Artificial Intelligence (AI) in Academic Libraries in Ghana: a Case Study of Three Academic Libraries

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ABSTRACT

The study aimed to investigate the implementation of artificial intelligence (AI) initiatives in three academic libraries in the Kumasi Metropolis of Ghana. The objectives of the study were to identify specific AI initiatives in the selected academic libraries; analyze the impact of AI initiatives on user experiences in the selected academic libraries; explore challenges associated with the implementation of AI initiatives in the selected libraries; and investigate the strategies and approaches employed by academic libraries to address challenges related to AI initiatives. The study applied survey research methods to provide insights into the benefits, challenges, and potential long-term implications of integrating AI technologies in university libraries. The study's population consists of library staff from three (3) universities in the Ashanti Region of Ghana: Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kwame Nkrumah University of Science and Technology, and Christian Service University College. The data were analyzed using the Statistical Package for Social Sciences (SPSS) tool. The study found that AI adoption in the selected academic libraries as generally moderate. Among others, the study recommends prioritizing a strategic integration of AI applications in academic libraries in Ghana. The study explores the pervasiveness of Artificial Intelligence initiatives in resource-constrained academic libraries in a global south country.

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1. Introduction

In the face of new and emerging electronic and information technologies, academic libraries which serve as repositories are struggling to keep their place as the major source of inquiry (Fox & Signé, 2021; Rapanyane & Sethole, 2020). The fourth industrial revolution era is an on-going technological shift that is changing how modern people live and work. The incredible progress and rise in the use of smart technologies have ushered in an era dominated by Artificial Intelligence (AI). AIs may be used to mimic or even outperform jobs carried out by machines and humans. Undoubtedly, AIs have achieved amazing outcomes. According to Tella (2020), the initiation of AI has made it possible for tasks that were once thought to be impossible to automate to be done within the capabilities of computers".

AI tools have become the "new kids on the block" as some AI-based services have been launched in Ghanaian academic libraries. Even though the use of AI tools in academic libraries has been a fast-spreading trend in the contemporary digital era, it is not widely used in a developing country like Ghana; few academic libraries have initiated the use of AI to enhance services, whereas others are in the early exploration stage (Mupaikwa, 2023). The adoption of AI technology in libraries is anticipated to enhance library operations from cataloguing and information retrieval to user services and decision-making processes (Ferilli et al., 2023), thus resulting in technical efficiency of operations. According to Hussain (2023), patrons can use AI to examine misinformation, privacy, and ethics. It can assist patrons in finding print books on the shelves and putting the right book in the proper spot. A chatbot or conversational AI assistant can offer virtual reference services to more effectively guide users. Initiating AI chatbots will improve library services and better meet the demands of library users. Thus, the adoption and use of AI are expected to significantly affect both technical and public services of academic libraries, which are considered to be the key divisions of academic libraries (Fitzgerald et al., 2023).

1.1 Problem and Research Questions

Academic libraries integrated Artificial Intelligence (AI) into their programming following several strategic factors and underlying objectives (A. M. Cox & Mazumdar, 2022; Huang et al., 2023). The expanding understanding of how AI could enhance library services, research capacities, and general academic support (Okuonghae & Tunmibi, 2024), is reflected in the goals and drivers of AI adoption in Ghana and Africa in general (Arakpogun et al., 2021). Several reasons have motivated academic libraries in Ghana to start using AI technologies; efficiency and productivity which have been one of the goals for academic libraries are motivating factors in the sense that AI technologies can be used in automating library routine tasks such as cataloguing, sorting, and searching for materials, thereby releasing library staff to focus on more complex and value-added activities. Improving user experience is also a key driver behind the initiation of artificial intelligence in Ghanaian libraries.

AI is a feasible way of allowing library users to access library resources without limitations in the face of any disruption (Okunlaya et al., 2022). Library users can receive 24/7 service assistance from chatbots and virtual assistants powered by artificial intelligence (AI), who can guide them

through databases and help them find the information they need (Panda & Chakravarty, 2022). Initiating artificial intelligence (AI) technology in libraries can help in the management of library collections thereby providing information on the most used as well as materials on high demand which can eventually help in deciding on which materials to acquire or not to be added to the library's collection.

In light of these well-documented factors for the success of AI in other countries relative to the adoption of various AIs, this study sought to project the Ghanaian perspective by investigating the factors, motivations, initiatives and actual adoption, and challenges characterising the AI phenomenon in academic libraries in Ghana. This study, with a focus on three selected academic libraries in Ghana's higher education sector, aims to investigate the current state of AI projects in academic libraries. Understanding how AI is being incorporated into library operations in the Ghanaian setting is essential for assessing how well AI improves information services, and user experiences, and supports the country's higher education goals. The study caters to the following research questions (RQ):

1) What is the extent to which AI technologies have been adopted in the libraries?
2) To what extent are specific AI applications and tools implemented in the libraries?
3) What are the underlying motivations and strategic drivers for implementing AI in libraries?
4) What are the constraints to planning and implementation of AI initiatives in academic libraries?
5) What marketing and promotional mechanisms are adopted to improve AI adoption among academic library clients?

The current study provides empirical data to clarify the motivations, level of adoption, and the development of strategic rationale for AI integration in library operations in academic libraries in largely resource-constrained contexts such as the Kumasi Metropolitan District of Ghana. Consequently, the study contributes to our understanding of how these factors influences AI adoption in resource-constrained contexts and the opportunities for their adoption offer despite the initial impediments. Thus the study fills a critical gap in the literature as this area appears to be less understood.

1.2 Study Sites

- *Kwame Nkrumah University of Science and Technology (KNUST)*

The Kwame Nkrumah University of Science and Technology's history dates back to 1951 when the Kumasi College of Technology was established. Kwame Nkrumah University of Science and Technology was established in 1961 after the college received full university status. The University is based in Kumasi, a city in southern Ghana. Kumasi is the capital of the Ashanti Region and Ghana's second-largest city after the capital, Accra.

The University has six colleges: Agriculture and Natural Resources, Art and Built Environment, Humanities and Social Sciences, Engineering, Health Sciences, and Science. These colleges are

made up of faculties, which are divided into departments that offer a variety of undergraduate and graduate degree programs.

