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The Application of Internet of Things (IoT) in Some Selected University Libraries in Delta State.

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Abstract

This study examined the application of Internet of Things (IoT) technologies in selected university libraries in Delta State, Nigeria. The study was guided by three research questions and adopted a descriptive survey research design. The population comprised 78 library staff drawn from Maritime University, Okerenkoko; Dennis Osadebay University, Asaba; and Delta State University, Abraka. Given the manageable size of the population, a total enumeration technique was employed. Data were collected using a self-structured questionnaire and analysed using descriptive statistics, including mean scores and percentages. A criterion mean of 2.50 and a percentage benchmark of 50% were used for decision-making. Findings revealed a low level of application of IoT technologies in the selected university libraries, as IoT tools were not fully integrated into core library operations such as automated inventory management, security surveillance, environmental monitoring, and personalised user services. Despite the low level of application, respondents acknowledged that IoT technologies positively impact library services through cost reduction, enhanced operational efficiency, improved automation, real-time data collection and analysis, better asset monitoring, and increased productivity. The study further identified poor internet connectivity, high implementation costs, inadequate management support, lack of technical expertise, and complexity and compatibility issues as major challenges hindering effective implementation. The study concluded that although librarians recognise the transformative potential of IoT technologies in improving library services, significant infrastructural, financial, policy, and capacity-building challenges continue to limit their adoption. The study recommends increased investment in technological infrastructure, continuous staff training, development of institutional policies, and stronger management commitment to facilitate effective IoT integration in university libraries.

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Keywords: Internet of Things (IoT), university libraries, library services, technology adoption, Delta State.

Introduction

University libraries play a critical role in supporting teaching, learning, research, and community service within higher education institutions. As centres for information acquisition, organization, storage, and dissemination, they provide access to scholarly resources that facilitate academic excellence and knowledge creation. According to Eiriemiokhale and James (2022), the primary mission of university libraries is to ensure that scholars, researchers, and students have access to relevant and current information resources that support their academic and research activities. However, the rapid advancement of information and communication technologies has transformed users' information-seeking behaviour and expectations, compelling university libraries to adopt innovative technologies that enhance operational efficiency and improve service delivery (Pajo & Rauch, 2019).

One of the emerging technologies attracting increasing attention in the library and information profession is the Internet of Things (IoT). The Internet of Things refers to a network of interconnected devices capable of collecting, transmitting, and processing data through internet-enabled systems (Abdulfatai, 2024). In library environments, IoT technologies include Radio Frequency Identification (RFID), smart shelves, environmental monitoring systems, and location-tracking devices that support automation, resource management, security, and user-centred services (Eiriemiokhale & James, 2022). Asim and Arif (2023) noted that IoT applications enable libraries to improve inventory management, optimize space utilization, and provide seamless access to information resources.

The adoption of IoT technologies has the potential to improve library service efficiency, resource utilization, and institutional decision-making processes (Al Jaafreh & Reyalat, 2021). Furthermore, emerging technologies such as IoT, artificial intelligence, and cloud computing are increasingly recognized as important tools for transforming library operations and supporting innovative service delivery (Jebreel, 2025). Despite these benefits, the implementation of IoT technologies in libraries also raises concerns regarding data privacy, information security, technical complexity, and ethical responsibility (Pajo & Rauch, 2019). Consequently, university libraries must balance technological innovation with the protection of user information and the development of appropriate implementation policies.

Although studies have highlighted the benefits and challenges associated with IoT adoption in libraries, evidence suggests that the application of IoT technologies in many developing countries remains limited. Abdulfatai (2024) reported that inadequate technological infrastructure, insufficient ICT competencies, low awareness levels, and resistance to technological change constitute major barriers to the adoption of emerging technologies among librarians. Similar concerns have been observed in university libraries in Delta State, where limited training opportunities, inadequate institutional support, and uncertainty regarding the practical relevance of IoT technologies may affect adoption and utilization.

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Previous studies have largely focused on emerging technologies in libraries, technological implementation frameworks, and the benefits of IoT applications. However, there is limited empirical evidence on librarians' awareness, attitudes, and perceived barriers regarding the application of IoT technologies in university libraries in Delta State, Nigeria. This gap in knowledge makes it difficult for library administrators and policymakers to develop evidence-based strategies for successful IoT implementation within the local context.

Guided by the Technology Acceptance Model (TAM), which emphasizes perceived usefulness and perceived ease of use as key determinants of technology adoption, this study examines the application of the Internet of Things in selected university libraries in Delta State, Nigeria. Specifically, the study investigates librarians' awareness of IoT technologies, their attitudes toward adoption, and the challenges affecting implementation. The findings are expected to contribute to the growing body of literature on emerging technologies in libraries and provide practical insights for university management, librarians, and policymakers seeking to enhance information service delivery through IoT adoption. Since the study focuses on selected university libraries, the findings should be interpreted within the context of the participating institutions.

1.2 Statement of the Problem

The emergence of the Internet of Things (IoT) has transformed information service delivery in many libraries through the use of technologies such as Radio Frequency Identification (RFID), smart shelves, and automated monitoring systems. These technologies have enhanced resource management, improved operational efficiency, and facilitated seamless access to information resources. As university libraries strive to meet the information needs of users in an increasingly digital environment, the adoption of IoT technologies has become essential for effective service delivery. However, despite the recognized benefits of IoT, its application in many university libraries in developing countries, including Nigeria, remains limited. Studies have attributed this situation to factors such as inadequate technological infrastructure, insufficient funding, low awareness, lack of technical expertise, resistance to technological change, and concerns about data privacy and security (Pajo & Rauch, 2019; Abdulfatai, 2024). These challenges may hinder libraries from fully utilizing IoT technologies to improve their services and operations.

