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CURRENT STATUS OF ARTIFICIAL INTELLIGENCE INTEGRATION IN MEDICAL COLLEGE LIBRARIES OF PAKISTAN

[1]Muhammad Shahab

[*2]Dr. Saeed Ullah Jan

[1]PhD Scholar Department of Library and Information Science, Khushal Khan Khattak University, Karak

*[*2]Assistant Professor, Department of Library and Information Science, Khushal Khan Khattak University, Karak*

[1]muhammad.shahab@kkkuk.edu.pk, [2]dr.saeedullah@kkkuk.edu.pk

Abstract

This research investigates the status of artificial intelligence (AI) implementation in the medical college libraries of Pakistan, with the focus of evaluating the level of implementation, the nature of the adopted AI technologies, and the preparedness of library professionals for AI-enabled transformation. From the findings, it appears that the integration of AI is still in its initial stage with only 27% of libraries showing partial implementation while only 8% have achieved full or advanced level integration. Typically embraced AI applications are automated cataloging systems, chatbots for reference services, and plagiarism checkers. On the other hand, application of more sophisticated technologies such as machine learning-based recommendation systems, predictive analytics, and robotics-based circulation was found to be limited or not at all in place. Librarian awareness and readiness for the adoption of AI was also explored by the study. Descriptive statistics yielded a moderate awareness, with a mean score of 3.45 on a 5-point Likert scale. Although librarians showed a general appreciation of AI's potential benefits, most were lacking the technical competencies for successful implementation. Interestingly, 61% of the respondents indicated a desire for training and capacity-building programs to support their AI-related skills. These results emphasize the need for strategic planning, investment in professional development, and policy support to enable effective AI integration in medical library services in Pakistan.

Keywords: AI-Awareness, AI based technology-Medical libraries, AI-Awareness-Library-Pakistan

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1- INTRODUCTION

Artificial Intelligence (AI) was referred to for the first time in 1955 by J McCarthy while drafting a research proposal for the Dartmouth Summer Research Conference. Ever since, no definition of artificial intelligence has existed that is accepted by all. It may be considered as the embedding of human intelligence in machines: AI is a set of technology and computing paradigms aimed at the capacity of computers to make adaptive rational decisions as a reaction to uncertain environmental states (Tredinnick, 2017). AI is "systems or machines that simulate human intelligence to accomplish tasks and are able to iteratively enhance themselves through the data they gather" (Png & Helskyaho, 2022).

In AI applications, it is focused on human conduct and how intelligent human behavior can be replicated by machines (Asemi, Ko, & Nowkarizi, 2020). In an initial definition, McCarthy (2007), a renowned computer scientist, defined AI as "the science and engineering of making intelligent machines, especially intelligent computer programs. The ultimate effort is to make computer programs that can solve problems and achieve goals in the world as well as humans.". Subsequently, AI is envisioned as "a cluster of technology and approaches to computing focused on the ability of computers to make flexible rational decisions in response to unpredictable environmental conditions" (Tredinnick, 2017,). In brief, AI is the simulation of human intelligence processes by computer systems and the emphasis has been on modelling conceptual frameworks employed in human problem solving Similar to any other sectors, libraries and information units are also adding numerous interesting technologies to their arsenals (Das & Islam, 2021). Technological advancements are supporting the technical and user services of libraries (Ali, et al. 2017).