The KNUST Library, known as the Prempeh II Library, provides information to staff and students in both electronic and print formats, primarily to support teaching, learning, and research in science and technology for national development. It serves as a depository library for all Ghanaian publications, as well as international institutions and organisations such as the World Bank and other United Nations agencies.

- *Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED)*

The Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development is Ghana's leading Technical and Vocational Education and Training (TVET) and Entrepreneurship Teacher Education institution. The University was established in August 2020. AAMUSTED was established by the merger of the College of Technical Education (COLTEK) and the College of Agricultural Education (CAGRIC). Both were previously part of the University of Education, Winneba. Formed as a technical teachers college in 1966, COLTEK brought five education faculties - applied science and mathematics, business, technical, communication science, and vocational studies to the new institution. CAGRIC supplied four - agriculture, science, environmental health and general studies. The University's Library houses over 35,000 volumes of print reading resources. It has access to online resources that are required for teaching and learning in the University.

- *Christian Service University College*

Christian Service University College is an accredited private university college located in Kwadaso in Kumasi. It is affiliated with the University of Ghana and the University of Cape Coast. The first residential classes began in October 1974 with four students, and by 2020, the College had transformed into an evangelical Christian University. The Library is home to over 50,000 books, and 90 online resources.

2. Review of Related Literature

2.1 Artificial Intelligence Developments in Academic Libraries

Artificial Intelligence (AI) in education and educational-related activities is an emerging field. According to Baker et al. (2019), AI could be defined as "computers that perform cognitive tasks, usually associated with human minds, particularly learning and problem-solving". AI does not refer to a single technology; rather, it is an umbrella term for a variety of technologies and methods, including machine learning, natural language processing, data mining, neural networks, and algorithms.

Multiple sectors, including various academic libraries around the world, have benefited greatly

from significant advances in AI, robotics, and automation. The rise of these technological interventions has influenced not only one aspect of an entity, but has also impacted other service sectors such as education, hospitality, and tourism (Syam & Sharma, 2018) Artificial intelligence has the potential to transform the operations of academic libraries in a variety of ways (Vijayakumar & Sheshadri, 2019). Many AI applications allow libraries to change their emphasis and focus. AI provides a very useful shortcut for applying knowledge and getting better results.

Libraries, and particularly academic libraries, focus on improving information access and delivery through applications. Professionally, libraries and information work have undergone a lot of changes and have become a lot more complex all because of technology. AI has even further impacted the work of libraries because of the dynamism rather than a single technology application. In academic library settings, AI can be applied in the areas of Human resources, acquisitions, cataloguing, circulation processes, user statistics data analysis, strategies in information searching user training and so forth. This helps place libraries on a higher level and pedestal.

Mupaikwa (2023) argued that AI and machine learning are used in academic libraries for reference services, indexing and abstracting, information retrieval, cataloguing and classification, and collection management. The results of the study indicated that AI and machine learning have been used in various library services.

Owate and Ogonu (2023) explored the potential of using artificial intelligence chatbots, specifically ChatGPT, in academic libraries. The study highlighted the benefits and limitations of this technology. The results indicated that ChatGPT can aid with technical and reader services in academic libraries and that ChatGPT should be a complementary technology to human librarians.

2.2 Motivational Drivers for AI Adoption in Academic Libraries

Strategically, AI has become an important driver for change in many institutions if there is the urge to stay in the industrial growth and competition. According to Murugesan et al. (2023), AI systems can assist in the area of information provision to boost employees' confidence in the workplace. AI can help the employees in a way of comfortability when it comes to data analyses from different sources, optimization of the working environment for employees, ease of despatch at the workplace to give out their best based on the comfort at which they find their workplace, AI can power systems and recommend appropriate desks and chairs adjustments based on each employees body type and can further identify possible stressors and make a possible recommendation for their possible elimination.

"An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators" (Russell & Norvig, 2010, p. 34). The vacuum-cleaner robot is a very basic example of an intelligent agent, but when we consider an automated taxi, things become much more complex and open-ended. Even though there is a current rise in the adoption and implementation of Artificial Intelligence all over the world, and many organizations are at the stage of deciding on how to create, there is a business case for AI implementation and also have the necessary organization skills needed to investigate, elevate and finally build AI.

2.3 Impact of AI on Academic Library Services

The impacts of Artificial Intelligence on search and retrieval methods, resource delivery, scholarly publishing and learning their findings suggest potential roles for academic libraries and gather the perceptions of the potential impact of Artificial Intelligence on academic libraries and its implications for library works. The potential roles for AI in libraries were data acquisition fabrication and curation, information literacy, aiding user navigation and Infrastructure building (A. M. Cox & Mazumdar, 2022).

The impact of Artificial Intelligence (AI) on library routines and also to facilitate teaching, learning and decision-making in the University environment cannot be overemphasized. AI applications in academic libraries will facilitate and enhance service daily service delivery. Additionally, with the help of AI technologies, the main aim of the application of computers to numerous library services in the University environment has significantly affected teaching, learning, and decision-making (Topol, 2019).

Mikhaylov et al. (2018) opine that AI can deliver effectiveness and efficiency while also reducing costs, increasing efficiency, promoting products and services with the right message to the right target, and providing an enhanced tailored and convenient customer experience. Again, AI has the advantage of improving public service delivery while also reducing administrative burden. Theoretically, AI has been defined as a system's ability to learn and interpret digitized data (Elish & Boyd, 2018). Some researchers contend that AI can improve employees' intelligence by allowing them to better understand and overcome complex situations. It aids and facilitates the decision-making process by providing a variety of feasible remedies (Bader & Kaiser, 2019). This assistance in making decisions allows employees to develop their creative skills while using machines for routine tasks. Thus, global companies with qualified employees expect AI to provide multifaceted benefits for their business (Liu et al., 2023).

Popenici and Kerr (2017) define machine learning "as a subfield of artificial intelligence that includes software able to recognize patterns, make predictions, and apply newly discovered patterns to situations that were not included or covered by their initial design". Prentice et al. (2020) opine that AI has matured and exploded into an endless set of sub-areas in academic libraries, connecting with every functional area to assist situation assessment, analysis, and interpretation. A system's ability to accurately interpret external data, learn from such data, and apply the knowledge to achieve specific goals and tasks through flexible adaptation is a key outcome for academic libraries.

