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Factors influencing the adoption of artificial intelligence in libraries: A systematic literature review

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Abstract
The study aimed to identify the factors influencing the adoption of artificial intelligence applications in libraries, find out the associated challenges with the adoption of AI apps, and develop a framework to effectively implement AI tools in libraries. A systematic literature review (SLR) was applied to address the study's objectives. 30 most relevant research papers published in impact factor journals were selected to conduct the study. Findings of the study showed that four major factors influenced the adoption of AI in libraries. These factors included transformation of library services, provision of innovative services, librarians and users' satisfaction, and technological revolution. The study manifested that technological challenges, skills and knowledge barriers, financial challenges, and organizational and cultural barriers caused barriers for librarians to adopt AI apps in libraries. The study has added valuable literature to the existing body of knowledge. It has developed framework on evidence based datasets to adopt AI apps in libraries effectively and efficiently.

Keywords
artificial intelligence, AI factors, barriers to adopt AI, AI potential, libraries

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Introduction

Rapid technological advancements are transforming all fields of life including education and libraries' landscape. The revolution in artificial intelligence (AI) tools are refining and reshaping library service methods and techniques (Borgohain et al., 2024; Okunlaya et al., 2022). "AI refers to the development of computer systems and algorithms that can perform tasks typically requiring human intelligence, such as learning, reasoning, problem-solving and decision-making". The adoption of AI tools in library settings prove fruitful in initiating user centered services to support library patrons efficiently (Harisanty et al.,

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2024; Huang, 2024). Innovations in AI have created fourth industrial revolution that is assisting in the implementation of smart library systems to support users' diverse needs (Iqbal et al., 2023; Yoon et al., 2022).

Innovation is a key factor that influences the adoption of artificial intelligence (AI) applications in library settings (Li et al., 2022; Pan and Xue, 2023). Integrated library services encourage the implementation of AI tools in libraries as users' diverse needs are supported through latest techniques (Asemi et al., 2021; Asim et al., 2023). Automatic library services to end users through machine-based methods is a major factor influencing the adoption of AI tools in libraries (Huang et al., 2023; Ocholla and Ocholla; 2020). Work support to librarians through AI applications proves fruitful in delivering value-added services efficiently (Hervieux and Wheatley, 2021). Transformation of library systems and services from traditional ones to smart ones also stimulate the adoption of AI applications in academic settings (Adarkwah et al., 2024; Okagbue et al., 2023).

Transformational leadership plays a fruitful role in the adoption of AI applications in library settings for the provision of smart services (Shal et al., 2024). Enhanced usage of library's resources is an essential element to implement artificial intelligence tools in academic settings (Nguyen et al., 2019). Improved work efficiency of librarians is also an important factor that encourages the incorporation of AI applications in routine libraries' operations (Ng et al., 2021). AI applications assist in the initiation of state-of-art automatic library facilities to address diverse queries of the library patrons (Kim and MacKinnon, 2018). AI applications prove valuable in the delivery of context based services to end users through automatic methods (Noh, 2015). Perceived usefulness of AI in the current age of ever happening technological changes assists in the implementation of AI applications (Chatterjee and Bhattacharjee, 2020). Promotion of library's products and delivery of innovative services are the major factors influencing the implementation of AI in libraries (Shahzad et al., 2024a). AI adoption assists librarians in the provision of smart library services to end users (Shahzad et al., 2024c; Shahzad et al., 2024f; Shahzad and Khan, 2024).

Lack of organizational support is a major challenge for the adoption of artificial intelligence applications in libraries (Albergaria and Jabbourb, 2020). Resistance from librarians to accept change is a key challenge for the incorporation of AI applications in academic settings (Arlitsch and Newell, 2017). Skills and knowledge barriers, financial and resource constraints create challenges to adopt AI-based services in university libraries (Shahzad et al., 2024a). Loss of critical thinking, technical issues, lack of organizational planning, financial hurdles, fear of job loss, shortage of skilled manpower, and ethical considerations cause barriers to the successful implementation of AI applications in academic libraries (Shahzad et al., 2024b). Unavailability of sufficient financial resources is a leading challenge for the adoption and sustainability of AI applications in library settings (Maragno et al., 2023). Inadequate experts, and limited power supply are potential barriers for the employment of AI integrated library services (Ajani et al., 2022; Roy et al., 2022). AI based library services may be resource intensive and complex in nature and may not be easily managed by the working librarians (Ali et al., 2020). Ever-changing nature of technological advancements makes it difficult for librarians to sustain AI based library services (Gul and Bano, 2019). Loss of critical thinking of the library patrons and librarians is also associated with AI based services in libraries (Cox, 2021). Lack of AI literacy causes multiple challenges for librarians for the successful sustainability of AI applications in libraries (Cox and Mazumdar, 2024).

Literature review

Artificial intelligence (AI) applications are vastly used in academic setting to support learning and teaching activities (Nguyen et al., 2022). AI based robots prove fruitful for students, faculty members, research scholars, and university staff in context of administrative and teaching efficiency. Various supportive tasks are carried out by using AI powered tools in universities. AI applications provide potential benefits to university manpower in reducing workload and enhance organizational efficiency (Pence, 2022). For providing cutting-edge library services to library patrons, AI is a game-changer. It helps librarians to efficiently provide library technological services. The data gathered from users through AI-powered solutions allows university librarians to make better decisions (Harisanty et al., 2024).

Library users and researchers can get assistance with a variety of information and research-related needs with the help of AI apps. University academics find AI-based research tools to be advantageous. AI is

useful for keeping library books secure. The use of AI assistants allows for the provision of smart reference services. Semantic indexing has the potential to replace traditional indexing. Automated user data management allows policymakers to make educated judgments about launching smart library services (Schoeb et al., 2020). Effective data mining techniques are used to create innovative library services. Management of library staff can be carried out efficiently (Frederick, 2020). It may improve digital skills of the library staff (Randhawa and Jackson, 2020).

Artificial intelligence tools have a significant positive impact on library services. Different people have different perceptions about AI adoption in library settings. Some think that AI adoption creates more job opportunities while some think that AI reduces library jobs and causes unemployment for library staff (Nakhoda and Tajik, 2017). Hervieux and Wheatley (2021) concluded in their study that not all the libraries were applying artificial intelligence in their libraries due to the lack of awareness about its potential advantages. Most of the libraries did not use AI tools as they were not well skilled and well aware.

Factors of personal learning, collaborative environment, and intelligent support influence the adoption of AI in universities. Library users get a real time experience of using library products (Tella, 2020). Operational efficiency is increased through innovative data analysis, visualization, and preservation of library materials. AI assists in meeting organizational objectives. Smart user services are initiated. The adoption of AI assists in developing capabilities more effective even from human intelligence. Intelligent and expert library systems are adopted through AI based systems in university libraries (Wheatley and Hervieux, 2019). Human errors are reduced in AI systems. Librarians carry out routine operations of the libraries quickly. Users are recommended required educational materials (Cox et al., 2019). AI has positive impact on information retrieval methods (Vijaykumar and Sheshadri, 2019; Winkler and Kiszl, 2022).

The adoption of AI increases research contributions. Researchers produce quality research by using AI powered applications. Librarians can better facilitate research scholars for enabling them to complete research based projects. AI chatbots assist in the provision of correct reference answers to users' queries (Arora et al., 2020). Information literacy instruction programs can be designed according to need based expertise of the current age. Off campus virtual services may be initiated to support distant users (Zimmett, 2020). AI applications can also be connected with technical tasks of the academic libraries including acquisition, classification, and cataloging. Context based services may be offered to library users. Library material can be acquired keeping in view users' growing demands. Users' data may be saved for future use. Informed decision making may be done in light of evidence based data sets (Hussain and Shahid, 2022).