The importance of this problem lies in the need for university libraries to remain relevant and responsive to the changing information needs of users. Failure to adopt innovative technologies may reduce service efficiency, limit access to information resources, and weaken the library's role in supporting teaching, learning, and research. Although previous studies have examined emerging technologies and IoT applications in libraries, most have focused on technological capabilities and implementation issues in developed countries, with limited attention given to librarians' awareness, attitudes, and perceived barriers to IoT adoption in Delta State, Nigeria. This lack of empirical evidence creates a knowledge gap that may affect policy formulation and implementation strategies for IoT adoption in university libraries. Therefore, this study investigates the application of the Internet of Things in selected university libraries in Delta State, Nigeria, with a view to examining librarians' awareness, attitudes, and perceived barriers to its adoption and utilization.

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Aim and Objectives of the Study

The aim and objective of this study is to examine the application of the Internet of Things (IoT) in selected university libraries in Delta State. The specific aim and objectives are to:

1. determine the level of application of Internet of Things (IoT) technologies in selected university libraries in Delta State
2. examine the impacts of Internet of Things (IoT) technologies on library services in selected university libraries in Delta State
3. identify the challenges hindering the effective implementation of Internet of Things (IoT) technologies in selected university libraries in Delta State

Research Questions

The following research questions were formulated to guide this study:

1. What is the level of application of Internet of Things (IoT) technologies in selected university libraries in Delta State?
2. What are the impacts of IoT technologies on library services in these selected university libraries in Delta State?
3. What challenges hinder the effective implementation of IoT technologies in the selected university libraries in Delta State?

Review of Related Literature

Theoretical Framework

This study is anchored on the Technology Acceptance Model (TAM), which was developed by Fred D. Davis in 1989 to explain and predict users' acceptance and adoption of information technologies. The model was derived from the Theory of Reasoned Action (TRA), proposed by Fishbein and Ajzen, and was specifically designed to understand factors influencing individuals' decisions to use technological systems. Davis (1989) argued that two major determinants influence technology adoption: perceived usefulness and perceived ease of use. Perceived usefulness refers to the degree to which an individual believes that using a particular technology will improve job performance, while perceived ease of use refers to the degree to which a person believes that using the technology will require little effort. According to the model, when users perceive a technology as useful and easy to use, they are more likely to develop positive attitudes toward it, leading to greater acceptance and actual usage. Subsequent studies by Davis, Bagozzi, and Warshaw (1989), as well as Venkatesh and Davis (2000), expanded the model and confirmed its effectiveness in explaining technology adoption across different organizational and technological settings. The Technology Acceptance Model has become one of the most widely used frameworks in information systems research because of its simplicity, predictive power, and ability to explain users' behavioural intentions toward emerging technologies.

The importance of the Technology Acceptance Model lies in its ability to provide a theoretical explanation for why individuals accept or reject technological innovations. As organizations increasingly depend on digital technologies to improve efficiency and productivity, understanding the factors that influence users' acceptance of such technologies has become

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essential. The model offers valuable insights for managers, policymakers, and technology developers by identifying perceived usefulness and perceived ease of use as critical factors influencing adoption decisions. Venkatesh and Davis (2000) further demonstrated that users' perceptions are shaped by social influence, job relevance, and organizational support, thereby extending the explanatory power of the model. In library and information science research, TAM has been extensively applied to investigate the adoption of digital libraries, electronic resources, library automation systems, cloud computing technologies, and other emerging technologies. The model is particularly important because it helps institutions identify barriers to technology adoption and develop strategies that encourage user acceptance. By focusing on users' perceptions and attitudes, TAM enables researchers to examine how technological innovations can be successfully integrated into organizational environments. Consequently, the model provides a useful framework for understanding the behavioural and organizational factors that influence the adoption and utilization of new technologies in academic and professional settings.
The relevance of the Technology Acceptance Model to this study stems from its focus on users' perceptions and attitudes toward technology adoption. The application of the Internet of Things (IoT) in university libraries requires librarians to accept, utilize, and support technologies such as RFID systems, smart shelves, automated inventory management tools, and sensor-based monitoring systems. Previous studies have shown that the successful implementation of IoT technologies depends largely on users' perceptions of their usefulness and ease of use (Kaushik & Kumar, 2020; Asim & Arif, 2023). Librarians who perceive IoT technologies as beneficial for improving service delivery, resource management, and operational efficiency are more likely to embrace and utilize them. Conversely, perceptions of complexity, inadequate skills, privacy concerns, or limited institutional support may negatively influence adoption. Studies by Igbinovia and Okuonghae (2021), Kamińska (2016), and Shahzad, Khan, and Iqbal (2024) identified awareness, technical competence, organizational readiness, and perceived benefits as significant factors influencing IoT adoption in libraries. Since this study seeks to examine librarians' awareness, attitudes, and perceived barriers regarding the application of IoT in selected university libraries in Delta State, the Technology Acceptance Model provides an appropriate theoretical lens for explaining how perceptions influence adoption behaviour. Therefore, TAM offers a suitable framework for understanding and interpreting librarians' acceptance and utilization of IoT technologies in the university library environment.