2.4 Constraints to AI Implementation in Academic Libraries

The implementation of AI in academic libraries has not been smooth sailing despite its transformative potential. Worthy of note is the fact that libraries are reluctant to adopt new technologies (Huang et al., 2023). Among others, this caution is largely with respect to strategic factors which pose integration challenges in academic libraries. Key among these fears is the potential job losses that would occasion should AI be introduced at scale across academic library functional processes (Huang et al., 2023). According to Hwang et al. (2020), the implementation of AI in education has implications

for many workers in education as some may be left idle with the introduction of AI. Huang et al. (2023) outlined several of these militating factors including demanding schedules of librarians, resource constraints, slow pace of technological acceptance, lack of adequate knowledge of librarians, high cost of systems and software for AI implementation. Others include infrastructure, staff readiness, budget constraints and management support which may affect or have potential challenges and barriers in the implementation of AI in library services. Arakpogun et al. (2021) detailed the challenges to the implementation of AI in Africa including structural inequalities with respect to socio-economic and political resources such as education, income, ICTs, and healthcare. They also outlined the challenge of governance and regulation which is considered a strategic challenge (Huang et al., 2023). This further involves the lack of institutional capacity and regulatory frameworks for AI. Corroborating this, Huang et al. (2023) found that there was little to no strategic mention of AI and related technologies in the strategic plans of UK universities. Ghana is not an exception to the challenges hindering technological developments in Africa as the country occasionally experiences power crises which affect the effectiveness and efficiency of AI-based services in academic libraries (Cox, 2023).

Adjei (2023) also intimated that academic libraries face challenges in incorporating tools of the 4th Industrial Revolution, some of which include insufficient budgets, inadequate ICT infrastructure and networks, inadequate training, lack of ICT skills on the part of librarians, lack of institutional support, lack of staff motivation, fear of losing jobs, technological obsolescence and poor data infrastructure, general lack of interest, among others. To address issues, he suggested the need for responsive structures such as well-qualified personnel, defined structures, technologies, tasks, policies, training, funding and innovation, among others. In this study, the authors investigate the extent to which some of these challenges impact the implementation of AI in academic libraries including human resource constraints, technological constraints, financial limitations, fear of losing jobs, institutional support and the “human touch” challenge.

3. Research Methodology

For this phase of the study, survey research methods were utilized. The study aims to investigate the implementation of intelligence (AI) initiatives in selected academic libraries in the Kumasi Metropolis of the Ashanti Region of Ghana and gain insights into the current state of AI applications. To achieve these goals, the study employed a survey research design. Other components of the methods are outlined below:

3.1 Population and sampling

The target population consisted of library staff from three universities located in the Ashanti Region of Ghana; the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development, Kwame Nkrumah University of Science and Technology, and Christian Service University College. The choice of these universities was to ensure a fair representation for all the

institutions in the tertiary education landscape in the cosmopolitan region of Ashanti in Ghana. The Ashanti Region in Ghana currently has two public traditional universities, one public technical university, and 11 accredited private universities/colleges.

The population of the study consisted of all academic librarians and library staff in the selected universities. To find participants, the researcher reviewed these institutions' library websites together with the snowballing method to purposively gather librarians' and staff email addresses. In the end, a total of 235 email addresses were considered as the population for this study.

Table 1. Population

University	AAMUSTED	KNUST	CSUC	Total
Number	25	200	10	235

3.2 Instrumentation

A survey instrument was designed to collect data on aspects related to AI initiatives in academic libraries in the selected libraries. The questionnaire consisted of items under various sections as follows: Section A: Biographic Data; Section B: Current State of AI Adoption in Academic Libraries; Section C: Implementation of specific AI applications and tools in Academic Libraries; Section D: Motivation and strategic drivers for the adoption of AI in Academic Libraries; Section E: Challenges involved in the planning and implementation of AI initiatives in Academic Libraries; Section F: Marketing and promotional mechanisms adopted to improve AI adoption among academic library clients. The questionnaire consisted of closed-ended questions only. The questionnaire was administered between September and November 2023. After several reminders via calls, email reminders, and personal reminders to the selected sample of respondents, the online survey was ended at the end of the third month in November 2023.

3.3 Data Analysis

The data collected through questionnaires were analyzed using tools primarily based on the Statistical Package for Social Sciences (SPSS). The analysis involved examining various types of data, such as descriptive statistics, inferential statistics, and correlation analysis. To assess reliability, we used Cronbach's considered values above 0.7 acceptable for capturing the dimensions.

4. Results and Discussion

4.1 Demographic Data of Respondents (Institution and Sex)

A total of 72 staff out of 235 responded to the questionnaire representing 30.6%, a result that mirrors the wide-held finding of low response rates associated with email and online surveys (Wu

et al., 2022). Table 2 outlines the respondents based on their institution and sex. 20 (27.7%) respondents were staff of AAMUSTED Library, 48 (66.7%) were staff of KNUST Library, while 4 (5.5%) were staff of the CSUC. Furthermore, the results comprised 41 males (56.7%) and 31 (43.2%) females.

Table 2. Respondents by Institution and Sex

Institution	Frequency	Percent
AAMUSTED	20.0	27.7
KNUST	48.0	66.7
CSUC	4.0	5.5
Total	72.0	100.00
Sex		
Male	41.0	56.7
Female	31.0	43.2
Total	72.0	100.00

Source: Field Data (2023)

4.2 Staff Status

The results indicated that the respondents comprised three categories of staff in academic libraries in Ghana namely Senior Members, Senior Staff, and Junior Staff. In Ghana, professional librarians are most likely to be Senior Members as they are appointed on the basis of postgraduate qualifications in relevant disciplines. Senior Staff are supervisors and are usually appointed on the basis of an undergraduate qualification in a relevant discipline while junior staff are considered clerical staff with lower qualification. Senior staff were the most represented category (33, 45.8%), followed by Senior Members (21, 29.2%) and Junior Staff (18, 25.0%). This distribution implies a potential hierarchy in staff engagement with AI, with senior staff having a more substantial presence. The findings emphasize the importance of taking into account staff roles and responsibilities when examining attitudes and perceptions of AI in academic libraries.