Developing AI-based solutions at university libraries is hindered by the availability of accurate data. Applications powered by AI also raise ethical questions. Third parties gain access to users' private information without their knowledge or consent. Another important obstacle is the lack of trained personnel to run AI-based systems (Ali et al., 2020; Yoon et al., 2022). AI driven library services may not be provided if high speed internet services are not available in universities. Internet connectivity is of great importance in the provision of quality AI services to facilitate the library patrons (Ajani et al., 2022). Developing countries may face problems in terms of data quality. Copyright issues are also attached with AI based systems in universities. Library may have limited access to their digital collections therefore full text access of the virtual library resources may not be extended through AI applications (Hervieux and Wheatley, 2021).

Cultural factors are also a barrier to adopt AI systems in universities. Local traditions affect the implementation of AI based technologies in educational institutions. Resistance to change is also a prominent cause that hinders the adoption of AI based applications in university libraries (Hussain, 2023). Library staff is not enough skilled to manage AI powered systems with convenience. They can't manage technical issues easily. They require technical issues to operate AI applications smoothly. They require specialized training to grab skills to manage AI systems in university libraries (Winkler and Kiszl, 2022). Strategic planning needs to be executed before the initiation of AI systems in universities. Research activities should be done to seek practical solutions for the success of AI based systems in universities. Networking infrastructure should be available in universities. Unreliable power supply causes obstacles to provide efficient AI based services to end users. Digital divide is also a prominent problem to get optimum advantages of AI based systems in university

libraries. Lack of collaborative environment in developing countries also causes problems for the successful adoption of AI systems in university libraries (Gasparini and Kautonen, 2022; Okunlaya et al., 2022).

Research gaps and the need for the systematic analysis

Artificial intelligence (AI) has changed the landscape of librarianship through its innovative applications. AI has significant positive impacts on libraries and librarians in the current age of consistent changes. It assists in the sustainable competence development of librarians for enabling them to implement user-centered-services to facilitate the library patrons. In the area of librarianship, various studies have been conducted in regards to AI tools however those studies measured the effects of AI on libraries and librarians by applying qualitative, quantitative, and mixed methods designs.

The current study identified the factors influencing the adoption of artificial intelligence applications (AI Apps) in libraries through systematic literature review methodology. Barriers associated with the implementation of AI Apps in library settings were also shown for offering evidence-based recommendations. The study collected data through 30 impact factor articles published in the world's reputed digital databases. The study centered to identify the factors stimulating the incorporation of AI tools in libraries for the provision of smart library services.

Ali et al. (2020) highlighted that in Pakistan, there was a low awareness of AI-based services among librarians. Their study recommended strategies for adopting artificial intelligence technologies in academic libraries in Pakistan, emphasizing the importance of collaboration between libraries and computer science departments to achieve successful AI integration. The findings showed the need for further research on AI outcomes in learning and library services. Asim et al. (2023) explored AI applications in Pakistani university libraries using an explanatory sequential mixed methods design. Their empirical investigation revealed that AI applications were not being fully utilized due to barriers such as insufficient financial resources, technical expertise, skilled manpower, organizational support, and IT infrastructure. The study recommended adopting AI-based applications to provide innovative library services to end users. Hussain (2023) examined the prospects and challenges of artificial intelligence in libraries. The study found that while AI can aid in designing innovative library services, funding and skill shortages posed significant challenges to its successful adoption. The study stressed the importance of assessing librarians' readiness to adopt AI-powered technologies for innovative learning experiences and smart library services. Various authors have previously emphasized the importance of conducting research through different methodologies to understand the effects of artificial intelligence on learning experiences and library services (Abayomi et al., 2021; Ajani et al., 2022; Barsha and Munshi, 2023; Huang, 2024; Jha, 2023; Shahzad et al., 2024a). This study was conducted to address the literature gaps identified by these investigators and to provide future directions for AI adoption in libraries.

The study has offered pertinent contributions by adding valuable literature in existing body of knowledge. It has identified the factors leading towards AI implementation in academic settings and associated barriers causing issues for its efficient employment in libraries. A framework has been developed based on the evidence-based datasets for the efficient implementation and sustainability of AI applications in library settings. It has recommended future studies for further exploration by other investigators. The study is a benchmark for the library management, policy-makers, management bodies, higher education bodies, AI apps developers, and all other stakeholders for sustainable adoption of artificial intelligence applications in libraries to address diverse needs of the end users. It is expected to deliver potential outcomes regarding innovative library services for potential library users.

Objectives of the study

The study's objectives are as follows:

- To identify the factors influencing the adoption of artificial intelligence applications (AI Apps) in library settings
- To determine the barriers associated with the implementation of AI Apps in libraries

Research questions

The study's research questions are as below:

RQ1. Which factors influence the adoption of artificial intelligence applications in libraries?

RQ2. Which barriers are associated with the implementation of AI Apps in libraries?

RQ3. What is an effective framework for the implementation and sustainability of AI Apps in library settings?

Methodology

"Preferred Reporting Items for the Systematic Review and Meta-Analysis" (PRISMA) were employed to carry out the study as a research methodology. Four steps are applied in PRISMA that are called identification, screening, eligibility, and inclusion. A four-phase flow chart is also displayed to show different steps applied in systematic literature review (SLR) based studies. The flow chart is shown for ensuring transparency and reproducibility of the review-based studies. It proves fruitful for tracking the flow of studies from identification to inclusion through a standardized and robust approach (Shahzad and Khan, 2024).

The focused research questions are shown in SLR based studies. The topic under investigation is explored systematically through the worldwide published studies. Through rigor eligibility criteria, the required studies are selected according to the pre-developed research questions. For avoiding any bias during the selection of the required studies, the validity-process is applied. For the interpretation of the findings, a thematic analysis is conducted (Shahzad et al., 2024d).

The research methodology of systematic literature review is used in several disciplines of knowledge including health sciences, information management, information technology, computer science, artificial intelligence, education, cyber security, law, psychology, political science, economics, media studies, global studies, archival studies, history, commerce and finance, digital communication, entrepreneurship, international relations, management studies, public policy, sociology, life sciences, and physical sciences. Several authors in past incorporated SLR in their investigations to offer a broader outlook. SLR based studies provide potential results, offer a holistic picture, valuable recommendations for policy-development and a baseline for the higher education and management bodies for evidence-based solutions of the existing problems effectively and efficiently (Shahzad et al., 2024e).

Systematic review-based investigations offer valuable benefits to researchers, readers, and policy makers. A structured approach is applied to synthesize extant literature published in available digital databases worldwide. Future studies are also recommended for the convenience of the future investigators. The validity and reliability of the research results increases through an in-depth analysis of various studies on the topic under investigations through SLR technique. Evidence-based information assists policy makers to employ policies for the efficient adoption of emerging technological tools across several disciplines (Iqbal et al., 2023).

The approach of SLR provides guidelines to researchers, practitioners, and decision-making personalities for making informed decisions in light of authentic information extracted through a huge variety of datasets. Based on the findings inferred through SLR based technique, existing systems and services of the organizations are refined to facilitate the end users. Social systems are improved through the impactful findings of the studies based on SLR based approach. The technique of SLR assists in sustaining replicability and transparency of the studies. It supports in advancing knowledge through the identification of existing patterns and providing future directions (Khan et al., 2022).