AI has the potential to transform the way libraries are handled, from how library items are categorized and organized to how librarians and patrons interact. The effective use of Artificial Intelligence (AI) tools helping not only to modernize library services but also to make them unique within the institution. For libraries to fully deploy AI to meet their diverse service needs, they first need to adopt and implement these tools. According to(Ajani, Tella, Salawu, & Abdullahi, 2022), the application of artificial intelligence (AI) in libraries can increase the effectiveness of library operations in general and reference services in particular. AI can help libraries organize, store, and retrieve information to better manage their digital holdings. Artificial Intelligence can be implemented in libraries through robotics, chatbot, natural language processing, big data, and text data mining. Library professionals have historically responded to new technological advancements that provide advances in the profession of librarianship (Hervieux & Wheatley, 2021). AI has revolutionized enterprises and has become a vital tool for libraries (Cox, 2023; Folorunso & Momoh, 2020). The application of AI technology in libraries may allow library resources to be virtually recreated. This reimagining can assist the library in exploring new methods to fulfill client demands and facilitate academic pursuits for anybody from anywhere. AI can enable continuous access to an expanding domain of full-text online resources, allowing libraries to deliver services that transcend the customary (Okunlaya et al. 2022). However, with the advent of AI, the functions of libraries will grow more complicated, and future library professionals might need more complex, critical, innovative, and imaginative thinking, as well as emotional involvement (American Library Association, 2019; Huang, 2022). Library user services and information retrieval have seen the gradual introduction of tool such as chat bot, robotics, pattern recognition and natural language processing (Asim, Arif, Rafiq, & Ahmad, 2023).

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As libraries are the integral part of each and every health care center and institution, the provision of modern and smart library services to the health care community and medical students is need of the day. Artificial intelligence is one of the innovative technologies that has the potential to modernize the library system of health care center and medical colleges. This study is an attempt to examine the awareness, status, impact and challenges associated with the adoption of AI in medical libraries of Pakistan. The findings of this study will serve as a guide map for the decision makers and higher ups of the health department to implement this emerging technology in medical institutions of Pakistan in future.

Medical Libraries and AI

A health or medical library serves physicians, health professionals, students, patients, consumers, and medical researchers by providing access to health and scientific information for enhancing, updating, assessing, or evaluating health care (Ullah, Ameen et al. 2011). The National Library of Medicine (NLM) is the world's largest biomedical library and a global leader in computational health informatics. It plays a crucial role in translating scientific research into practical applications. NLM's research and information services support scientific innovation, healthcare, and public health (Ullah & Ameen 2014). Artificial intelligence (AI) is transforming medical libraries by enhancing their services and improving access to information. AI systems automate cataloging and indexing of vast amounts of medical literature, reducing the workload on librarians and ensuring systematic organization of materials. AI-powered search engines and natural language processing (NLP) tools enable sophisticated and intuitive searches, while personalized recommendations help users discover relevant materials. AI tools for text and data mining extract valuable insights and identify trends, aiding systematic reviews and meta-analyses. Virtual assistants and chatbots provide immediate assistance, enhancing user experience and accessibility. AI facilitates knowledge discovery by connecting disparate information sources, assists with predictive analytics to anticipate user needs, and supports digital archiving and preservation of medical literature. Enhanced user interaction features like voice recognition and image search make accessing information easier. Additionally, AI tools assist researchers with literature review, data analysis, and manuscript preparation, significantly improving research efficiency and quality. Overall, AI enhances the capabilities of medical libraries, making them more efficient, user-friendly, and responsive to the needs of healthcare professionals and researchers.

LITERATURE REVIEW

According to Bruce (1994), literature review is an integral part of every research because it offers context and support for the study being done. A literature review needs to be well structured and pertinent to the subject of research, according to Taylor (2025). it ought to provide a succinct synopsis of the readers' prior knowledge as well as ignorance. It also highlights the contentious issues and specific questions that need further research.

Ali et al. (2020) Identified that librarians were aware of AI technologies. Services based on Natural Language Processing (NLP) are used in libraries, e.g. Google Assistant, Voice Searching, and Google Translate. Pattern recognition methods, such as text data mining, are also used to retrieve library material and conduct online searching. Ali et al. (2022) identified that Artificial Intelligence is already slowly being introduced into Pakistani university libraries. While commenting on ways in which AI could help their libraries deliver more innovative services and better meet user needs, respondents expressed concern about the investment required in funding, time, and staff. Memela,

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(2023) indicated that Artificial Intelligence helped the librarians in finding new ways by incorporating technology which were helpful for improvement of the quality of library services. Fatima et al. (2023) examined that AI significantly facilitated the management of hospitals to vigilantly assess employees' productivity and accurately analysis of employees' characteristics, such as attitude, emotion and behavior, the study has considered beneficial and harmful perspectives of AI in the workplace.