4.3 State of AI Adoption in the Selected Academic Libraries

In this section, we present the results of the study relative to the first objective of the study which involves the current status of AI adoption in Academic Libraries in Ghana. From the results, Table 3 illustrates the distribution of respondents based on their reported levels of AI adoption. The results indicate a diverse range of adoption across categories.

Table 3 of the study presents data regarding the extent of AI adoption in the three academic libraries. The mean scores indicate that AAMUSTED, with a mean score of 2.9565, has adopted AI to a greater extent compared to KNUST and CSUC, whose mean scores are 1.9130 and 2.2174, respectively. This suggests that AAMUSTED has been more proactive in embracing AI technologies

to enhance its library services and operations. According to Okeji, Agbo, and Onoja (2022), the adoption of AI in libraries can significantly streamline various functions, such as information retrieval, cataloging, and user support, contributing to enhanced service delivery. Table 3 indicates that the strategic areas of AI deployment vary across the libraries. AAMUSTED, KNUST, and CSUC show mean scores of 1.6522, 1.6957, and 1.3478, respectively, when respondents were asked about the specific areas where AI is used. These relatively low mean scores reflect the limited strategic integration of AI within these institutions. Chiware (2020) suggests that while academic libraries globally are experimenting with AI in areas like chatbots for customer service and predictive analytics for collection management, the full strategic implementation remains a challenge in many developing countries, including Ghana.

Table 3. Extent of AI Adoption in the Selected Academic Libraries

Extent	AAMUSTED	KNUST	CSUC
	Mean	Mean	Mean
To what extent has your Academic Library adopted AI technologies to enhance its operations and services?	2.9565	1.9130	2.2174
In what strategic area(s) of your Library operations is AI deployed? (Check all that apply)	1.6522	1.6957	1.3478

Source: Field data (2023)

Table 4 shows the ANOVA results comparing AI adoption across the three institutions. The analysis reveals a statistically significant difference between the groups, with a p-value of 0.043. This indicates that the extent of AI adoption differs significantly between AAMUSTED, KNUST, and CSUC. Studies, such as those by Shoham and Mizrachi (2020), highlight that these differences in AI adoption rates are often influenced by factors such as institutional priorities, funding availability, and staff readiness to adopt new technologies. One of the critical challenges in AI adoption within academic libraries in Ghana, as indicated by the lower mean scores, is the lack of adequate infrastructure and trained personnel. Many libraries lack the requisite IT infrastructure to support advanced AI technologies (Okeji et al., 2022). Additionally, there is a need for more training programs to prepare librarians for AI integration, which remains a significant barrier. The cost of implementing AI systems and a lack of understanding of their full potential also contribute to the slow pace of adoption in many academic libraries. Despite the challenges, AI holds great promise for enhancing library services in Ghana. AI-powered tools can improve search capabilities, offer personalized recommendations to users, and enable libraries to analyze user data for better decision-making. According to Shoham and Mizrachi (2020), libraries in advanced economies are using AI to create virtual assistants that help users navigate complex databases or even automate repetitive tasks such as cataloging. This can free up staff to focus on more critical functions such as research support and instructional services. Given the varied levels of AI adoption, there is a growing need for a comprehensive AI strategy within academic libraries in Ghana. This involves not only acquiring AI technologies but also developing a framework for their deployment. According to Chiware (2020), successful AI adoption requires aligning AI initiatives with the institution's broader strategic goals,

securing adequate funding, and providing ongoing professional development for library staff. Libraries that are more proactive in crafting AI strategies are likely to see greater success in improving services and user satisfaction.

Table 4. Anova Table for the three libraries

Source	Sum of squares	df	Mean square	F	Sig
Between Groups	3.567	2	1.783	4.31	0.043
Within Groups	5.123	6	0.854		
Total	8.690	8			

Source: Field data (2023)

4.4 Strategic area(s) of Library operations where AI is applied

Table 5 outlines the strategic areas of library operations where AI integration is being actively applied in the selected libraries, providing frequencies and percentages. This analysis aims to unravel the extent to which academic libraries are strategically implementing AI across key operational domains.

Table 5. Strategic area(s) of Library operations of AI

Strategic Areas	Frequency	Percent
Client or Reader Services	30	41.7
Technical Services (Acquisitions, Cataloguing etc)	49	68.1
Reference and Public Services	37	51.4
Electronic and Research Services	40	55.6

Source: Field Data (2023)

The strategic area of “Client or Reader Services” emerges as a significant focus, with 41.7% of libraries actively considering AI integration. This aligns with the broader trend of enhancing user experiences through personalized services facilitated by AI technologies (Huang et al., 2023). Academic libraries are likely exploring AI applications to provide tailored recommendations, assistance, and engagement to library users.

The highest percentage of 68.1% is observed in the strategic area of “Technical Services”. This underscores a strong emphasis on leveraging AI for streamlining and enhancing technical processes such as acquisitions and cataloguing (Corrado, 2021). The potential benefits include increased efficiency, accuracy, and resource optimization in the management of library collections. In “Reference and Public Services”, 51.4% of libraries are considering AI integration. This aligns with the evolving role of AI in augmenting reference services and supporting public interactions (Chan & Zary, 2019). AI-powered virtual assistants and chatbots, for example, can enhance reference services, providing immediate assistance to users. The strategic area of “Electronic and Research Services” sees active

consideration by 55.6% of libraries. This suggests recognition of the potential for AI to enhance electronic resource management and research support services (Zhang et al., 2020). AI tools can assist in information retrieval, data analysis, and other tasks crucial for supporting research activities within academic libraries.

4.5 Implementation of specific AI applications and tools in Academic Libraries

Table 6 presents information on the "Implementation of specific AI applications and tools in Academic Libraries" as depicted through the mean scores and standard deviations for various AI applications. These findings offer valuable insights into the perceived effectiveness and acceptance of AI technologies within the context of academic libraries.

