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Emerging technologies in academic libraries: prospects and challenges in Nigeria

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Abstract
This paper explores the prospects and challenges associated with emerging technologies in Nigerian academic libraries. A systematic review of literature was employed for the study. Thematic analysis was applied to synthesize insights from diverse studies. The findings reveal that the integration of technologies such as artificial intelligence (AI), robotics, automated systems, and electronic security has significantly transformed library services. Emerging technologies enable enhanced efficiency, streamlined operations, and broader access to digital resources, promoting inclusivity and improved user engagement. However, the review also highlights several challenges impeding their adoption. These include inadequate infrastructure, financial constraints, limited technical expertise among librarians, and societal resistance due to fears of job displacement and privacy concerns. Despite these barriers, the prospects for leveraging emerging technologies remain promising. Libraries are increasingly adopting AI for personalized user interactions and robotic systems for automating tasks like shelving and cataloging.

Keywords: Emerging technologies, Artificial intelligence, Robotics, Academic libraries, Circulation Services, Nigeria.

Introduction

Emerging technology which has the internet and information and communication technology (ICT) at its forefront, has brought a paradigm shift into librarianship and library services across the entire globe, and Nigeria is not exempted. Academic libraries in Nigeria are rich in various collections of information resources such as; journals, magazines, books, reference works, newspapers, government publications, reports, theses/dissertations, databases, CD ROMS, artworks, photos, manuscripts, and many more covering different subjects to serve the academic community. In recent years, automation has played a vital role in library systems and handles tasks

of acquisition, cataloging, serials, and circulation. Rafiqu et al. (2021) stated that libraries are automated, networked, and now progressing through fewer paper or virtual libraries.

Library services have changed from conventional to hybrids. Most libraries now render both print and digital services. Academic libraries are the libraries that are situated in tertiary institutions such as university libraries, polytechnic libraries, colleges of education libraries, and a host of others. They provide support to the academic activities of the host institutions on research, teaching, and learning. According to Ngeme et al., (2022), university libraries over the centuries have played a critical dimension in supporting teaching and research of their host institutions. This is done through the provision of information resources. Most academic library resources are now digitalized because the use of digital technology is an innovation. The emerging technologies could be hardware and software or a combination of both. Examples are the use of computers, mobile phones, computer apps, social media, and others.

The emerging technologies have changed the mode of information dissemination in academic libraries. Shashikumara, et al (2019) declared that traditional library users ask questions at the reference desk and check out physical books. But now the library also has a new type of its users who bring several electronic devices and expects those devices to work with the library's technology. They want to plug into the library's computers, connect to the library's Wi-Fi network, and upload and download content from their device to Facebook, Instagram, or YouTube. They want to download e-books, digital audiobooks, and music, recharge their devices, and others. Library users who love to read print books, magazines, and newspapers are moving from print to digital formats. Moreover, due to the new technology trends libraries have migrated to e-readers' services, e-technical services, e-cataloging, e-collection, e-serials, and others like every other business sector. Some cases abound like e-services, e-banking, e-billing, e-payment, e-commerce, e-business, e-governance, e-learning, e-libraries, and the like (Elegbede, 2016). Most academic libraries in Nigeria are now rendering e-services and e-resources to their users. This paper explores the use of emerging technologies tools in circulation or readers' services and the use of electronic security technology systems in academic libraries in Nigeria.

Emerging Technologies used in Circulation Services of Academic libraries in Nigeria

Circulation services in the library involve the dissemination of information resources acquired by the library to the library users. The daily routine of readers' services in a library is to ensure adequate circulation of information resources among library users. Circulation services involve any service that ensures the circulation of library resources among the readers for reading and reference purposes. The most common activities in the circulation unit of academic libraries are checking materials out, receiving returned materials and administering fines and procedures for late or lost materials. We have entered the knowledge age where social networking technologies are changing business, media, and political structures. Users can now access information wherever and whenever. The increased connectivity has changed the pace at which knowledge and information are dispersed (Winthrop & Mcgivney, 2016). Academic Libraries are digitizing their collections not only to preserve them but also to provide more access to their content from multiple locations and provide avenues to enrich the teaching and learning environment which is virtually impossible with traditional printed materials. (Kalu & Akidi, 2021). Emerging technologies have brought about changes in the activities of circulation of information in libraries because library

users need not to be physically present in the library before they can access the information of a library due to different emerging technologies of Information and communication technologies, (ICT), like: automated check – out and check-in system, open access software, robots artificial intelligence and electronic security system have changed the modes of information dissemination academic libraries in Nigeria.