The current study employed SLR methodology due to its various benefits and impactful outcomes. The nature of the study also required this methodology for the delivery of potential outcomes. There are four stages that are applied in the studies based on SLR. These are called planning, selection, extraction, and execution. Each stage is supported by several sub- stages. These stages are elaborated as follows alternately:

Stage 1: planning

1) *Research questions*

The study's research questions cover the specific criterial that include the factors influencing the adoption of artificial intelligence applications (AI Apps) in libraries and associated barriers with the implementation of AI Apps in libraries. These research questions may be addressed systematically.

2) *Search strategy*

Several strategies and techniques were employed to search the extant literature published. These techniques and strategies are described as follows:

a: Search terms

Through pre-developed criteria and methods, different search terms were devised. Table 1 shows the search strategies that were incorporated to extract the required literature from worldwide published literature.

Different techniques were applied to search required research articles from the worldwide published literature. The following keywords and phrases were used to locate the seminal studies related to the topic under investigation:

Table 1. Search strategies to search relevant literature.

Sr. No.	Search strategies to extract required literature
1.	Finding the most common themes from the study's research questions
2.	List of possible alternative spellings
3.	Usage of keywords from the title of the article as a major strategy during the literature search
4.	Construction of general key research question of the study
5.	Selection of keywords from the study's objectives showing directions of the research
6.	Incorporation of keywords used by other authors in their similar studies
7.	Development of a list of synonyms for further searching
8.	Employment of the Boolean operator "AND" to narrow search results by requiring both terms to be present
9.	Usage of Boolean operator "OR" to broaden search results by retrieving documents that contain either of the terms or both
10.	Incorporation of Boolean operator "NOT" to retrieve required records and to exclude irrelevant material

("Artificial intelligence in libraries" OR "Factors influencing AI in libraries" OR "AI adoption in libraries" OR "Impact of AI on library services" OR "Effects of AI on librarians") "Challenges to adopt AI applications in libraries")

AND

("AI based library services" OR "Awareness of AI in libraries" OR "AI implementation in libraries" OR "Perceptions of adopting AI" OR "AI innovations in libraries" OR "Applications of AI in libraries" OR "AI in library settings" OR "Transformative journey of libraries" OR "AI in library services" OR "AI acceptance in libraries" OR "AI in library operations" OR "Automatic library services" OR "AI for integrated services" OR "AI based library management" OR "Effects of AI in libraries" OR "AI for smart libraries" OR "AI for innovation" OR "AI based opportunities for librarians" OR "Librarians' readiness to adopt AI" OR "Leveraging AI in libraries" OR "Perspectives of librarians about AI" OR "AI for professional development" OR "AI as game changer for libraries" OR "AI for librarians" OR "Impact of AI tools on libraries and librarians"

b: Literature resources and existing research

Google Scholar and 13 different electronic databases were used for searching articles on the factors influencing the adoption of AI applications in libraries. The electronic databases included LISA, LISTA, Web of Science, Computer Index Australia (CIA), Scopus, ERIC, ProQuest, EBSCO Host, Emerald, Wiley Inter Science, Association of Computing Machinery (ACM), Science Direct and IEEE Xplore. Research papers published in impact factor journals were considered for inclusion. For locating the maximum available articles on the topic, Index terms were used. For finding narrow results, different filters were applied through advanced search options. The research team retrieved relevant documents studies from their different working universities to avoid any search bias. The required research papers were located by fixing the years range from 2015 to 2024.

Required studies were explored on the factors influencing the adoption of AI apps in libraries and the associated barriers to implement AI applications in libraries. Different keywords were used to retrieve maximum required studies having alignment with the study's objectives. Phrase search option was also used to avoid any irrelevant documents for ensuring the authenticity of the retrieved literature. The most relevant core studies published in Web of Science indexed journals were selected. Only the latest impact factor articles were included to carry out the study using the SLR methodology.

Stage 2: selection

1) *Search process*

The relevant studies are retrieved from the worldwide published literature in SLR based investigations. Figure 1 displays four phase PRISMA diagram of the search process.

Step 1: Google Scholar and 13 electronic databases were explored to search research articles published in world's reputed journals having an impact factor score.

Step 2: The searched documents were sorted, duplications were excluded, and irrelevant studies were skipped. Titles of the retrieved documents were observed carefully to ensure relevancy. To match the shortlisted sorted articles having an integration with the study's research questions, quality and assessment criteria were used.

3) *Scrutiny and filtering*

3984 explored manuscripts shown through Figure 1 were filtered to ensure relevancy and precision. This

process included careful observation of the titles of selected articles, type of the articles, language, content, journal type, journal impact factor, and journal scope for the inclusion of the most relevant articles to conduct the study. Table 2 shows inclusion and exclusion criteria that was adopted to include and exclude the studies.

Stage 3: extraction

The method of scorekeeping was used for the explored documents keeping in view the pre-developed questions. A checklist was constructed for checking quality of the studies. The retrieved articles were allocated a score having relevancy with specific categories. The score mapping was based on the options of 'yes', 'no', 'partially' and 'not at all'. The studies meeting the specific criteria were given a score. The documents required a sufficient quantity of the score for the inclusion in the current study. This process assisted in selecting the most relevant seminal studies for conducting the systematic literature review on the factors influencing the adoption of AI apps in libraries. Table 3 illustrates the checklist that was applied for mapping quality of the studies.

Stage 4: execution

The final phase was to ensure validity of the explored studies. The list was tallied against the pre-set eligibility criteria. Only the articles published in Web of Science Indexed journals were considered for inclusion in the study. A critical and careful evaluation was applied to include the most relevant core research papers. Finally, 30 research papers meeting all requirements were included in the list to conduct the SLR on the factors influencing the adoption of AI apps in libraries.

The selected articles for the systematic review (n = 30) were indexed in Web of Science Journals. The findings published in impact factor articles are considered robust and authentic. Keeping in view the credibility, novelty, and authenticity of the Web of Science Indexed journals, only impact factor articles having an alignment with the study's objectives were selected to conduct the systematic literature review (SLR) on the topic. 30 articles are sufficient to carry out studies based on the SLR methodology. In past, many authors conducted SLR based studies having selected 15 to 25 articles. In this context, 30 articles published in impact factor journals were considered sufficient to conduct the current study.

Figure 1 shows the search process explicitly. It reveals that initially 3984 studies were retrieved through 13 different electronic databases and Google Scholar engine. 1378 studies were skipped as they did not match the eligibility criteria. 254 studies were withdrawn on account of duplications. 741 studies were eliminated through the process of the screening of titles and abstracts of the studies. 17 articles were removed for not being published in English language. 493 studies were eliminated through the process of evaluation. Additionally, 1071 articles were not selected as those were not relevant. Finally, the 30 most relevant seminal articles having either an impact factor score were selected to conduct the study.

Results

An overview of the selected studies

Table 4 displays an overview of the extracted datasets. It shows information about the authors, publishing years of the studies, countries of the studies' contributors, and titles of the journals of the published articles. In case of more than one author, the affiliated place of the first author has been mentioned. The table also mentions information about the key variables of the study. It identifies factors influencing the adoption of artificial intelligence applications in libraries, and barriers to adopt AI Apps in library settings.