Concept of IoT Application in University Libraries

The Internet of Things (IoT) has emerged as a transformative technology capable of enhancing operational efficiency and service delivery in academic libraries. The concept gained prominence in 1999 through the work of the Auto-ID Center at the Massachusetts Institute of Technology (MIT), where Kevin Ashton coined the term “Internet of Things” to describe a system in which physical objects are connected through the internet using unique identifiers such as RFID tags, QR codes, barcodes, and sensors (Bansal, Arora & Suri, 2018). According to the OECD (2016), IoT facilitates communication among interconnected devices, enabling the collection, exchange, and processing of data for improved services. In university libraries, IoT technologies have been applied in collection management, inventory control, user identification, theft prevention, and location-based services (Pujar, 2015). Li (2014) noted that IoT supports self-service functions

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such as self-checkout and self-return systems, thereby reducing staff workload and improving user convenience. Similarly, Mondal (2021) identified RFID tags and QR codes as essential components that facilitate seamless library operations. Through these applications, university libraries are gradually transitioning from traditional service centres to technology-driven information hubs capable of meeting the evolving needs of users in the digital age.

Level of Application of Internet of Things (IoT) Technologies in University Libraries

The level of application of Internet of Things (IoT) technologies in university libraries has increased steadily as libraries seek innovative ways to improve service delivery, resource management, and user satisfaction. IoT refers to a network of interconnected devices that communicate and exchange data through the internet to support automated operations and informed decision-making (OECD, 2016). In library environments, IoT technologies are applied through tools such as Radio Frequency Identification (RFID), Quick Response (QR) codes, wireless sensor networks, smart shelves, and automated circulation systems. Pujar (2015) identified collection management, user access services, location-based services, and information literacy programmes as major areas where IoT can be effectively applied in libraries. Similarly, Li (2014) observed that IoT technologies facilitate self-service operations such as self-checkout and self-return systems, thereby improving efficiency and reducing dependence on manual processes. Studies have shown that many academic libraries have adopted IoT technologies for inventory control, user identification, theft detection, and resource tracking (Bansal, Arora & Suri, 2018; Mondal, 2021). However, the extent of application varies across institutions depending on factors such as technological infrastructure, funding, staff competence, and management support. While libraries in developed countries have achieved relatively advanced levels of IoT integration, many libraries in developing countries are still in the early stages of implementation.

Evidence from empirical studies indicates that the level of IoT application in academic libraries ranges from moderate to high awareness but relatively low to moderate utilization. Nongo et al. (2021) reported that although librarians in selected academic libraries in Benue State, Nigeria, acknowledged the benefits of IoT technologies, the actual deployment of IoT tools remained modest due to infrastructural and financial challenges. Similarly, Eiriemiokhale and James (2022) found high levels of awareness and positive perceptions of technologies such as RFID systems, QR codes, and wireless sensor networks among librarians in selected university libraries in Kwara State. The study revealed that IoT technologies were utilized for collection security, inventory management, and resource accessibility, although implementation remained constrained by high costs and inadequate infrastructure. Fagbola and Olajide (2022) also observed that academic libraries in Osun State had adopted selected IoT-enabled services, including electronic library tours, online fine payment systems, and automated shelf guidance tools. Furthermore, Sinha (2022) found that students recognized the application of IoT technologies in remote monitoring, user identification, access control, and self-service circulation systems. These findings suggest that while awareness and appreciation of IoT technologies are increasing, the actual level of implementation remains uneven across institutions.

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Recent studies further indicate that IoT application in university libraries is gradually expanding, driven by the need to enhance service quality and align with global trends in digital transformation. Asim and Arif (2023), in a systematic review of IoT adoption in academic libraries, found that libraries increasingly utilize IoT for automated notifications, inventory management, virtual user tracking, and self-guided library tours. Similarly, Eiriemiokhale and James (2023) reported that technologies such as RFID, cloud computing systems, smoke and heat sensors, and wireless sensor networks are increasingly being applied to improve service quality and operational efficiency in university libraries. However, Ogwo, Ojobor, and Babarinde (2025) revealed that although awareness of IoT technologies among library personnel in federal university libraries in Southeastern Nigeria was high, actual utilization remained low due to inadequate training, poor internet connectivity, and shortages of skilled personnel. Abdulfatai (2024) also found that while awareness of IoT technologies among library users and staff was relatively high, practical application was hindered by financial constraints, security concerns, and limited technical expertise. These findings indicate that the level of IoT application in university libraries can generally be described as moderate, with awareness exceeding actual utilization. The literature therefore suggests that greater investment in infrastructure, staff training, and institutional support is necessary to facilitate broader and more effective implementation of IoT technologies in university libraries.

