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# Application of the Internet of Things for Quality Service Delivery in Nigerian University Libraries

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*Abstract* - **The study examined the application of the Internet of Things (IoT) for quality service delivery in Nigerian university libraries. The study's objectives were to identify the Internet of Things (IoT) technologies that are available in Nigerian University Libraries; identify the areas of use of Internet of Things (IoT) technologies in Nigerian University Libraries; examine the functions of Internet of Things (IoT) technologies in Nigerian University Libraries; and identify the benefits of the Internet of Things (IoT) technologies in Nigerian University Libraries. The study adopted a descriptive survey research design, and the population comprises 37 professional librarians in three university libraries in Kwara State. A self-designed questionnaire was used for data collection, while data were analyzed using descriptive statistics of frequency counts and percentages. The study's findings revealed the available IoT technologies, including Wireless Sensor Networks, Cloud Computing, Smoke or Heat sensor, and RFID. The study also revealed that the aforementioned are used in technical services, readers services, theft management, and alerting services for quality service delivery in university libraries. The study recommended that Nigerian University libraries should increase awareness of existing IoT technologies available, put appropriate measures in place for its application to various library routines and departments and employ it to transform into innovative libraries.**
*Keywords:* **IoT, Application, Quality Service, Service Delivery, University Libraries**

## I. INTRODUCTION

Overtime, the evolution of information and wireless communication technologies has had a significant impact on the role of libraries in society and educational institutions in several ways, leading to the interconnection between different library devices, users, and librarians in a wireless networking environment within and outside the four walls of a library (Mohammadi & Yegane, 2018).

The university library serves as a resource and knowledge centre, essential to learning, teaching, and scientific research in an academic institution, leveraging technologies that have shaped modern lives and the Internet of Things (IoT) as one of the many promising technologies (Nie, 2016) that enhance quality information service delivery such as Referral services (RS), Current Awareness Services (CAS), Selective Dissemination of Information (SDI), Internet Services (IS), Interlibrary Loan Services (ILLS), Reference Services (RS), and Circulation Services (CS), (Ebiwole, 2010; Agoh & Omekwu, 2021).

Today, the Internet of Things (IoT) in university libraries has transformed intelligentized libraries into smartened libraries (Xu, He, & Li, 2014). Unlike traditional libraries, the Internet of Things (IoT), according to Nag and Nikam (2016) uses intelligently connected devices and systems to obtain data gathered by embedded sensors, actuators in machines, and other physical objects. Obodovski (2014) and Massis (2016) described the Internet of Things (IoT) as being extremely beneficial to libraries in terms of saving staff time and improving patron service as it uses patron data to make tailored recommendations, all by collecting real-time data (Pera, 2014).

Adetayo, Adeniran, and Gbotosho (2021) posited that the smart library aims to provide users with more valuable and high-quality services with more dazzling information interconnection and a more diverse information-sharing environment. A 24-hour self-borrowing and returning system, self-renewal system, intelligent inventory of library collections, intelligent seat reservation system, and 3D/Augmented Reality/Virtual Reality navigation system are among the smart library's mature application scenarios (Tingting, 2017). The possibilities of the Internet of Things (IoT) used in libraries are almost endless (Engard, 2015). There is no denying the Internet of Things' vast array of possibilities for improving library services. However, obtaining studies about its application in developing country university libraries such as Nigeria proves abortive as there is currently no systematic and comprehensive review of recent research available on this research topic. As a result, this serves as the study's justification. The study's findings and discussions are expected to spark further and broader discussions in Nigerian university libraries on this study.

### *A. Statement of the Problem*

According to Hoy and Brigham (2015), the concept of the "Internet of Things" (IoT) has been around for almost as long as the internet itself. However, it is still poorly defined and even more poorly understood as the reality of the Internet of Things (IoT) is much more complex and has

many more possible uses and misuses. While some countries have conducted studies on the Internet of Things (IoT) awareness and the potential for library services, it is still difficult to find studies on this topic in Nigeria, particularly in terms of use and functionality (Yusuf, Ifijeh& Owolabi, 2019). It is against this backdrop that this study aimed to identify, amid all odds, the application of the Internet of Things (IoT) for quality service delivery in Nigerian University libraries.

