



APPLICATION OF INTERNET OF THINGS IN THE OPERATIONS AND SERVICES OF ACADEMIC LIBRARIES IN SOUTH EAST, NIGERIA: OPPORTUNITIES AND CHALLENGES

By

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Abstract

The internet of things has a great prospect for libraries. Libraries and librarians need to embrace this smart technology, especially at this evolving stage to compete favorably in the global information service world. This research aims to investigate the opportunities and challenges that can be associated with the use of the Internet of Things in the operations and services of academic libraries in South East Nigeria. For this study, a descriptive research approach was used. The goals were to pinpoint where IoT can be applied in academic libraries, the opportunities such application brings, and note the challenges such application have in the operations and services of academic libraries in South East, Nigeria using IoT. There were 176 librarians in the study's population. It is composed of academic librarians from a few South East institutions. For this investigation, comprehensive enumeration and accidental sampling were used. A questionnaire titled "Internet of Things Questionnaire (ITQ)" was the study's tool. Frequency and percentage statistics were employed to analyze the data. The study's findings showed how IoT is used in libraries for inventory management, self-issue/return of books, user authentication, and access control, remote resource monitoring, lending sections, and book theft management. The benefits of using IoTs included timely resource delivery to library patrons, marketing and promotion of library services, a quicker book issue/return process, lower maintenance costs, easier information literacy training for library users, faster collection of more relevant and reliable information, increased library security, and improved entry and exit control. Some of the difficulties academic librarians faced while using IoT were power outages, training for tech-inclined users, budget cuts, and the expensive cost of IoT installation. The study concluded that collaboration between librarians and stakeholders is necessary to increase awareness of IoT technologies and secure financing for their deployment and use in academic libraries.

Keywords: Internet of things, wireless technologies, and computer technology.

Introduction

Computer technology, communication technology, sensor technology, and IoT have all seen rapid growth and development in recent years (Kumar, 2023). According to Abo-Seada (2019) and Yusuf, Ifijeh & Owolabi (2019), IoT is a network of networked computers, gear, people, animals, and other items that can transfer data over a network without either human-to-

human or human-to-computer contact. An assortment of gadgets or items connected through an Internet connection is referred to as the "Internet of Things." The hub for the collection, or the "things" element, is what uses the Internet to communicate and gather data. This enables the devices to recall certain patterns and routines and make judgments, allowing actions to be carried out automatically and



without the need for human intervention (Abo-Seada, 2019).

Pujar and Satyanarayana (2015) defined IoT as a platform that allows any artificial device, with or without human involvement, to connect and transmit data using a given internet. IOT is used in libraries to keep an eye on patron behavior, user reviews service efficacy, etc. For libraries to remain relevant and valuable in today's technologically advanced society, IoT technology is essential, as well as for providing the best services to the user community (Gardiner, 2021).

IoT has improved the control and functionality of library systems, leading to a closer relationship between libraries and IoT. These days, libraries provide a variety of reading services to their users, such as self-checkout and self-return of books and materials, long-term storage, and research on study patterns. The way libraries run and offer services has significantly changed because of the use of IoT technology, leading to better resource management and higher efficacy (Ehsanian, Tahmasebi, Limooni, & Ghiasi, 2022).

Research Questions

The following research question guided this study:

1. In what areas in the operations and services of academic libraries in South East, Nigeria is IoT applied?
2. What are the opportunities that IoT avails in the operation and service delivery in South East, Nigerian academic librarians?
3. What are the challenges militating against the application of the Internet of Things in the operations and services of academic libraries in South East Nigeria?

Literature Review

Internet of Things and its application in libraries

The introduction of smart technology, which embeds sensors in things to allow anything to be connected to the internet via a preset protocol, has drastically changed people's lives all around the world. Simply described, the IoT is a network of items that use processors, sensors, cloud computing, wireless networking, and other infrastructure and technologies (Bindu, 2021). The use of IoT in libraries is becoming a topic of discussion among experts. Libraries cannot

afford to fall behind in offering their patrons better information services. Improvements in information literacy, appliance management, location-based services, recommendation services, collection management, use of data, and enhanced access to the library and its materials are just a few of the advantages Pujar and Satyanarayana (2015) listed for using IoT in libraries.

