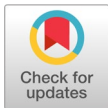


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Artificial Intelligence as Digital Transformation in University Libraries of Pakistan: A Qualitative Study on Challenges and Benefits

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Abstract

The purpose of this study is to explore the challenges and benefits associated with the use of artificial intelligence (AI) in the university libraries of Pakistan. Given the novelty of the phenomenon, this study opted a qualitative research approach, and interviews were conducted with 20 university librarians who were purposefully chosen. The findings indicate that the use of AI in libraries improves operations and services by minimizing human errors caused by the repetitive nature of routine tasks. The study identified several challenges encountered by university librarians, including financial issues, inadequate specialization in emerging technologies, and limited resources to adopt and use AI-based technologies. Such challenges may be addressed by equipping librarians with necessary knowledge and technical skills such as basic IT skills, understanding AI concepts, data analysis and management, knowledge of AI algorithms, and critical thinking. This research significantly contributes by identifying the precise technical and professional competencies necessary for effective AI integration in university libraries, which encompass fundamental IT skills, comprehension of AI concepts, data analysis and management, familiarity with AI algorithms, and critical thinking. This work presents empirical evidence from a developing-country viewpoint, offering novel insights for higher education administrators, politicians, and library professionals aiming to deploy AI-driven library services in Pakistan and analogous contexts.

Keywords: artificial intelligence, digital transformation, emerging technologies, fourth industrial revolution

Introduction

Digital transformation has become a driving force behind organizational growth, innovation, and adaptability in the face of rapid industrial advancements (Kotarba, [2018](#)). Due to the increasing productivity and

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effectiveness of AI, organizations around the globe are adopting its various applications to secure the ideal benefits. In 1956, John McCarthy, a computer scientist, introduced the term AI while compiling a research proposal for the Dartmouth Summer Research Conference. This conference, which took place from June 18 to August 17, 1956, had as its main goal bringing together scholars from many fields, including computer science, cognitive psychology, and mathematics, to investigate the potential for building robots that could mimic human intelligence (Yang et al., [2020](#); Zhang & Lu, [2021](#)). Due to the novel technology, there isn't a single definition of AI that academics agree upon. So, several researchers have defined AI in different settings. Marsico ([2019](#)) described it as “the application of pattern-identifying computational methods for extrapolating from training sets to create predictions was considered to be the basis for AI, which refers to robots that carry out tasks normally done by humans, such as problem-solving” (p. 2).

AI is gradually altering academic libraries in terms of operational efficiency, automation of routine operations, and the improvement of user services (Hussain, [2023](#)). Academic libraries, like other economic sectors, are using AI more and more to boost productivity and provide cutting-edge services (Hussain & Ahmad, [2023](#)). University libraries are continuing to devise strategies to improve their services with the support of AI applications. By offering information and knowledge services, university libraries have a big part to play in enlightening the quality of a student's forthcoming education through AI applications (Claudé & Combe, [2018](#)). Evidence from Cox et al. ([2019](#)) supports the hypothesis that an AI-driven library may help students learn more effectively by using a customized approach to individual learning. According to the AI scenario, libraries now have an effective expert system for managing and processing information as well as providing technological services. Recently, AI-based facilities have been introduced in libraries, such as chatbots, robotic systems, RFID systems, RFID security systems, barcode, QR code for patron recognition, voice command to retrieve information from Google Assistant, an AI-powered indexing tool, natural language processing, and so on (Ali et al., [2020](#)).

The use of AI in university libraries is rapidly rising in developing nations, including Pakistan, although its implementation is in its initial phases due to numerous institutional and technological challenges.

Research studies conducted in Pakistan reveal that AI applications are being adopted in library automation, reference service, and information retrieval (Ali et al., [2021](#); Asim et al., [2023](#); Aslam et al., [2025](#)). There is increased interest in AI; however, university libraries in Pakistan face obstacles such as financial limitations, a lack of technological infrastructure, inadequate competence among personnel, and restricted possibilities for training (Asim et al., [2023](#); Hussain, [2023](#)). The literature indicates that library professionals are integrating AI technologies into the existing library and information systems for service innovation (Hussain & Ahmad, [2024](#)). AI has boundless capacity, but it also brings challenges for individuals and organizations to adopt and use it at both the individual and organizational levels. Librarians are essential in the implementation and management of AI-enabled services, so the skills needed are crucial for the effective integration of AI in university libraries. The purpose of this study is to investigate the perceived benefits and challenges associated with the adoption and utilization of AI in Pakistani university libraries.

