Readiness to Adopt Robotic Technology in Nigerian Public Libraries: Strategies for Improving Information Service Delivery

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Abstract
The study investigated the readiness to adopt robotic technology in Nigerian public libraries as a strategy for improving information service delivery. The study employed a purely qualitative research approach. The population for the study comprised librarians who have been certified by the Librarian Registration Council of Nigeria. The participants chosen were the head librarian of each public libraries because they control the affairs of each library. One head librarian from each geo-political zones in Nigeria was purposively selected; this gave total of six librarians who participated in the study. Thematic analysis techniques were adopted for this study. The findings indicate that Nigerian public libraries are not fully ready for the adoption of robotic-technology in libraries. The findings also show that the Nigerian librarians unanimously agreed that robotics have the potential to greatly transform library services. The librarians identified several tasks that robots could handle, including collecting and organizing books, providing guidance and directions, and offering multilingual support. However, Librarians' perspectives on the adoption of

robots in libraries revealed several key factors. These include the need for a strong technological infrastructure, sufficient funding, and resources for robotics technology. Librarians' knowledge and training in operating robots are crucial, as are user acceptance and engagement. As a result of these findings, the study recommends that Nigerian public libraries should focus on enhancing their technological infrastructure, providing training to librarians and staff members in robotics, and actively engaging library users in the process of incorporating robots into library services.

***Keywords:** **R**obots adoption, Readiness, Public libraries, Information Service Delivery.*

Introduction

In the recent past, public libraries have played a vital role in communities by preserving cultural heritage and providing access to information and knowledge. They engage in various tasks related to information services and library operations to fulfil their mission. Their primary objective is to support research by collecting, preserving, and making a wide range of information resources available to their community. Public libraries are globally recognized as essential institutions that cater to the information needs of diverse segments of society, including students, academics, researchers, business professionals, job seekers, and lifelong learners (Kee et al., 2023). These libraries demonstrate an impressive capacity for innovation by actively incorporating the latest technological trends into their services to meet the evolving needs of users (Perez-Montoro, 2019). As highlighted by Tella and Ajani (2022), public libraries are not only adapting to the dynamic digital landscape but also shaping it.

In the realm of education, public libraries serve as catalysts for transformative learning experiences, recognizing the importance of staying at the forefront of the ongoing digital revolution (Earman, 2022). This shift positions libraries beyond their traditional roles, transforming them into intelligent spaces that foster interactive and dynamic learning environments (Okunlayaet al., 2022). This transformation has become increasingly evident in recent years as libraries leverage cutting-edge digital technologies to enhance the user experience (Perez-Montoro, 2019). Examples of these transformative technologies include virtual reality, offering immersive simulated environments; augmented reality, overlaying digital content onto the physical world; immersive reality, providing multisensory experiences; sensory immersion, engaging users through their senses; gesture recognition, enabling intuitive interaction; and humanoid robots, contributing to the interactive and dynamic nature of intelligent spaces (Tella & Ajani, 2022; Ajani et al., 2023). By seamlessly integrating such technologies, public libraries actively shape the future of education and

knowledge dissemination (Ylipulli et al., 2023), solidifying their indispensable role as pillars in our digitally-driven society.

Initially, robots were used for industrial operations, but robots are now finding applications in a wide range of sectors. Notably, modern robots have evolved in the last two decades. It has now been used across fields such as industrial robots, which are being used in industrial environments, medical robots which are primarily being used in surgery, Military robots in armed forces, Space robots in space operations and the most popular Humanoid robots, which resemble humans (Dilip Yadav &Bundele, 2021). Therefore, as robots are in wide use across various fields, their use in modern libraries is not an exception. According to Hou et al. (2020), the rapid development of robotics and artificial intelligence technologies as well as the commercial availability of these technologies are making inroads into libraries. Beyond automated storage and retrieval systems, we now have autonomous shelf reading robots, telepresence and humanoid robots, and Chabot and voice-activated systems. These Robots are now becoming our co-workers and several libraries around the world have deployed different robots for internal operations as well as public services. This combination of skilled human resources and robotics technologies also complements library services in the fourth Industrial Revolution (4IR) era.

Similarly, Tella (2020) emphasized the use of robot technology is no more news. Many libraries across the world have resulted to using humanoid robots to serve different library operations. The use of robots in libraries can now offer solutions for tasks such as book sorting, customer service and facility management. However, these initiatives have changed their user experience and made information discovery more intuitive, accessible and entertaining (Cotera, 2018). It should be noted that public libraries have rich collections of various information materials (journals, magazines, books, reference works, newspapers, government publications, reports, theses/dissertations, databases, CD ROMS, artworks, photos, manuscripts, etc.) covering an array of subjects to serve the public. Diverging from the body of literature that highlights the successful integration of robots into the operations and services of public libraries in developed nations, as pointed out by Akinola and Afolabi (2020), it is evident that a significant proportion of public libraries in African countries, specifically Nigeria, have not embraced robotic technologies. This delay can be ascribed to multiple factors, with infrastructure and funding challenges being notable contributors. Therefore, this study seeks to explore the readiness to adopt robotic technology in Nigerian public libraries and to look into the prospective opportunities they might offer in the future.