Factors influencing the adoption of artificial intelligence apps in libraries

The study identified four major categories of factors influencing the adoption of artificial intelligence apps in libraries. These factors are transformation of library services, provision of innovative services, librarians and users' satisfaction, and technological revolution. These themes are interpreted as follows:

Transformation of library services

Artificial intelligence assists in the transformation of library services (Adarkwah et al., 2024). Refined library services are delivered to end users through AI apps effectively and efficiently (Arlitsch and Newell, 2017). Security of the library material is ensured and intelligent data analysis is done for collection management (Asim et al., 2023). AI technologies, such as machine learning and deep learning, have the potential to significantly enhance library information systems, making them more efficient in handling

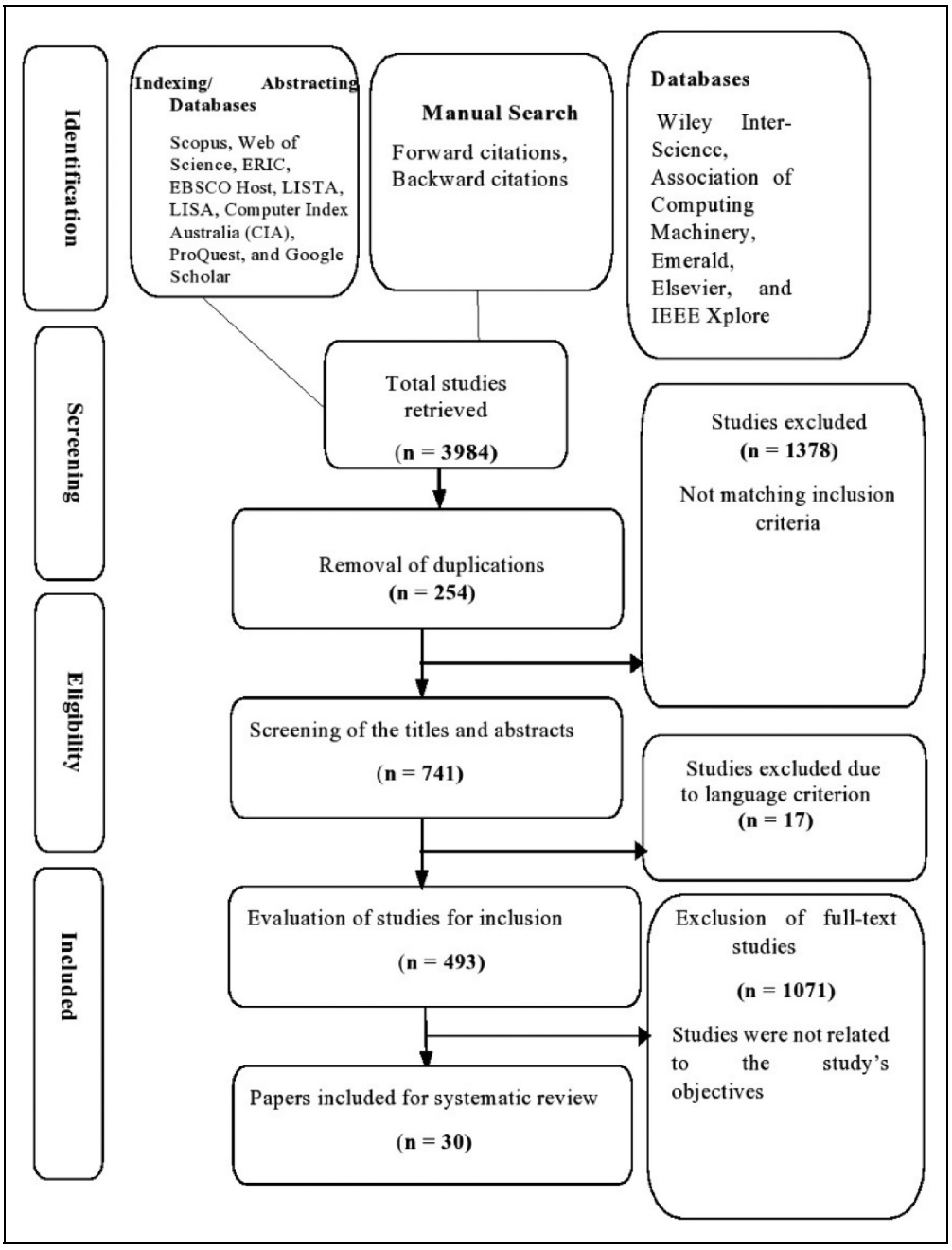

Figure 1. Four-phase PRISMA flow diagram.

large datasets and complex information tasks (Borgohain et al., 2024). Accurate decisions making, semantic library services, smooth functioning of libraries, and effective collection management are done through the implementation of AI apps in library settings (Chatterjee and Bhattacharjee, 2020; Cox and Mazumdar, 2024; Hervieux and Wheatley, 2021; Nguyen et al., 2019; Pan and Xue, 2023).

Creativity in library operations, open access information services, context awareness services, creative library system, state of the art library services are delivered through AI apps (Maragno et al., 2023; Noh, 2015). AI technologies can help libraries modernize their services, enhancing university research and learning by integrating digital innovations (Okunlaya et al., 2022). Alignment of library services with the fourth industrial revolution (4IR), personalized services, and transformational leadership are key factors that influence the adoption of AI apps in libraries (Shahzad et al., 2024a, 2024b; Shal et al., 2024).

Table 2. Inclusion and exclusion criteria.

Sr. No.	Inclusion criteria	Exclusion criteria
1	Research papers published in the English language	Research papers not published in the English language
2	Articles covering research questions of the study	Articles not matching with the study's objectives
3	Research papers published from January 1, 2015 to June 1, 2024	Research papers published before 2015
4	Papers covering key constructs of the study. These documents were related to the factors influencing the adoption of AI applications in libraries, and the challenges to adopt AI apps in libraries.	Articles not covering key variables of the study
5	Only peer-reviewed research papers	Conference proceedings, grey literature, dissertations, books, book chapters, magazines articles, institutional reports, newspaper articles, and institutional newsletters etc.
6	Web of Science indexed studies	Studies not indexed in Web of Science Databases
7	Selection of seminal research papers having originality, influence, and citation impact	Articles not having impact factor
8	Research papers published in the world's renowned electronic databases and Google Scholar i.e., LISTA, LISA, Web of Science, EBSCO Host, Scopus, Computer Index Australia (CIA), ProQuest, ERIC, Wiley Inter Science, Emerald, Association of Computing Machinery (ACM), IEEE Xplore, and Science Direct	Articles published in institutional repositories, social networking websites, blogs, and search engines
9	Articles covering at least one study's objective	Articles not covering any research objectives
10	Articles matching with the study's topic	Articles not matching with study's topic

Table 3. Checklist for mapping quality of the studies.

QA ID	Checklist questions
QA 1	Is the study's topic relevant?
QA 2	Are the study's objectives clearly developed?
QA 3	How research questions are constructed?
QA 4	Is problem statement adequately elaborated?
QA 5	Does adequate relevant literature exist?
QA 6	Is the research methodology appropriate?
QA 7	Is an appropriate population available?
QA 8	Has an adequate sample size been taken?
QA 9	Are suitable data collection tools have been applied?
QA 10	Does an adequate response rate exist?
QA 11	How the gathered data were coded and analyzed?
QA 12	Are reasonable findings elaborated?
QA 13	Is there similarity between topic, objectives, introduction, problem statement, literature review, methodology and findings?
QA 14	Are theoretical, practical, and social implications available?
QA 15	Is the research information useful for extensive academic research?

