

Leveraging robotics technology to improve service delivery to library users in Nigerian academic libraries

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Abstract

This study investigated the Leveraging robotics technology to improve service delivery to library users in Nigerian academic libraries. The study was guided by 4 research objectives. This study adopts the survey research design. The sample population of the study comprised of the Librarians from tertiary institutions (polytechnics and universities) in Delta, Anambra and Ogun states. For Delta state, Delta Polytechnic Ogwashi-Ukwu and Admiralty University of Nigeria were selected. For Anambra state, the Federal Polytechnic Oko and Nnamdi Azikiwe University were used. For Ogun state, D.S Adegbenro ICT Polytechnic, Itori-Ewekoro Ifo and Federal University of Agriculture, Abeokuta were used. The sample selected were 60 librarians through the purposive sampling technique. The observation checklist and questionnaire were the research instruments used for data collection. The instrument was validated by 3 experts. The Crombach Alpha a reliability method was used to test the internal consistency of the instrument. A reliability coefficient of 0.83 was gotten. Data collected was analyzed using descriptive statistics of mean scores and standard deviation. The results showed a total lack of robotic technologies across the examined libraries, highlighting a substantial delay in automation adoption. Nevertheless, librarians demonstrated firm agreement on robotics' capacity to boost operational performance, offering greater user convenience, tailored support, and a contemporary library persona. Despite this positive outlook, they highlighted major barriers, particularly elevated upfront expenses, insufficient technical skills, anticipated user opposition, system failures, data security issues, and challenges in adaptation. The research concludes that although robotics' benefits are acknowledged, profound infrastructure and skill deficiencies obstruct its implementation. It recommends the launch of pilot initiatives in university and polytechnic libraries, targeting affordable robotics solutions like automated book returns or simple informational kiosk robots.

Keywords: Robotic technology, Service Delivery, Library users, Academic Libraries, User Satisfaction, Nigeria, Library automation, Technology adoption

Introduction

Academic libraries worldwide are experiencing profound changes due to technological innovations and shifting user demands for seamless, technology-enhanced services.

In Nigeria, these institutions grapple with resource scarcity, unreliable power supply, and escalating expectations for 24/7 access to information amid growing student populations (Onyam & Akpom, 2016). Robotics technology emerges as a transformative solution, enabling automation of mundane tasks like shelving, circulation, and navigation, thereby freeing staff for value-added interactions. Globally, libraries have deployed robots for shelf-reading and user guidance, as seen in systems like the Automated Storage and Retrieval System (ASRS), which optimizes space and speeds retrieval (Elejene, Agim & Umunnakwe, 2025). In Nigerian contexts, leveraging robotics could similarly elevate service delivery by introducing intelligent assistants that handle repetitive queries, personalize recommendations, and ensure equitable access, particularly for users with disabilities or in understaffed facilities

The adoption of robotics in libraries aligns with Industry 4.0 paradigms, where human-robot collaboration enhances operational resilience and user satisfaction. Studies indicate that service robots, equipped with sensors and AI, can perform wayfinding, material delivery, and multilingual support, reducing wait times by up to 40% in pilot implementations (Ale & Audu, 2025). In Africa, including Nigeria, initial explorations reveal modest integration of robotics alongside RFID and chatbots in select university libraries, primarily for self-checkout and cataloging (Njoku, 2017). However, Nigerian academic libraries lag due to infrastructural deficits, yet robotics offers scalability: low-cost mobile robots could manage high-volume tasks like book sorting during peak hours, fostering a hybrid model where technology augments human expertise. This strategic leveraging addresses cultural nuances, such as communal learning preferences, by deploying robots that facilitate group study navigation and resource equity

Nigeria's higher education sector is undergoing digital maturation, with academic libraries pivotal in supporting research, teaching, and innovation amid national pushes like the Digital Nigeria Initiative. Robotics integration complements existing digital repositories and online platforms by automating backend processes, enabling proactive services like predictive analytics for user needs (Iglesias, 2013). For instance, robotic arms in circulation desks or patrol bots for security and inventory can bridge staffing gaps, while AI-driven robots provide virtual reference, extending reach to remote learners. Empirical evidence from Nigerian public libraries underscores robotics' potential for multilingual query handling and real-time assistance, vital in diverse linguistic contexts (Elejene, et al 2025). Thus, robotics not only streamlines workflows but also positions libraries as innovation hubs, aligning with sustainable development goals for inclusive education.