Research Objectives

Three research questions were drawn up for investigation in the study. They are:

1. What is the level of readiness of Nigerian public libraries in the adoption of robotic technology in supporting the provision of

library and information services?

2. What are the services that are currently available in Nigerian public libraries that can be potentially rendered through robotic technology?

3. What are the potential factors that may influence the facilitation of robotic technology in providing library and information services in Nigerian public libraries?

Literature Review

Originally, in the early 1960s, robots were employed primarily within industrial and factory settings to handle labour-intensive and perilous tasks (American Library Association, 2015). Fundamentally, a robot denotes a machine capable of autonomously executing a complex sequence of actions by a pre-set computer program. Its structure consists of three fundamental components: the controller, the mechanical element, and the sensor. The controller serves as the central processing unit, governed by a computer program that transmits directives to the robot's mobile segments. Mechanically, the robot integrates motors, pistons, grippers, wheels, and gears, facilitating the execution of lifting, grasping, rotating, and locomotion. Simultaneously, the sensor enables the robot to perceive its environment, enabling it to assess dimensions, forms, and distances between objects.

Recently, the advancement of robots in conjunction with artificial intelligence has resulted in the emergence of more intelligent, adaptable, and human-friendly robots. These robots, termed 'humanoid robots' or 'social robots,' possess the capability to operate in social settings, characterized by a physical structure and properties that bear resemblance to the human body (Yamane & Murai, 2019). Recognizing the potential, numerous industries and cooperative organizations are now acknowledging the importance of incorporating these AI-powered robots into their operations. According to Tella (2020), the integration of AI and robot technology has brought about significant transformations in the provision of information services within libraries, introducing changes in internal operations, public services, and automated information storage and retrieval systems. As a result, the influence of robots extends not only to libraries but also to the broader information and social environment within which libraries and librarians operate, as highlighted by Owolabi et al. (2022).

The incorporation of robots within library settings allows librarians to allocate their time and resources more effectively, catering to the ever-evolving demands of contemporary information services. As outlined by Harisanty et al. (2020), robot technologies have found application in various facets of library operations, encompassing tasks such as organizing and locating library resources, enhancing security measures, addressing repetitive reference and directional inquiries, facilitating outreach efforts, and engaging in public relations activities through library tours, as well as instructing on information

literacy. Moreover, the integration of robots has facilitated the implementation of automated storage and retrieval systems, contributing significantly to the efficient management of library space (Echedom and Okuonghae, 2021).

Schaffhauser (2019) defines a "humanoid" as a robot with human-like characteristics, capable of engaging in various activities such as conversation, storytelling, dancing, and instructing individuals of different age groups on coding. Moreover, humanoid robots have demonstrated their utility in public relations by assuming roles such as library greeters or concierges. The same source further suggests that these robots possess the ability to identify the direction of sound, move towards it, conduct facial recognition for attributes like gender, age, and mood, detect breathing, and adjust the lighting in their eyes and ears. They are equipped with a head sensor that allows them to switch between sleep and wake modes upon human interaction.

Additionally, the robots have been programmed to introduce themselves, provide information about their origin, offer weather forecasts, and acknowledge the birthdays of both the robot itself and various library users. Furthermore, the robots are capable of recognizing specific individuals, including library staff members. In essence, these humanoid robots, resembling human beings in appearance, are actively employed in public libraries for tasks encompassing coding instruction, library guidance, and engaging social interactions like conversation, storytelling, and dancing. Libraries utilize robots to access physical materials through a real-time web interface. Upon user activation, the system deploys a robot to retrieve the requested item, as highlighted by OkpokwasiliNonyelum (2019).

Subsequently, the robot transfers the item to another robotic system that automatically opens it, flips through the pages, guides students to relevant bookshelves, and retrieves newspapers from any specific date and time, as indicated by Norwin (2020). Specifically tailored for children, robots contribute to coding education, storytelling, and active participation in show-and-tell sessions. Moreover, research by Nguyen (2019) suggests that robots can positively impact children, especially those with autism, fostering confidence, affection, and increased interaction. This interaction often leads to novel language learning experiences, with many participants engaging in enjoyable English practice facilitated by the robot.

Humanoid robots are designed to engage library-goers, entertain them, and encourage their involvement within the library community, as proposed by Nguyen (2019). Moreover, the integration of an expert system within the library, proposed by Das and Islam (2021), can aid patrons in sourcing specific information and learning about proper referencing. By establishing strategic partnerships with parent institutions, universities, and robotics centres, public libraries can effectively implement and leverage emerging technologies such as humanoid robots, as emphasized by the need for a well-thought-out strategic plan. Collaborative efforts between library management boards, librarians, and

robot vendors should be actively cultivated, ensuring effective communication channels are maintained, particularly in addressing any issues related to the integration of humanoid robots. As the utilization of humanoid robots within libraries continues to evolve, concerted global efforts must be intensified to maximize their potential and benefits for communities and stakeholders alike.