Note: Yes = 1, Partially = 0.5, No = 0.5, Not at all = 0

Provision of innovative services

Provision of innovative services is an important factor influencing the adoption of artificial intelligence applications in libraries (Adarkwah et al., 2024). Service innovation, provision of smart library services, revolution in library services, and creativity in routine operations of the libraries encourage librarians to adopt AI apps in libraries (Ajani et al., 2022; Chatterjee and Bhattacharjee, 2020; Cox, 2021; Harisanty et al., 2024; Hervieux and Wheatley, 2021; Huang et al., 2023; Kim

Table 4. Data extracted from 30 research papers.

S.N.	Author	Year	Country	Journal	Factors influencing the adoption of AI apps in libraries	Barriers to adopt AI in libraries
1.	Adarkwah et al.	2024	Germany	The Journal of Academic Librarianship	1. Transformation of library services 2. Provision of innovative services 3. Librarians and users' satisfaction 4. Efficient work output	1. Poor internet access 2. Lack of technological skills 3. Infrastructure difficulties 4)Insufficient funding 4. Poor digitization policies
2.	Ajani et al.	2022	Nigeria	Internet Reference Services Quarterly	1. Service innovation 2. Personal interest 3. Technology revolution	1. Problem of funding 2. Inadequate experts 3. Limited power supply 4. Limited budget to procure the technology and training personnel that will be in charge of the system maintenance.
3.	Albergariaa and Jabbourb	2020	Brazil	International Journal of Information Management	1. Collaboration 2. Organizational support 3. Motivation 4. Innovative attitude	1. Funding issues 2. Skills problems 3. Strategic vision 4. Traditional approaches
4.	Ali et al.	2024	Pakistan	Global Knowledge, Memory and Communication	AI could help their libraries deliver more innovative services and better meet user needs.	Concern about the investment required in funding, time and staff
5.	Arlitsch and Newell	2017	USA	Journal of Library Administration	1. Refined library services 2. User satisfaction 3. Innovation	1. Lack of IT skilled staff 2. Nature of fast happening changes in IT 3. Sustainability 4. Integration issues
6.	Asim et al.	2023	Pakistan	The Journal of Academic Librarianship	1. Security of library material 2. Intelligent data analysis for collection management.	1. Lack of budget 2. High cost of AI technologies 3. lack of staff expertise
7.	Borgohain et al.	2024	India	Library Hi Tech	1. Potential for System Improvement: AI	Resource and Expertise Gaps: The integration

(continued)

Table 4. (continued)

S.N.	Author	Year	Country	Journal	Factors influencing the adoption of AI apps in libraries	Barriers to adopt AI in libraries
					technologies, such as machine learning and deep learning, have the potential to significantly enhance library information systems, making them more efficient in handling large datasets and complex information tasks. 2. Research Growth: Although AI research in libraries is limited compared to other fields like medicine and agriculture, its exponential growth, as shown by the Price law, suggests increasing interest and future expansion in this area.	of AI technologies requires specialized knowledge in areas like machine learning and large datasets, which libraries may currently lack, making implementation challenging.
8.	Chatterjee and Bhattacharjee	2020	India	Education and Information Technologies	1. Emergence of IT innovations 2. Refined library services 3. Accurate decisions making 4. Provision of smart library services	1. Technical hurdles 2. IT skills issues 3. Traditional work approaches
9.	Cox	2021	UK	Journal of Association of Information Science Technology	1. Work support 2. Innovation 3. Technology revolution 4. Digital revolution	1. Technical limitations 2. Lack of financial resources 3. Resistance to change
10.	Cox and Mazumdar	2024	UK	Journal of Librarianship and Information Science	1. Semantic library services 2. Informed decision making 3. Effective collection management	There could be some negative impacts on equality, diversity and inclusion if AI skills are not spread widely.
11.	Gul and Bano	2019	India	The Electronic Library	1. Libraries are becoming smarter, which enhances their working capabilities and satisfies the users. 2. Implementing the smart technologies in the libraries has bridged the gap between	1. Technical hurdles 2. Traditional approaches by librarians 3. Sustainability challenges

(continued)

Table 4. (continued)

S.N.	Author	Year	Country	Journal	Factors influencing the adoption of AI apps in libraries	Barriers to adopt AI in libraries
					the services offered by the libraries and the rapidly changing and competing needs of the humans.	
12.	Harisanty et al.	2024	Indonesia	Library Hi Tech	Librarians provide innovative library services to end users.	Competency and Skill Development: The need for specific competencies to support AI, including librarian training and development, is identified as a key factor influencing successful AI implementation. Infrastructure and Facilities: Proper facilities and technology infrastructure are crucial to support the integration of AI applications in libraries, enabling effective deployment and use.
13.	Hervieux and Wheatley	2021	Canada	The Journal of Academic Librarianship	1. Smooth functioning of the libraries 2. Work support to librarians 3. Deliver of innovative library services	1. Lack of training opportunities 2. Traditional mind setup 3. Unavailability of organizational support
14.	Huang	2024	Taiwan	Library Hi Tech	Positive Attitude and Support: Librarians recognize that AI applications are inevitable, and a generally positive attitude among librarians supports their adoption, especially with sufficient organizational backing.	Technological Problems: Issues related to the technological aspects of implementing AI, such as system compatibility or integration challenges, serve as significant impediments to AI adoption. Execution Difficulties: Even though librarians are aware of the potential benefits of AI, the practical difficulties in executing and managing AI projects have hampered the pace of adoption.
15.	Huang et al.	2023	China	The Journal of Academic Librarianship	1. Smart library services 2. Service innovation	1. Technical hurdles 2. Unavailability of skilled staff
16.	Kim and MacKinnon	2018	UK	Clinical Radiology	Innovation	Technical problems

(continued)

Table 4. (continued)

S.N.	Author	Year	Country	Journal	Factors influencing the adoption of AI apps in libraries	Barriers to adopt AI in libraries
17.	Maragno et al.	2023	Italy	International Journal of Information Management	1. Perceived ease of use 2. Behavioral intention 3. Work support 4. Creativity in library operations	1. Integration challenges 2. Technical hurdles 3. Sustainability issues
18.	Ng et al.	2021	Hong Kong	Computers and Education: Artificial Intelligence	1. Revolution in library services 2. Innovative reference services 3. General convenience 4. Changing nature of IT tools 5. Smart library users	1. Technical concerns 2. Competency issues 3. Unavailability of organizational support 4. Traditional attitude of librarians
19.	Nguyen et al.	2019	Slovakia	Artificial Intelligence Review	1. Informed decision making 2. Effective collection management 3. Delivery of smart library services 4. Efficient work support to librarians	1. Compatibility issues 2. Integration challenges 3. Privacy threats 4. Dependence on machines
20.	Noh	2015	South Korea	The Journal of Academic Librarianship	1. Innovative library services 2. Open access information services 3. Context awareness services 4. Creative library systems 5. State of the art library services	1. Lack of librarians' interest 2. Unavailability of motivation 3. Personal priorities 4. Traditional environment
21.	Okunlaya et al.	2022	Malaysia	Library Hi Tech	1. Support for Digital Transformation: AI technologies can help libraries modernize their services, enhancing university research and learning by integrating digital innovations. 2. Re-invention of Skills and Competencies: AI will encourage library professionals to acquire new skills, enabling them to meet both current and future user needs and	1. Skills and Competency Gaps: Library staff may lack the necessary expertise and skills to effectively implement and use AI technologies. 2. Challenges in Adapting to Digital Transformation: Navigating the complexities of digital transformation can be challenging, creating resistance or difficulties in fully adopting AI technologies within the organization.

