Investigating the Use of Artificial Intelligence in Transforming the Academic Libraries into Smart Libraries

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Abstract

The advent of modern technologies, for example, artificial intelligence (AI) calls for innovations in the way information is accessed, stored and used. The librarians have long been conducting a variety of library-related activities like borrowing, locating and access of books in the library manually. AI offers support to some of the library activities through automation thereby reducing human workload and challenges. The reports from studies in emerging economies like Tanzania regarding the use of AI in libraries are nevertheless scarce. The availability of physical and wireless internet has eased and facilitated the change in how libraries should operate smartly. One of the innovations which can be tapped in our libraries is the use of security in securing library resources using radio frequency identification (RFID) technology. The new technologies are in many ways transforming the activities of libraries providing users with access to library resources from any place and anytime without being physically in the libraries. The suggested conceptual framework provides a platform for more debates and studies on the attaining of smart libraries using AI.

Keywords: Artificial Intelligence, library transformation, smart library

Introduction

Libraries constitute a place which promotes cultural and scientific institutions, with holdings, book stacks, reading rooms, physical and virtual or online learning spaces, as well as virtual hubs of knowledge consumption and production. They play a role in education and information literacy. In the past decade, there has been the influence of new technologies prompting changes in the way different activities are being done in societies. The societies include business organisations, academic institutions, industries and many other sectors. Artificial intelligence (AI) is one of the technologies leading in transforming different sectors (Sharipova, 2021; Borgohain, Bhardwaj & Verma, 2022). The libraries in academic institutions have found themselves in the middle of inevitably starting to use technologies in serving the distribution of information, books, articles, journals, etc.. The technologies promote the library into being a smart library. A smart library is the kind of library that is equipped with unique intelligence of providing the kind of services that allow library users, for example, to have access to the services at any time and from anywhere. The smart library has realised the digital space intelligence from where the information resource (knowledge) organisation intelligence, service mode intelligence and information management provide the users with information from anywhere and anytime. According to Yu *et al.* (2019), the methods of intelligence in the library include the internet of things, big data, cloud computing, RFID technology, AI, virtual reality and other new technologies. AI is the kind of technology that enhances the already established smart library concept to be extended for development issues as explained by such scholars like Mohammed, Thabit and Azeez (2019) in doing such activities as descriptive cataloguing, technical services, collection development, subject indexing, reference services and database searching and document delivery (Asemi & Asemi, 2018). The main objective of this was to find out how AI technology can be used to transform academic libraries in emerging economies like Tanzania into smart libraries. The study was guided by the following research question:

i.   How artificial intelligence (AI) technologies can be used to transform academic libraries into smart libraries?

Research Methodology

Secondary data analysis was used for this study. Several studies were read and analysed to understand the extent of information regarding the use of AIin smart libraries. The analysed data were collected from variety of studies under the

themes: smart library, AI, library transformation using technologies and a conceptual framework was suggested.

Smart library

According to Schöpfel (2018), the outline of a new concept of the smart library can be described in four dimensions, i.e., smart services, smart people, smart place and smart governance. This implies that as far as a smart library is concerned, users expect the library to have a conducive environment for reading, good services from the library staff (smart people) and reliable access to all library services. The smart library strives to provide users with more efficient and high-quality services, build a more attractive information interconnection environment and create a more diversified information-sharing space.

A study (Liau, 2019) shares how the adoption of robotics and automation technologies has transformed library operations and improved customer experiences in libraries. The study was conducted in Singapore whose libraries use robots and automatic machines to help library staff and volunteers with sorting and returning books, shelf reading and transportation of library materials. A study by Bi *et al.* (2022), narrated that in a smart library environment, obtaining the books only involves concise steps via a smart terminal device whose tasks could involve confirming and making an appointment for the intended books, fetching the books under the smart guide and devices furnished by the library, e.g., the optimal schedule for the borrowing process. The smart library aims at introducing modern scientific and technological means to increase readers' experience and enhance readers' services (Yu *et al.*, 2019). There are many successful cases in the smart library environment (Yaman *et al.*, 2020). The inventory of books in university libraries utilises technologies for improving their inventory and access. For example, the ultra-high-frequency RFID technology intelligent book inventory robot of Nanjing University Library in China mainly uses automatic identification technology and RF phase technology in RFID technology, as well as machine automation technology to realize the automatic library book counting function (Yu *et al.*, 2019).