Additionally, in an attempt to classify various types of robots based on their areas of application, some examples of robotic services that could be relevant to libraries have been identified. For instance, shelf-reading robots can help locate books on the shelves that are missing or out of order, and they can independently scan the print collection after the library closes by detecting RFID tags included in the volumes (Cox, 2021). Another example is chatbots, which consist of a user interface like a website or messaging platform that can accept text input and use natural language processing to understand the user's intent. Chatbots can help users find books on the library's website, alert users when a book is overdue, guide users to useful library resources, and answer basic information requests, as well as redirect users to librarians for further assistance (Ali, 2019).

Tella, (2020) further stated that Robots are also employed in libraries to browse printed items in real-time using a Web interface. When the user activates the system, a robot is sent out to retrieve the required object A second robotic system will receive this item and open it and turn the pages automatically. It will also direct students to the proper bookshelves and get newspapers from any time and location.

Current application of robotics in Public Libraries across the globe

According to Kim (2017), the University of Pretoria Libraries in South Africa have implemented robots that can welcome guests and provide directions. Similarly, Covenant University acquired robots in 2018, which were programmed to navigate library stacks, pick up books, and deliver them to users.Meanwhile, Tokyo's Toshokan Library in Japan, specifically the Tokyo Metropolitan Library, has integrated humanoid robots called Nao to assist visitors (Tokyo's Toshokan Library, n.d.). These robots possess language processing capabilities and are programmed to communicate in multiple languages. Their main functions include helping visitors find books, providing information about library services, and addressing basic inquiries. The library also employs Nao robots to engage children in interactive storytelling sessions and educational activities, thereby promoting literacy and technological engagement. Additionally, the Nao robots serve as guides, leading visitors to different sections of the library and offering information about specific collections and resources. This utilization of Nao robots at the Tokyo Metropolitan Library demonstrates the potential for robotics to enhance the user experience and encourage literacy among library visitors.

Furthermore, the Helsinki City Library in Finland introduced a notable robot called Oodi, designed to enhance the user experience and provide innovative services (Helsinki City

Library, n.d.). These robots have been specifically programmed to assist library visitors with various tasks, including guiding them through the library's facilities, providing information about available resources, and helping users locate specific books or materials within the extensive collection. Oodi's interactive capabilities enable it to communicate with visitors in multiple languages, thereby improving accessibility for the diverse population in Helsinki. Moreover, Oodi acts as a bridge between the library's technological resources and its users, facilitating navigation of the digital catalogue, access to online databases, and knowledge about various services and programs offered by the library. The interactive features and friendly demeanour of Oodi contribute to creating a welcoming and inclusive atmosphere for all visitors, aligning with the Helsinki City Library's commitment to promoting community engagement and knowledge dissemination. However, it should be noted that the use of robots in public libraries in Africa is still relatively new, prompting libraries to explore innovative solutions to enhance their services and operations (Okunlayaet al., 2022).

Benefits of Robotics in Public Libraries
The integration of robotics in public libraries has revolutionized the user experience, making libraries more engaging, accessible, and technologically advanced. The benefits of incorporating robots in library settings are numerous and impactful.Firstly, robotics in libraries enhances user engagement by creating interactive and captivating experiences. This fosters a vibrant learning environment and encourages active involvement in educational endeavours (Liu, 2018). Robots can interact with users, conduct storytelling sessions, and facilitate STEM workshops, creating a stimulating and engaging atmosphere for library visitors (Das & Islam, 2021).Das and Islam (2021) noted that robots contribute to efficient information retrieval. They streamline the organization and retrieval of library resources, simplifying the process of locating and accessing information for users. By autonomously navigating library stacks and delivering books, robots save time and effort for both users and library staff.

Furthermore, robots equipped with multilingual communication capabilities enhance accessibility for diverse populations. They provide language support and guidance, assisting non-native speakers in navigating the library and accessing resources (Tuna & Tuna, 2019).Robotics initiatives in libraries also play a crucial role in promoting digital literacy. Educational programs offered by robots introduce users to coding, programming, and other digital competencies, fostering technological literacy among library visitors (Moraitiet al., 2022).In addition to these benefits, implementing robots for specific library tasks improves operational efficiency. By automating certain processes, such as book retrieval and basic inquiries, robots free up staff time, allowing them to focus on more intricate and valuable services (Tella, 2020).Moreover, robots serve as valuable tools for community outreach and engagement. They can act as

interactive guides and facilitators during library events, workshops, and programs, encouraging community involvement and active participation (Tuna& Tuna, 2019). Thus, the integration of robotics in public libraries brings about a multitude of benefits, ranging from enhanced user engagement and efficient information retrieval to the promotion of digital literacy and improved operational efficiency. These robots serve as catalysts for innovation and community engagement, transforming libraries into dynamic learning spaces.

Future opportunities for robotics in public Libraries

Artificial Intelligence and other new technological devices are the future of our public Libraries, which is to enhance user experience in all ramifications. Therefore, public libraries should incorporate the use of robotics into the library system to help users have a seamless transaction in the library. Robotics can help in areas such as interactive assistance and guidance, education and programming support, information retrieval, and display among many others.