Impacts of Internet of Things (IoT) Technologies on Library Services in University Libraries

The application of Internet of Things (IoT) technologies has significantly transformed library operations and enhanced service efficiency in university libraries. IoT enables the interconnection of devices, systems, and resources through internet-based networks, thereby facilitating the automation of routine library functions. Technologies such as Radio Frequency Identification (RFID), smart shelves, sensors, and automated circulation systems have improved the management of library collections and reduced the workload of library personnel (Bansal et al., 2018). Through RFID-enabled systems, libraries can perform inventory management, book tracking, self-checkout, and self-return services with greater speed and accuracy. These technologies reduce human errors, minimize delays in service delivery, and improve access to information resources. According to Igbinovia and Okuonghae (2021), IoT technologies have enabled libraries to monitor the movement and location of resources in real time, thereby enhancing collection security and resource utilization. Furthermore, automated systems supported by IoT have improved decision-making processes by generating accurate data on resource usage and library operations. As libraries continue to embrace digital transformation, IoT technologies provide an effective means of streamlining workflows, improving operational efficiency, and ensuring that users receive timely and reliable services. Consequently, the integration of IoT technologies has become an important strategy for modernizing university libraries and enhancing their capacity to meet the information needs of diverse user communities. One of the most significant impacts of IoT technologies on library services is the improvement of user experience and access to information resources. IoT facilitates the delivery of user-centered services by enabling libraries to provide personalized, responsive, and convenient information services. Smart technologies allow users to locate resources quickly, receive

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automated notifications about overdue materials, and access information through self-service platforms without relying heavily on library staff (Sheeja & Susan, 2019). Smart shelves equipped with sensors and RFID technologies assist users in identifying the exact location of materials, while mobile applications connected to IoT systems provide real-time information about resource availability. Gupta and Singh (2018) observed that IoT technologies also contribute to the creation of comfortable and conducive learning environments by monitoring study spaces, regulating lighting systems, and controlling environmental conditions such as temperature and air quality. In addition, IoT supports personalized recommendations and tailored information services based on users' preferences and information needs. These innovations enhance user satisfaction, encourage greater utilization of library resources, and promote independent learning among students and researchers. Bamigboye and Ademola (2019) further noted that the integration of digital resources and online platforms through IoT technologies has expanded access to information beyond the physical boundaries of the library, enabling users to access resources anytime and anywhere. Thus, IoT contributes significantly to improving the quality, accessibility, and effectiveness of library services.

Beyond operational efficiency and user satisfaction, IoT technologies have contributed significantly to innovation, research productivity, and academic excellence in university libraries. The vast amount of data generated through interconnecteda devices enables librarians to analyze user behaviour, evaluate resource usage patterns, and make informed decisions regarding service improvement and resource allocation (Ea et al., 2021). Such data-driven approaches help libraries develop services that align with the needs of students, researchers, and academic staff. Moreover, IoT technologies support the development of smart library environments that facilitate collaborative learning, digital scholarship, and innovative research activities. Arowoiya et al. (2020) emphasized that librarians with adequate technological skills can leverage IoT tools to design innovative services that support teaching, learning, and research. Similarly, Bayani et al. (2018) argued that the adoption of emerging technologies enables libraries to implement strategic initiatives that enhance institutional competitiveness and academic performance. In developing countries such as Nigeria, where libraries often face funding and infrastructural constraints, IoT technologies provide opportunities for maximizing available resources and improving service delivery despite existing challenges (Igbinovia, 2021). The integration of IoT also prepares libraries for future technological developments by fostering a culture of innovation and continuous improvement. Consequently, IoT technologies have become valuable tools for strengthening the role of university libraries as centres of knowledge creation, research support, and academic development.

Challenges Hindering the Effective Implementation of Internet of Things (IoT) Technologies in University Libraries

The implementation of Internet of Things (IoT) technologies in university libraries offers numerous benefits; however, several challenges continue to hinder their effective adoption and utilization, particularly in developing countries such as Nigeria. One of the major barriers is inadequate funding, which limits libraries' ability to acquire, install, and maintain essential IoT infrastructure such as RFID systems, sensors, smart shelves, and advanced networking

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equipment (Yusuf et al., 2019). Many university libraries operate under constrained budgets, making it difficult to prioritize investment in emerging technologies. In addition, inadequate technological infrastructure, including poor internet connectivity and unstable electricity supply, significantly affects the functionality and reliability of IoT systems (Ayelaagbe, 2024). Since IoT technologies depend on uninterrupted internet access and power supply for efficient operation, infrastructural deficiencies often result in system failures and reduced service effectiveness. Another critical challenge is the lack of technical expertise among librarians. Abdulfatai (2024) observed that many librarians lack the necessary knowledge and skills required to operate, manage, and troubleshoot IoT technologies. This skills gap limits the effective integration of IoT into library operations and may lead to the underutilization of available technologies. Consequently, the potential benefits of IoT technologies are often not fully realized within university library environments.

Another significant challenge affecting IoT implementation in university libraries is concern over data privacy and security. IoT systems collect, process, and transmit large volumes of user and operational data, creating vulnerabilities to cyber threats, unauthorized access, and data breaches (Gupta & Singh, 2018). These concerns discourage some institutions from adopting IoT technologies due to fears of compromising user confidentiality and information security. Resistance to change among library staff and management also poses a major obstacle. According to Sheeja and Susan (2019), some librarians are reluctant to embrace new technologies because of uncertainty, fear of job displacement, or preference for traditional library practices. Furthermore, the absence of clear policies, strategic plans, and institutional frameworks for IoT implementation often results in fragmented and inconsistent adoption efforts (Algarni et al., 2021). Infrastructural limitations, inadequate technical support, and insufficient management commitment further compound these challenges (Igbinovia & Okuonghae, 2021). To address these barriers, libraries require continuous staff training, improved technological infrastructure, adequate funding, and supportive institutional policies. Strong leadership commitment and strategic investment in technology are also necessary to promote successful IoT adoption and maximize its potential for enhancing library services and information delivery (Muthumari et al., 2021; Al-Salmi et al., 2020).