## II. OBJECTIVES OF THE STUDY

The objectives of the study are to:

1. Identify the Internet of Things (IoT) technologies that are available in Nigerian University Libraries;
2. Identify the areas of use of Internet of Things (IoT) technologies in Nigerian University Libraries;
3. Examine the functions of Internet of Things (IoT) technologies in Nigerian University Libraries; and
4. Identify the benefits of the Internet of Things (IoT) technologies in Nigerian University Libraries.

## III. LITERATURE REVIEW

Since the late 1990s, the term "Internet of Things" (IoT) has been used extensively (Wojcik, 2016). IoT refers to anything connected to the internet and can "talk" to one another (Hess, 2016). It is a massive network of interconnected things and people with relationships between them (Morgan, 2014). The term "Internet of Things" was coined by Kevin Ashton while working for Procter & Gamble to improve supply chain management to manage and inventory them using tagging machines apart from Radio Frequency Identifier (RFID), barcodes, and QR codes (Bansal, Arora, & Suri, 2020). IoT has the potential to create a plethora of innovative applications and services that can improve the quality of life and create new revenue opportunities (Bansal *et al.,* 2020). It is a complex system with numerous heterogeneous features such as artificial intelligence, connectivity, and sensors that make up the digital revolution of a dynamic global network with self-configuring capabilities based on standard and interoperable communication protocols (physical and virtual things) having identities and physical attributes, and virtual personalities that are integrated into the information network (Tutorials point. com 2016; Chandrashekhar 2016; & Zennaro 2016).

### *A. Internet of Things (IoT) Technologies Available in University Libraries*

There are not many existing descriptions of IoT technology that is used solely by university libraries, but a search of the literature and network resources revealed some intriguing initiatives, which include:

*1. Wireless Sensor Network:* This remote sensing application uses low-power integrated circuits and wireless communications. A sensor network comprises many intelligent sensors that are used for collecting, processing, analysing, and disseminating valuable information gathered in various environments (Kaladhar & Raoz, 2017).

*2. Measure the Future:* Measure the Future is a funded knight foundation project utilising IoT technologies for supporting space assessment. The project produces hardware and software solutions that provide a "Google Analytics-style" dashboard for a library building, the number of visits and time, what patrons browsed, and what parts of the library were busy, among others (Jasongriffey.net, 2022). It uses simple and inexpensive sensors to collect data about invisible building usage. Making these hidden occurrences explicit will allow librarians to make strategic decisions for more efficient and practical experiences for their patrons (Hahn, 2017).

*3. Beacon:* This IoT device combines a Smartphone app and a transmitter to provide location-specific information and updates tailored to individual patrons (Mathew, 2015). Libraries can use it for event announcements, wayfinding, and item recommendations (Mishra, 2014).

*4. Magic Mirror:* This is an application technology that has been added throughout the library to sense what title the user is holding, recommend other library materials, mention related events, and give a sneak peek into the books (Shah & Bano, 2020). It consists of a smart camera, sensor, and Wi-Fi-enabled interaction between people and computers that saves the information from user reviews in the database (Gupta, 2015). Nag and Nikam (2016) conclude that this system will quickly find its way into daily library use.

*5. Cloud Computing:* Cloud computing is a catch-all term for delivering hosted services over the internet rather than directly accessing them from a desktop or internal server (Shah & Bano, 2020). It is made up of a super storage capacity that acts as the central nervous system of the "brain" of the Internet of Things (IoT) in computing and storage capacity. IoT sensors and Internet operators exchange data with the cloud via network lines and computer terminals to provide data to the cloud and receive technical services from the cloud (Zhuang, 2021). It provides computing services such as servers, storage, databases, networking, software, analytics, and intelligence via the internet cloud to enable faster innovation and more flexible resources. It allows multiple users to access the internet (Bigelow, 2019). Libraries may also use cloud computing to store all their catalogue entries, which can then be harvested automatically by other libraries in the same way that Mendeley harvests citations. Hence, IoT is a model for gaining shared, on-demand access to a pool of customisable computer resources (Khuntia *et al.,* 2016).

*6. Spotzer:* This technology company worked with Neue Galerie in New York and Boston Atheneum to provide enriched information about works of art using a mobile application. Once a museum visitor downloads the app, it

tracks the person's movements to art, learns the person's preference, and provides a personalised experience as he/she moves to other art (Shamprasad, Pujar & Satyanarayana, 2015).