Statement of the Problem

The revolutionary impact of digital technology is evident in various organizations. As AI applications become more accessible and developed, they are more widely used in many areas (Vinuesa et al., [2020](#)). The revolutionary impact of digital technology has been shown on various organizations. As AI applications become more accessible and developed, they are more widely used in many areas (Vinuesa et al., [2020](#)). The application of AI in library services enhances client satisfaction and efficiency in operation. But traditional library services often struggle to keep up with the needs of the modern world, and this raises the problem of how AI applications can improve these services. The deployment of AI in academic libraries can bring many benefits, including higher efficiency, better management of resources, and more tailored services to users (Cox et al., [2019](#); Huang, [2024](#); Tella & Ajani, [2022](#)). Asim et al. ([2022](#)) highlighted university libraries are utilizing the Internet of Things to promote learning and research activities in Pakistan. However, they face numerous challenges, including the necessity for a highly interconnected environment, issues related to hacking and viruses, the lack of a comprehensive network and integration, the absence of policies, procedures, and strategic plans, as well as insufficient funding and interest from university administration to implement new technologies (Ali et al.,

[2020](#)).

In a recent survey, Huang et al. ([2023](#)) found a growing trend toward AI applications in university libraries in China and the UK. In contrast, AI adoption in Pakistani universities is very slow, so it is essential to explore the benefits and associated challenges to deploy AI applications in university libraries (Ali et al., [2024](#)). Ajani et al. ([2022](#)) indicated that individuals who are more familiar with novel technologies are more inclined to adopt and use them. So, to fill the knowledge gap in the extant literature, the study explores challenges to implementing AI and key benefits for the Pakistani university libraries. Moreover, this research adds a valuable contribution to the body of knowledge, especially from an AI-driven technologies adoption and use perspective that is positioned at an embryonic stage in Pakistan. The results of this study would also support university management and library professionals in decision-making and strategic planning to implement AI tools in libraries, resulting in improved library operations and service innovation.

Research Objectives

The purpose of this study was to investigate the advantages and challenges associated with the integration of AI in Pakistani university libraries. Thus, to accomplish the stated objective, the following two study objectives were developed:

- To explore challenges faced by university libraries in Pakistan when implementing AI applications.
- To explore librarians' perceptions of AI benefits in the Pakistani university libraries.

Literature Review

There are a few instances where it is already possible to see AI and similar technologies adopted in libraries. In the literature review, the integration of AI applications into library systems and the challenges and benefits associated with it have been discussed in detail.

Artificial Intelligence

The development of digital technology leads us to a technological civilization, in which automated machines are gradually created and developed to serve human needs. AI refers to robots or systems that can do

tasks similar to human intelligence, such as interpreting natural language, recognizing patterns, making decisions, and learning from new experiences (Asim et al. [2022](#)). AI technology has the potential to enhance the performance of existing information systems. Basically, the concept of AI consists of machine learning and other deep learning (Janiesch et al., [2021](#); Woschank et al., [2020](#)). A subfield of AI called machine learning focuses on developing algorithms and statistical models that enable computers to learn from data and perform better at a particular task (Chahal & Gulia, [2019](#)). In other words, rather than being explicitly programmed to do a task, a machine learning system learns to make predictions or choices based on examples and data, and, on the other hand, deep learning is an extension of machine learning that concentrates on modelling and solving complex problems using artificial neural networks. Deep learning has received significant attention and has produced amazing results, for example, image identification, natural language processing, speech recognition, and so on, in a variety of sectors, including libraries (Arel et al., [2010](#); Rao et al., [2022](#)). Like other sectors of the economy, libraries are also adopting AI to offer innovative user services (Hussain & Ahmad, [2023](#)).

AI Benefits and University Libraries

Universities are modifying their methodology of teaching and research approaches in response to the emergence of new technology (Okunlaya et al., [2022](#)). University libraries play an important role in promoting learning and research activities. The novel technologies, for example, AI, big data, drones, IoT, robots, blockchain, virtual reality, etc., have been introduced in university libraries to support learning and research activities (Asim et al., [2022](#); Tella, [2020](#)). Artificial intelligence enhances human productivity in workplaces like libraries by enabling faster, more efficient, and more productive work. Library content is classified, cataloged, and indexed using expert systems and artificial intelligence (Jha, [2023](#)). Integrating artificial intelligence is expected to enhance library services, minimize human mistakes, and enable faster completion of tasks than humans (Breeding, [2023](#)). Artificial intelligence systems in libraries can reduce the amount of work that librarians do in technical, reference, circulation, and serial management services, etc. (Pence, [2022](#)). Librarians may work more successfully and efficiently when they have access to AI technologies like automated lending and returning machines, robotic shelving, expert system-based automatic indexing, automated cataloguing and classification, stolen

book detectors, cataloguing software, etc. (Harisanty et al., [2024](#)). The emerging technologies contribute to the development of modern libraries that offer innovative information provider tools. AI may be viewed as a required digital aptitude for academic librarians to be equipped to create and maintain digital collections (Ali et al., [2021](#); Haq, [2021](#)).