Methodology

This section discussed the research methods, procedures and the techniques adopted in carrying out this research work.

Research Design

This study employed a descriptive survey research design to examine library staff members perceptions regarding the application of Internet of Things (IoT) technologies in selected university libraries in Delta State, Nigeria. The descriptive approach was considered most suitable as it enables objective, systematic collection of data from respondents, offering a reliable foundation for comprehensive analysis and informed recommendations. As noted by Odede et al.

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(2023), this method is particularly valued for its ability to capture unbiased information and provide broad, detailed coverage of a research phenomenon.

Population of the Study

The study population consisted of 78 library staff members drawn from three universities: Maritime University, Okerenkoko; Dennis Osadebay University, Asaba; and Delta State University, Abraka. Specifically, Maritime University included 15 staff, Dennis Osadebay University had 29, and Delta State University, Abraka comprised 34 library staff members.

Sample and Sampling Technique

Given the relatively small and manageable size of this population, a total enumeration sampling technique was adopted. This approach ensured that all available library staff were included, enhancing the comprehensiveness and accuracy of the findings. In line with Canonizado (2024), when a population is sufficiently small and accessible, total enumeration is preferable as it eliminates sampling errors and provides full representation.

Research Instrument

The research instrument employed for data collection in this study was a meticulously structured questionnaire, purposefully designed by the researcher to extract pertinent data from respondents. This instrument, titled "Application of Internet of Things (Iot) in University Libraries Questionnaire" (AITULQ). Section A gathered demographic information, while subsequent sections focused 3 research question. The questionnaire was crafted to be clear and straightforward, ensuring respondents could easily understand and accurately provide their views.

Validation of the Instrument

The instrument was validated using face and content validation techniques to ensure its suitability for data collection. The questionnaire was carefully reviewed by two senior lecturers in Library and Information Science with expertise in measurement and evaluation. Their assessment focused on the clarity, relevance, and adequacy of the items in relation to the study objectives. This process ensured that the instrument effectively measured the variables under investigation and enhanced the credibility of the study.

Reliability of the Instrument

The reliability of the instrument was established through a pilot test involving twenty librarians from Nigeria Delta University, Bayelsa State. Cronbach's alpha was used to determine internal consistency. The coefficients obtained were 0.777 for level of IoT application, 0.775 for impacts of IoT technologies on library services, and 0.758 for implementation challenges. Since all values exceeded the acceptable benchmark of 0.70, the instrument was considered reliable for the study.

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Method of Data Collection

The researcher personally distributed the questionnaires to ensure maximum participation and immediate collection upon completion, thereby reducing the risk of loss or low response rates.

Method of Data Analysis

Data collected for this study were analysed using descriptive statistics, specifically mean scores and percentages. The mean statistic was used to answer the research questions, while percentages were employed to describe respondents' demographic characteristics and response distributions. The analysed data were presented in tables for ease of interpretation. Decision Rule: A four-point Likert scale was used for the questionnaire items, with response options weighted as follows: Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1). To determine the criterion mean for decision-making, the numerical values assigned to the response categories were summed and divided by the number of response options: $\frac{4+3+2+1}{4} = \frac{10}{4}$ = 2.50. Therefore, a mean score of **2.50 and above** was regarded as an indication of agreement, high awareness, positive perception, or high application, depending on the variable being measured, while a mean score **below 2.50** was interpreted as disagreement. Similarly, percentage scores of **50% and above** were considered significant for interpretation purposes.

Result and Discussion of Findings

This section examines the presentation of results and discussion of finding in line with research questions that were raised.

Application of IoT in University Libraries in Delta Stat

Table 1: Level of Application of Internet of Things (IoT) Technologies

Statements	**SA**	**A**	**D**	**SD**	**x̄**
IoT technologies are fully integrated into daily library operations.	17	13	10	38	2.12
My library uses IoT for automated book tracking and inventory management.	16	14	16	32	2.18
IoT devices are used for security and surveillance.	20	15	16	27	2.36
Environmental monitoring systems are IoT-based.	20	10	16	32	2.23
IoT supports personalized services for users (e.g., notifications, tracking).	23	13	12	30	2.37
IoT systems are regularly maintained and updated.	22	9	11	36	2.22
There is a clear policy guiding IoT use in my library.	19	11	15	33	2.21
Average Mean					**2.24**
Criterion Mean					**2.50**

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Data in Table 1 reveals that the average mean score of 2.24 is lower than the criterion mean of 2.50, indicating that the overall level of application of Internet of Things (IoT) technologies in the selected university libraries in Delta State is low. Specifically, the results show that IoT technologies are not yet fully integrated into daily library operations ($\bar{x}$ = 2.12), and their use for automated book tracking and inventory management is similarly limited ($\bar{x}$ = 2.18). The application of IoT for security and surveillance purposes recorded a slightly higher mean score ($\bar{x}$ = 2.36), while environmental monitoring systems showed moderate use ($\bar{x}$ = 2.23). The provision of personalised services through IoT, such as notifications and user tracking, also reflected a low level of application ($\bar{x}$ = 2.37). Additionally, responses indicated inadequate maintenance and updates of IoT systems ($\bar{x}$ = 2.22) and a lack of clear policies guiding IoT usage in the libraries ($\bar{x}$ = 2.21). Overall, these findings suggest that while some elements of IoT technology are present, their integration and utilisation remain insufficient, underscoring the need for increased investment, policy development, and strategic implementation to enhance library services through IoT.