*7. Bluu Beam:* This application is based on ibeacon technology, commonly used in extended reality programs. The Bluu Beam application was founded in 2014 by Chris Zabaleta. It is a mobile application that sends location trigger information to mobile devices of library clientele to assist them in searching for resources that match their interest. It also sends alerts about library offers and events to users. According to the company's founder, Bluu Beam is used in about 30 other libraries in the United States (Sarmah, 2015).

*8. Smoke or Heat Sensors:* This IoT device protects the library from a fire outbreak. Simultaneously, the device can alert library staff when users misplace books on the racks (Kaladhar & Raoz, 2017).

*9. Radio-Frequency Identification (RFID):* RFID is part of a group of technologies known as Automatic Identification and Data Capture (AIDC), which automatically identifies objects, collect data about them and enters that data directly into computer systems, with little or no human intervention, (rfidcard.com, 2022) American Barcode and RFID, (2022) further reiterated that, at a simple level, RFID systems consist of three components: an RFID tag or smart label, an RFID reader, and an antenna. RFID tags contain an integrated circuit and antennas that transmit data to the RFID reader (also called an interrogator). The Reader then converts the radio waves to a more usable form of data. Information collected from the tags is transferred through a communications interface to a host computer system, where the data can be stored in a database and analysed later.

*B. Areas of Use of the Internet of Things (IoT) Technologies in University Libraries*

The areas of use of the Internet of Things (IoT) as identified by (Gupta & Singh, 2018; Kaladhar & Rao, 2017; Bansal, Arora & Suri 2018) include a virtual library and book tracking. It allows mobile app users to take a virtual library tour on their mobile devices. It also keeps and tracks the book's availability on the respective shelves or checks other resources regardless of location, thereby familiarizing new users with the library.

*1. Technical and Reader Services:* The Radio Frequency Identification Device (RFID) is an IoT technology that is used in university libraries to aid data identification and tracking by attaching an RFID tag containing bibliographic information and transaction logs to each item in the acquisition department (Adebayo, Adeniran, & Gbotosho, 2021). The circulating unit may use RFID to charge and discharge books by combining the library card with RFID tags. As a result, libraries will be able to notify users of overdue items and allow them to pay fines online (Addepalli & Addepalli, 2014). It also helps University libraries market library holdings more effectively by utilizing IoT technologies that detect user behaviours in the library and transact data to help them locate books inside the library using RFID, Near Field Communication, and Zig Bee will (Kaladhar & Rao, 2017). This enables the analysis of book transactions via Mobile alert. When a researcher searches a database for resources on the topic of their research, other resources that may be of interest to them can be suggested (Shamprasad, Pujar & Satyanarayana, 2015).

*2. Online Fine Payment:* The Internet of Things can tell librarians how much fines a user owes and allow them to pay online without having to wait in line. Gupta and Singh (2018) also proposed an option for online payment of fees for services such as plagiarism checks.

*3. Availability of Various Machines:* IoT assists patrons in the library in determining which PCs, printers, photocopiers, and scanners, among others, are available within the library building. It also helps them find available seats in common reading areas, discussion rooms, meeting rooms, research scholar's cabins, and faculty rooms - all of which are quick to check from patron's phones as they enter the library (Gupta & Singh, 2018).

*4. Maintenance of Infrastructure:* Sensors can aid in the control of lights, fans, and air conditioners by turning them on and off based on their usage (Kaladhar & Rao, 2017). For example, imagine a user walking into the library, using a cubicle or reading table, the Internet of Things (IoT)-enabled mobile phones can control lighting, air conditioning, and Wi-Fi (Shamprasad, Pujar & Satyanarayana, 2015).

*5. Gate Registration Through Biometrics:* In an IoT-enabled Library**,** users must enter the library through biometric identification. Without proper authentication, the entry may be restricted (Bansal, Arora & Suri, 2018).

*6. Inventory Control:* Besides books, journals, and magazines, various other library sources, such as microfiche, video, and audio, can also be controlled by applying sensors. It provides all the real-time data on the mobile of the librarian/manager. Hence, better inventory control can assist the library personnel in doing less stock verification work (Bansal, Arora & Suri, 2018).

*7. Theft Management:* With tags on each item of the library inventory (scanners, printers, hard disks, and CDs), library collection can be tracked at all-time to prevent theft from the library gate using high-end sensors and transponders, which, apart from signaling the authorities on their mobiles or by loud alarm, can also block the theft by taking automatic prompt action like shutting the door. It also lets the library staff remotely see camera views of their homes and sends a warning when something is not suitable for emergency service people to take action (Bansal, Arora & Suri, 2018).