AI is useful in several sciences, and similarly, it is applicable in library systems and databases. In qualitative research, Cox et al. ([2019](#)) indicated that library directors and IT workers in the United Kingdom believed AI would have far-reaching implications for reference services, information surfing and search, information literacy, and cataloguing. Expert systems are suitable intelligent systems in university libraries since they mimic the behavior of expert library workers, whereas robots are better suited for identifying and arranging books on the shelf (Wójcik, [2021](#)). According to Harisanty et al. ([2024](#)), several AI-based solutions might be used in university libraries to assist with traditional or regularly performed tasks such as categorization, cataloguing, shelving, and circulation desk duties. Nonetheless, decision-making and the capacity to drive innovation are constrained since libraries remain skeptical about AIs viability.

In Pakistan, Ali et al. ([2020](#)) discovered that limited AI applications such as QR, Bar Code, or RFID patron recognition, and voice search on Google and YouTube were deployed in Pakistani university libraries. In another qualitative study, Ali et al. ([2021](#)) conducted interviews with five chief librarians from Pakistani university libraries to identify AI-based services. Due to a lack of funding and technical staff, they revealed that AI is being gradually implemented into Pakistani university libraries. Hussain and Ahmad ([2024](#)) reviewed AI applications in library services. They proposed AI-based library services, for example, face recognition for entrance and circulation activities, RFID to control the theft rate, virtual assistance, and automated cataloging. In the age of information explosion, AI in library services will supply users with trustworthy information and serve as a beneficial tool for libraries and readers (Hussain, [2023](#)).

AI Challenges and University Libraries

Although technology has boundless promise, it also brings challenges to individuals and organizations negotiating AI adoption and placement, such as standardization, privacy, and security issues. When investigating the impact of AI on university libraries, several challenges were identified,

including ethical dilemmas, decision intelligibility, and maintaining data quality (Cox et al., [2019](#)). The main challenge of AI is that librarians are afraid of losing their employment because they believe AI will create worries about job loss and data privacy within the organization (Frederick, [2020](#); Kieslich et al., [2022](#)). AI technology may result in fewer work prospects for library professionals since they have created tools and robots that have replaced manual labor (Wang, 2020).

Financial restrictions, inadequate infrastructure, insufficient skills, and lack of exposure to international standards are some of the challenges that libraries face when adopting innovative technological solutions (Echedom & Okuonghae, [2021](#)). Although AI is an emerging technology that may be used for library services, it is constrained by several complications, including a lack of funding, librarians attitudes, and technological skills (Hussain, [2023](#)). However, in dynamic environments where moving necessitates making physical contact with objects, it becomes more challenging to program recognition of such items (Krishna & Rohit, [2018](#)).

Research Gap

According to the evaluation of the existing literature in the section before this one, numerous investigations on AI have been carried out in advanced nations. The limited research in Pakistani university libraries has concentrated on the potential for AI execution in libraries and the kinds of library facilities that would benefit from AI. So, there is a scarcity of research that investigates the challenges and benefits of AI in Pakistani university libraries. Keeping in view the context, the current study will fill the knowledge gap by highlighting the challenges and benefits of the implementation and use of AI in the university libraries of Pakistan.

Research Methodology

This study aims to explore the benefits and challenges of implementing and using AI in Pakistani university libraries. AI is an emerging technology, especially in developing countries such as Pakistan (Ali et al., [2021](#)). Researchers employ qualitative research methodologies to investigate a novel phenomenon (Creswell, [2009](#)). The benefits and challenges of AI may differ among Pakistani library workers due to the novelty of the issue being examined. Thus, this study used a qualitative research approach to explore in-depth insights regarding the benefits and challenges associated with the

deployment and use of AI in Pakistani university libraries.

The population of this study comprised library professionals from universities accredited by the Pakistan Higher Education Commission, the nations principal regulatory authority for higher education. Participants with pertinent knowledge and experience on AI applications and library technologies were chosen through the use of purposeful sampling. Participants were chosen from both public and private universities spread throughout several parts of Pakistan in order to make sure a diversity of viewpoints. Marshall et al. (2013) suggested that “typically, 20 to 30 participants for interviews should be included in grounded theory qualitative studies” (p. 21).

Keeping in view the objectives of the study, a semi-structured interview guide was developed by reviewing relevant literature (Ali et al., 2022; Asim et al., 2022; Cox et al., 2019; Frederick, 2020; Hussain, 2023; Kieslich et al., 2022). Two approaches were employed to ensure both trustworthiness and validity of the interview guide (Saunders et al., 2009). First, the interview guide was shared with a panel of three information system researchers who have experience in conducting qualitative research to explore novel technology adoption and use in libraries. Minor suggestions received from the experts were incorporated into the interview guide. Secondly, conducted interviews with three librarians with experience in implementing information systems in Pakistani libraries for the validity of the instrument. During the interviews, the participants discussed AI applications and the level of their understanding of the questions asked. On their recommendations, some of the interview questions were revised for the easy comprehension of the research participants. Further, 18 interviews were conducted through telephonic calls, and the remaining two were face-to-face. However, for a better understanding of the topic, the interview guide was shared before the interviews through WhatsApp.