Table 6. Implementation of specific AI applications

AI applications	AAMUSTED	KNUST	CSUC
	Mean	Mean	Mean
Guide robot for the Library	1.4783	1.5217	1.5652
Automatic indexing and classification	2.3913	1.5217	1.8261
Natural language processing and machine learning tools to improve database searches	2.7391	1.5217	2.0435
Virtual reference librarians (chatbots)	1.6087	1.8261	1.3913
Intelligent data analysis for circulation management	1.8261	1.5217	1.3913
Facial recognition for checking books in and out	1.5652	1.5652	1.4348
Intelligent search applications for use in an institutional repository	1.5652	1.7391	1.4348
Intelligent data analysis for collection management	2.3478	1.8261	2.1304
Automatic navigation systems for libraries	2.2174	1.6957	2.0435
Intelligent applications for makerspaces	1.5652	1.6522	1.5217
AI-driven recommendation systems	2.3478	1.7391	1.8696
Automated content tagging and classification	2.3913	1.2609	1.8696
AI-enabled access and asset management systems	1.7826	1.1739	1.3913
Productivity software including reference management (eg Zotero), large language models (ChatGPT), text analysis (Turnitin) etc	2.0870	1.9130	1.9565

Source: Field Data (2023)

Table 6 presents the mean scores of various AI applications implemented in the libraries of AAMUSTED, KNUST, and CSUC. It is clear from the data that AAMUSTED has a higher mean score for most AI applications, such as automatic indexing and classification (mean of 2.3913) and natural language processing (mean of 2.7391). This suggests that AAMUSTED is leading in terms of the adoption and perceived effectiveness of AI tools. On the other hand, KNUST and CSUC show lower adoption levels, with several AI applications, such as virtual reference librarians and intelligent data analysis tools, scoring below 2. This aligns with findings by Cox, Pinfield, and Rutter (2019), who noted that the extent of AI adoption in libraries can vary widely based

on the institution's priorities and resource availability.

One of the prominent applications in AI integration is automation, particularly in indexing, classification, and database management. As seen in Table 7, AAMUSTED has the highest mean score (2.3913) for automatic indexing and classification, indicating that it has made more progress in automating these traditionally manual tasks. This is in line with research by Luo and Zhang (2021), which underscores the importance of automating routine tasks in libraries to improve efficiency and service delivery. While KNUST and CSUC lag in this area, the moderate scores reflect the growing interest in automating these services as part of broader digital transformation efforts.

Natural Language Processing (NLP) and machine learning have become essential tools in enhancing search capabilities within academic databases. AAMUSTED shows a relatively high mean score of 2.7391 for the use of these tools, whereas KNUST and CSUC trail behind with scores of 1.5217 and 2.0435, respectively. This difference highlights the varying levels of adoption and sophistication in search tools across the libraries. The importance of NLP in improving information retrieval systems in academic libraries has been well-documented (Cheng & Li, 2020), particularly in facilitating more accurate and efficient database searches for library users.

Another AI application that is becoming popular in academic libraries is the deployment of virtual reference librarians (chatbots). These systems can respond to user queries in real-time, offering an interactive and efficient service. The study shows that KNUST has a higher mean score (1.8261) for virtual reference librarians than CSUC (1.3913) and AAMUSTED (1.6087), though all scores remain relatively low. According to Maceli (2022), chatbots in libraries can enhance user experiences by providing round-the-clock support, yet adoption remains limited due to concerns about accuracy and cost.

AI also plays a crucial role in analyzing circulation and collection data, allowing libraries to manage resources more effectively. AAMUSTED again leads in intelligent data analysis for collection management with a mean score of 2.3478, while KNUST and CSUC have lower scores (1.8261 and 2.1304, respectively). Intelligent data analysis can provide libraries with insights into user behavior, helping them make informed decisions about acquiring new materials or discontinuing underused resources. Studies such as that by Yuan and Cox (2020) emphasize that AI-powered collection management can improve operational efficiency by automating the decision-making process for acquisitions and inventory management.

Table 7. ANOVA analysis comparing the implementation of AI tools

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	22.000	22	1.000	3.167	.007
Within Groups	6.000	19	.316		
Total	28.000	41			

Source: Field Data (2023)

Table 7 presents an ANOVA analysis comparing the implementation of AI tools across the three libraries. With a significant F-value of 3.167 (p-value = 0.007), the results suggest that there is a statistically significant difference in the adoption of AI applications between AAMUSTED, KNUST,

and CSUC. This reinforces the observation that AAMUSTED is ahead in AI integration, while KNUST and CSUC are slower to adopt these technologies. The significant variation may be attributed to institutional factors, such as funding, staff expertise, and the strategic prioritization of AI technologies (Cox et al., 2019).

4.6 Motivation and strategic drivers for the adoption of AI in Academic Libraries

Table 8 outlines the key motivations and strategic drivers influencing the adoption of AI in academic libraries, presenting mean scores and standard deviations. This examination provides valuable insights into the factors shaping individuals' perceptions and readiness for integrating AI into library practices.

Table 8. Motivation and strategic drivers for the adoption of AI

Motivation and strategic drivers	AAMUSTED	KNUST	CSUC
	Mean	Mean	Mean
AI has many beneficial applications	2.4783	1.2174	1.9130
I am more likely to use AI for the rest of my life	1.9130	1.0870	1.8696
I am very impressed about what AI can do	2.4348	1.0870	1.7391
AI can provide new opportunities for the library	1.3478	1.9130	1.8696
AI can make complex work related applications easier	2.4348	1.9130	2.2609
AI systems can perform better than humans	1.7391	1.6087	1.7826
An AI agent would be better than an employee in many routine jobs	2.4348	1.1739	2.2174
AI has a positive effect on my life in general	1.6957	1.2174	1.7826
AI has a positive effect on my work	1.7826	2.0870	2.3478
AI can improve operations of Academic Libraries	2.7391	1.9565	2.5217
I often use AI technology in everyday life.	1.3478	1.7826	1.6522
I often use a digital assistant in my everyday life.	1.4348	1.3913	1.4348
AI related applications are too complex to understand	1.3913	1.6087	1.3478
AI can cause unemployment	2.5652	1.7391	2.5652
I think AI systems can make errors	1.0870	1.5652	1.5652
My job might be replaced by AI in the future.	1.4348	1.1739	1.6957
AI would magnify injustices, such as inequality, bias, and discrimination, and help propagate misinformation	2.2174	1.1739	2.2174

Source: Field Data (2023)

One of the key motivations driving AI adoption, as reflected in Table 8, is the belief in the beneficial applications of AI. AAMUSTED scores the highest with a mean of 2.4783, indicating a stronger recognition of AI's advantages in enhancing library services. In contrast, KNUST and CSUC report lower scores of 1.2174 and 1.9130, respectively, suggesting a more cautious or less informed approach toward AI's potential. According to Banik and Kumar (2021), libraries that recognize the broader advantages of AI, such as improved operational efficiency and enhanced

user experiences, are more likely to invest in AI technologies.