Impacts of IoT technology on Library Services

Table 2: Impacts of IoT Technologies on Library Services

Statements	SA	A	D	SD	$\bar{x}$
Cost reduction through improved efficiency	43	23	12	0	3.30
Real-time data collections and analysis	27	34	14	3	3.00
Enhanced automation	27	29	14	8	2.90
Better asset monitoring	21	32	11	14	2.70
Improved productivity	26	25	16	11	2.80
Average Mean					2.94
Criterion Mean					2.50

Data presented in Table 2 shows that the average mean score of 2.94 is higher than the criterion mean of 2.50, indicating that Internet of Things (IoT) technologies have a positive impact on library services in the selected university libraries in Delta State. Specifically, respondents agreed that IoT contributes significantly to cost reduction through improved operational efficiency, as reflected in the highest mean score of 3.30. Real-time data collection and analysis ($\bar{x}$ = 3.00) and enhanced automation ($\bar{x}$ = 2.90) were also identified as notable benefits, suggesting that IoT tools streamline routine processes and provide timely access to critical information. Furthermore, better asset monitoring ($\bar{x}$ = 2.70) and improved staff productivity ($\bar{x}$ = 2.80) were recognised as additional advantages, though with slightly lower mean scores. These results collectively suggest that IoT technologies, where applied, enhance the effectiveness and efficiency of library services, supporting improved decision-making, resource management, and user experience across the institutions surveyed.

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Challenges Hinder the Effective Implementation of IoT Technologies

Table 3: Challenges Hinder the Effective Implementation of IoT Technologies

Statements	SA	A	D	SD	x̄
Poor policies and support from management	23	26	14	15	2.70
Lack of knowledge	26	20	15	17	2.70
High implementation costs	22	24	13	19	2.60
Complexity and compatibility issues	28	23	17	10	2.80
Poor internet connectivity	28	32	11	7	3.00
Average Mean					**2.76**
Criterion Mean					**2.50**

Data presented in Table 3 reveals that the average mean score of 2.76 is higher than the criterion mean of 2.50, indicating that respondents generally agreed that several significant challenges hinder the effective implementation of IoT technologies in the selected university libraries in Delta State. The most critical challenge identified was poor internet connectivity ($\bar{x}$ = 3.00), which reflects the foundational importance of reliable network infrastructure for the successful operation of IoT systems. Complexity and compatibility issues also emerged as substantial barriers ($\bar{x}$ = 2.80), suggesting that integrating IoT technologies with existing library systems remains technically demanding. Additionally, poor policies and insufficient management support ($\bar{x}$ = 2.70), along with a lack of knowledge among library staff ($\bar{x}$ = 2.70), were highlighted as key organisational and human capacity challenges. High implementation costs ($\bar{x}$ = 2.60) further exacerbate the difficulty of adopting these advanced technologies. Overall, these findings underscore the need for targeted investment in internet infrastructure, comprehensive training for staff, clearer institutional policies, and stronger management commitment to facilitate the successful adoption and integration of IoT technologies in university libraries.

Discussion of Findings

Level of Application of IoT Technologies in University Libraries

The study revealed a low level of application of IoT technologies in university libraries in Delta State. Although librarians demonstrated awareness of IoT technologies and their potential benefits, this awareness has not translated into widespread implementation. This finding suggests that knowledge alone is insufficient to drive technological adoption when organizational, financial, and infrastructural conditions are unfavourable. The low utilization of IoT technologies such as RFID systems, smart shelves, automated tracking devices, and environmental monitoring systems indicates that many university libraries remain dependent on traditional service delivery approaches. From the perspective of the Technology Acceptance Model (TAM), librarians may perceive IoT technologies as useful, but concerns about complexity, inadequate support, and implementation challenges may reduce their perceived ease of use, thereby limiting adoption. The absence of comprehensive policies and structured implementation plans further indicates that university management may not yet regard IoT as a strategic priority. This finding supports

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the studies of Abdulfatai (2024) and Eiriemiokhale and James (2023), who similarly observed a gap between awareness and actual utilization of IoT technologies in Nigerian university libraries. The implication is that without deliberate institutional commitment, awareness alone will not lead to meaningful technological transformation. Therefore, improving infrastructure, strengthening policy frameworks, and providing adequate funding are essential for moving libraries from the awareness stage to full-scale adoption and integration of IoT technologies.

Impacts of IoT Technologies on Library Services

Despite the low level of implementation, librarians acknowledged that IoT technologies have the potential to significantly improve library services. The findings showed that IoT enhances operational efficiency, reduces costs, improves resource monitoring, and facilitates real-time data collection for decision-making. The significance of this finding lies in the fact that librarians already recognize the value and usefulness of IoT technologies, which is a critical factor in technology acceptance and future adoption. This suggests that resistance to IoT may not necessarily stem from negative attitudes toward technology but rather from practical constraints that limit implementation. The finding also indicates that even limited exposure to IoT technologies has enabled librarians to appreciate their capacity to automate routine tasks, reduce human errors, and improve service quality. This observation is consistent with Asim and Arif (2023) and Nongo et al. (2021), who reported that IoT technologies contribute to improved service delivery, operational effectiveness, and user satisfaction. More importantly, the finding demonstrates that IoT technologies have the potential to address persistent challenges facing university libraries, such as inefficient resource management and slow service delivery. Consequently, the positive perceptions expressed by librarians provide a strong foundation for future adoption initiatives. If adequately implemented, IoT technologies could support the transformation of university libraries into smart information environments capable of meeting the evolving needs of students, researchers, and academic staff.