1. Automated check-out and check-in system
2. Open access software
3. Robotic (Artificial Intelligence)
4. Electronic security system technology

Automated Check-out and Check-in System

This is an automated circulation system where the manual system of operation is replaced with a computer-based system of operation (Indraji et al., 2024). In this system, the books and other library collections are checked - out and checked – in through a computer. The library has a web-based catalog that shows the details of the library holdings e.g. books, journals, etc. and their availability in the library including the record of registered users of the library is also available on the computer (Odunlade & Ojo, 2023). This is made available through the emerging technology of integrated library management software. This circulation module performs the following services: lending, return, renewal, and putting on hold, sending reminders (Akawu et al., 2024). A registered library user can be able to access the resources of the library through an automated method.

The implementation of automated check-out and check-in systems in Nigerian libraries reflects a shift towards digital innovation aimed at enhancing user experiences and operational efficiency. Odunlade and Ojo (2023) highlight that the pandemic accelerated the adoption of automated systems in academic libraries, enabling seamless transactions and reducing physical interactions. These systems often integrate with Library Management Systems (LMS) to allow users to borrow and return books independently, using RFID (Radio Frequency Identification) or barcode technology. This advancement aligns with the broader digital transformation efforts to improve service delivery and ensure sustainability in library operations.

Similarly, Akawu et al. (2024) examine the evaluation of LMS in Nigerian federal university libraries, emphasizing the importance of automated systems in streamlining library workflows. They note that these systems not only enhance user satisfaction but also reduce manual labor, allowing library staff to focus on more value-added services. The study highlights challenges such as inadequate funding and technical expertise, which can hinder the full-scale implementation of such systems. Beyond operational efficiency, automated check-out and check-in systems also offer libraries the ability to collect valuable usage data. This data helps in understanding user preferences and optimizing collection management. However, the success of these systems depends on addressing infrastructure challenges and providing adequate training for both staff and users.

Open Access Software

Open Access software makes information available to scholars free of charge, circulation unit of any academic library aims to disseminate information to scholars, researchers, and faculty members at no cost or minimal cost. One of the major tasks of academic libraries is circulating the resources of the libraries. Users have access to the resources of the libraries for utilization. Due to the increased demand for scholarly articles and the technological advances of the internet, open access is quickly becoming a major priority among research libraries today (Chiware, 2024; Rafiq et al., 2021). The term "Open-Source Software" (OSS) refers to computer applications and operating systems released under terms allowing users to use, modify, or redistribute the software in any way they see fit, without requiring users to pay the creators a fee (Segall, 2021). The mission of circulation services of libraries and open-source software (OSS) initiatives are very similar because OSS is based on sharing, collaboration, as well as the free and open exchange of intellectual property.

The main circulation unit of a library ensures the maximum use of library information resources (Ibegwam, Agboke & Ezeibe, 2023). The adoption of the technology of Open Access in academic libraries is very important because it is free no subscription rate attached; users freely have access to the information in open-access software**.** Examples are Open Access (OA) journal publishing. One of the major barriers for scholars and researchers in tertiary institutions in Nigeria is the lack of access to the current literature on their subject, much of which may be published in journals that have high annual subscription rates and are too expensive for many academic scholars and researchers to access, open access made accessibility possible. Open Access is the free, immediate, online availability of research articles combined with the rights to use these articles fully in the digital environment (SPARC, 2023).

Examples are Open access (OA) journal publishing. Open-source code, like OA journals, is freely disseminated, easily archived on multiple sites such as ReaseachGate, and Google Scholar, etc (Mullen, 2024). Google's partnership with libraries around the world, for example, has digitized and made available online 20 million books previously confined to the walls of elite institutions. ResearchGate is a social network for academics to share their OA articles, preprints/post-prints of publications, and other authorized copies of their research. It's similar to an individualized institutional repository. It boasts one hundred million articles, despite only a fraction of those articles being from OA journals. However, it seems that many of these copies are publisher PDFs. Open-access software supports the free dissemination of information in academic libraries. It has gained considerable momentum in recent years among librarians in institutions of higher education, spurring funds dedicated to supporting authors who wish to publish in open-access journals, the creation of library-run online open-access journals, and open-access mandates for faculty members.