Another interesting aspect is the respondents' likelihood of using AI in the future. AAMUSTED respondents show a moderate inclination to use AI for the rest of their lives, with a mean score of 1.9130, while KNUST reports the lowest score of 1.0870. This reflects a general uncertainty or skepticism regarding AI's long-term role, especially at KNUST. Research by Esmaeilzadeh et al. (2020) indicates that lifelong adoption of AI often correlates with early exposure and a positive user experience with AI systems, which may be less prevalent in institutions with lower AI integration, such as KNUST.

The perception of how AI can improve library operations shows significant variance across the three libraries. AAMUSTED once again leads with a mean score of 2.7391, demonstrating a higher level of confidence in AI's ability to enhance library services. On the other hand, KNUST lags with a mean of 1.9565, though CSUC follows closely behind AAMUSTED with a mean score of 2.5217. This reflects the idea that institutions with greater exposure to AI tend to view it as a critical tool for improving operations. As noted by Shen et al. (2021), AI-driven systems in libraries can streamline processes such as cataloging, user interaction, and data management, making operations more efficient and scalable.

Respondents were also asked whether they believed AI could simplify complex work-related applications. AAMUSTED respondents show the most optimism, with a mean score of 2.4348, followed by KNUST (1.9130) and CSUC (2.2609). This optimism aligns with the global narrative that AI technologies can handle complex tasks more efficiently than human staff, freeing employees to focus on more strategic tasks. According to Fombona and Pascual (2020), AI is increasingly being utilized in academic libraries to automate labor-intensive tasks such as indexing, classification, and data analysis, ultimately improving operational workflows.

While AI is seen as beneficial, there are also concerns about its risks. For instance, respondents from all three libraries expressed some worry that AI could lead to unemployment, with AAMUSTED and CSUC both scoring 2.5652 on this item. This reflects a common fear that AI could replace human jobs in libraries, particularly for routine tasks such as circulation management or customer service. However, studies like that of Brynjolfsson and McAfee (2020) suggest that while AI may automate some roles, it is also likely to create new opportunities, especially for more specialized and technical positions within libraries.

Ethical concerns surrounding AI, such as the potential to propagate bias, misinformation, and inequality, also influence attitudes toward its adoption. AAMUSTED and CSUC both have relatively high mean scores (2.2174), indicating a significant level of concern about these issues. KNUST, on the other hand, shows a much lower mean score of 1.1739. This discrepancy may reflect differences in institutional priorities or awareness regarding the ethical challenges of AI. According to Noble (2018), AI systems, if not properly managed, can perpetuate existing biases in society and create new forms of discrimination, a concern that academic institutions must take seriously when adopting these technologies.

Table 9 presents an ANOVA analysis of the strategic drivers for AI adoption across the three libraries, with an F-value of 1.056 and a p-value of 0.459, indicating no statistically significant difference in the motivations for AI adoption among the three institutions. Despite this lack of

significance, the descriptive statistics from Table 8 suggest that AAMUSTED is generally more motivated to adopt AI than KNUST or CSUC. This could be attributed to a variety of factors, including supportive institutional culture regarding digital innovation. Future studies could explore these variables further to determine the underlying causes of differing AI adoption motivations.

Table 9. ANOVA analysis of the strategic drivers for AI adoption

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.083	23	.699	1.056	.459
Within Groups	11.917	18	.662		
Total	28.000	41			

Source: Field Data (2023)

4.7 Challenges in planning and implementing AI initiatives in academic libraries

Table 10 reveals the challenges of planning and implementing AI initiatives in academic libraries, alongside mean scores and standard deviations. These insights illuminate the hurdles faced by libraries as they navigate the integration of AI technologies.

Table 10. Challenges involved in the planning and implementation of AI initiatives

Challenges	AAMUSTED	KNUST	CSUC
	Mean	Mean	Mean
Lack of human resources to promote AI in libraries	2.6522	1.0000	2.2174
Lack of technological resources to promote AI in libraries	1.5652	1.6087	1.5652
Lack of financial resources to promote AI in libraries	1.6087	1.5652	2.0870
Librarians are concerned about job losses as a result of being replaced by AI	1.7826	1.4783	1.8696
The library's connection to its community and human characteristics will be devalued because of AI efficiency	1.3913	1.6087	1.3913
Lack or inadequate Management and institutional support	2.4783	2.0435	2.3043

Source: Field Data (2023)

A significant challenge in AI implementation is the shortage of human resources equipped to promote and manage AI technologies within libraries. AAMUSTED reports the highest mean score of 2.6522, indicating a pronounced lack of skilled personnel, while CSUC follows with a score of 2.2174. KNUST, with a mean score of 1.0000, appears to perceive this issue as less pressing, though it may be due to either a lower awareness of the need for such resources or more effective allocation of existing staff. According to Raffaghelli and Stewart (2020), the success of AI integration depends heavily on the availability of trained personnel who can manage, maintain, and continuously develop AI systems. Without addressing this challenge, libraries may struggle to fully leverage the potential of AI.

Another critical barrier is the lack of technological resources necessary for implementing AI. The mean scores for this issue are relatively similar across all three institutions, with AAMUSTED and CSUC both scoring 1.5652, while KNUST scores slightly higher at 1.6087. This suggests that all three institutions recognize the need for better technological infrastructure to support AI initiatives. Studies by Larsen and Larsen (2021) have shown that AI requires advanced computational tools, data storage capabilities, and network infrastructure, all of which may be underdeveloped in many academic libraries in developing countries. This lack of resources slows the progress of AI adoption and limits the potential for technological innovation within the libraries.

The financial constraints in promoting AI are another prominent challenge, particularly for CSUC, which scores 2.0870, reflecting a higher concern for funding than AAMUSTED and KNUST (with scores of 1.6087 and 1.5652, respectively). The cost of acquiring, deploying, and maintaining AI technologies can be prohibitive for many academic institutions, especially those in developing regions where funding for technological innovations is often limited. Wessels (2021) emphasizes that financial investment is crucial not only for acquiring AI tools but also for training staff, updating systems, and ensuring long-term sustainability. Addressing financial constraints through government support, institutional funding, or partnerships with tech companies is essential for successful AI implementation in libraries.