*8. Circulation Desk:* The circulation desk in libraries involves activities such as issuing and return of books and other library material, maintaining records, creating and updating library cards, and overdue reminders, among others. IoT enables demanding users receive notifications of returned books using RFID (Purnik, 2019). In the case of eBooks, the required book will be issued automatically as the computers at the desk can provide options for their needs and take action accordingly. Users can also use library Smartphone applications to locate resources, reserve books and research spaces, follow library events, and participate in user education initiatives (Guo et al., 2018; Kerr & Pennington, 2018).

*9. User Identification:* The sensors at the library gate can do face recognition of all visitors and will match the face with the available databases. Then, the gate will allow only authorized users to enter. Otherwise, an electronic message will be sent to the librarian in charge, who can take action from a distance whether to open the door for the unknown face or not (Bansal, Arora & Suri 2018).

*10. Reservation of Books:* One potential use of the IoT is that it enables the patron to search for the desired book from the OPAC of the library available on the internet through their Smartphone and also make reservations. The desired book available on the library's shelf uses sensors through a network to show its presence through a beep or may start flashing light for the librarian to quickly identify the required books to be issued to the patrons. This way, IoT helps in saving the human resources and time of both the librarians and the users (Bansal, Arora & Suri, 2018).

*11. Fire Detection and Prevention:* Suppose there is a fire in the library, and no one notices it. The fire detection devices will alarm and automatically send a message to the Fire Department responsible for taking action. This way, the Internet of Things (IoT) will help take action automatically at an early stage and prevent further damage (Bansal, Arora & Suri, 2018).

*12. Tracking the Movement of Resources and Inventory:* IoT allows users to be categorized based on the criteria for accessing library resources. Some libraries offer access rights to faculties, students, staff, and regular and non-regular students. Suppose in case a book/magazine was wrongly issued to a non-authorized user; IoT makes tracking possible on the mobile of the librarian where the library resource is physically present inside or outside the library. With the Internet of Things (IoT), it is possible to track the location of the inventory outside the library (Bansal, Arora & Suri, 2018).

*13. Assistive Technology:* Today, smart phones also provide features such as text-to-speech, touch navigation, and hands-free operations, especially for people with disabilities. IoT adopts this feature of mobile phones and offers services to such library users. With the Internet of Things (IoT), such persons can request the required resource (say, a book, which will have a tag) with speech. Once they want the resource physically, they can find directions to that book in the library via voice communication on their mobile (Bansal, Arora & Suri, 2018).

### *C. Functions of Internet of Things (IoT) Technologies in University Libraries*

According to an OCLC survey conducted in 2015, IoT is primarily concerned with the University Libraries' intelligent use of space and facilities for their clientele. Some IoT technologies include RFID, WSN, QR codes, Cloud computing, and Bluebeam, among others. The function of RFID tags is to aid in increased visibility and unique identification of library materials. Hussain (2019) expressed that some libraries incorporate IoT technology in their system, such as Smart Building Technology. These modern library buildings are interconnected with IoT to keep the library temperature regular in the summer and winter seasons.

A good example is the Russian State Library for Young Adults (RSLYA) http://www.rgub.ru/en/ as identified by (Purnik, 2022); these systems can be controlled through a Smartphone application. The usefulness of the people counter is worth mentioning; a Google analytics-style dashboard through which library staff measures the future through open hardware sensors for identifications of different services. These sensors enable librarians to make strategic decisions for their patrons, resulting in a more efficient and practical experience (Hussain, 2019).

### *D. Benefits of the Internet of Things (IoT) to University Libraries*

Libraries, in addition to classrooms, play an essential role in the learning process. Hussain expressed that, formerly, students borrowed books, went to the library, and copied information for class work. But with the advent of the IoT, Students now do the same thing via their Smartphones, which connect them with librarians to aid strategic academic decisions.

Even though the Internet of Things (IoT) is still in its early stages, it has enormous potential for university libraries. According to Pujar and Satyanarayana (2015), it provides more value in addition to its services. It provides patrons with a rich library experience, as the Internet of Things (IoT) is all about connecting objects uniquely identifiable to each other online. They further stated that, since Libraries have books, journals, CDs/DVDs, theses, and many other physical objects, the Internet of Things (IoT) can be a Godsend in overcoming some of the perennial library problems, such as object misplacement and usage.