After the collection of qualitative data, it was transcribed into English and entered into an Excel sheet. A thematic approach was used to analyze the data. Thematic analysis offers considerable flexibility in analyzing data and makes it simpler to approach large data sets by categorizing them into major themes (Flick, 2014). There were multiple iterative steps to the analysis. To become familiar with the data, the transcripts were first read several times. Secondly, the coding procedure encompassed multiple stages. Initially, open coding was performed to figure out significant claims and

preliminary thoughts about AI comprehension, benefits, skills, and challenges. Related codes were further categorized, and general themes were developed through the ongoing comparison of participants responses. In the last, the concluding themes were carefully developed and categorized into thematic groups, as illustrated in Table 2. When further interviews produced no new codes or themes and participant replies became repetitive, data saturation was reached, signifying that the gathered information was adequate to fully meet the studys goals.

Findings

Twenty university librarians were interviewed regarding the benefits and challenges of AI faced during the implementation and usage. The collected data were analyzed thematically, and four themes were developed, including (1) understanding of AI, (2) benefits of AI, (3) competencies required to implement AI tools, and (4) associated challenges with AI. The findings of the study are discussed explicitly under these four themes (Figure 1).

Figure 1

Core Themes of the Study



According to the topic framework, participants viewed AI as an institutional and professional change that affected library operations, staff competencies, and service delivery in addition to being a technological instrument. These topics interconnectedness shows that both technological preparedness and the growth of human potential are necessary for the successful deployment of AI.

Table 1*Demographic Information*

Labeling	Gender	Designation	Qualification	Experience	University Status	Interview Mode	Duration of Interview
Interviewee 1	Male	Chief Librarian	Ph. D.	21 and above	Public Sector	Face-to-face interview	10 minutes
Interviewee 2	Male	Director Learning Resource Centre	M. Phil.	11-20 years	Private Sector	Telephonic Call	15 minutes
Interviewee 3	Male	Chief Librarian	M. Phil.	11-20 years	Public Sector	Telephonic Call	15 minutes
Interviewee 4	Male	Chief Librarian	MLIS	11-20 years	Private Sector	Recorded Audio	10 minutes
Interviewee 5	Male	Librarian	M. Phil.	11-20 years	Public Sector	Telephonic Call	15 minutes
Interviewee 6	Male	Librarian	M. Phil.	11-20 years	Public Sector	Telephonic Call	15 minutes
Interviewee 7	Male	Librarian	M. Phil.	11-20 years	Public Sector	Telephonic Call	15 minutes
Interviewee 8	Female	Chief Librarian	Ph. D.	11-20 years	Public Sector	Telephonic Call	15 minutes
Interviewee 9	Female	Librarian	MLIS	11-20 years	Private Sector	Telephonic Call	10 minutes
Interviewee 10	Female	Librarian	MLIS	11-20 years	Public Sector	Telephonic Call	10 minutes
Interviewee 11	Male	Chief Library Officer	Ph.D.	11-20 years	Private Sector	Telephonic Call	15 minutes
Interviewee 12	Male	Chief Librarian	Ph.D.	21 and above years	Private Sector	Recorded Audio	10 minutes
Interviewee 13	Male	Librarian	M.Phil	11-20 years	Public Sector	Telephonic Call	10 minutes
Interviewee 14	Female	Deputy Librarian	Ph.D.	11-20 years	Public Sector	Telephonic Call	10 minutes
Interviewee 15	Male	Librarian	M.Phil	11-20 years	Public Sector	Telephonic Call	10 minutes
Interviewee 16	Male	Librarian	M.Phil	11-20 years	Public Sector	Telephonic Call	10 minutes
Interviewee 17	Male	Librarian	M.Phil	11-20 years	Public Sector	Telephonic Call	10 minutes
Interviewee 18	Male	Librarian	M.Phil	11-20 years	Public Sector	Telephonic Call	10 minutes
Interviewee 19	Male	Librarian	M.Phil	01-10 years	Public Sector	Telephonic Call	10 minutes
Interviewee 20	Female	Librarian	M.Phil	11-20 years	Public Sector	Face-to-face interview	15 minutes

Demographic Information of the Participants

Table 1 presents the descriptions of the 20 interviewees who participated in this study via telephonic call, recorded audio, or face-to-face interview. These participations lasted 10 to 15 minutes. Of the 20 participants, most were male and working in the capacity of librarians. Most participants possessed an M.Phil. degree in library and information management sciences, with experience ranging from 11 to 20 years. To ensure diversity in this study, the participants were selected from both public and private university libraries. The participation of librarians from diverse institutional backgrounds enabled the study to reflect variations in AI preparedness, resources, and institutional support across universities.