Dongare (2022) found that the IoT can be effectively implemented and integrated into cloud computing and Internet-based library routines and services, such as mobile technology, location-based services, automated gate entry devices, reference services, collection development, and notification services, electronic devices, drones, automated polls, and program and event displays. In their investigation of the IoT infrastructures in fifteen Iranian tertiary libraries, Harati, Shekofteh, Valizadeh-Haghi, and Kazerani (2021) found that sixty points fifty-three (60.53%) of the libraries possessed the infrastructures necessary for IoT usage to a fair degree. According to Wojcik (2016), "IoT has the potential to improve library services by giving users tools that allow for constant contextual help, easy library use, and personalization processes." Wojcik went on to mention that IoT may be helpful for information exchange, advice and training, granting access to places and tools, compiling, characterizing, storing, analyzing and choosing collections, and marketing and promotion. IoT-enabled libraries may be able to handle the infrastructure of the library more effectively in several ways. With cloud resources for long-term planning, IoT has the potential to significantly help libraries make well-informed decisions. IoT-derived data might be stored for use in decision-making processes that support long-term resource planning for libraries, thereby improving the performance of conventional libraries (Pizam, 2017).

According to Sinha, Panja, and Brar (2022), many of their respondents supported the integration of IoT into library services and operations. They knew what IoT was about, both in general and in terms of library services. IoT technology can do a range of library tasks and



services, according to Alagumalai and Natarajan (2020). These tasks and services include collection management, online learning portals, location-based services, appliance management, information literacy, etc. Kumar (2023) claims that some of the world's most famous libraries, including the University of Chicago, Congress libraries, Seattle Public Library, Birmingham Central Library in the United Kingdom, and Seattle Public Libraries in the United States, have implemented Internet of Things (IoT)-based systems like automated retrieval, smart door locks, video surveillance, and self-checkout. These solutions were used to increase energy usage, manage library resources more effectively, boost security, and improve patron services. Libraries and academic institutions are collaborating to use digital innovation to provide staff and students with improved services to enhance the academic productivity of their staff and students (Cao et al., 2018).

In Kaushik's (2019) survey, most participants knew that IoT may be utilized for access control, user authentication, and remote resource monitoring, among other library services. These were followed by Google Glass for newspaper clippings, inventory management, book self-issue, and return, book theft control management, and text-to-speech converters. Through IoT, readers and books may be connected, providing consumers with a wide range of reader services. The IOT might support smart library administration by offering long-term preservation, intelligent self-borrowing and returning books and materials, reader behavior analysis, intelligent management, and other conveniences (Fu, 2021). Rahman and Islam (2019) provided some examples of how IoT-enabled libraries might support efficient management of the physical infrastructure of libraries, such as automatic book renewal, a fee for overusing resources, and fingerprint-based book tagging. A few IoT applications for library services and operations were mentioned by Bansal et al. (2018). These included circulation, user identification, inventory control, theft management, book reservations, and mobile references. They believe that libraries would adjust to IoT despite its initial installation hurdles, just as earlier library automation

initiatives. According to reports, library IoT installations include digital and physical resources. The primary advantages and obstacles are the ease of navigating library collections, faster service delivery, remote resource monitoring, a shortage of domain-specific experienced library employees, and problems with interoperable devices (Sinha, Panja & Brar, 2022). Because IoT applications can make user authentication easier and allow for easy remote monitoring of library resources, they represent a significant development in library technology. They can also speed up service delivery and the loan/return process for books. However, certain drawbacks to IoT applications must be recognized, such as a shortage of personnel with domain-specific training, a lack of funding and infrastructure, and installation compatibility problems (Priyanka, Ayan, & Khushpreet, 2022).