In a study report explained by Mohammed, Thabit, & Azeez (2019). Smart libraries are linked to the enhancement of sustainable development practices in the sense that libraries are, therefore, educational institutions with a clear impact on society They seek seeks to promote sustainable development by providing environmentally friendly services, reducing practices that waste time, natural

resources and increasing the amount of waste and harmful emissions. In a study done by Yaman *et al.* (2020) a method for ultra-high frequency radio frequency identification (UHF RFID)-based book positioning and counting developed for smart libraries was proposed. In the experimental setup created, RFID tags placed in books were automatically detected using three RFID antennas. This provided a flexible way to count, locate and access a book in a library and, therefore, save time.

In elaborating on what is meant or expected in a "smart library" a study done in Nigeria by Orji and Echezonamanyira (2021) narrated that the components of smart libraries are encapsulated in the acronym "S.M.A.R.T." for "Service, Methods, Automation, Resources and Technologies"'. Being smart, enables libraries to align with developmental trends and innovations in education delivery in the digital age. This calls for the inevitable use of technologies in a library to be called a smart library. Out of many emerging technologies, one of them is AI.

Background to Artificial Intelligence (AI)

Artificial intelligence (AI) refers to the use of computers and information technology to create machines that can mimic human beings' cognitive abilities. AI is a comprehensive discipline developed by computer science, control science, information science, cognitive science, neuroscience, neurophysiology, psychology, linguistics, brain science and other disciplines (Andreu-Perez, 2017). Its essence is to study the production of intelligent machines or intelligent systems, simulate human intelligence activities and extend the science of human intelligence.

AI is associated with intelligent machines, especially computer programmes that foster intelligence as opposed to dumb terminals. It is related to the study and creation of computer systems that show some forms of intelligence: the system that can learn new ideas and a variety of tasks, systems that can reason and draw useful conclusions about the data and environment, systems that can understand a natural language or perceive and comprehend a visual scene and systems that perform other types of feat that relate to human types of intelligence (Carter, 2007; Ezrachi &Stucke, 2017).

AI, therefore, is the application of computer systems and utilisation of computer-based output in the performance of different operations and functions or the provision of various services and production of output products. Automation related to AI implies a degree of mechanisation where the procedures and

accessible jobs or operations are left to be performed by machines with little or no intervention by human beings. The lesser the degree of human intervention the greater the degree of automation. This does not mean that automation does away with human beings. On the contrary, human beings are relieved of routine responsibilities giving them more time for the tasks which require their intelligence (Carter, 2007; Ezrachi & Stucke, 2017).

AI in libraries transformation

Organisations like universities are changing their teaching, learning and research models to influence students' strategic upgrading in response to the emergence of ever-changing new technologies (Okunlaya, Syed Abdullah & Alias, 2022). The issue is related to providing the kind of services that offers smooth operations of libraries operations that favours both librarians and library users. AI is an adequate means to enable library users to access library resources without restrictions in the face of any disruption. AI technology usage in the library can allow library resources to be virtually reimagined. This reimagination can help the library explore new ways to meet customer needs and support academic activities for anyone from anywhere. In libraries, the activities like cataloguing, indexing, information retrieval, reference and other purposes have been well enhanced by the use of among other technologies AI (Asemi, Ko and Nowkarizi, 2020).

A study on the application of AI in libraries done in Nigeria (Okpokwasili, 2019) measured two variables, namely: the use of AI in libraries and user satisfaction. The study found and concluded that there was a high level of roles played by AI in the delivering of libraries services and high level of satisfaction by the users of AI in the libraries of higher institutions in Nigeria. Among other things, the study recommends that libraries should intensify efforts in adopting AI in the delivery of libraries services for libraries users to gain very high-level satisfaction.