(continued)

Table 4. (continued)

S.N.	Author	Year	Country	Journal	Factors influencing the adoption of AI apps in libraries	Barriers to adopt AI in libraries
					contribute to a meaningful digital transformation.	
22.	Pan and Xue	2023	China	IEEE Access	1. Assistance in informed decision making 2. Innovative services to end users	Technical issues
23.	Roy et al.	2022	India	IEEE Access	1. Innovation in library services 2. Smart library services 3. Work support to librarians	1. Technical challenges 2. Skills issues 3. Resistance to change
24.	Shahzad and Khan	2024	Pakistan	The Electronic Library	Support in initiating smart library services to deliver customer-focused services	Shortage of skilled manpower, the unavailability of adequate IT infrastructure, a lack of technical support, copyright issues, poor planning and ineffective library leadership are major challenges.
25.	Shahzad et al. *(a)*	2024	Pakistan	Global Knowledge Memory and Communication	1. Innovative library services 2. Alignment of library services with the fourth industrial revolution (4IR) 3. Collection management and user services 4. Transformation of library Systems	1. Skills and knowledge barriers 2. Financial and resource constraints 3. Resistance to change
26.	Shahzad et al. *(f)*	2024	Pakistan	Global Knowledge Memory and Communication	1. The adoption of AI enhances innovative learning. 2. AI adoption assists librarians in the provision of smart library services to end users.	1. Technical limitations 2. Lack of IT skilled staff 3. Unavailability of organizational cooperation
27.	Shahzad et al. *(b)*	2024	Pakistan	Journal of Librarianship and Information Science	1. Innovation 2. Advancements in artificial intelligence 3. Library security 4. Personalized services	1. Loss of critical thinking 2. Technical issues 3. Lack of organizational Planning 4. Financial hurdles

(continued)

Table 4. (continued)

S.N.	Author	Year	Country	Journal	Factors influencing the adoption of AI apps in libraries	Barriers to adopt AI in libraries
						5. Fear of job loss 6. Shortage of skilled manpower 7. Ethical considerations
28.	Shahzad et al. *(c)*	2024	Pakistan	Global Knowledge Memory and Communication	1. Implementation of smart library services 2. Innovation 3. Sustainable competence development	1. Financial resources limitations 2. Traditional mind setup 3. Unavailability of organizational cooperation
29.	Shal et al.	2024	Qatar	The Journal of Academic Librarianship	1. Transformational leadership 2. Fast happening IT changes 3. Service innovation	1. Professional training issues 2. Lack of IT skilled staff 3. Traditional approaches 4. Funding barriers
30.	Yoon et al.	2022	Korea	Library Hi Tech	Perceived Usefulness of Technology	Lack of Sufficient Knowledge: Only 45% of librarians feel they have sufficient knowledge to adopt AI technologies, indicating a gap in understanding that can hinder widespread AI adoption. Fear of Job Loss and Role Changes: Librarians express concerns about AI potentially replacing their current roles and functions, which creates anxiety and resistance to adopting AI applications in libraries.

and MacKinnon, 2018; Ng et al., 2021; Nguyen et al., 2019; Noh, 2015; Pan and Xue, 2023; Roy et al., 2022; Shahzad et al., 2024a, 2024c, 2024f). AI can help their libraries deliver more innovative services and better meet user needs (Ali et al., 2024).

Librarians and users' satisfaction

Librarians and users' satisfaction, efficient work output, personal interest, collaboration, organizational support, motivation, and innovative attitude influence librarians to adopt AI apps in libraries (Adarkwah et al., 2024; Ajani et al., 2022; Albergaria and Jabbourb, 2020; Arlitsch and Newell, 2017). Librarians recognize that AI applications are inevitable, and a generally positive attitude among librarians supports their adoption, especially with sufficient organizational backing (Cox, 2021; Hervieux and Wheatley, 2021; Huang, 2024). Libraries are becoming smarter, which enhances their working capabilities and satisfies the users. Implementing the smart technologies in the libraries has bridged the gap between the services offered by the libraries and the rapidly changing and competing needs of the humans (Gul and Bano, 2019; Maragno et al., 2023; Nguyen et al., 2019). AI encourages library professionals to acquire new skills, enabling them to meet both current and future user needs and contribute to a meaningful digital transformation (Okunlaya et al., 2022; Roy et al., 2022; Shahzad et al., 2024c).

Technological revolution

Technology revolution is a key factor to influence the adoption of artificial intelligence applications in library to facilitate the library patrons (Ajani et al., 2022). Digital revolution encourages library professionals to implement AI tools in libraries to satisfy diverse needs of the end users (Cox, 2021). Changing nature of IT tools is a major influencer that causes the adoption of AI apps in libraries (Noh, 2015). Fast happening IT changes stimulate practicing librarians to adopt AI apps to keep pace with the trending technological tools to play an active role in the current age of AI to cater different needs of the library community (Shal et al., 2024).

Figure 2 displays the factors influencing the adoption of artificial intelligence applications in libraries.

Barriers associated with the adoption of AI apps in libraries

The study identified four major barriers to adopt artificial intelligence applications in libraries. These challenges include technological challenges, skills and knowledge barriers, financial challenges, and organizational and cultural barriers. These are detailed as follows simultaneously:

Technological challenges

Poor internet access, limited power supply, and integration issues are key barriers to adopt AI apps in libraries (Adarkwah et al., 2024; Ajani et al., 2022; Arlitsch and Newell, 2017). Technical limitations, technical hurdles, and integration challenges cause problems for the successful implementation of AI apps in library settings (Cox, 2021; Gul and Bano, 2019; Huang et al., 2023; Kim and MacKinnon, 2018). Issues related to the technological aspects of implementing AI, such as system compatibility or integration challenges, serve as significant impediments to AI adoption. Even though librarians are aware of the potential benefits of AI, the practical difficulties in executing and managing AI projects have hampered the pace of adoption (Huang, 2024; Ng et al., 2021). Compatibility issues, integration challenges, and technical issues are associated with the successful adoption of AI apps in library environment (Nguyen et al., 2019; Okunlaya et al., 2022; Pan and Xue, 2023; Roy et al., 2022; Shahzad et al., 2024b, 2024f).

Skills and knowledge barriers

Lack of technological skills, inadequate experts, skills problems, and lack of IT skilled staff cause problems for the adoption of AI apps in library settings (Adarkwah et al., 2024; Ajani et al., 2022; Albergaria and Jabbourb, 2020; Arlitsch and Newell, 2017; Asim et al., 2023). The integration of AI technologies requires specialized knowledge in areas like machine learning and large datasets, which libraries may currently lack, making implementation challenging (Borgohain et al., 2024; Chatterjee and Bhattacharjee, 2020). The need for specific competencies to support AI, including librarian training and development, is identified as a key factor influencing successful AI implementation (Harisanty et al., 2024). Unavailability of skilled staff, competency issues, and shortage of trained IT staff are key challenges for the adoption of AI tools in academic settings (Huang et al., 2023; Ng et al., 2021; Shal et al., 2024). Library staff may lack the necessary expertise and skills to effectively implement and use AI technologies. Navigating the complexities of digital transformation

can be challenging, creating resistance or difficulties in fully adopting AI technologies within the organization (Okunlaya et al., 2022; Roy et al., 2022). Shortage of skilled manpower, the unavailability of adequate IT infrastructure, a lack of technical support, copyright issues, poor planning and ineffective library leadership are major challenges (Shahzad et al., 2024a, 2024b, 2024f; Shahzad and Khan, 2024).