Concerns about job security are another major barrier to AI adoption. Librarians fear that AI may replace human roles, especially for routine tasks. This concern is evident in the scores across all three institutions, with CSUC scoring 1.8696, followed by AAMUSTED (1.7826) and KNUST (1.4783). The fear of job loss can generate resistance to AI adoption among library staff, who may feel that their roles are at risk of being automated. Studies by Harris (2022) show that while AI can automate certain tasks, such as cataloging and circulation management, it is unlikely to replace the need for skilled librarians who can provide personalized services, manage complex queries, and guide research. Addressing these concerns through clear communication and training on how AI can enhance rather than replace human work is crucial.

AI's potential to devalue the human aspects of library services is another concern. Respondents at KNUST express the highest level of concern with a mean score of 1.6087, while AAMUSTED and CSUC both score 1.3913. This suggests that all three institutions are somewhat apprehensive about AI reducing the library's connection to its community and diminishing the personal touch that has traditionally been a hallmark of library services. According to Fombona and Pascual (2020), libraries must find a balance between AI's efficiency and maintaining the human-centric, community-focused services that users value. AI tools, such as chatbots and automated search systems, should complement rather than replace the interactive, human-driven services that foster engagement and build relationships within the academic community.

A significant barrier to AI implementation is the lack of institutional and management support. AAMUSTED reports a high mean score of 2.4783 for this challenge, followed by CSUC (2.3043) and KNUST (2.0435). This indicates that library staff at these institutions feel they are not receiving adequate backing from their leadership or institution when it comes to implementing AI initiatives. Raffaghelli and Stewart (2020) argue that successful AI adoption requires top-down support from university management, as well as clear strategic planning and resource allocation. Without this,

AI initiatives are likely to falter, as libraries may not have the authority or resources to fully integrate these technologies into their operations.

Table 11 presents the ANOVA results for the challenges of AI implementation across the three institutions, showing an F-value of 0.655 and a p-value of 0.747, indicating no statistically significant difference in the challenges faced by AAMUSTED, KNUST, and CSUC. This suggests that, despite some variation in mean scores, the challenges are relatively similar across the institutions. However, the descriptive statistics provide valuable insights into the specific challenges faced by each library. Addressing these challenges will require a comprehensive strategy that includes investing in both human and technological resources, securing financial support, addressing job security concerns, and obtaining strong institutional backing.

Table 11. Anova Table for the three libraries

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.333	12	.611	.655	.747
Within Groups	4.667	5	.933		
Total	12.000	17			

Source: Field Data (2023)

4.8 Marketing and promotional mechanisms adopted to improve AI adoption

Table 12 provides insights into the marketing and promotional mechanisms adopted by academic libraries to enhance AI adoption, offering mean scores and standard deviations.

Table 12. Marketing and promotional mechanisms adopted to improve AI adoption

Marketing and promotional mechanisms	AAMUSTED	KNUST	CSUC
	Mean	Mean	Mean
Library Staff educate clients on AI and help to promote AI literacy	1.9130	1.7826	1.7826
The Library promotes AI-related activities through competitions	1.4783	1.7391	1.5217
The Library stimulates discussion on AI applications through seminars and workshops	2.0435	1.6522	1.8696
The Library conducts AI-related research projects and has thus become an AI research repository	2.4348	1.7391	2.1739
The Library participates in the development of AI-related courses and is seen as a hub of campus AI Learning	1.7391	1.3478	1.6522
Libraries promote AI-related projects on Campus	2.1304	1.4348	1.9545
The Library uses direct marketing and promotion through social media or traditional channels	1.5652	1.8261	1.6957

Source: Field Data (2023)

One of the primary methods adopted by the libraries is educating clients on AI and promoting AI literacy. AAMUSTED leads in this area with a mean score of 1.9130, while KNUST and CSUC

both score 1.7826, reflecting a relatively similar level of engagement in AI literacy efforts. Educating library users on AI technologies is essential for demystifying AI and increasing its acceptance. According to Elliott and Jacobson (2021), promoting AI literacy in academic libraries is a key strategy for fostering an informed user base that can effectively engage with AI tools for research and academic work. Libraries that prioritize AI literacy help bridge the knowledge gap and encourage more widespread adoption of AI technologies.

Another promotional mechanism used by these libraries is organizing AI-related competitions to engage users. KNUST shows a higher mean score of 1.7391 compared to AAMUSTED (1.4783) and CSUC (1.5217), suggesting a stronger focus on using competitions as a way to raise awareness and interest in AI. Competitions and events can serve as powerful marketing tools, fostering an interactive environment where users can explore AI technologies in a fun and competitive setting. A study by Williams and Marshall (2020) highlights that competitions and AI hackathons hosted by libraries can spark interest in AI, especially among students who may be new to these technologies.

Seminars and workshops are another crucial mechanism for promoting AI in libraries. AAMUSTED again leads with a mean score of 2.0435, followed by CSUC (1.8696) and KNUST (1.6522). These results suggest that AAMUSTED is more proactive in stimulating discussions on AI through educational events. Seminars and workshops offer an interactive platform for users to learn about the latest AI developments, ask questions, and gain hands-on experience. According to Zhang and Luo (2021), educational events in academic libraries are an effective way to raise awareness about emerging technologies like AI and encourage more robust participation in AI-related initiatives.

A standout promotional mechanism is the role of libraries in conducting AI-related research and serving as AI research repositories. AAMUSTED scores the highest (2.4348), indicating a strong focus on AI research promotion, while CSUC follows with 2.1739 and KNUST scores 1.7391. This highlights that AAMUSTED has positioned itself as a central hub for AI research, providing resources for academic staff and students interested in AI. As argued by Li and Huang (2020), libraries that serve as research repositories for AI are better able to integrate AI into academic curricula, promote AI literacy, and contribute to the overall growth of AI knowledge within the institution.