According to Ivwighrehweta and Igere's (2014) research, among the issues impeding efficient internet access at Nigerian higher institutions were power outages, sluggish internet speed, a shortage of computer terminals, an excessive number of hits or information overload, and insufficient computers. According to Ivwighrehweta (2012), Ivwighrehweta and Onoriode (2012), Ogbomo and Ivwighrehweta (2013), Ivwighrehweta and Efeverberha-Ogodo (2013), and Ivwighrehweta and Eireyi-Fidelis (2022), users and library employees are unable to fully utilize electronic resources when there is a lack of power supply. According to Muthumani, Ganesamoorthy and Selvakamal (2025), the Internet of Things has a great potential for libraries to bring more value to their services and provide patrons with a more enriching library experience. Echedom, Kakiri, and Oyadonghan (2020) and Pujar and Satyarayana (2015) noted the following aspects of library services which as benefited from the use of IoT technology to include information literacy/library orientation services, mobile reference services, user identification, theft management, inventory management, collection management, and access to the library and its resources.



According to Miorandi (2012), IoT-enabled technologies can be utilised to significantly improve the functionality of existing systems, offering less intrusive and more affordable alternatives to the widespread installation of cameras while maintaining user privacy. Abdulfatai (2024) highlights the benefits of Internet of Things (IoT) platforms, including high interoperability and interconnectivity due to heterogeneous devices based on different hardware platforms and networks, sensors that detect and measure environmental changes, and the combination of algorithms, computation, software, and hardware, allowing for interconnectedness with global information and communication infrastructure.

Makori (2017) noted that the Internet of Things (IoT) has the potential to transform academic and research information organizations as knowledge sources, in addition

to expanding access to education, data, information, and communication anywhere, at any time, through hyperconnectedness and networking. IoT has potential applications in libraries, including connecting buildings, users, resources, and services, and supporting IoT

technologies like IPV6, WSNs, RFID, and Cloud Computing (Muthumani, Ganesamoorthy & Selvakamal 2025). Noh and Son (2025) identified no compatibility standards, intricate Systems over-reliance on technology in day-to-day life, security and privacy and less manual staff as challenges militating against the applications of IoT in libraries. Abdulfatai (2024) identified data interpretation issues, lack of skilled workers, cost, online security challenges, and software complexity as major challenges in Kwara State's university libraries.

Method

The study's research design was a descriptive survey. There are 176 participants in the research. It is composed of librarians from Nigeria's Southeast area. The "Application of Internet of things Questionnaire" (AITQ) was the name of the questionnaire that was utilized as the instrument for data collecting in this research. 176 questionnaires were sent out, and 144 of them were returned and were determined to be valid. Frequency counts and percentages were used to assess the data that were obtained.

Demographic Description of the Study Participants

Table 1: Population and Response Rate

Name Of University	No of Librarians	Questionnaire Returned
University of Nigeria, Nsukka	52	37
Imo State University, Imo	41	41
Abia State University, Uturu, Abia State	38	25
Nnamdi Azikiwe University, Anambra	45	41
Total	176	144

Table 1 shows that (176) one-hundred, and seventy-six questionnaires were administered and (144) one hundred and forty-four of them were returned and found usable.

Research Question 1. What areas in the operations and services of academic libraries in South East, Nigeria is IoT applied?

Table 2: Areas of application of IoT

IoT in library services	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
Remote monitoring of library resources	65(45%)	34(24%)	13(9%)	32(22%)
User authentication and access control	41(28%)	54(37%)	17(12%)	32(22%)
Inventory management	24(17%)	41(28%)	28(19%)	51(35%)
Loan section	61(42%)	18(12%)	45(31%)	20(14%)
Self-issue/return of books	52(36%)	29(20%)	21(15%)	42(29%)



Books theft control management	43(30%)	39(27%)	42(29%)	20(14%)
Text-to-speech converter (used by visually impaired users and archives)	12(8%)	52(36%)	72(50%)	8(6%)
Google glass for newspaper clippings	23(16%)	42(29%)	9(6%)	70(49%)

Table 2 demonstrates that the majority of respondents agreed that one area where IoT is used in library services is remote resource monitoring. Next in order were access control (37%) and user authentication (28%). This research concurs with that of Priyanka, Ayan, and Khushpreet (2022), who found that the usage of IoT in libraries is a significant advancement due to its potential for user identification and simple remote monitoring of library resources.

Research Question 2: What are the opportunities that IOT avails in the operation and service delivery in South East, Nigeria academic librarians?