Empirical Review

The conducted by Ajani et al. (2022) on the perspectives of librarians on the awareness and readiness of academic libraries to integrate artificial intelligence (AI) for library operations and services in Nigeria. The findings reveal that Nigerian libraries are aware of the integration of AI systems in libraries and how it is now being adopted and used in many libraries around the globe. However, this is not so in the Nigerian context. The findings also

reveal that librarians have mixed feelings about the readiness of libraries to integrate AI systems into library operations and services. Based on the librarian perception, libraries in Nigeria may likely face the problem of funding, inadequate experts, limited power supply, and limited budget to procure the technology and training personnel that will be in charge of the system maintenance. The study recommends the need for adequate funding for libraries to be able to procure, AI and other information and communication technology infrastructure; and recruitment of librarians with relevant requisite skills to work with the technology.Lin et al (2014) used a design-based approach to understand how children locate books. They recognized book location as a crucial activity in the library setting. The study's findings suggest that the library robot was effective as a mobile, humanoid service agent for navigating child clients toward resources. Books that are misplaced or out of order can be located on the shelves using shelf-reading robots. Robots can independently scan and identify the book by detecting the RFID tag in the book once the library is closed. Chingath and Babu (2015) also examined the impact of AI-enabled robots and how to implement them in a library setting. This study discussed how several libraries, such as the New York Public Library, Temasek Polytechnic Library, UMKC Library, University of Chicago Library, etc., used artificially intelligent robots and how it was effective for them. They also discussed the various library tasks that can be performed by robots, including book arrangement, sorting, retrieval,

inventory, handling of materials, user engagement, promoting library events, etc. Additionally, they stressed that it is still in its very early stage in India and will develop over time. Martinez (2021) and Decker (2015) indicated that the application of robots in libraries depends on factors like good document policy and technological resources, including strong Wi-Fi connectivity zones.

Methodology

This section delineates the approach employed to conduct the study, which includes the research design, target population, sample selection, data collection instruments, administration procedures, data analysis techniques, and the presentation of results. The study employed a purely qualitative research approach. Qualitative research is designed to collect data through interviews, observations, and open-ended surveys, facilitating in-depth exploration and further probing of responses. This method is well suited for understanding the motivations and emotions of participants, providing an empirical analysis of the current applications of robots in public libraries in Nigeria and the future opportunities they offer. The qualitative method was chosen due to its ability to reveal the perspective of librarians' readiness to use and adopt robots for library services in Nigeria. This approach allows for the collection of descriptive data, which in turn enables the researcher to draw meaningful inferences from the responses of the participants. Furthermore, qualitative research is cost-effective, particularly when self-administered. The utilization of an interview in this study provided a means to gather relevant data. Although various qualitative research methods are available (Creswell & Poth, 2018), the interview was selected due to its commonality and practicality, particularly in the current context of obtaining nuanced in-depth data from the participants.Currently, there are 38 public Libraries in Nigeria (IFLA) considering the six geopolitical zones in Nigeria. The population for the study comprised librarians who have been certified by the Librarian Registration Council of Nigeria. The respondents chosen were the head librarian of each public library because they control the affairs of each library. One head librarian from each geo-political zone was purposively selected; this gave six librarians who participated in the study.

To comprehensively address the study's three primary research questions, an interview guide was meticulously designed to ensure its effectiveness. The interview guide featured thoughtfully crafted questions; each directly aligned with the research goals, and provided clear instructions to guide respondents in completing it. Additionally, the interview included an informative explanation within the realm of public libraries on the readiness and adoption of robotic technology for library services. The interviews were deliberately adopted to ensure they capture all relevant data that directly address the study's three research questions. These questions were carefully crafted to elicit insightful responses, ultimately enhancing our understanding of the subject matter under investigation. The administration of the research was carefully planned and executed, showing meticulous

consideration. Initially, the plan was to collect data through an open-ended survey via email with the respondents. However, due to the specific nature of the study and the need for detailed and nuanced data gathering, a change in approach became necessary, leading to the adoption of an interview-based methodology. As a result, an alternative plan was developed by reaching out to participants at each library using WhatsApp audio calls and emails to convey the importance of the research. Before commencing any data collection activities, the researcher actively sought informed consent from each participant, ensuring their comfort with the adjusted approach. The discussion of consent occurred between September 12 and October 25, 2023, demonstrating a firm commitment to ethical standards. The interview period lasted for twenty-five minutes each with each participant, providing them the opportunity to express their perspectives. Throughout the entire process, participants were informed of their right to withdraw from the study at any point, and the complete interview was recorded to maintain transparency and accountability. This commitment to ethical standards, coupled with the flexibility offered to respondents, ensured the implementation of a well-thought-out and responsible research methodology.