In addition, the Internet of Things (IoT) can make it easier to access libraries and their resources. Most university libraries provide their members with a virtual library card, which allows them to gain access to the library and its

resources. When a user accesses the library catalogue to find the help they need, the library app on their mobile device displays a library map, guiding the user to the resources (Mohammed &Yegane, 2018).

## IV. METHODOLOGY

This study was conducted using the descriptive survey method. The respondents were 37 professional librarians selected from three (3) university libraries in Kwara State (University of Ilorin (24), Kwara State University (9), and Al-Hikmah University (4). The instrument used for data collection was a questionnaire titled: Questionnaire on the Application of Internet of Things (IoT) for Quality Service Delivery (QAIQSD) in Nigerian University Libraries in Kwara State. The questionnaire consisted of two parts. Part 1 consisted of items on the respondents' bio-data, such as age, gender, and academic level. Part 2 included items that captured information about the study's four (4) objectives. The questions were designed using the Likert scale. Simple descriptive (mean, percentage, and frequency counts) were used to analyse the collected data with a statistical package for social science (SPSS v.23).

## V. RESULTS AND DISCUSSION

TABLE I DISTRIBUTION OF THE RESPONDENTS

| Sl. No. | Demographic Information of Respondents | | F | % |
|---|---|---|---|---|
| 1 | Name of Institution | University of Ilorin Library | 23 | 62.2 |
| | | Kwara State University Library | 9 | 24.3 |
| | | Al-Hikmah University Library | 5 | 13.5 |
| | | Total | 37 | 100.0 |
| 2 | Gender | Male | 21 | 56.8 |
| | | Female | 16 | 43.2 |
| | | Total | 37 | 100.0 |
| 3 | Age-ranges | 20- 30 years | 6 | 16.2 |
| | | 31-40 years | 15 | 40.5 |
| | | 41-50 years | 7 | 18.9 |
| | | 51 years Above | 9 | 24.3 |
| | | Total | 37 | 100.0 |
| 4 | Years of experience | 1-5 years | 4 | 10.8 |
| | | 6-10 years | 7 | 18.9 |
| | | 11-15 years | 11 | 29.7 |
| | | 16-20 years | 4 | 10.8 |
| | | 21-25years | 4 | 10.8 |
| | | 26-30 years | 6 | 16.2 |
| | | 31-35 years | 1 | 2.7 |
| | | Total | 37 | 100.0 |
| 5 | Highest Educational Qualification | B.Sc./BLIS | 10 | 27.0 |
| | | Master's | 21 | 56.8 |
| | | PhD | 6 | 16.2 |
| | | Total | 37 | 100.0 |
| 6 | Job Status | Asst. Librarian | 2 | 5.4 |
| | | Librarian II | 16 | 43.2 |
| | | Librarian I | 4 | 10.8 |
| | | Senior Librarian | 7 | 18.9 |
| | | Principal Librarian | 2 | 5.4 |
| | | Deputy-University Librarian | 3 | 8.1 |
| | | University Librarian | 3 | 8.1 |
| | | Total | 37 | 100.0 |

Source: Field survey, 2022

According to findings in Table I, the University of Ilorin Library has the majority of respondents with a frequency of 23 (62.2%). It also revealed that males make up the majority of respondents, with a frequency of 21 (61.3%). Respondents between the ages of 31 and 40 have the highest frequency of 15 (40.5%). The table also reveals that most respondents had 11-15 years of experience, with a frequency of 11(29.7 %). According to the table above, the average of the respondents has a Master's degree with a frequency of 21(56.8 %). Furthermore, the table depicts that the job status of most respondents to this questionnaire is Librarian II with a frequency of 16 (43.2 %).