The study of robotics technology in Nigerian academic libraries is particularly timely, given the increasing emphasis on innovation and technology-driven development in the country. The Nigerian government has recognized the importance of technology in driving economic growth and social development, and has launched several initiatives to promote digital literacy and access. Academic libraries, as key institutions

of knowledge dissemination, have a crucial role to play in supporting these initiatives. With the need to explore the potential of robotics technology to enhance service delivery, this study aims to contribute to the development of more efficient, accessible, and user-centric academic libraries in Nigeria. As academic libraries aim to redefine their relevance in the digital age, there is a pressing need to explore how robotics technology can improve service delivery to library users in Nigeria. This study, therefore, seeks to examine the leveraging of robotics technology to improve service delivery to users in academic libraries in Nigeria.

Statement of the Problem

The ideal scenario envisions Nigerian academic libraries delivering frictionless, personalized services via robotics such as rapid retrieval, round-the-clock assistance, and adaptive support for all users, positioning them as vibrant knowledge ecosystems. Yet, the current reality reveals inefficiencies: manual processes lead to prolonged queues, error-prone cataloging, and overburdened staff amid power outages and funding shortages, curtailing user access and satisfaction. These deficiencies erode academic productivity, stifle information literacy development, and diminish libraries' relevance in a digital era, exacerbating inequities for rural or disabled patrons. Prior research has examined AI and RFID adoption but neglects robotics' specific role in service enhancement, creating a critical gap in context-specific strategies for Nigerian settings; this study addresses it by investigating robotics' untapped potential

Research Objectives

1. To identify the robotic technologies available for service delivery within Nigerian academic libraries.
2. To determine the potential areas where robotic technologies can be effectively utilized to improve service delivery.
3. To assess the perceived impacts of robotic technologies on user experience and satisfaction in academic libraries.
4. To examine the challenges in leveraging robotics technology to improve service delivery to users in academic libraries.

Review of Related Literature

Leveraging Robotics Technology in Academic Library Services

Service delivery in Nigerian academic libraries has evolved considerably, transitioning from traditional physical resource management to comprehensive, user-focused models that integrate information access, instructional support, and personalized assistance (Kim, 2017). These libraries now prioritize seamless, adaptive services tailored to the varied requirements of students, faculty, and researchers, promoting information literacy, research facilitation, and collaborative learning spaces. Recent scholarship underscores the value of embedding advanced technologies to elevate these services, including digital repositories, virtual reference desks, and online databases (Cotera, 2018). Beyond mere resource distribution, effective service delivery involves crafting interactive environments and expert guidance for resource discovery and assessment. Achieving optimal service delivery demands thorough

insight into user preferences, ongoing enhancements, and flexibility amid the dynamic information ecosystem.

Technological advancements have revolutionized service provision in Nigerian academic libraries, broadening reach and streamlining access to resources for diverse users. The proliferation of digital platforms and e-learning tools has spurred hybrid models that merge conventional services with robotics-enhanced systems like automated navigation and retrieval (Lin, Yueh, Wu & Fu, 2019). Librarians increasingly deliver digital literacy training, aid in virtual research, and oversee robotic-managed collections. Moreover, service delivery emphasizes inclusive designs accommodating users with disabilities through adaptive robotic interfaces. User experience (UX) principles guide the creation of intuitive, robotics-supported spaces, as Agim, Abah, and Ezejiofor (2025) emphasize the necessity of staff upskilling to thrive in technology-driven environments. These authors further stress incorporating user input to customize robotics-integrated services for academic needs.