Use of Robotics and other artificial intelligence as circulation tools in academic libraries

A robot is a system that can perform difficult tasks with the assistance of coded programmes using computers. Robotic technology is a disruptive technology that has revolutionized information dissemination in libraries. Robotics and artificial intelligence (AI) developments are having an impact on the circulation of library services in this era of emerging

technologies. According to Nepali and Tamay (2022), libraries have integrated robotics with other AI technologies like a drone being controlled by a robot to make sure that the library is always under surveillance. Talking robots can be placed in various sections of the library as a user aid and guide. Circulation unit routine services and work in the library can be performed by robots. For example, robots can perform the functions of shelf reading of books, checking in and out of books. There are self-directed shelf reading robots, virtual reality, virtual agents, and intelligent robots for reference services and circulation shelf-reading record maintenance (Ashiq et al., 2021).

The librarian can control the robot with the remote or technologies of artificial intelligence and virtual reality. Robots are used for various purposes in day-to-day life and are part of the library's innovative progress. Odeyemi, (2019) investigated infrastructural readiness and potential for academic libraries in Nigeria through the use of Robots in rendering library services. The finding of this research reported that all the participant were aware of the use of Robots in the library. The authors further concurred that robots are used for day-to-day activities of the library and are part of the library's innovative progress. Disruptive technology, economy, and competition have created a desire to do work in less time, for instance, library management robot (LMR) will mitigate the problems by collecting the books from the library counter and then arranging the books, one by one, into shelves. They also agreed that the deployment of robotic systems will minimize the efforts required to arrange books in a library because libraries consist of thousands of books and there are few employees to arrange them which will save time. Considering the advantages of robots in the circulation of library services, the study also made us understand that funding of such infrastructure and other challenges will impede the use of academic library services in Nigeria.

Use of Electronic Technological Security System

Electronic security systems are modern technological devices that are used with the aid of electrical apparatus to secure library materials. According to Song et al., (2018), electronic security systems are technological devices used with the aid of electrical gadgets, terminals, and circuits to protect and secure library collections from theft, mutilation, and sudden disappearance. The security of academic libraries in Nigeria is a major concern to the librarians because so much funds have been expended on the collections therefore, there is a need to ensure adequate security of the resources from book theft and mutilations. If the books are not secure it hinders the provision of good library services to the users because users' information needs will not be satisfactorily met. Aba et al. (2016) opined that video surveillance and closed-circuit television (CCTV) systems serve as a way to monitor and record security, deter crime, and ensure safety. CCTV can also be used to identify visitors and employees, monitor work areas, deter theft, and ensure the security of the premises and other facilities.

Kumbhar and Veer (2016) submitted that the various library security technologies and systems available today include Radio Frequency Identification (RFID), 3M Technology, Magnetic tackle tape, and web cameras. Aba et al. (2016) concurred that they are two basic elements of electronic surveillance. Primarily, the device or 'trigger' that is fitted into each book-hardback, paperback, or journals; cassettes, records, discs, etc. This trigger is very discreet and when concealed within books is virtually undetectable. Secondly, the free-standing sensing installed at the exit such as the metal detective door of the library also serves as a means for curbing

theft and mutilation. Books left on the shelf or the reading tables are sensitized and remain so until a book to be borrowed by a patron is desensitized at the issue desk by the library staff and the patron then exits from the library. Except the book is checked out, the trigger sounds an alarm that alerts the security personnel at the gate. Trapskin (2008) stated that Closed Circuit Television (CCTV), Cameras; Radio Frequency Identification (RFID) systems, Surveillance Cameras; metal detectors, door intrusion alarms; delay devices, panic alarms, and heat sensors are useful in detecting security patterns and ensuring effective security strategies in the protection of library materials. The electronic security systems helped to control book theft and mutilations in academic libraries in Nigeria since the traditional way of manually checking patrons is found to be ineffective and unfriendly.

Challenges that Impede the Use of Emerging Technologies in Academic Libraries in Nigeria

The integration of emerging technologies in academic libraries in Nigeria holds great potential but faces several challenges that impede its widespread adoption. One of the foremost barriers is the inadequate technological infrastructure in Nigerian academic libraries. Oyetola et al. (2023) emphasize that the lack of stable internet connectivity, poor power supply, and outdated hardware are significant impediments to leveraging artificial intelligence (AI) and robotic technologies. Similarly, Tella (2020) discusses the infrastructural deficiencies that hinder the deployment of robotics, noting that many libraries lack the physical and technical environment necessary to accommodate these systems.

Financial limitations also pose a major challenge. Oladokun et al. (2023) highlight that the high cost of acquiring and maintaining emerging technologies, such as AI and robotics, often exceeds the budgets allocated to academic libraries. This financial constraint is further compounded by limited government funding and a lack of alternative financing options for technological investments. Further, the readiness and capacity of library staff to adopt and utilize emerging technologies are also significant concerns. Owolabi et al. (2022) and Lund and Wang (2023) point out that there is a lack of adequate training and professional development opportunities for librarians to acquire the technical skills required for AI and robotics integration. These studies reveal that the gap between technology adoption and staff competency undermines the effective implementation of emerging technologies.