Challenges Hindering IoT Implementation

The study identified poor internet connectivity, high implementation costs, inadequate management support, insufficient technical skills, and compatibility challenges as major barriers to IoT implementation. These findings suggest that the challenges are not merely technological but also organizational and institutional in nature. The persistence of these barriers reflects broader issues affecting technological innovation in many developing-country institutions, including inadequate funding, weak infrastructure, and limited investment in staff development. From the TAM perspective, these challenges negatively influence librarians' perceptions of ease of use and create uncertainty regarding the successful adoption of IoT technologies. The finding that management support is inadequate is particularly significant because institutional leadership often determines the availability of resources, policy direction, and strategic commitment required for technology adoption. Furthermore, insufficient technical expertise among librarians suggests that awareness does not necessarily equate to competence, highlighting the need for continuous professional development. This finding corroborates those of Eiriemiokhale and James (2022) and Ogwo et al. (2025), who identified financial constraints, infrastructural deficiencies, and inadequate training as major obstacles to IoT adoption. The implication is that

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successful implementation of IoT technologies requires a holistic approach that addresses financial, technical, managerial, and policy-related factors simultaneously. Without such interventions, university libraries may struggle to realize the full benefits of IoT technologies despite recognizing their value and potential.

Conclusion

The findings of this study indicate that while librarians in university libraries across Delta State, Nigeria, acknowledge the potential benefits of IoT technologies, their actual level of application remains low. Libraries have not yet fully embraced IoT for core functions such as automated inventory, security, and personalised user services. Nevertheless, librarians recognise that IoT can significantly enhance efficiency, reduce costs, and improve overall service quality. The study further revealed substantial challenges, including infrastructural limitations, high costs, lack of policies, and inadequate technical knowledge among staff. These barriers highlight the need for a strategic approach to IoT adoption. In conclusion, although IoT technologies offer transformative opportunities for university libraries, a concerted effort is required to overcome existing challenges, strengthen infrastructural support, and build staff capacity to ensure successful implementation.

Recommendations

Based on the findings, the following recommendations are proposed to facilitate the effective adoption of IoT technologies in university libraries in Delta State:

1. The study revealed a low level of application of IoT technologies in the selected university libraries. Therefore, university management should take deliberate steps to integrate IoT technologies into core library operations such as inventory management, security, and personalised user services in order to improve service delivery.
2. Since the findings showed that poor internet connectivity is the most critical challenge hindering effective IoT implementation, universities should prioritise the provision of reliable and high-speed internet facilities to support the successful operation of IoT systems in their libraries.
3. Given that lack of technical knowledge among library staff was identified as a major constraint, regular training and capacity-building programmes should be organised to equip librarians with the skills required to operate, manage, and maintain IoT technologies effectively.
4. As the study found that the absence of clear policies negatively affects IoT adoption, university libraries should develop and implement clear institutional policies and guidelines to regulate the use, management, and maintenance of IoT technologies.
5. Considering that high implementation costs limit the adoption of IoT technologies, a gradual or phased approach should be adopted, beginning with service areas where IoT has demonstrated positive impacts, such as security and asset monitoring.
6. Since inadequate management support was identified as a challenge, university administrators should show stronger commitment by providing adequate funding and institutional support for IoT-related initiatives in university libraries.

References

Abdulfatai, S. (2024). Awareness and application of Internet of Things in university libraries in Kwara State, Nigeria. *International Journal of Knowledge Content Development & Technology*, *14*(4), 65–84.

Abdul-Quayyum, G., Oyedele, L., Abdul-Majeed, M., Habeeb, K., & Oladimeji, O. (2019, June 17–21). *The role of the Internet of Things in delivering smart construction*. Paper presented at the CIB World Building Congress, Hong Kong SAR, China.

Algarni, M., Alkhelaiwi, M., & Karrar, A. (2021). Internet of Things security: A review of enabled application challenges and solutions. *International Journal of Advanced Computer Science and Applications, 12*(3). https://doi.org/10.14569/IJACSA.2021.0120325

Al-Salmi, J., Ateeq, K., & Al-Hinai, A. (2020). The role of the Internet of Things in knowledge management in information organizations. *Journal of Information and Technology Studies, 3*(1), 1–9.

Arowoiya, V., Oke, A., Aigbavboa, C., & Aliu, J. (2020). An appraisal of the adoption of the Internet of Things (IoT) elements for sustainable construction. *Journal of Engineering, Design and Technology*, *18*(5), 1193–1208.

Asim, M., & Arif, M. (2023). Internet of things adoption and use in academic libraries: A review and directions for future research. *Journal of Librarianship and Information Science, 52*(1), 3–20.

Ayelaagbe, S. O. (2024). Undergraduates' use of Internet of Things (IoT) technologies in the classroom in Ondo State, Nigeria. *FNAS Journal of Computing and Applications, 2*(1), 6–14.

Bamigboye, F., & Ademola, E. (2019). Internet of Things: The present status, future impacts and challenges. In *Proceedings of the 6th iSTEAMS Multidisciplinary Cross-Border Conference* (pp. 212–217).