Understanding of AI among University Librarians

The findings reveal that library professionals understand the concept of AI. Library professionals demonstrate a thorough comprehension of AI ideas, demonstrating adeptness in identifying and utilizing AI to improve resource accessibility, user services, and information management in library environments. Twelve participants opined that AI is a computer program designed to mimic the human intelligence process to perform routine work tasks. All participants agreed that AI is a computer software that has been carefully created to replicate the functions of human intellect. In terms of problem-solving, decision-making, and task automation, this refers to the programs capacity to understand, learn, and carry out tasks while simulating cognitive processes shared by humans.

Two participants explained that AI applications work like humans and automate daily activities. One participant disclosed that AI is a novel technology that assists library professionals in reference queries, searches through voice command, and scanning books and users' cards for circulation activities, etc. In the context of libraries, the participant emphasized AI as a cutting-edge technology that is transforming traditional library services. This shows that AI brings new ideas to the arrangement, retrieval, and user interface of information, advancing and improving library operations. The findings about the understanding of the AI concept indicate that university librarians were well aware of basic AI concepts and were enthusiastic to apply various AI applications in their libraries to reap the optimum benefits (Table 2).

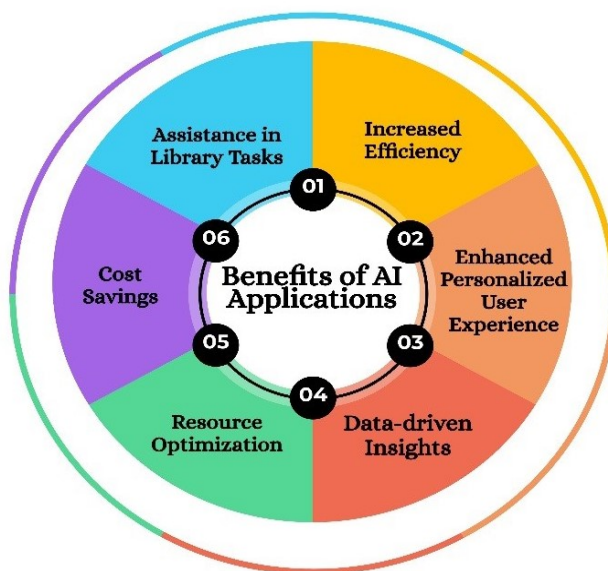
Benefits of AI Applications in Libraries

The main advantages of AI applications mentioned by participants in the interviews are shown in Figure 2. These categories developed as a result of frequent mentions of improved user accessibility, automation, operational efficiency, and service quality. The participants were asked about the benefits of AI in their university libraries. All the participants agreed that the use of AI helps to increase the efficiency as well as the quality of library services. Twenty participants frequently explained various benefits of the AI applications implemented in the libraries, such as shelving, shelf reading, circulation, collection management, subject indexing, information retrieval, reference services, and automating the process of metadata creation and extraction. Additionally, eleven participants explained,

“AI can assist librarians in answering complex and diverse queries, digitizing and preserving library collections, using image recognition and optical character recognition, optimizing services through chatbots and virtual assistants, ultimately leading to more effective and relevant services for patrons”.

Figure 2

Benefits of AI Applications



According to three participants, “AI applications increased efficiency, personalized user experiences, 24/7 support, resource optimization, preservation aid, language access, cost savings, bridging the informational accessibility gap, operational efficiency of libraries, the improvement of service delivery, and the eradication of human error in library operations”. Moreover, the delivery of library services could be enhanced through AI applications. These findings were that librarians consider AI not only as a technological advance but also as a practical remedy to operational inefficiency in university libraries. Participants also highlighted how AI may enhance user experience via tailored services and faster access to information. One participant highlighted “the trendiest app, ChatGPT, which librarians can get maximum benefits from using this chatbot service to respond to users’ queries quickly”. Notably, whereas all participants acknowledged operational advantages, only a minority addressed “strategic benefits like data-driven decision-making and sustained service innovation”. This demonstrates that the use of AI in Pakistani university libraries is predominantly perceived from a practical rather than a transformational approach. Librarians can get a lot by applying AI applications in their libraries. The results align with previous studies indicating that AI improves productivity, quality of service, and interaction among users in academic libraries (Asim et al., [2023](#); Cox et al., [2019](#)). This study enhances previous research by offering concrete evidence from Pakistani university library systems, where constrained human resources and growing user needs make automation particularly beneficial. The results indicate that AI is mainly associated by librarians with increasing operational effectiveness and decreasing manual work.

Technical and Soft Skills Required to Implement AI Applications

The participants were asked about the needed expertise to implement AI applications. The participants highlighted various skills that a librarian should have to implement AI applications. To design, implement, assess, and maintain AI systems in libraries to effectively accomplish the aforementioned tasks. Four participants nearly agreed that “library professionals should possess a variety of technical know-how, including an understanding of AI applications, programming, data literacy, analytics, and other problem-solving skills”. One participant described that “library professionals who wish to apply AI applications in their libraries should have strong IT skills, such as an understanding of databases, programming,

and content management systems”.