Cultural resistance and ethical dilemmas further complicate the adoption of new technologies in libraries. According to Yoon, Andrews, and Ward (2022), perceptions of AI and related technologies often evoke fear of job displacement and concerns about user privacy. Ajani et al. (2024) add that societal skepticism towards robotics and AI in libraries can create resistance among both staff and patrons, slowing adoption rates. The absence of robust policies and strategic frameworks for implementing emerging technologies in Nigerian academic libraries is another obstacle. Cox (2023) discusses the need for libraries to establish clear governance structures and ethical guidelines to manage the complexities associated with AI-driven services. Without these, the use of emerging technologies remains fragmented and inconsistent.

Prospects of emerging technologies in academic libraries in Nigeria

The prospects of emerging technologies in academic libraries in Nigeria are promising with the potential to revolutionize service delivery, enhance access to information, and streamline library operations. These advancements are particularly significant in the context of artificial intelligence (AI), robotics, and other digital innovations, which are increasingly being explored in library settings globally and Nigeria. Emerging technologies such as AI-powered tools and robotic systems have the potential to significantly enhance the quality and efficiency of services offered by academic libraries. Oyetola et al. (2023) highlight that AI applications, including intelligent chatbots and recommender systems, can support personalized user interactions and improve information retrieval processes. Similarly, Lund and Wang (2023) emphasize the role of AI tools like ChatGPT in assisting with academic research, creating content summaries, and addressing user queries, thereby expanding the scope of library services.

Robotic technologies also present exciting opportunities for streamlining routine library tasks. According to Tella (2020), robots can automate activities such as shelving, inventory management, and book delivery, reducing manual workload and enhancing operational efficiency. Oladokun et al. (2023) further discuss the implications of robotic systems for academic libraries, noting that their adoption could free librarians to focus on more complex and intellectual tasks, such as research support and information literacy training. Emerging technologies are particularly promising in broadening access to knowledge and fostering inclusivity in academic libraries. Asemi, Ko, and Nowkarizi (2020) point out that intelligent systems, including expert systems and AI algorithms, can facilitate access to diverse and specialized resources, making libraries more inclusive for users with varying needs. This aligns with global trends towards democratizing information access through digital innovations.

The adoption of emerging technologies also creates opportunities for innovation and professional growth within the library profession. Cox (2023) underscores that librarians equipped with competencies in AI and digital technologies can redefine their roles and contribute to cutting-edge developments in academic libraries. Yoon, Andrews, and Ward (2022) similarly note that embracing these technologies encourages a shift towards more innovative and adaptive library practices, ultimately enhancing the relevance of libraries in the digital age.

Conclusion

The study underscored the transformative potential of emerging technologies in reshaping library services within Nigerian academic institutions. The study argues that academic libraries are positioned to enhance user experiences and streamline operations through the integration of AI, robotics, automated circulation systems, open-access platforms, and electronic security technologies. These technologies provide a means to expand access to information, democratize resource distribution, and adapt to the evolving digital needs of users.

Artificial intelligence applications, such as chatbots and recommendation engines, have been identified as pivotal in personalizing library services. AI enables libraries to offer dynamic responses to user inquiries and improve research support, fostering a more interactive and user-centric environment. Similarly, robotic technologies are redefining traditional library workflows

by automating routine tasks, such as book shelving and inventory management, thereby freeing staff to focus on higher-order responsibilities. Further, open-access platforms represent another cornerstone of technological innovation, providing unrestricted access to scholarly resources and bridging gaps in resource availability. These platforms align with global trends in knowledge democratization, facilitating equitable access to high-quality information for students, researchers, and faculty members. Additionally, electronic security systems have emerged as indispensable tools for safeguarding library collections, effectively curbing theft and resource misuse.

Despite these advancements, significant barriers impede the seamless adoption of these technologies. Limited technological infrastructure, characterized by unreliable internet connectivity and power supply, continues to restrict implementation. Financial constraints further compound these challenges, as many libraries struggle to allocate resources for procuring and maintaining advanced systems. Moreover, skill deficits among library staff and societal apprehensions about automation's impact on employment exacerbate the complexities of adoption. However, addressing these challenges demands a strategic approach, involving increased investment in infrastructure, capacity-building initiatives for library staff, and advocacy for supportive policies. Public-private partnerships and international collaborations could also play a vital role in overcoming financial and technical hurdles.

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