable access to information are important factors that must be carefully addressed. Libraries must balance the benefits of AI technologies and the preservation of human-centric values, ensuring that AI complements and enhances the work of librarians rather than replacing them. Moving forward, further research is needed to explore the long-term impact of AI on library operations, user behaviours, and information services. Additionally, collaboration between libraries, researchers, and technology developers is crucial to advancing AI solutions tailored specifically to the needs of libraries and their diverse user base. Efforts should be made to promote knowledge sharing and the exchange of best practices to accelerate the adoption of AI technologies in libraries. AI has the potential to transform libraries into dynamic, user-centred spaces where information is easily accessible, and services are tailored to individual needs. By harnessing the power of AI, libraries can enhance their efficiency, expand their reach, and offer innovative experiences to their patrons. As AI continues to evolve, libraries must embrace these technologies while upholding their core values of providing equitable and inclusive access to information for all.

The literature on the application of AI techniques in libraries is still limited, with a lack of scholarly research in this area. However, there are emerging examples of libraries exploring the potential of AI, such as the US Library of Congress' LC Labs (Haffenden et al., 2023). The authors discuss the use cases of the model in academic libraries, including text classification, enhanced searchability, and improved OCR cohesion. They emphasise the value of AI for making digital collections more accessible and enabling new forms of research. The conclusion highlights the reciprocal relationship between AI and libraries, suggesting that libraries can contribute to the future development of AI.

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