Financial challenges

Infrastructure difficulties, insufficient funding, limited budget, funding issues cause hurdles for the adoption of AI apps in libraries (Adarkwah et al., 2024; Ajani et al., 2022; Albergaria and Jabbourb, 2020; Ali et al., 2024). Lack of budget, high cost of AI technologies, lack of financial resources, sustainability, and resource constraints are key challenges to adopt AI apps in academic settings to support information and research needs of the library patrons efficiently (Asim et al., 2023; Harisanty et al., 2024; Shahzad et al., 2024b, 2024c, 2024f; Shal et al., 2024).

Organizational and cultural barriers

Lack of librarians' interest, unavailability of motivation, personal priorities, traditional environment, traditional approaches by librarians, privacy threats, and dependence on machines create problems for AI adoption in libraries (Gul and Bano, 2019; Nguyen et al., 2019; Noh, 2015). Strategic vision, traditional approaches, technical hurdles, traditional work approaches, and resistance to change cause barriers for the implementation of AI in library environment (Albergaria and Jabbourb, 2020; Chatterjee and Bhattacharjee, 2020; Cox, 2021; Roy et al., 2022; Shahzad et al., 2024a). Unavailability of organizational support, traditional attitude of librarians, lack of training opportunities, traditional mind setup, unavailability of organizational support fear of job loss and role changes cause barriers for the successful adoption of AI tools in libraries (Hervieux and Wheatley, 2021; Ng et al., 2021; Shahzad et al., 2024c; Yoon et al., 2022). There may be some negative impacts on equality, diversity and inclusion if AI skills are not spread widely (Cox and Mazumdar, 2024). Poor digitization policies, unavailability of organizational cooperation, professional training issues, and traditional approaches are key challenges to adopt AI (Adarkwah et al., 2024; Shahzad et al., 2024f; Shal et al., 2024). Loss of critical thinking, lack of organizational planning, fear of job loss, and ethical considerations cause problems for the successful implementation of AI apps in library settings (Shahzad et al., 2024b).

Discussion

Artificial intelligence (AI) is revolutionizing various sectors by automating tasks, enhancing decision-making processes, and improving efficiency. Overall, AI contributes significantly to advancements in industries like healthcare, finance, education, and more by providing insights from data, enabling personalized experiences, and optimizing operations. In library settings, AI transforms how information is managed, accessed, and delivered. AI tools can streamline cataloging, enhance search capabilities through natural language processing, and offer personalized recommendations to users. AI-driven systems can help libraries analyze user behavior, optimize resource allocation, and provide virtual assistance, ultimately improving the quality and accessibility of library services. The adoption of AI applications in library settings brings various innovative changes to support users effectively and efficiently.

The first objective of the study was to identify the factors influencing the adoption of AI applications in library settings. Findings of the study revealed that artificial intelligence proves highly fruitful in the automation of processes by streamlining repetitive and time-consuming tasks in libraries. Automatic library services influenced the adoption of AI applications in libraries. AI-powered systems can automate cataloging by accurately tagging, classifying, and indexing large volumes of resources without manual intervention. This reduces errors and speeds up the process of making new materials available to users. AI can also automate user interactions through virtual assistants or chatbots, offering real-time responses to inquiries and guiding users in navigating databases or finding resources. AI-driven automation in data management allows libraries to efficiently process, analyze, and organize vast datasets, enabling better decision-making on resource allocation and service enhancements. Overall, AI's ability to take over routine tasks leads to improved productivity, operational cost savings, and enhanced user experience in libraries. Librarians find work support due to the adoption of AI applications in libraries. They provide user focused services innovatively so delivery of automatic tasks influences the adoption of AI apps in libraries. These

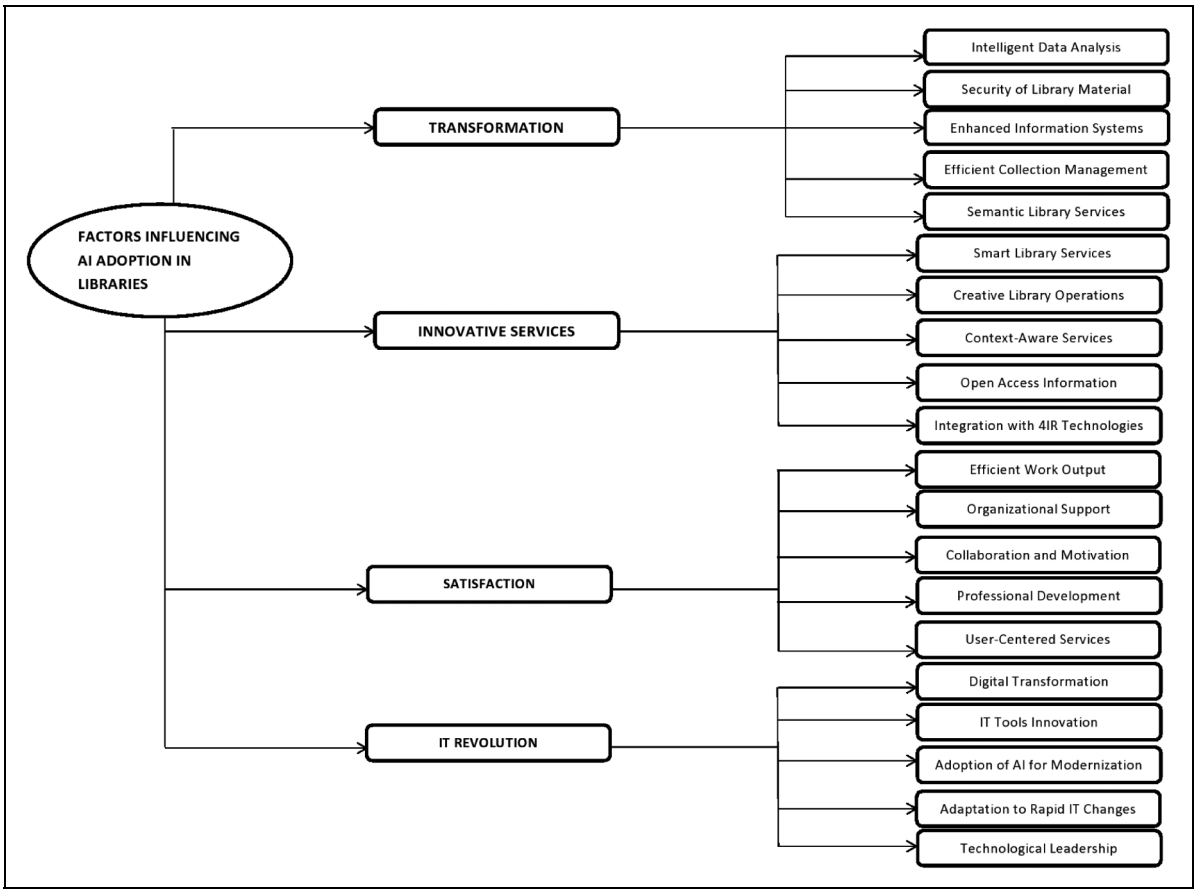

Figure 2. Factors influencing the adoption of AI apps in libraries.

results are similar to the findings of the studies conducted by Adarkwah et al., 2024; Arlitsch and Newell, 2017; Asim et al., 2023; Borgohain et al., 2024; Nguyen et al., 2019; Chatterjee and Bhattacharjee, 2020; Hervieux and Wheatley, 2021; Cox and Mazumdar, 2024; Pan and Xue, 2023; Noh, 2015; Maragno et al., 2023; Okunlaya et al., 2022; and Shal et al., 2024.