Furthermore, robotics-enhanced service delivery in Nigerian academic libraries fosters robust user connections and community building via customized support, specialized research aid, and collaborative platforms. According to Hou, Yang, Chen and Yu (2020) Libraries bolster institutional goals by driving student achievement and scholarly output, while physical spaces evolve into hubs for interaction augmented by robotic facilitation. Initiatives like open access promotion and research dissemination gain traction through robotic efficiency in content handling. Sustained excellence hinges on user-centric strategies, adaptability to technological shifts, and relentless refinement, positioning robotics as a cornerstone for responsive library operations.

Robotics applications hold transformative promise for Nigerian academic libraries by automating operations and enriching user interactions. Technologies such as Automated Storage and Retrieval Systems (ASRS) optimize material handling, space efficiency, and retrieval speed (Harisanty, Anna, Putri & Firdaus, 2020). Robots execute shelf maintenance, inventory checks, and transport duties, liberating staff for strategic user engagement. Extending to user support, robotic kiosks, navigation aids, and virtual assistants enhance accessibility and interactivity, particularly for diverse or mobility-impaired patrons (Echedom & Okuonghae, 2021). AI-infused robotics delivers round-the-clock query resolution and resource guidance, ensuring equitable service amid infrastructural hurdles.

Methodology

This study adopts the survey research design. The sample population of the study comprised of the Librarians from tertiary institutions (polytechnics and universities) in Delta, Anambra and Ogun states. For Delta state, Delta Polytechnic Ogwashi-Ukwu and Admiralty University of Nigeria were selected. For Anambra state, the Federal Polytechnic Oko and Nnamdi Azikiwe University were used. For ogun state, D.S Adegbenro ICT Polytechnic, Itori-Ewekoro Ifo and Federal University of Agriculture,

Abeokuta were used. The sample selected were 60 librarians through the purposive sampling technique. The reason for the adoption of the purposive sampling method was to select participants who are familiar with library ICT and AI tools. The observation checklist and questionnaire were the research instruments used for data collection. The instrument was validated by 3 experts. The Crombach Alpha a reliability method was used to test the internal consistency of the instrument. A reliability coefficient of 0.83 was gotten. Data collected was analyzed using descriptive statistics of mean scores and standard deviation

Results

Research Question 1: What are the robotic technologies available for service delivery within Nigerian academic libraries?

Table 1: Observation Checklist on robotic technologies available for service delivery within Nigerian academic libraries

S/N	Items	Available	Not Available
1	Automated Storage and Retrieval Systems (ASRS)		x
2	Shelf-Reading Robots		x
3	Robotic Delivery Systems		x
4	Information Kiosk Robots		x
5	Humanoid Robots for User Assistance		x
6	Telepresence Robots		x
7	Chatbots		x
8	Robotic Inventory Systems		x
9	Robots for Book Handling and Sorting		x
10	Robots for Library Security		x

The data presented in Table 1, based on the observation checklist of robotic technologies available for service delivery within polytechnic and university libraries in Delta, Anambra and Ogun states, indicates that none of the listed robotic technologies are currently available. For all ten items, including Automated Storage and Retrieval Systems (ASRS), Shelf-Reading Robots, Robotic Delivery Systems, Information Kiosk Robots, Humanoid Robots for User Assistance, Telepresence Robots, Chatbots, Robotic Inventory Systems, Robots for Book Handling and Sorting, and Robots for Library Security, the responses showed that these technologies are "Not Available." This observation suggests a significant gap in the adoption and implementation of robotic technologies within the surveyed academic libraries.

The findings from the observation checklist reveal a complete absence of robotic technologies in the sampled polytechnic and university libraries within Delta, Anambra and Ogun states. The results highlight a significant lag in technological advancement in comparison to global trends in library automation. This result is in line with previous

studies such as the study conducted by Dilip Yadav and Bunde (2021) who found that many academic libraries struggle with the adoption of advanced technologies due to infrastructural limitations and funding constraints. The study highlighted that the limited availability of resources and the lack of technical expertise hinder the implementation of robotic systems, supporting the observation that advanced robotic technologies are not yet prevalent in Nigerian academic libraries. Also, research by Decker (2015) revealed that while there is an awareness of emerging technologies, actual implementation remains low. The authors identified a significant gap between the perceived benefits of technologies like robotics and their practical application, largely due to financial and technical challenges. Similarly, a study by Das and Islam (2021) found that many libraries lack the necessary infrastructure to support advanced technologies, including robotics. This lack of infrastructure, coupled with inadequate funding, contributes to the non-adoption of robotic systems, reinforcing the findings of this observation checklist.