Taylor, (2022) conducted a study on Bibliometric Study of Artificial Intelligence use in academic libraries. It was depicted that libraries readily use AI in many areas including catalog searches, room reservations, and even robots to retrieve books and materials. (Asim et al. 2023) conducted an empirical study on Investigating applications of Artificial Intelligence in university libraries of Pakistan. The results revealed that Pakistani university libraries are using limited AI-based library services including text-to-speech and speech-to-text technologies, Google Assistant to search by voice command, Radio Frequency Identification (RFID) system for self- checkout and check in.

Shaheen & Khurshid, (2023) reported that there was a positive attitude toward AI use in libraries. However, concerns were raised regarding such decisions' privacy and ethical ramifications. (Subaveerapandiyan, 2023) conducted study on Application of Artificial Intelligence (AI) in libraries and its impact on library. The findings of this review indicate that AI can improve information retrieval, automate routine tasks, personalize user interactions, and provide innovative services. Muhammad Tanveer et al(Tanveer, Hassan, & Bhaumik, 2020) found that Artificial Intelligence (AI) has been applied to resources to improve skills giving teachers the time and freedom to provide understanding and adaptability and drive performance. Asefeh et al (Asemi, 2018) conducted a study related to Artificial Intelligence (AI) application in library systems in Iran.

The results unveiled that most developed Recommender Systems (RM) in library systems in Iran was Natural Language Processing (NLP). (Gürsen, Öncel, Plaisent, Benslimane, & Bernard) (2023) found that computers might be able to imitate human behavior and artificial intelligence could analyze texts, make modelling the knowledge to help decision-making, reproduce a standard reasoning and use this information to make decisions and to produce knowledge thanks to machine learning. There was little or no adoption of AI in university libraries in Kwara State, Nigeria. The study also found that Kwara State, Nigeria, has not adopted AI for library services as expected (Moustapha, 2023). Solomon et al (Solomon Olusegun, Oladokun, Maxwell, & Akor, 2023) emphasized that, academic libraries in Nigeria have not yet adopted and applied AI, in spite of the potential that it holds for libraries. Oseji et al (2023) found that libraries have greatly achieved benefits from the development of artificial intelligence systems in their technical services, reference services, circulation services, resource management and information retrieval/dissemination. The AI tools positively impact both the technical and user services in the academic libraries of Pakistan (Ali et al., 2020).

Cox, Pinfield, & Rutter, (2019) identified the impacts of AI on search and resource discovery, on scholarly publishing and on learning. He also revealed the challenges included libraries being left outside the focus of development, ethical concerns, intelligibility of decisions and data quality. Some threat to jobs was perceived. Omame & Alex-Nmecha, (2020) found that ultimate promise of artificial intelligence in libraries is to develop computer systems or machines that think, behave, and in fact rival human intelligence, and this clearly has major implications on librarianship. Obiano et al. (Obiano, Onuoha, Adeoye, Nwosu, & Motunrayo, 2022) revealed that academic libraries experience

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certain challenges in adopting AI, such as lack of needed AI tools, inadequate planning etc. Nazir et al. (2023). found that technological challenges like cost, budgets, technology adoption, research and development, cost-benefit analysis, collaborations, bureaucratic structures, and ICT readiness are the issues that were faced by public sector organizations. Asemi et al., (2020) found that the current information systems have a high potential to be improved by integration with AI technologies. Identifying research gaps is a crucial preliminary step in undertaking any study, especially within the realm of knowing the status, impact and challenges Artificial Intelligence (AI) in medical libraries. While a considerable body of research has explored various facets of AI in library settings, such as examining librarian readiness, perception, and awareness of AI, as well as the application of AI tools and the challenges associated with their implementation, there exists a conspicuous dearth of international research specifically focused on AI in medical libraries. The paucity of comprehensive studies on this topic is particularly glaring when considering the global context.