Another participant expressed that “if library professionals are interested in reaping the benefits of AI, then they should possess expertise in data analysis and management, knowledge of AI algorithms and techniques, understanding of information retrieval systems, familiarity with programming languages and tools for machine learning, and the ability to assess and address ethical considerations associated with AI implementation in library services”. As hard skills are needed to implement AI applications, soft skills are equally important. In addition to technical proficiency, participants also emphasized the importance of soft skills, including analytical thinking, problem-solving, and adaptability. A participant stated that “library professionals would benefit from soft skills such as critical thinking and problem-solving to implement AI applications in libraries”. So, library professionals should have soft skills because of the numerous changes that will occur in libraries as a result of the application of AI. The focus on both technical and soft skills is reflective of the changing role of librarians from conventional data managers to technology-enabled information specialists. This aligns with prior research that found digital literacy and adaptable skills to be necessary for AI incorporation in libraries (Aslam et al., [2025](#)).

Challenges of AI Applications in University Libraries

The participants explained the challenges faced during the implementation and use of AI applications in their libraries. Seven participants indicated that “the major challenge to adopting AI applications is to convince the universitys top management to implement AI applications”. Some of the AI applications require a substantial budget, but top management is not ready to pay in advance for the innovation in the library. The most commonly cited problem was financial restrictions. Fifteen participants mentioned the reluctance of university administrations to invest in AI technology because of the high costs of implementation. Participant 1 highlighted, “Libraries are often seen as secondary units in universities and so AI investment is not a priority for top management”. The findings indicate that there is a larger structural problem inside the Pakistani higher education system, which has limited institutional funds and restricted technology innovation in libraries. Another key difficulty discovered was the absence of AI-related expertise and training of librarians. Participants recognized that they were aware of the concepts of AI, but many said that

they did not have the practical abilities to implement these. The finding indicates an inequality between awareness and real readiness for technology. Issues relating to infrastructure were also important, especially among those from public sector universities. Some librarians identified inconsistent electrical supply, poor internet access, and poor IT infrastructure as major obstacles. One Participant explained: “Frequent interruptions in electricity and inadequate technological infrastructure make the consistent operation of AI systems difficult”.

Two panelists expressed significant apprehensions over the security and privacy of users data. They assert that user data is susceptible to theft in an online setting. Another participant indicated that the library is deficient in the requisite IT infrastructure, posing a significant obstacle to the implementation of AI applications. These results support earlier research in Pakistan and other developing countries that found that the main obstacles to the use of AI in academic libraries were a lack of funding, technological limits, and insufficient professional training (Asim et al., [2023](#); Hussain, [2023](#)). However, by demonstrating how these difficulties are encountered differently in Pakistani institutional contexts, our study adds deeper qualitative insights.

Table 2

Themes Overview

Explained Theme	Theme	Sub themes	Quotation
Participants understanding of the AI concept	Understanding of the AI concept	1. Understanding of AI as a computer mimicking human intelligence.	1. “A computer program designed to mimic human thought processes and behavior” (Chief Librarian, Chief Library Officer).
		2. Understanding of AI as automating activities in libraries.	2. “A computer that mimics human intelligence and automates activities” (Director LRC, Deputy Librarian).
		3. Understanding of AI as assistance to librarians.	3. “A technology-based system that supports users in carrying out their regular tasks at the library” (Librarian).
			4. “AI can assist the library professionals to perform the daily tasks” (Chief Librarian).
Participants explained the benefits of AI	Benefits of AI applications in university	1. Increasing effective and relevant AI-based	1. “Preserve and digitize their collections, using image recognition and optical character

Explained Theme	Theme	Sub themes	Quotation
technologies for libraries	libraries	services 2. Enhancing the quality of AI-based library services 3. Improving information accessibility	recognition, optimizing services through chatbots and virtual assistants, ultimately leading to more effective and relevant services for patrons” (Chief Librarian). 2. “Security (RFID) and providing reference services, automate the process of metadata creation and extraction, enhance the quality and consistency of bibliographic records, landscape, using data mining and machine learning, etc.” (Librarian, Deputy Librarian). 3. “Bridging the informational accessibility, operational efficiency of libraries, the improvement of service delivery, the eradication of human error in library operations, and the maximization of effectiveness enhanced and comprehensive user experience in the delivery of library services” (Librarian, Chief Library Officer). 4. “ChatGPT, a research assistant” (Chief Librarian, Director LRC)R
Respondents describe that expertise is required for librarians to implement AI applications in a library	Technical and soft skills needed for AI implementations	Hard Skills: IT skills, professional competencies, ICT literacy, problem-solving skills, data analysis, and management. Soft Skills: Critical Thinking	1. “Professional competencies, which include gaining fundamental IT skills” (Librarian). 2. “IT skills include things like databases, programming, and content management systems” (Chief Librarian). 3. “ICT literate with modern technologies like AI, data literacy, programming, analytics, and problem-solving skills to design, implement, evaluate, and maintain AI systems” (Director LRC, Chief Library Officer). 4. “Techniques of data analysis and management, knowledge of AI algorithms, understanding of information retrieval systems, familiarity with programming languages and tools for machine