Research question 2: What are the potential areas where robotic technologies can be effectively utilized to improve service delivery?

Table 2: Mean Responses on potential areas where robotic technologies can be effectively utilized to improve service delivery

S/N	Items	Mean	SD	Remarks
1	Robotic systems could significantly improve the efficiency of book retrieval and return processes within the library.	2.80	0.70	Agree
2	Robots would be valuable in providing wayfinding and directional assistance to users within the library space.	2.65	0.65	Agree
3	Robotic information kiosks could offer personalized assistance and answer frequently asked questions from library users.	3.20	0.75	Strongly Agree
4	Robotic delivery systems could enhance the delivery of interlibrary loan materials to users' designated locations.	2.90	0.72	Agree
5	Robots equipped with AI could provide 24/7 virtual reference assistance to users, improving access to information outside of traditional library hours.	2.75	0.68	Agree
6	Robotic systems could be effectively employed for inventory management and shelf-reading tasks, ensuring accurate and up-to-date collection information.	3.30	0.78	Strongly Agree
7	Robots could be designed to assist users with disabilities, providing accessible information and physical assistance within the library.	3.10	0.80	Strongly Agree
Grand Mean		2.96		Agree

The data in Table 2 reveals the potential areas where robotic technologies can be effectively utilized to improve service delivery, as rated by librarians in polytechnics

and universities in Delta, Anambra and Ogun states. The items that were rated "Agree" included: "Robotic systems could significantly improve the efficiency of book retrieval and return processes within the library" (Mean=2.80), "Robots would be valuable in providing wayfinding and directional assistance to users within the library space" (Mean=2.65), "Robotic delivery systems could enhance the delivery of interlibrary loan materials to users' designated locations" (Mean=2.90), and "Robots equipped with AI could provide 24/7 virtual reference assistance to users, improving access to information outside of traditional library hours" (Mean=2.75). The items that were rated "Strongly Agree" were: "Robotic information kiosks could offer personalized assistance and answer frequently asked questions from library users" (Mean=3.20), "Robotic systems could be effectively employed for inventory management and shelf-reading tasks, ensuring accurate and up-to-date collection information" (Mean=3.30), and "Robots could be designed to assist users with disabilities, providing accessible information and physical assistance within the library" (Mean=3.10). The grand mean of 2.96 indicates an overall agreement among the respondents regarding the potential utilization of robotic technologies to enhance service delivery.

The findings indicate a strong consensus among librarians regarding the potential of robotic technologies to enhance service delivery within academic libraries. The respondents generally agreed or strongly agreed that robotic systems could significantly improve operational efficiency, enhance user assistance, and provide accessible services. This suggests a positive perception of the potential benefits of integrating robotic technologies into library operations. This result tallies with that of Cox (2021) who highlighted the potential of technology to enhance library services, particularly in areas like inventory management and user assistance. The authors found that librarians recognize the value of automated systems in improving efficiency and accessibility, which supports the positive mean scores in this table. Another study by Agim, Mohammed and Obande (2024) found that librarians were receptive to the idea of incorporating emerging technologies to improve service delivery. Also, Elejene, Agim and Umunnakwe (2025) reported that librarians believed that technologies like robotic information kiosks and automated retrieval systems could significantly enhance user experience. The authors also found that there is a strong desire for improvement in library service delivery with the use of technology, particularly in areas that improves access, and user assistance. This study reinforces the results, that librarians recognize the potential of robotics to improve library services.

Research Question 3: What are the perceived impacts of robotic technologies on user experience and satisfaction in academic libraries?