Table 3: Opportunities that IOT avails in the operation and service deliveries

Opportunities	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
Reduce the time of book issue/return procedure	93(65%)	11(8%)	8(5%)	32(22%)
Delivering timely materials to library users	65(45%)	43(30%)	30(20%)	6(4%)
Low maintenance costs	43(30%)	8(6%)	41(28%)	52(36%)
Promotion and marketing of library services	85(59%)	32(22%)	25(17%)	2(2%)
Assisting library patrons with information literacy training	32(22%)	41(28%)	18(12%)	53(37%)
Improved admission and exit management and increased library security	54(37%)	32(22%)	5(4%)	53(37%)
Building a solid, integrated database to improve administration	34(24%)	43(30%)	26(18%)	41(28%)
Obtaining more trustworthy and pertinent information quickly	71(49%)	12(8%)	19(14%)	42(29%)

The advantages that academic librarians experience from using IoT are shown in Table 3. Providing services to library customers promptly (75%), marketing and promoting library services (81%), and shortening the time it takes to issue and return books (75%) are only a few of the advantages of using IoT. This result is consistent with Liang's (2019) research, which demonstrated that IoT is a technical development that librarians should be mindful of due to its potential to enhance user experiences, results, and services provided by librarians. In a similar vein, Cao et al. (2018) proposed that the usage of IoT in libraries would improve service delivery efficacy and patrons' access to resources.

Research Question 3: What are the challenges militating against the application of the internet of things in the operations and services of academic libraries in South East, Nigeria?

Table 4: Challenges militating against the application of IoT

Challenges	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly Disagree (%)
Privacy and Security	51(36%)	42(30%)	28(20%)	23(17%)
Trimmed budget and exorbitant IoT installation Costs	45(31%)	53(37%)	36(25%)	10(7%)
Requires domain specific skilled staff	61(42%)	31(22%)	11(8%)	41(28%)
Lack of power	62(43%)	43(30%)	15(10%)	24(17%)
Lack of infrastructure	71(49%)	12(8%)	34(23%)	27(19%)
Technology Inclined Users/Users Training	43(30%)	56(39%)	22(15%)	23(16%)
Programme Malfunction	61(42%)	34(24%)	40(28%)	9(6%)
Limitation on device storage and energy capacity	52(36%)	23(16%)	42(29%)	27(19%)
Problems with device compatibility during Installation	72(50%)	31(22%)	17(11%)	24(17%)



Table 4 demonstrates that most respondents (73%), named lack of power as one of the difficulties academic librarians encounter while implementing IoT. Technology-inclined users and users' training came next, (69%). This research concurs with that of Ivwighreghweta and Igere (2014), who found that among the issues impeding efficient Internet access at Nigerian tertiary institutions were power outages, sluggish Internet speeds, and a shortage of computer terminals.

Conclusion

If properly implemented, IoT has huge possible opportunities for libraries. It may produce the desired effects and improve the operations and services offered by the library. Librarians are continuously at the head of applying new technology to better serve their clientele. The findings show that libraries employ IoT in the following areas: inventory management, lending sections, user identification and access control, self-issue/return of books, and management of book theft. Some of the advantages of using IoTs include timely resource delivery to library patrons, marketing and promotion of library services, a shorter book issue/return process, low maintenance costs, the ability to help library users receive information literacy training, faster collection of more relevant and reliable information, increased library security, and improved entry and exit control. Some of the challenges include power outages, lack of power, and training for technology-inclined users. The study concluded that for IoT technologies to fully realize their potential in academic libraries, stakeholders and librarians must collaborate to create awareness and find financing for their application and use.

Recommendations

The following recommendations are suggested:

1. ICT proficiency ought to be incorporated into all graduate and post-graduate LIS programs. This is intended to give professionals the skills they need to offer services effectively, while individuals who are currently working in the system should receive training or retraining to stay up to date on the skills required to deliver services effectively in an IoT-enabled environment.
2. New and modern technology and networking equipment should be installed in future libraries as soon as feasible. Users

and librarians will, therefore, need to be adequately knowledgeable about IOT technology.

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