In this study, a qualitative approach was applied to analyze data that originated from discussions. The discussions were meticulously transcribed by hand to ensure that the nuanced and authentic insights shared by the participants were accurately captured. The manual transcription process was pivotal in preserving the authenticity and vibrancy of the participants' interactions during the interview. Thematic analysis techniques systematically unearthed the depth and meaning inherent in the qualitative data collected during these discussions, contributing to a holistic understanding of the research topic.

S/N	Geopolitical zone	Selected State	Name of Public Library	Surveyed Received	Participant Code
1	North Central	Kwara State	Kwara State Library Board	1	P1
2	South-West	Osun State	Osun State Library Board	1	P2
3	North-West	Kano State	Murtala Muhammed Library	1	P3
4	South-South	Edo State	Edo State Library Board	1	P4
5	South-East	Abia State	Abia State Library Board	1	P5
6	North-East	Adamawa State	Adamawa public Library	1	P6

The above table was a result of data obtained from the Survey which was collated and manually transcribed by the researcher and reported accordingly

Results

This section presents the results derived from the analysis and transcription of data collected through an open-ended survey. The results are organized thematically

Level of readiness of Nigerian public libraries in the adoption of robotic technology in supporting the provision of library and information services:

Librarians were questioned about their readiness to adopt robotics for providing library and information services. In general, the librarians indicated that their libraries are not fully ready for the adoption of robotics in libraries. According to P1, factors such as the absence of robust internet facilities and effective communication systems significantly impede the readiness of public libraries for the seamless integration of robotic technology. The overarching concern is that the lack of adequate technological infrastructure poses a considerable obstacle, potentially hindering the preparedness of public libraries to embrace the transformative capabilities of robots in delivering library services. P 2 enthusiastically shared "The public library I head is not ready for the adoption and use of robots in libraries due to certain factors which are Funding and Resources, Hestated that: "the availability of funds and resources for investing in robotics technologies could be a significant challenge for many public libraries in Nigeria, but due to the unavailability of funds it has potentially affect our readiness for integrating robotics into library services. He further stated that: libraries in developed countries have harnessed the use of robotics in their services which has added value to current libraries' services. In alignment with the previous perspective, P3 added another dimension to the discussion by highlighting the challenges specific to a developing country like Nigeria. According to P3, "the difficulty in adopting robots in libraries stems from issues such as a poor maintenance culture, inadequate funds, and the potential impact of certain government policies." The participant underscored that the readiness for robotics adoption in libraries is intricately linked to the broader socio-economic context, emphasizing the critical role of government policies. P3 further noted that: "without supportive government policies for technological modernization in public libraries, the readiness for robotics adoption could be significantly hindered." On a positive note, the participant suggested that proactive government initiatives have the potential to serve as catalysts, facilitating the integration of robotics into library services.

Additionally, the perspectives shared by P4 and P5 align with those of earlier respondents regarding the hesitancy and lack of preparedness for the integration of robotics into library services. They underscore the apprehension among some librarians who may fear the potential displacement of their roles by automation. Moreover, the shortage of knowledgeable staff with a limited understanding of robots and their significance poses a significant barrier to the readiness, use, and adoption of robotics in library services. Contrarily, P6 expressed a somewhat optimistic view by asserting that: "the library is partially prepared for the

adoption and utilization of robotics to enhance user services." However, P5 raised a valid concern, pointing out that challenges related to maintaining the robots and other necessary resources could impede the library from fully implementing the use of robotics. This insight highlights the nuanced nature of readiness, emphasizing that while there may be some level of preparedness, addressing logistical issues and ensuring sustained support is crucial for the successful implementation of robotic technologies in library services.

Services that are currently available in Nigerian public libraries that can be potentially rendered through robotic technology:

Librarians were asked to share their views on the current services available in libraries that can be potentially rendered through robots. It is worthy of note that the participants all agreed that robots are used for various purposes in day-to-day life and are part of the library's innovative progress and the rapid advancements in technology, along with the changing economy and competitive landscape, have fostered a growing demand for efficient and time-saving work processes. In this context, robotic technology has emerged as a potential game-changer in the realm of library services. The question asked by the participants, P1 enthusiastically, mentioned: "In my opinion, robotic technology can be of great help in rendering certain services such as collecting books from the library counter and then arranging the books, one by one, into shelves, Guidance and Directional Support; Robots equipped with navigation capabilities can serve as

interactive guides, providing directions and guidance to users within the library premises, thereby facilitating seamless navigation and access to different sections and resources."

Furthermore, P2 shared insights regarding the specific application of robots, emphasizing their potential significance in providing services in the children's section of the library. According to P2: "the introduction of robots could serve as a compelling attraction for children, increasing their engagement with the library. This heightened interest could be particularly pronounced when robots are employed in delivering innovative educational programs, such as storytelling sessions, creating a dynamic and stimulating learning environment for children." P2 further noted that: "the integration of robotics in the library setting extends beyond captivating children's attention. Robots can play a pivotal role in facilitating easy information retrieval, contributing to a more efficient and user-friendly library experience." This multifaceted approach aligns with the evolving landscape of library services, emphasizing not only the potential for increased engagement among children but also the broader enhancement of information access and educational programs through the incorporation of robotic technologies.