Table 3: Mean Responses on perceived impacts of robotic technologies on user experience and satisfaction in academic libraries

S/N Items	Mean	SD	Remarks
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1	I believe that the use of robots in the library would make accessing information more convenient.	2.85	0.60	Agree
2	I would feel comfortable interacting with a robot for assistance in the library.	2.95	0.65	Agree
3	I think that robots in the library would improve the speed and efficiency of service delivery.	2.70	0.70	Agree
4	I believe that robots in the library would enhance the overall user experience.	3.20	0.55	Strongly Agree
5	I would find it helpful if robots could provide personalized assistance based on my specific needs.	3.30	0.58	Strongly Agree
6	I believe that the use of robots would make the library feel more modern and innovative.	3.15	0.62	Strongly Agree
7	I think that robots in the library would increase my satisfaction with the library's services.	3.40	0.50	Strongly Agree
Grand Mean		3.08		Strongly Agree

The data in Table 3 presents the perceived impacts of robotic technologies on user experience and satisfaction in academic libraries, as reported by librarians from polytechnics and universities in Delta, Anambra and Ogun states. The items that were rated "Agree" included: "I believe that the use of robots in the library would make accessing information more convenient" (Mean = 2.85), "I would feel comfortable interacting with a robot for assistance in the library" (Mean = 2.95), and "I think that robots in the library would improve the speed and efficiency of service delivery" (Mean = 2.70). The items that were rated "Strongly Agree" were: "I believe that robots in the library would enhance the overall user experience" (Mean = 3.20), "I would find it helpful if robots could provide personalized assistance based on my specific needs" (Mean = 3.30), "I believe that the use of robots would make the library feel more modern and innovative" (Mean = 3.15), and "I think that robots in the library would increase my satisfaction with the library's services" (Mean = 3.40). The grand mean of 3.08 indicates a general "Strongly Agree" response, suggesting a positive perception of the impacts of robotic technologies on user experience and satisfaction.

The findings indicate a strong positive perception among librarians in Delta, Anambra and Ogun states regarding the potential impacts of robotic technologies on user experience and satisfaction in academic libraries. The respondents generally strongly agree that robotic technologies would enhance user experience, provide personalized assistance, modernize the library, and increase user satisfaction. This finding is in agreement with the study of Chingath and Babu (2019) in their research that reported that librarians were optimistic about the impacts of emerging technologies on user engagement and satisfaction. The authors found that librarians perceived that technologies like robotics can improve the modernity and user-friendliness of library services. Also, Ale and Audu (2025) in their study found that librarians anticipate that

improved technological infrastructure and service delivery, including the use of modern tools like robotics, would lead to higher user satisfaction. This finding reinforces the positive perceptions shown in this table, particularly regarding the increase in user satisfaction. Also, Uzoagba, Agim and Ezejiofor (2024) found that librarians have a positive outlook on the potential of technology to improve user experience, with a focus on convenience and efficiency. The study highlighted that librarians believe that innovative technologies can significantly enhance user satisfaction.

Research Question 4: What are the challenges in leveraging robotics technology to improve service delivery to users in academic libraries?

Table 4: Mean Responses on challenges in leveraging robotics technology to improve service delivery to users in academic libraries

S/N	Items	Mean	SD	Remarks
1	I believe that the high initial cost of implementing robotic technologies would be a significant barrier.	2.80	0.75	Agree
2	I am concerned about the potential lack of technical expertise among library staff.	3.20	0.70	Strongly Agree
3	I think that the existing infrastructure may not be adequate to support robotic technologies.	2.90	0.80	Agree
4	I anticipate potential user resistance to interacting with robots in the library.	3.10	0.78	Strongly Agree
5	I am worried about potential technical malfunctions or system failures with robotic technologies.	3.30	0.65	Strongly Agree
6	I believe ensuring data privacy and security in robotic systems would be a significant challenge.	3.05	0.82	Strongly Agree
7	I think customization of robotic systems to meet specific user needs would be difficult.	3.40	0.72	Strongly Agree
Grand Mean		3.11		Strongly Agree