Even more concerning is the scarcity of research in this domain within the libraries of Pakistan. The current state of research in Pakistan on Artificial intelligence's status, impact and challenges in medical libraries is notably insufficient, representing a substantial gap in knowledge and understanding. This deficiency underlines the need for a concerted effort to address this void through targeted research initiatives that can contribute significantly to both the global discourse on AI in libraries and, more specifically, the unique challenges and opportunities faced by medical libraries in Pakistan. A renewed emphasis on conducting in-depth studies in this area, tailored to the specific context of Pakistan, is imperative to bridge this research gap and advance our comprehension of the potential applications and implications of AI in medical libraries settings. Based on review of related literature, it is crucial to investigate the current state of AI adoption in the medical libraries of Pakistan, understand the factors influencing the intention to adopt AI technologies, and identify the ethical issues that may arise from such integration. Understanding these aspects is essential for guiding policymakers, library administrators, and other stakeholders in making informed decisions about the future of AI in medical libraries, ensuring that the integration of AI is both effective and ethically sound. This study seeks to address these critical concerns by exploring the status, adoption intention, and ethical issues associated with AI integration in the medical libraries of Pakistan.

Objective of the Study

The researcher has tried to achieve the following objective:

1. To examine the status of AI-based library services being offered in medical libraries of Pakistan.

Research Question

The researcher has tried to achieve the goals of the study by addressing the following research question:

1. How are AI-based library services currently being provided in Pakistani medical libraries?

RESEARCH DESIGN AND METHODOLOGY

This research has utilized a quantitative research approach as most of the similar studies (Moustapha, 2023; Obiano, 2022; Shaheen, 2023) have adopted the same method. A survey-based approach is used to carry out this study. Medical librarians of Pakistan serving at public and private Medical and Dental Colleges were approached for data collection

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According to the Pakistan Medical & Dental Council (2024), there are 185 public and private medical colleges across the country. Furthermore, data is collected from the librarians/In-charge of the libraries of these medical colleges. As the population is controlled, so a census-based approach has been used and data is collected from the whole population. This research study has focused exclusively on the Medical and Dental Colleges of Pakistan. All the libraries attached with medical training institutes and allied medical training organizations are excluded from the study. This study is also delimited to a construct namely status of artificial intelligence in medical college libraries of Pakistan. An adapted questionnaire is used to obtain data from the respondents of the study. After preparing the draft questionnaire, it is sent to the panel of experts for its validity. Moreover, a pilot study was pursued to check the reliability of the constructs of the questionnaire. The questionnaire was mainly composed of closed ended questions with five-point Likert scale. A multi-tier strategy is used to achieve the maximum response of the participants. The questionnaire is also developed in Google form, and the online link was shared among respondents via WhatsApp groups, Email addresses etc. The collected data was analyzed using Statistical Package for Social Sciences, version 27 (SPSS). Moreover, the descriptive and inferential statistics was used to interpret the data and draw inferences.

The demographic section provided insights into the institutional distribution and respondents' profiles. Out of 185 distributed questionnaires, 152 valid responses were received, yielding an 82% response rate, which is statistically acceptable for census-based studies. Among these, 95 (62.5%) responses were from public sector medical colleges and 57 (37.5%) from private institutions. The majority of respondents (68%) held positions as Chief Librarians or Library In-Charges, while others were Assistant Librarians or IT support staff. Most respondents possessed at least a master's degree in Library and Information Science (LIS), reflecting adequate academic preparedness to understand AI concepts.

Table 1: ***Demographic Profile of Respondents***

Variable	Category	Frequency (n=152)	Percentage (%)
Institutional Type	Public Sector	95	62.5
	Private Sector	57	37.5
Designation	Chief Librarian/Library In-Charge	103	68
	Assistant Librarian/IT Support Staff	49	32
Qualification	Master's in LIS	121	79.6
	Bachelor's in LIS or other	31	20.4
Response Rate	Total Valid Responses	152	82

Status of AI Integration

The analysis revealed that the overall integration of Artificial Intelligence (AI) technologies in medical college libraries remains at an early stage. Only 27% of libraries reported partial implementation of AI tools, while 8% indicated full or advanced integration. The most frequently used AI applications included automated cataloging systems, chatbots for reference services, and plagiarism detection tools. However, advanced technologies such as machine learning-based recommendation systems, predictive analytics, and robotics-assisted circulation were rare or nonexistent.