P3 contributed additional valuable insights, underscoring the tangible advantages of incorporating robots to handle specific services in the library, thereby transforming it into a smart library. The participant identified crucial areas where they envision the utility of robots, one of which is in the

provision of Multilingual Support Services. P3 noted that; "Robots, equipped with language capabilities, can play a pivotal role in offering language support and assistance to non-native speakers. This includes providing translation services, language tutorials, and other linguistic support, thereby enhancing accessibility for a diverse range of library users." He further noted that: "the potential use of robots as security personnel at the library entrance, addressing issues such as book theft. By deploying robots in this capacity, libraries can enhance security measures and minimize the risk of theft, contributing to a safer and more secure library environment." This multifunctional role of robots aligns with the vision of a smart library, showcasing their versatility in improving both accessibility and security within the library setting.

However, P4, P5, and P6 express similar perspectives as their peers, elaborating on the possible applications of robotic services in a library context. These participants identified additional areas where robots could offer valuable assistance. A notable application is in the domain of current awareness, where robots engage with users to share information about recently acquired materials. This interactive method ensures that users stay informed about the latest additions to the library collection, promoting heightened awareness and optimizing the utilization of available resources P5 and P6. Additionally, the P5 underscored the significance of robots in promoting library events and programs. He noted that: "Robots can effectively function as tools for publicizing upcoming library activities, initiatives, and events. Serving as interactive information disseminators, they actively involve users in various library activities and community outreach programs." P4 stated that: "this creative utilization of robots not only enhances awareness but also nurtures active participation and community engagement, aligning with the evolving role of libraries as vibrant centres of information and community interaction."

Factors influence the adoption and use of robots by librarians in providing and accessing library and information services

Librarians were questioned to share their perspectives on factors that could influence the adoption and use of robotics to provide information services. Mostof the participants have similar views on the factors that influence the adoption and use of these robotic technologies. In the view of P1: "The presence of sophisticated technological infrastructure, encompassing dependable internet connectivity, compatible hardware, and software support, plays a pivotal role in facilitating the inclusion of robots in library services. P2 noted that "adequate funding and allocation of resources for the procurement, upkeep, and advancement of robotics technology can significantly affect the capacity of librarians to successfully incorporate and utilize robots within their library environments. He further stated that Keeping abreast of the latest trends and innovations in robotics and artificial intelligence will empower librarians to evaluate the potential applications and advantages of

integrating robotics technology into their library services.

As stated by P3, "the proficiency of librarians and library staff in understanding and operating robotics technology is essential for the effective assimilation and utilization of this advanced tool. Implementing robust training programs and skill enhancement initiatives can significantly fortify librarians' readiness to embrace and seamlessly integrate robotics into their service provisions." Additionally, P4 emphatically noted that: "one critical aspect influencing the adoption and use of robotics in libraries is the acceptance and engagement of users with this technology. Understanding user inclinations, expectations, and comfort levels in interacting with robots becomes paramount. Knowing these will aid libraries in devising and implementing robotics-based services that align with user requirements, ensuring that these technological advancements enhance the overall user experience."

As articulated by P5 and P6, a supportive organizational culture coupled with a strong leadership commitment to technological advancement serves as a foundational element in cultivating an environment conducive to the adoption of robots in libraries. P5 noted that: "this supportive culture will encourage librarians to actively explore and seamlessly incorporate robotics to elevate service delivery and enhance user experiences. Furthermore, P6 shared that: "the presence of well-defined policy frameworks and guidelines governing the utilization of robotics in libraries provides librarians with a structured approach. This structured approach will

enable libraries to navigate ethical, legal, and privacy considerations associated with the adoption and application of robots in delivering library and information services. Therefore, the synergy of organizational support, leadership commitment, and robust policy frameworks will contribute to a comprehensive and ethically sound integration of robotics in library settings.

Discussion of Findings

The study focused on the readiness to adopt robotic technology in Nigerian public libraries and to look into the prospective opportunities they might offer in the future. The findings of this study underscore the present state of readiness within public libraries in Nigeria regarding the incorporation of robotics for library and information services. A majority of respondents expressed that most public libraries face substantial challenges that hinder their readiness for adopting robotics. These challenges include limitations in technological infrastructure, financial constraints, government policies, and the need for specialized expertise. This corresponds with the findings of Ajani et al. (2022), who investigated librarians' perceptions of readiness for artificial intelligence, highlighting similar challenges such as funding limitations, a shortage of experts, limited power supply, budget constraints for technology acquisition and personnel training, and inadequate technological infrastructure. Oladokun et al.'s (2023) study also aligns with these findings, emphasizing the necessity for ample funding, particularly for acquiring AI and other