Explained Theme	Theme	Sub themes	Quotation
			learning” (Deputy Librarian). 5. “Critical thinking and problem-solving” (Librarian).
Respondents describe the challenges of AI adoption and usage in university libraries.	Adoption and usage challenges of AI	Highlighted issues: lack of funds, electricity/ power shortage, high cost of AI tools, reluctance to change/adopt an advanced technology, lack of skills/ competency to use AI technologies, lack of trained personnel, and outdated technologies.	1. “Lack of awareness in higher authorities, lack of funds, electricity/power shortage” (Chief Librarian, Chief Library Officer). 2. “Lack of will/reluctance to change/adopt an advanced technology” (Director LRC). 3. “Lack of sufficient training for library staff to effectively use and manage AI systems” (Librarian, Deputy Librarian). 4. High cost of AI system development and repair, few providers of library Automation” (Chief Librarian).

Discussion

The fourth industrial revolution is defined by the integration of digital, physical, and biological technology, which results in disruptive changes in a variety of societal areas such as industry, economics, healthcare, education, and others. Industry 4.0 has the potential to change global economies and cultures (Philbeck & Davis, [2018](#)). It provides prospects for economic growth, job creation, and enhanced quality of life. AI is a famous technology of this revolution that brings amazing results in various sectors of life. Like other sectors of the economy, over the last decade, the applications of AI have been introduced in libraries (Omame & Alex-Nmecha, [2020](#); Vijayakumar & Sheshadri, [2019](#)). Consequently, AI-driven platforms have improved processes, quality of services, and brought service innovations. However, the review of the extant literature reveals a research gap regarding AI applications in Pakistani university libraries. This knowledge gap motivated us to conduct a qualitative inquiry into the benefits and challenges of AI applications in the university libraries of Pakistan.

Concerns regarding awareness of a novel technology might significantly impact its adoption, acceptance, and successful integration into society (Ajani et al., [2022](#)). Without access to clear and accurate information, individuals may confuse the technology's purpose, benefits, and potential

issues. This may result in skepticism, fear, and resistance (Kim et al., [2023](#); Tsai et al., [2020](#)). This study's findings were that Pakistani university librarians possess a fundamental comprehension of AI. Nonetheless, the utilization of AI in libraries is diverse, as university libraries have adopted only a few AI applications. The university librarians have a favorable disposition towards AI and demonstrate eagerness regarding the implementation of its many applications in reference services, digitization, and the preservation of knowledge resources. Technology awareness is important while deciding whether or not to adopt a technology. Individuals may be discouraged from attempting to learn about technology if it is complicated to grasp. It is critical to communicate technical concepts simply and understandably.

The findings of this study provide a variety of advantages for AI deployment in university libraries. According to the university librarians, AI applications support and improve numerous library services such as shelving, shelf reading, circulation, collection administration, topic indexing, information retrieval, reference services, and automate the metadata development and extraction process. Furthermore, the study explored how AI increased the efficiency of routine library tasks. Libraries are leveraging the power of AI and related technologies to enhance various services, including providing seamless access to information in multiple languages through a language translation service, responding to user questions efficiently and accurately, guiding users in navigating and accessing library resources through virtual assistance, and making complex information easier to understand through content summarization, etc. Moreover, the novel technologies helped librarians in answering complex and diverse queries, preserving and digitizing collections through image recognition and optical character recognition, optimizing services through chatbots and virtual assistants, and ultimately leading to more effective and relevant services for patrons. The benefits of AI indicate that the technologies assist university librarians in their routine work tasks and user services. Therefore, university librarians are strongly advised to integrate AI applications in their libraries. If developing-country university libraries face financial problems, they ought to prioritize the implementation of low-cost AI applications (Gul & Bano, [2019](#); Zawacki-Richter et al., [2019](#)).

The needed skills are critical for the effective adoption of disruptive technologies. Innovative technologies sometimes feature cutting-edge

ideas, complex designs, and intricate systems (Allioui & Mourdi, [2023](#)). Expertise ensures that those working on the implementation properly understand the technology, allowing them to recognize possible issues and design effective solutions (Kliushnyk et al., [2019](#); Maddikunta et al., [2022](#)). This study also highlighted the expertise and skill sets for university librarians to implement AI applications in the libraries. The Pakistani university librarians suggested various types of hard and soft skills, such as know-how of basic IT solutions, understanding of AI concepts, data literacy, data analysis and management, knowledge of AI algorithms and techniques, understanding of information retrieval systems, familiarity with programming languages, critical thinking, and problem-solving behavior. Several skills are required to implement a technology for library services. So, library professionals should seek the indicated skills to implement cutting-edge technology such as AI in their libraries.