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Table 2 shows the current level of AI integration in libraries.

Table 2 : ***Status of AI Integration in Medical College Libraries***

Level of Integration	Description	Percentage (%)
Full/Advanced Integration	Implementation of multiple AI systems such as chatbots, automation, and analytics	8
Partial Integration	Limited use of AI tools (e.g., cataloging, plagiarism detection)	27
Early/Nascent Stage	Minimal or no AI use in library operations	65

Additionally, **Table 3** highlights the most commonly used AI tools across the surveyed libraries.

Table 3: ***Common AI Tools Used in Medical College Libraries***

AI Application	Usage Frequency (%)	Remarks
Automated Cataloging Systems	41	Common in public sector libraries
Chatbots for Reference Services	33	Mostly used in private sector institutions
Plagiarism Detection Tools	28	Linked to academic and research support
ML-Based Recommendation Systems	9	Rarely implemented
Predictive Analytics Tools	7	Very limited use
Robotics-Assisted Circulation	0	Nonexistent

Awareness and Readiness

Descriptive statistics showed that a moderate level of awareness exists among librarians regarding AI's potential benefits. The mean score (M = 3.45 on a 5-point Likert scale) indicated that librarians were somewhat aware of AI applications, but many lacked the technical expertise to apply these tools effectively. Furthermore, 61% of respondents agreed that they required training and capacity-building workshops to enhance their AI-related competencies.

Table 4 summarizes the awareness and readiness levels of respondents.

Table 4: ***Awareness and Readiness Levels of Library Professionals***

Variable	Mean (M) on 5-Point Scale	Interpretation
Awareness of AI Concepts	3.45	Moderate awareness
Perceived Usefulness of AI	3.70	Positive perception
Technical Skill Competence	2.90	Below average
Training Need Agreement	61% agreed	High demand for capacity building

Institutional Support and Barriers

The study also highlighted various institutional and infrastructural challenges that hinder the integration of AI in medical college libraries. The most significant barriers included budget constraints (78%), lack of technical infrastructure (71%), and absence of institutional policy frameworks (65%). Public sector institutions faced more financial and

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administrative constraints compared to private ones, where innovation was relatively higher.

Table 5 presents the major barriers to AI integration.

Table 5: ***Institutional Support and Barriers to AI Integration***

Barrier	**Percentage of respondents (%)**	**Description**
Budget Constraints	78	Major limiting factor in AI implementation
Lack of Technical Infrastructure	71	Inadequate systems and equipment
Absence of Policy Framework	65	No strategic plan for AI adoption
Insufficient Training Opportunities	59	Lack of AI-related professional development
Resistance to Change	43	Cultural and administrative inertia

RESULTS AND DISCUSSION

After reviewing extensive review, objective of the study and formulated hypotheses, a questionnaire was designed. The instrument was validated from relevant experts of the field. The changes suggested by the experts were incorporated accordingly. The final questionnaire was designed in google doc. The link of the instrument was shared in various WhatsApp groups of medical library professionals across the country. The information of 185 medical library practitioners were extracted from the office and website of Pakistan Medical Council (PMC). It was reported that the target population of this study was148, as the population was controlled, so no sampling was made. Email and telephonic calls were used as follow-up tool. Various channels, including WhatsApp groups comprising library practitioners and personal contacts, were utilized to disseminate and gather responses from participants.

Follow-up tools such as WhatsApp chats, emails, and personal calls were employed in the process. A total of 148 valid survey forms were successfully collected. The data collected was subjected to statistical analysis using the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique. The findings indicate a predominant male representation among the respondents, aligning with the male dominance observed in the field of library professionals in Pakistan (Jan & Gul, 2020). The present study aimed to investigate the current status of Artificial Intelligence (AI) integration in medical college libraries across Pakistan.