information and communication technology infrastructure, as well as recruiting skilled librarians capable of working with such technology. The study also identifies various library services that could benefit from the integration of robotics technology, including resource retrieval, current awareness, event and program promotion, digital literacy training, guidance and directional support, interactive educational programs, multilingual support services, information retrieval assistance, security services, and book shelving. Utilizing robotics technology to enhance these services has the potential to improve operational efficiency, expand service capabilities, and create more interactive and user-friendly environments within Nigerian libraries. It is crucial to highlight that the adoption of robotics in Nigerian libraries should be tailored to the specific needs and requirements of local communities, taking into account the available technological infrastructure and resources. This approach aligns with Chingath and Babu's (2015) study, which explored the impact of AI-enabled robots in libraries, citing examples such as the New York Public Library, Temasek Polytechnic Library, UMKC Library, and the University of Chicago Library. These libraries successfully employed artificially intelligent robots for various tasks, including book arrangement, sorting, retrieval, inventory management, material handling, user engagement, and promotion of library events. The discussion extends to the identification of influential factors such as policy frameworks and regulations, organizational culture, leadership support, staff training and expertise, and

user engagement. These factors act as a guiding compass for librarians to effectively adopt and utilize robots, enhancing library and information services and creating more interactive, efficient, and user-centered environments. This is consistent with Martinez's (2021) assertion that the application of robots in libraries relies on factors like robust document policies and technological resources. Additionally, the study resonates with Decker's (2015) perspective that the effective adoption of robots in libraries requires sufficient technological facilities, including a strong Wi-Fi connectivity zone. In conclusion, these findings offer valuable insights for Nigerian libraries navigating the integration of robotics, considering the diverse challenges and opportunities inherent in the adoption process.

Conclusion

The study focused on the readiness to adopt robotic technology in Nigerian public libraries. This study concluded that the adoption of robotic technology in public libraries plays a vital role in modernizing and improving library services to meet the evolving demands of library users and communities. The findings indicate that Nigerian public libraries are not fully ready for the adoption of robotictechnology in libraries. Robotic technology brings various advantages, including increased operational efficiency and streamlined access to information, as well as interactive educational opportunities and heightened user involvement. The findings also show that the Nigerian librarians unanimously agreed that robots have the potential to greatly

transform library services. They viewed robots as essential for driving innovation and efficiency in libraries, given the advancements in technology and the changing economic landscape. The librarians identified several tasks that robots could handle, including collecting and organizing books, providing guidance and directions, and offering multilingual support. Additionally, they recognized robots as valuable tools for engaging children, improving information retrieval, enhancing library security, promoting awareness of new materials, and fostering community participation. However, Librarians' perspectives on the adoption of robots in libraries revealed several key factors. These include the need for a strong technological infrastructure, sufficient funding, and resources for robotics technology. Librarians' knowledge and training in operating robots are crucial, as are user acceptance and engagement. A supportive organizational culture and leadership commitment are important, along with well-defined policies and guidelines to address ethical and legal considerations. These findings emphasize the significance of infrastructure, funding, training, user engagement, organizational support, and policy frameworks in successfully adopting robots in libraries.

Recommendations

Based on the findings that Nigerian public libraries are not fully prepared to incorporate robotic technology, the following suggestions can be made:

1. Nigerian public libraries should prioritize improving their technological infrastructure by ensuring reliable internet connectivity, acquiring compatible hardware and software, and establishing a dependable support system. This will create a strong foundation for integrating robots into library services.

2. Libraries should invest in comprehensive training programs to equip librarians and staff with the necessary knowledge and skills to effectively operate robots. This training should cover areas such as robotics technology, programming, maintenance, and user interaction. By enhancing the expertise of library personnel, the successful integration of robots into library services can be facilitated.

3. Libraries should actively engage library users in the process of adopting robots and seek their feedback and preferences regarding this technology. This can be done through surveys, focus groups, or pilot projects. By understanding user expectations and comfort levels, libraries can customize robotics-based services to meet user needs and ensure a positive user experience.

Additionally, libraries should foster a supportive organizational culture that encourages innovation and technological advancements. This can be achieved by demonstrating leadership commitment and creating an environment that values and supports the integration of robotic technology. Furthermore, it is crucial to develop clear policies and guidelines

that address ethical, legal, and privacy considerations associated with the adoption and use of robots in libraries. These policies will provide guidance and structure, ensuring that robotic technology is implemented ethically and responsibly. By implementing these recommendations, Nigerian public libraries can enhance their readiness to adopt robotic technology and leverage its benefits in modernizing and improving library services.

Contribution to Advancing Knowledge

In the Nigerian context, there is a notable scarcity of literature that has explored Robotics in public libraries: an empirical analysis of current applications and future opportunities through qualitative research. As such, this study stands as a significant contribution to expanding our understanding of the topic.

References

Ajani, Y. A., Enakrire, R. T., Oladokun, B. D., & Bashorun, M. T. (2023). Reincarnation of libraries via metaverse: A pathway for a sustainable knowledge system in the digital age. Business Information Review, 02663821231208044.

Chingath, V., & Babu, R. (2019). Application of artificially intelligent robots in libraries. Reshaping of Librarianship, Innovations and Transformation, January, 59–63.

Cotera, M. (2018). We embrace digital innovation: IE University Library reinventing higher education. In 4th Lebanese Library Association Conference "Innovative Libraries: Paths to the future", in collaboration with IFLA Asia Oceania Section, May 9-11, Lebanon.