Artificial intelligence (AI) proves beneficial in delivering creative library services by enabling personalized, interactive, and dynamic experiences for end users. Personalized services to end users is an important factor that encourages librarians to adopt AI apps in their libraries. Through advanced algorithms, AI can analyze users' preferences, reading habits, and search behaviors to provide tailored recommendations. AI-driven recommendation systems can suggest books, articles, or digital resources aligned with users' interests. Additionally, AI-powered tools like virtual reference assistants or chatbots allow users to interact with library systems 24/7, asking questions, accessing information, or getting reading suggestions without human intervention. AI also enhances access to digital archives by using machine learning techniques to improve the discoverability of rare or historical documents for making library collections more accessible to a broader audience. These creative AI-enabled services elevate the user experience by offering personalized, efficient, and flexible engagement with library resources. Library patrons feel immense joy when they are provided their preferred information resources through automatic methods. Similar findings were reported by Adarkwah et al., 2024; Noh, 2015; Kim and MacKinnon, 2018; Nguyen et al., 2019; Chatterjee and Bhattacharjee, 2020; Cox, 2021; Hervieux and Wheatley, 2021; Ng et al., 2021; Ajani et al., 2022; Ali et al., 2024; Roy et al., 2022; Huang et al., 2023; Pan and Xue, 2023; and Harisanty et al., 2024.

The second objective of the study was to reveal the challenges for the adoption of AI apps in libraries. Results of the study revealed that lack of technical expertise causes a significant challenge for librarians in adopting artificial intelligence (AI) applications in libraries. Technical skills are essential to manage AI based operations in libraries. Most librarians are

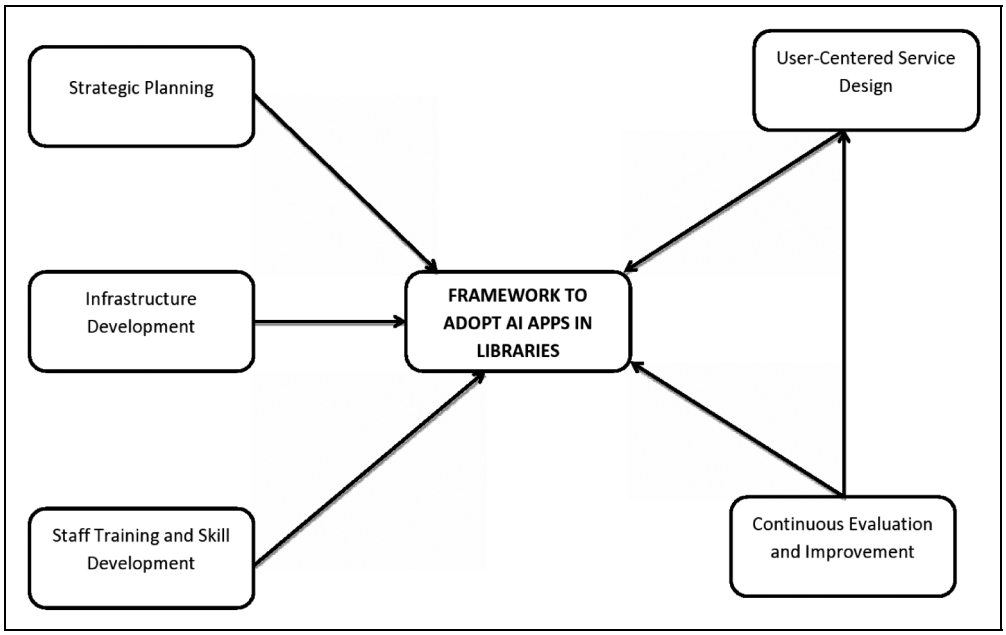

Figure 3. Framework for the adoption of AI apps in library settings.

trained in traditional library sciences, focusing on cataloging, information management, and user services, rather than on advanced technological tools like AI. Without the necessary technical expertise, librarians may not understand the functionality of AI applications, from integrating them into existing library systems to troubleshooting issues. This gap in knowledge creates barriers in several key areas, including decision-making, system management, and effective use of AI technologies. Without an adequate understanding of AI technology, librarians may find it difficult to make informed choices about the capabilities, limitations, and long-term viability of specific AI tools. Moreover, once AI systems are in place, maintaining them becomes another hurdle. AI tools often require ongoing updates, monitoring, and configuration adjustments to function optimally. Inadequate technical expertise leaves librarians dependent on external IT support or vendors, which can be both costly and slow. Librarians also face challenges in training and educating both staff and users on how to use AI-enhanced services effectively. Without deep technical knowledge, they may find it difficult to guide users in leveraging AI-powered search tools. Librarians need to be provided technical knowledge and skills to efficiently manage AI based library services. These findings are related to the findings of the studies conducted by Arlitsch and Newell, 2017; Ajani et al., 2022; Adarkwah et al., 2024; Kim and MacKinnon, 2018; Gul and Bano, 2019; Cox, 2021; Huang et al., 2023; Ng et al., 2021; Huang, 2024; Nguyen et al., 2019; Okunlaya et al., 2022; Roy et al., 2022; and Pan and Xue, 2023.

Figure 3 shows the framework for the adoption of artificial intelligence applications in library settings.

The framework integrates strategic planning, infrastructure development, staff training and skill development, user-centered service design, and continuous evaluation and improvement to effectively implement AI applications in library environment. Strategic planning is essential to adopt AI applications in library settings. Without an adequate planning, AI applications may not be efficiently implemented and sustained for the attainment of valuable outcomes. Required infrastructure is highly essential for the successful adoption of AI based operations in libraries. Without the availability of required infrastructure, sustainability of AI applications is a prominent challenge in academic settings for the provision of innovative library services to end users. Staff training is essential for the success of AI based activities in libraries. Continuing professional development (CPD) opportunities should be provided to the practicing librarians for tackling issues related to AI. AI based systems should be user centered to satisfy diverse needs of the library users. Continuous evaluation should be ensured for efficiently implementing and sustaining AI applications in library environment.

Limitations and future research

1. The research team searched and explored literature through electronic databases and Google Scholar to conduct a systematic literature review for identifying the factors influencing the adoption of artificial intelligence applications in library settings. Institutional repositories, Lib guides, blog posts, educational websites, etc. were not used. Future researchers may also search literature through these sources of knowledge to offer a broader outlook.
2. We selected only impact factor articles to conduct the study. Other types of information resources i.e., books, book chapters, conference proceedings, dissertations, etc. were not included. Future investigators may consider the inclusion of these types of knowledge resources to conduct a study on the impact of augmented reality in university libraries.
3. The current investigation has included only those studies published in the English language.
4. Future researchers may measure the effects of AI tools on university librarians and libraries through quantitative, qualitative, experimental, and mixed methods.
5. Future researchers can conduct systematic literature review on AI and librarians' work support.

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