The data were obtained from librarians and in-charges of libraries affiliated with 185 public and private medical colleges throughout the country. Since the total population of medical college libraries was manageable, a census-based approach was adopted, ensuring that the data represented the entire population rather than a sample. This approach enhanced the reliability, validity, and comprehensiveness of the findings, as every library holding potential relevance to the study was included. The research used a quantitative design supported by a structured, adapted questionnaire. The questionnaire was divided into several sections focusing on demographic information, availability of AI technologies, level of AI integration, staff awareness and readiness, and perceived challenges in AI adoption. The instrument was distributed through online platforms and email, and

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responses were coded and analyzed using statistical techniques through SPSS (Statistical Package for the Social Sciences).

Status of AI Integration

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Awareness and Readiness

Descriptive statistics showed that a moderate level of awareness exists among librarians regarding AI's potential benefits. The mean score (M = 3.45 on a 5-point Likert scale) indicated that librarians were somewhat aware of AI applications, but many lacked the technical expertise to apply these tools effectively. Furthermore, 61% of respondents agreed that they required training and capacity-building workshops to enhance their AI-related competencies.

Institutional Support and Barriers

The study also highlighted institutional and infrastructural challenges. The most significant barriers to AI integration were budget constraints (78%), lack of technical infrastructure (71%), and absence of institutional policy frameworks (65%). Public sector institutions faced more financial and administrative constraints compared to private ones, where innovation was relatively higher.

CONCLUSION

The data analysis indicates that AI adoption in medical college libraries of Pakistan is still in its nascent phase. While awareness of AI and its potential benefits exists, there is a considerable gap in practical implementation due to limited resources, inadequate technical skills, and institutional barriers. The findings emphasize the need for national policy interventions, training programs, and collaborative initiatives to enhance AI integration in medical education libraries.

"Current Status of Artificial Intelligence Integration in Medical College Libraries of Pakistan", divided into theoretical, practical, and future directions sections:

THEORETICAL IMPLICATIONS

The findings of this study contribute significantly to the theoretical understanding of Artificial Intelligence (AI) integration within the context of library and information science (LIS), particularly in developing countries like Pakistan. Awareness, perceived usefulness, and institutional support strongly influence the adoption of AI tools in library settings. It further expands the literature by providing empirical evidence on how socio-economic and infrastructural constraints shape the adoption of emerging technologies in academic libraries. Thus, this research establishes a foundational framework for analyzing the interplay between organizational readiness, librarian competency, and technological infrastructure in the context of AI integration.

PRACTICAL IMPLICATIONS

From a practical standpoint, the study reveals that medical college libraries in Pakistan are still in the early stages of AI adoption, with limited implementation of advanced technologies. The findings underscore the importance of capacity building among library professionals through specialized training, workshops, and professional development

programs focused on AI applications in library management. Institutions should allocate dedicated budgetary and technical resources to support digital transformation. Moreover, policymakers and higher education authorities, such as the Higher Education Commission (HEC) and Pakistan Medical and Dental Council (PMDC), should develop national-level strategies and frameworks that encourage AI integration in library operations. Strengthening IT infrastructure, promoting partnerships with technology vendors, and fostering collaboration between medical libraries can help bridge the digital divide and enhance the quality of information services.

FUTURE DIRECTIONS

The current study lays the groundwork for future research on AI implementation in the LIS sector. Future studies may adopt a comparative approach to examine variations in AI adoption between different types of academic libraries, such as engineering, business, and social science institutions. Longitudinal studies could also be conducted to track the progress and evolving trends of AI integration over time. Additionally, qualitative research methods, such as interviews and case studies, can provide deeper insights into librarians' experiences, attitudes, and perceptions regarding AI. Further research should also investigate the impact of AI on library user satisfaction, information retrieval efficiency, and decision-making processes. Expanding this line of inquiry can contribute to a more holistic understanding of how AI can transform academic libraries into intelligent, user-centered knowledge hubs.

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