Cox, A. (2021). The impact of AI, machine learning, automation and robotics on the information professions: a report for CILIP. Retrieved from www.cilip.org.uk/page/research report

Das, R. K., & Islam, M. S. U. (2021). Application of artificial intelligence and machine learning in libraries: a systematic review. arXiv preprint arXiv:2112.04573.

Decker, E. N. (2015). The role of robotic telepresence in the academic library. In Encyclopedia of Information Science and Technology (3rd ed., pp. 6648-6655). IGI Global.

Dilip Yadav, S., &Bundele, C. (2021). Importance of robotic technology in different fields, 06, 986–992. IRJMETS, www.irjmets.com

Earman, N. (2022). The Changing Landscape of Public Libraries (Doctoral dissertation, University of Cincinnati).

Echedom, A. U., &Okuonghae, O. (2021). Transforming academic library operations in Africa with artificial intelligence: opportunities and challenges: a review paper. New Review of Academic Librarianship, 27(2), 243-255.

Harisanty, D., Anna, N. E. V., Putri, T. E., & Firdaus, A. A. (2020). Designing 'library smart bot' to support information services in an academic library. Journal of Southwest Jiaotong University, 55(6), 12. https://doi.org/10.35741/issn.0258-2724.55.6.15

Hou, H., Yang, J., Chen, Y., & Yu, M. (2020). A material delivery system built on the Internet of Things and the role of libraries. Library Hi Tech, 38(1), 195-209.

Kee, H. C. L., Chan, M. M. W., & Chiu, D. K. (2023). Building Social Capital in Contemporary Major US Public Libraries: Leading Information Services and Beyond. In M. Khosrow-Pour (Ed.), Emerging Technology-Based Services and Systems in Libraries, Educational Institutions, and Non-Profit Organizations (pp. 239-269). IGI Global.

Kim, B. (2017). AI-powered robots for libraries: exploratory questions: information technology satellite meeting [Conference session abstract]. Retrieved from www.library.ifla.org/id/eprint/2700/1/s08 2019-kim-en.pdf

Lin, W., Yueh, H. P., Wu, H. Y., & Fu, L. C. (2019). Developing a service robot for a children's library: a design-based research approach. Journal of the Association for Information Science and Technology, 65(2), 290-301.

Martinez-Plumed, F., Gomez, E., & Hernandez-Orallo, J. (2021). Futures of artificial intelligence through technology readiness levels. Telematics and Informatics, 58(12), 12-21.

Nguyen, L. C. (2020). The impact of humanoid robots on Australian public libraries. Journal of the Australian Library and Information Association, 69(2), 130-148. https://doi.org/10.1080/24750158.2020.1729515

Norwin, S. (2020). AI, robot and library: a new dimension in LIS [Blog post]. Retrieved from https://shohanasite.wordpress.com/2016/12/04/airobot-and-library-a-new-dimension-in-lis/

Okpokwasili-Nonyelum, P. (2019). Artificial intelligence in libraries and user satisfaction in higher institutions in Nigeria. International Journal of Research in Informative Science Application & Techniques (IJRISAT), 3(2), 2581-5814.

Okunlaya, R. O., Syed Abdullah, N., & Alias, R. A. (2022). Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education. Library Hi Tech, 40(6), 1869-1892.

Oladokun, B. D., Owolabi, A. K., Aboyade, M. A., Wiche, H. I., &Aboyade, W. A. (2023). Emergence of robotic technologies: implications for Nigerian academic libraries. Library Hi Tech News, 40(6), 15-18. https://doi.org/10.1108/LHTN-02-2023-0031

Owolabi, K. A., Okorie, N. C., Yemi-Peters, O. E., Oyetola, S. O., Bello, T. O., & Oladokun, B. D. (2022). Readiness of academic librarians towards the use of robotic technologies in Nigerian university libraries. Library Management, 43(3/4), 296-305. doi: 10.1108/LM-11 2021-0104.

Schaffhauser, D. (2019). Humanoid robot teaches coding at the public library. Retrieved from https://steamuniverse.com/articles/2019/05/21/humanoid-robot-teaches-coding-at-public-library.aspx (accessed 21 May 2022).

Tella, A. (2020). Robots are coming to the libraries: are librarians ready to accommodate them? Library Hi Tech News, 37(8), 13-17.

Tella, A., & Ajani, Y. A. (2022). Robots and public libraries. Library Hi Tech News, 39(7), 15-18.

Ylipulli, J., Pouke, M., Ehrenberg, N., & Keinonen, T. (2023). Public libraries as a partner in digital innovation project: Designing a virtual reality experience to support digital literacy. Future Generation Computer Systems, 149, 594-605.

Yusuf, T. I., Adebayo, O. A., Bello, L. A., & Kayode, J. O. (2022). Adoption of artificial intelligence for effective library service delivery in academic libraries in Nigeria. Library Philosophy and Practice (e-Journal), 6804. Retrieved from www.digitalcommons.unl.edu/libphilprac/6804