Bansal, A., Arora, D., & Suri, A. (2018). Internet of things: Beginning of a new era for libraries. *Library Philosophy and Practice (e-Journal)*. http://digitalcommons.unl.edu/libphilprac/2081

Bayani, M., Segura, A., Alvarado, M., & Loaiza, M. (2018). IoT-based library automation and monitoring system: Developing an implementation framework. *E-Ciencias de la Información*, 1–18.

Bi, S., Wang, C., Zhang, J., Huang, W., Wu, B., Gong, Y., & Ni, W. (2022). A survey on artificial intelligence aided Internet-of-Things technologies in emerging smart libraries. *Sensors, 22*(8), 2991.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982–1003.

Eiriemiokhale, K. A., & James, B. O. (2023). Application of the Internet of Things for quality service delivery in Nigerian university libraries. *Indian Journal of Information Sources and Services, 13*(1), 17–25. https://doi.org/10.51983/IJISS-2023.13.1.377

Fagbola, O. O., & Olajide, F. (2022). Prospects of Internet of Things (IoTs) technology application for library and information service delivery among library personnel in

academic libraries in Osun State, Nigeria. *Social & Digital Media Discourse, 3*(1), 115–128.

Gupta, J., & Singh, R. (2018). Internet of Things (IoT) and academic libraries: A user-friendly facilitator for patrons. In *2018 5th International Symposium on Emerging Trends and Technologies in Libraries and Information Services (ETTLIS)* (pp. 71–74). IEEE. https://doi.org/10.1109/ETTLIS.2018.8485234

Igbinovia, M. O. (2021). Internet of Things in libraries and focus on its adoption in developing countries. *Library Hi Tech News, 38*(4), 13–17.

Igbinovia, M. O., & Okuonghae, O. (2021). Internet of Things in contemporary academic libraries: Application and challenges. *Library Hi Tech News, 38*(5), 1–4.

Jebreel, A. (2025). Internet of Things (IoT) adoption in higher education institutions: An empirical study in Saudi Arabian universities. *International Journal on Recent and Innovation Trends in Computing and Communication, 13*(1), 50–57.

Kaushik, A., & Kumar, A. (2020). Internet of Things and its applications in libraries: A literature review. *Library Hi Tech, 38*(1), 67–77.

Kamińska, A. M. (2016). Internet of Things: Potential for libraries. *Library Hi Tech, 34*(2), 404–420.

Kumar, R. (2023). Students' perspectives on the application of the Internet of Things for redesigning library services at Kurukshetra University. *Open Information Science, 7*(1), 201–215. https://doi.org/10.1515/opis-2023-0017

Li, L. (2014). Designing and implementing a university library automatic management system based on the Internet of Things. *Lecture Notes in Computer Science, 8351*, 241–247. https://doi.org/10.1007/978-3-319-07731-4_27

Liang, X., & Chen, Y. (2020). Libraries in the Internet of Things era. *Library Hi Tech, 38*(1), 79–93. https://doi.org/10.1108/LHT-10-2018-0145

Makori, E. O. (2017). Promoting innovation and application of Internet of Things in academic and research information organizations. *Library Review, 66*(8/9), 655–678.

Mondal, H. (2021). Application of IoT in library. *International Journal of Research Publication and Reviews, 2*(3).

Muthumari, P., Kulkarni, A. M., & Kulkarni, C. M. (2021). IoT application in smart libraries. *International Journal of Research in Library Science, 7*(3), 113–120.

Nongo, C. J., Terna, R., & Ode, M. (2021). Internet of Things: Fourth Industrial Revolution challenges in academic libraries in Benue State. *Proceedings of the Management of Information, Knowledge, Research and Innovation for Sustainable Development*, 1.

Ogwo, U., Ojobor, R. C., & Babarinde, E. T. (2025). Awareness and utilization of emerging technologies for effective services in selected federal university libraries in Southeastern Nigeria. *Journal of Library Services and Technologies, 7*(1), 81–94.

Organisation for Economic Co-operation and Development (OECD). (2016). *The Internet of Things: Seizing the benefits and addressing the challenges*.

Pajo, A., & Rauch, M. (2019). Internet of Things in contemporary academic libraries: Application and challenges. *Library Hi Tech News, 38*(5), 1–4.

Vol. 10, No.06; 2026

ISSN: 2456-7760

Perera, C., Liu, C. H., & Jayawardena, S. (2017). The emerging Internet of Things marketplace from an industrial perspective: A survey. *IEEE Transactions on Emerging Topics in Computing, 3*(4), 585–598.

Pujar, S. (2015). Internet of Things and libraries. *Annals of Library and Information Studies, 62*, 186–190.

Shahzad, K., Khan, S. A., & Iqbal, A. (2024). Factors influencing the adoption of Internet of Things (IoT) in university libraries: A systematic literature review. *The Electronic Library, 42*(2), 1–11.

Shashidhara, K. (2023). IoT and its application in library: A review of emerging trends. *Library Philosophy and Practice (e-Journal), 7773*.

Sheeja, N. K., & Susan, M. K. (2019). Internet of Things (IoT) in academic libraries. In *Proceedings of the 12th International CALIBER Conference* (pp. 45–51).

Sinha, F. (2022). Internet of Things based book tracking system for smart library. *International Journal of Computer Science and Mobile Computing, 9*(7), 12–18.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science, 46*(2), 186–204.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425–478.

Yusuf, F., Ifijeh, G., & Owolabi, S. (2019). Awareness of the Internet of Things and its potential in enhancing academic library service delivery in a developing country. *Library Philosophy and Practice (e-Journal), 2831*.