Today's technology applications in the business world continue to improve decision-making efficiency and the overall transformation of business operations. Business management and activities are in a data era, which shapes business operations' day-to-day processes (Sharipova, 2021). AI seeks to transform and leverage the existence of expansive data to encourage the decision-making of business intelligence using advanced algorithms that are used to oversee the insight into imminent business processes, consumer behaviour and market trends and to encourage management-informed decision-making, giving companies a competitive edge over other competitors.

Today, AI is taking over business intelligence applications due to both small-scale and large-scale businesses' easy access to technology. By allowing the automation of production processes, AI continues to disrupt industries, for example, limiting the number of workers in an organisation. Because of their ability to automatically produce highly accurate computations and reports, AI apps are being used in financial services, industries, agriculture and many other sectors. Modern library and business decision-making have been greatly improved and transformed by AI. Previously, leaders relied on unreliable and imperfect knowledge that was still in its rudimentary stages from business intelligence systems. Big data can be chopped into AI software and broken down into possible actionable insights that can be used to help executives make more informed decisions.

A good score of studies has reported on the role technology revolution in the transformation of libraries into utilising this technology for physical space intelligence, information resource organisation intelligence and service mode intelligence (Yao, Zhang, & Chen, 2015; Yu *et al.*, 2019; Bi *et al.*, 2022). Consequential to the arrival of new digital transformation technologies, institutions of higher learning have found novel means to get a competitive advantage through, for example, using AI (Abbattista, Semeraro, & Bordoni, 2003). The transformation of libraries and their operations are not only based on the online access to library resources, but rather considering also other factors, for example, the identification of the location of the books in the library, browsing the available resources before a physical visit, the security, the management of space and resources and the self-borrowing and return of books (Yao, Zhang, & Chen, 2015). Indeed, library transformation takes a variety of forms and stages to allow the library environment to be easily managed and automated as compared to the traditional library system.

Adopting AI in academic libraries in the Tanzanian context
Academic institutions in Tanzania have their libraries equipped with systems that allow access to a variety of education and other related resources of information. They are equipped with internet infrastructure whereby the access to information is and can be both physical (a visit to the library) and online. Such infrastructure enhances the wider range of educational resources to be obtained abundantly and at any time (Mwandosya *et al.*, 2020). On the other hand, the developments in mobile technologies (wireless internet and mobile devices) have prompted the accessibility of education resources anywhere and at the users' flexibility (Oyelere *et al.*, 2018) and the students extend the learning to self-regulated learning for them to learn at their own pace (Mwandosya, Mbise and Oyelere, 2019).

The development in technology and technology use has been a pillar in the enhancement of the activities in organisations that are being done. AI has been one of those constantly being used technologies to enhance activities in different sectors, for example, health, military and education, just to mention some of them. AI use in libraries, for example, has been reported in many studies (citations) but the same has not been reported in the Tanzanian context despite its usefulness. A study by Vijayakumar and Sheshadri, (2019) reports on the way AI can be used in enhancing the activities of academic libraries worth mentioning. The summary of the findings of (Vijayakumar & Sheshadri, 2019) work is seen in Table 1.

Table 1: The summary of the application of AI in transforming the academic libraries.

SN.	AI Element	Related Library Application
1.	**Expert Systems**	Application of expert systems in libraries where dialogue between staff and users, users and databases are promising. The expert system will help the librarians to understand the need for productivity improvement. A well-programmed expert system will also improve the quality of library services.
2.	**Natural Language Processing**	Natural Language Processing in Library Services when we think of the term NLP, which is the ability to speak or write a complete sentence and have a mechanical process of requesting and speaking. NLP can apply to many disciplines, including libraries. When we apply to the field of library and information science, more specifically, to search databases such as the Online Public Access Catalogue (OPAC), indexing is the basis of document retrieval. The purpose of the index is to improve the precision of retrieving parts of the relevant documents and to reduce the proportion of recalls and related files retrieved in libraries.
3.	**Machine Learning**	One specific challenge that is ripe is the improvement of library metadata generation. Libraries, through various vendors as part of the purchasing and acquisitions process, acquire thousands of pieces of metadata for print and digital resources made available to their library users. In cases where an e-book platform does not include metadata, libraries generate their own. For the increasing majority of born-digital resources, machine learning provides an array of possible tools to help libraries generate metadata for digital resources, allowing cataloguing to not only increase the speed of metadata generation but also vastly improve the depth and breadth of subject terms.