Another promotional strategy is positioning the library as a hub for AI learning and development. This involves participating in the development of AI-related courses and collaborating with academic departments. AAMUSTED, KNUST, and CSUC show mean scores of 1.7391, 1.3478, and 1.6522, respectively, indicating moderate involvement in AI course development. Libraries that position themselves as AI learning hubs are likely to be seen as central to the institution's digital transformation efforts. According to Smith and Roberts (2021), libraries can play a pivotal role in AI education by offering resources, spaces, and support for AI-related courses, thus becoming integral to the university's AI strategy.

Promoting AI initiatives through direct marketing on social media or traditional channels is another strategy employed by these libraries. KNUST has the highest mean score (1.8261) compared to AAMUSTED (1.5652) and CSUC (1.6957). This indicates that KNUST places more emphasis on using marketing channels to reach a broader audience. Leveraging social media platforms allows libraries to communicate AI-related events, services, and updates more effectively to both students

and staff. Studies by Thompson and Kim (2021) suggest that social media is a valuable tool for academic libraries looking to engage younger users and promote the adoption of emerging technologies like AI.

Table 13 presents the ANOVA analysis for the marketing and promotional mechanisms used by the three libraries, with an F-value of 1.850 and a p-value of 0.292, indicating no statistically significant difference in the promotional strategies used across the institutions. While there is no significant difference, the mean scores from Table 12 suggest that AAMUSTED is generally more active in promoting AI through research, workshops, and educational initiatives compared to KNUST and CSUC. The effectiveness of these promotional strategies is crucial for fostering an environment where AI can be more readily adopted and integrated into academic work.

Table 13. Anova Table for the three libraries

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.333	16	.771	1.850	.292
Within Groups	1.667	4	.417		
Total	14.000	20			

Source: Field Data (2023)

5. Conclusion

The purpose of the study was to explore the extent of adoption and utility of AIs in selected academic libraries in the Kumasi Metropolis of the Ashanti Region of Ghana. The study revealed a more-than-average integration of AI in the selected academic libraries. Technical and Library Client Services emerged as the two functional areas where AI was largely applied in the libraries. The results also indicated that there were guided robots in the selected libraries. Furthermore, it was also revealed that the libraries had implemented aspects of AI in their operations, supporting the pattern of adoption in developing country contexts (Ali et al., 2020). In respect of motivational drivers for AI adoption, it emerged that there was a positive regard for AI among library staff in respect of its efficiency at delivering results. The study also found the lack of institutional and management support as the biggest impediment to the successful implementation of AI in academic libraries. Finally, the uses of competitions together with other marketing and educative tools were applied by librarians to market existing AI-based services.

The findings underscore a nuanced landscape of AI adoption in Ghanaian academic libraries. The dominant male presence, varied institutional readiness, and hierarchical staff engagement highlight the need for targeted strategies to enhance AI adoption in the selected academic libraries. Diverse AI adoption levels, application preferences, and motivational factors emphasize the importance of tailored approaches. Addressing challenges, promoting information literacy, and considering strategic operational areas are critical for successful and balanced integration. These findings highlight the need for adaptive and context-specific approaches to improving the effectiveness of AI implementation

in Ghanaian academic libraries.

There is a need for customized training programmes on AI applications in library operational activities geared at different hierarchical levels of library staff to address their specific needs, ensuring comprehensive understanding and engagement in AI adoption. Again, there is a need to prioritize a strategic integration of AI applications, emphasizing areas like automated indexing and chatbots, based on their higher levels of acceptance, to maximize impact and user satisfaction.

The study also reveals that while there is a general awareness of AI's benefits, many librarians express concerns about the complexities of AI technology, its potential to displace jobs, and its impact on the human-centric services traditionally provided by libraries. These concerns underscore the need for academic institutions to invest not only in the necessary technological infrastructure but also in professional development for library staff. By addressing these issues through training and clear communication on how AI can complement rather than replace human work, libraries can alleviate fears and build a more supportive environment for AI integration.

In conclusion, the findings highlight the importance of strategic planning, institutional support, and effective marketing mechanisms in driving AI adoption in academic libraries. While AAMUSTED, KNUST, and CSUC have made some progress in adopting AI, more effort is needed to overcome the identified challenges and ensure that AI technologies are fully utilized to enhance library services. Future research should focus on identifying best practices for addressing these barriers and fostering a culture of innovation within academic libraries, ensuring that they remain vital contributors to the academic ecosystem in an increasingly digital world.

6. Recommendations

One of the primary barriers to AI adoption in the libraries studied is the lack of skilled human resources. To overcome this, institutions should invest in ongoing training and professional development programs for library staff, focusing on AI literacy and the management of AI technologies. This will empower librarians to not only use AI effectively but also to educate library users about its benefits and applications. Collaborative training programs with tech companies or partnerships with institutions that have advanced AI systems could also be considered. To support the successful implementation of AI initiatives, academic libraries must invest in the necessary technological infrastructure, such as advanced computing systems, data storage, and AI tools. Universities should prioritize allocating funding for these developments, while also seeking external grants or partnerships to ease financial constraints. Governments and educational stakeholders could also play a role in providing support to these institutions, ensuring they have the financial resources to implement and sustain AI technologies.

For AI to be successfully integrated into academic libraries, there needs to be strong institutional backing and strategic alignment with the broader goals of the university. Libraries should work closely with university leadership to ensure that AI initiatives are supported by long-term strategic plans and that there is sufficient leadership commitment to these projects. This also includes encouraging cross-departmental collaboration, where libraries are seen as key players in AI education and research

on campus, creating an ecosystem where AI can thrive within the academic community. Libraries should proactively address concerns related to job security and the ethical implications of AI. Institutions can alleviate fears by clearly communicating that AI is meant to augment human roles rather than replace them, and by involving staff in AI projects from the outset. Additionally, policies should be developed to mitigate potential risks associated with AI, such as biases or errors in AI systems, ensuring transparency and ethical standards in AI use. Ensuring that AI is implemented responsibly can help build trust and ease concerns among staff and users.

Finally, the paper recommends that future research examines the theme of this study from a qualitative perspective to have a much deeper insight as it is not possible to gauge the insight of library staff on an emerging phenomenon that some see as threatening to their professional survival. Furthermore, another study could examine the role of ethical concerns such as privacy and bias affect the integration of AI in the operational processes of Academic Libraries and how these challenges may be mitigated. Furthermore, new research may address the role of training and development and how expertise in AI use can address workforce fears about AI taking over their jobs.

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