Implementing new technology could be an exciting endeavor, but it is not without its challenges (Cook et al., [2019](#); Sinsel et al., [2020](#)). This study explored challenges faced by university librarians during the implementation and use of AI applications in university libraries. This researcher explored several challenges that university librarians encounter while implementing and using AI applications in their libraries. These challenges include convincing top management to implement AI applications, requiring a substantial budget, a lack of knowledge and required skills to implement AI applications, power fluctuation, security and privacy of user data, and a lack of advanced IT infrastructure. Howard ([2019](#)) also found that, for university libraries of developing nations, the main constraint to implementing novel technology like AI is the required budget. Moreover, the libraries mostly face a budget deficit. From this context, the university libraries may prioritize low-cost AI applications and focus on providing as much assistance to their patrons as feasible (Tella, [2020](#)).

University librarians are keen to implement cutting-edge technology in libraries throughout the world. Despite the numerous benefits of AI-based platforms, there are plenty of challenges to deploying AI-based platforms. Addressing the mentioned challenges may greatly improve the scenario and allow libraries to create and employ AI applications for library processes and services. The Ministry of Information Technology and Telecommunication, the National Information Technology Board, the

Punjab Information Technology Board, and the Pakistan Telecommunication Authority oversee the implementation of IT applications throughout Pakistan. To fully leverage the advantages of disruptive technologies, immediate national participation across all major stakeholders is needed.

Theoretical and Practical Implications

This qualitative study examines the benefits and challenges of AI in university libraries, which have tangible implications for library staff, administrators, scholars, and policymakers. This study's conclusions may offer significant insights for formulating strategic decisions, enhancing user experiences, and guiding the ethical incorporation of AI technology in library settings. The study's findings provide library professionals with a more thorough understanding of the advantages and problems associated with AI deployment and utilization. This understanding empowers them to make informed decisions regarding the adoption, implementation, and administration of AI technology in their libraries. The study's findings can assist university library administrators in formulating strategic plans for AI integration. Comprehending the potential benefits and challenges enables institutions to effectively allocate resources and prioritize sectors that correspond with their objectives and user needs.

Limitations and Directions for Future Research

Qualitative research generally seeks profound insights instead of extensive generalizability (Creswell & Creswell, [2018](#)). Qualitative research generally seeks profound insights instead of extensive generalizability (Creswell & Creswell, [2018](#)). The study offers significant insights into the chosen sample; however, more caution is advised when generalizing the results to a larger population. The study's results may be constrained by a restricted or homogeneous sample size. Ensuring a broad array of university libraries, encompassing various sizes, locations, and academic specialties, could augment the applicability of the results. Furthermore, the swiftly advancing characteristics of AI technology indicate that the benefits and challenges recognized in the study may change. The study may not comprehensively encompass developing trends or difficulties that develop after the data collection period. Researchers should adopt a mixed-methods strategy, integrating qualitative insights with quantitative data. This may offer a more thorough comprehension of the

advantages and obstacles, facilitating a more rigorous triangulation of findings (Connaway & Radford, [2021](#)). Future research may focus on understanding the experiences and viewpoints of library users, including students, professors, and researchers, about AI services and resources. This user-focused perspective may provide profound insights about usability and efficacy.

Conclusion

Digital transformation is a progressive development that utilizes technology to improve an organizations offerings/services. A novel technology offers several opportunities but also poses challenges to organizations navigating the digital revolution. This study investigates the challenges and benefits of AI applications in university libraries in Pakistan using a qualitative approach. The results show that most of the librarians are well-informed about the benefits of AI in university libraries. The use of AI in library operations and services can advance libraries by minimizing human errors caused by the repetitive nature of routine processes. University libraries in Pakistan may encounter challenges integrating AI systems, such as financial issues, inadequate specialization in technology, electricity issues, limited resources to support the technology, and a lack of employees trained to handle system maintenance. However, this study suggests that library professionals should have basic IT skills, a clear AI concept, knowledge of AI algorithms and techniques, understanding of information retrieval systems, familiarity with programming languages, critical thinking, and problem-solving behavior. By mastering the needed skills, library professionals can overcome challenges to implement various AI applications in university libraries. Finally, this study also indicates future research directions in the AI realm.

Author Contribution

Sanila Aslam: conceptualization; data curation; formal analysis; investigation; methodology; visualization; writing – original draft. **Muhammad Arif:** conceptualization; supervision; writing – review & editing. **Muhammad Asim:** writing – review & editing.

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

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