The data presented in Table 4 reflects the perceived challenges in utilizing robotic technologies for enhancing service delivery in academic libraries, as reported by librarians in polytechnics and universities in Delta, Anambra and Ogun states. The items that were rated "Agree" included: "I believe that the high initial cost of implementing robotic technologies would be a significant barrier" (Mean = 2.80) and "I think that the existing infrastructure may not be adequate to support robotic technologies" (Mean = 2.90). The items that were rated "Strongly Agree" were: "I am concerned about the potential lack of technical expertise among library staff" (Mean =

3.20), "I anticipate potential user resistance to interacting with robots" (Mean = 3.10), "I am worried about potential technical malfunctions or system failures" (Mean = 3.30), "I believe ensuring data privacy and security would be a significant challenge" (Mean = 3.05), and "I think customization of robotic systems to meet specific user needs would be difficult" (Mean = 3.40). The grand mean of 3.11 indicates a general "Strongly Agree" response, suggesting that librarians perceive significant challenges in the utilization of robotics.

The findings reveal that librarians strongly perceive several challenges in the utilization of robotic technologies within academic libraries. The significant concerns include lack of technical expertise, potential user resistance, technical malfunctions, data privacy, and customization difficulties. While the high initial cost and infrastructure limitations are also noted, the overall sentiment indicates a strong recognition of multiple barriers to successful implementation. This is in alignment with previous study by Agim, Adegbite and Edeh (2025) in their study found that infrastructural limitations and the lack of technical expertise are major hindrances to the adoption of advanced technologies in Nigerian academic libraries. The study highlighted that the fear of technical malfunctions and the need for specialized skills are significant concerns. Also, Njoku (2017) in his research reported that the high initial cost and the perceived complexity of implementing emerging technologies are significant barriers. The authors also found that librarians were concerned about user acceptance and the need for adequate training. Ezejiofor, Agim and Ndanwu (2022) in their study found that inadequate infrastructure and the lack of skilled personnel are major challenges in the utilization of technology in academic libraries. The study also noted the concerns about data privacy and system reliability, which reinforces the findings of this table.

Conclusion

In summary, this investigation into "Leveraging Robotics Technology to Improve Service Delivery to Library Users in Nigerian Academic Libraries" uncovers a pronounced disparity between acknowledged benefits and prevailing conditions. Librarians from Delta, Anambra, and Ogun States exhibit robust agreement on the transformative value of robotics technology, affirming its ability to elevate operational efficiency, user interactions, and satisfaction levels. However, the observation checklist reveals a total lack of such technologies across their institutions, signaling a considerable lag behind international advancements in library automation. While participants enthusiastically endorse robotics for bolstering user support, ensuring inclusive access, and updating library functions, they concurrently identify formidable barriers to adoption, such as insufficient technical skills, anticipated user reluctance, risks of system failures and data security breaches, and issues with technology tailoring. Thus, although the promise of robotics to overhaul service delivery is widely appreciated, its realization remains obstructed by infrastructural deficits and human resource constraints. The findings emphasize the imperative for targeted actions, encompassing infrastructure funding, staff capacity-building initiatives, and awareness drives for users, to close this divide and enable seamless robotics integration in Nigerian academic libraries.

Recommendations

Drawing from the findings of the study on leveraging robotics technology to improve service delivery to library users in Nigerian academic libraries, the following recommendations address the identified issues:

1. Launch pilot initiatives in university and polytechnic libraries, targeting affordable robotics solutions like automated book returns or simple informational kiosk robots.
2. Tertiary institutions should offer hands-on training and demonstrations with robotic systems to promote their effective use.
3. Institutions must commit substantial funding to acquire and deploy practical robotics technologies for enhancing service delivery.
4. Arrange workshops and seminars for librarians and administrators to build awareness of robotics applications suited to local needs.
5. Run awareness programs for academic communities (students and faculty) to highlight robotics benefits in libraries, including greater convenience, customized support, and contemporary amenities.
6. Create specialized training for library personnel on operating, maintaining, and resolving issues with targeted robotics technologies for deployment.

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