SN.	AI Element	Related Library Application
4.	**Robotics**	The robot is "A reprogrammable, multipurpose manipulator, automatically controlled, programmable in three or more axes, which can be fixed on the location or portable for use in automation applications". Libraries providing an increased variety of services and resources for digital libraries are still acquiring a great number of printed documents. This combined pressure to provide electronic and printed resources and services has caused serious space constraints for many libraries, especially academic libraries and research. The objective of CAPM (comprehensive approach to printed material) is to build a personalised robotic scanning system based on a series, which allows the browsing of imprints in real-time via the web interface. The user includes a CAPM system that, in turn, starts a robot that recovers the item requested. This item is delivered to another robotic system, which opens the item and rotates pages automatically.
5.	**Intelligent Interface**	Online access to databases is still difficult for many potential users. The user may need to know different communication protocols, master language control, search techniques, database file structures and terminological terminology. The intelligent interface aims to facilitate access to the construction of some of the necessary knowledge in the front-end software used to test the online search system. This goal does not coincide to create an intelligent search system. The interface of access to existing online systems, with all their limitations and disadvantages, so it can be equally successful as an online search system. The interface does not solve the problem of restructuring the database, but rather allows the search system itself to make the approach more intelligent.

The conceptual framework for AI adoption in Tanzania's smart library

Literature on the importance of AI in transforming academic libraries has been well reported. However, in the Tanzanian context, the literature on the use of AI in academic libraries is less written although there are several examples of the importance of utilisation of technologies in the access, use and download of educational resources by the users. Stepping from the explanation of the transformation of AI in libraries and from the works of (Vijayakumar & Sheshadri, 2019) and (Schöpfel, 2018), the following conceptual framework is suggested.

The AI elements as explained by Vijayakumar and Sheshadri (2019) are five but may not be possible to implement all of them in a single project in a given

academic library. So, there is a need to define the requirements of a specific academic library (See Figure 1). The current requirements will determine the kind of AI to be employed to acquire some or all levels of the smart library which are smart services (quick, accurate and on time), smart people (highly knowledgeable and expert in the field), smart places (the library is neat, well arranged and comfortable) and governance.
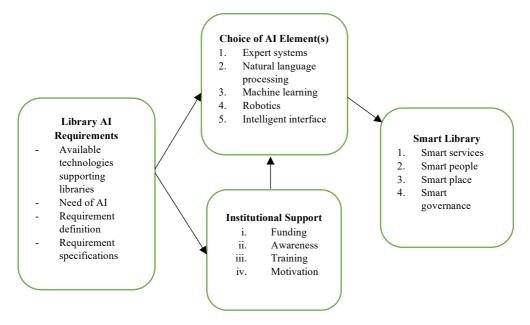

Figure 1: A conceptual framework for transforming academic libraries in Tanzania.

Source: Researcher (2022)

Conclusions

AI as explained by a good number of authors has been used as one of the technologies in transforming libraries into smart libraries. There are a good number of possible applications of AI implemented and they have been creating a positive impact on libraries. This has proved that applications of AI save time and money in almost all sectors of society. The application of AI in academic libraries has been increasing at a very high speed. As the author of this paper discussed that the implementation of AI in libraries has triggered the discovery of many new ideas and has changed the way libraries have been working. Smart library transformation provides one of many academic excellences whereby a library contributes.

AI systematically tops popular lists of the most imperative emerging technologies. With mixed feelings of fear and eagerness, readers seem to agree that AI shapes future libraries. With the smart library technology described in this study, such operations as book scanning, borrowing, returning and counting books are carried out easily for library employees and users. The counting, borrowing, returning and book security of books are done more successfully by using RFID tags which brings efficiency to library functions. The conceptual framework explained in this study is suggested for the environment in emerging economies like Tanzania as a starting point and can be easily updated accordingly depending on the needs and the available technologies.

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