TABLE II RESPONSE ON AVAILABLE INTERNET OF THINGS TECHNOLOGIES

| Sl. No. | Available Internet of Things | Not Available | | Available | | Mean |
|---|---|---|---|---|---|---|
| | | F | % | F | % | |
| 1 | Wireless Sensor Network | 0 | 0.0 | 37 | 100.0 | 2.00 |
| 2 | Measure the Future | 37 | 100.0 | 0 | 0.0 | 1.00 |
| 3 | Beacon | 37 | 100.0 | 0 | 0.0 | 1.00 |
| 4 | Magic Mirror | 37 | 100.0 | 0 | 0.0 | 1.00 |
| 5 | Cloud Computing | 0 | 0.0 | 37 | 100.0 | 2.00 |
| 6 | Spotzer | 37 | 100.0 | 0 | 0.0 | 1.00 |
| 7 | Bluu Beam | 37 | 100.0 | 0 | 0.0 | 1.00 |
| 8 | Smoke or Heat sensor | 6 | 16.2 | 31 | 83.8 | 1.84 |
| 9 | RFID (Radio-Frequency Identification) | 6 | 16.2 | 31 | 83.8 | 1.84 |

Source: Field survey, 2022

Table II contains a comprehensive statistical summary of 9 variables estimated to identify the IoT technologies available in Nigerian university libraries. As revealed by respondents, the available IoT technologies are Wireless Sensor Networks and Cloud Computing having the same frequency of 37(100 %). While Smoke or Heat sensors and RFID also have the same frequency of 31(83.8 %).

Eiriemiokhale and Ibeun (2017) found that there is a correlation between awareness, accessibility, and usage of library resources. The correlation, according to them, is that what one is not aware of is hardly desired and once something is not desired it will not be needed and once it is not needed, it will not be sought for and once it is not sought for, it will not be available and accessible for use (Idowu and Eiriemiokhale, 2020).

According to Tutorials point.Com (2016), Chandrashekhar (2016), and Zennaro (2016) a sensor is a general and fundamental feature of the Internet of Things (IoT) infrastructure and a game-changing tool that elevates the IoT from a passive network of devices to an active system capable of real-world integration. According to Kaladhar and Raoz (2017), deploying a Wireless sensor network enables the collection, processing, analysis, and dissemination of valuable data gathered in various environments.

On the other hand, cloud computing delivers computing services such as servers, storage, databases, networking, software, analytics, and intelligence over the internet cloud for faster innovation and more flexible resources (Bigelow, 2019). The smoke and heat sensors keep the library safe from fires and can notify library staff (Kaladhar & Raoz, 2017). According to (Shah & Bano, 2020), RFID technology is used to manage activities in the circulation section of the library and allows for self-check-in and self-check-out of books.

A keen observation of data in Table III provided a statistical summary of all component variables identified as areas of use of Internet of Things technologies in university libraries. 100% of the respondents noted that technical services; readers services; theft management; alerting services; reservation of books; fire detection and prevention; inventory control of library collections; gate registration via biometric and user identification. They further revealed the other areas of IoT application in University Libraries include; Library infrastructure maintenance 34 (91.9 %); determining the availability of various ICT technologies, vacant reading chairs and tables 35 (94.6 %); tracking library collections and availability 36 (97.3 %); online fine payment 33 (89.2 %); and virtual tour of the library on mobile devices 32 (86.5 %).

According to Gupta and Singh (2018), to implement IoT in an academic library, the first step is to create a virtual tour or library orientation video on mobile to introduce users to the library properly. The acquisition department provides technical services by attaching an RFID tag containing bibliographic information, transaction logs, and virtual representations to each item (Adebayo, Adeniran, & Gbotosho, 2021).

Furthermore, university libraries can more effectively market their library holdings by utilising IoT technologies that detect user behaviours in the library and their transaction data to assist them in locating books within the

library using RFID (Kaladhar & Rao, 2017). It also allows library staff to remotely view camera views of their homes, send alerts when something is incorrect, and contacts emergency services to report the theft (Bansal, Arora & Suri, 2018).

TABLE III RESPONSE ON AREAS OF USE OF THE INTERNET OF THINGS (IOT) TECHNOLOGIES IN UNIVERSITY LIBRARIES

| Sl. No. | Areas of Internet of Things (IoT) Applications in University Libraries | Strongly Disagree | | Disagree | | Agree | | Strongly Agree | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | % | F | % | F | % | F | % | |
| 1 | Virtual tour of the library on mobile devices | 1 | 2.7 | 4 | 10.8 | 13 | 35.1 | 19 | 51.4 | 3.35 |
| 2 | Tracking of library collections and availability | 0 | 0.0 | 1 | 2.7 | 19 | 51.4 | 17 | 45.9 | 3.43 |
| 3 | Technical services | 0 | 0.0 | 0 | 0.0 | 6 | 16.2 | 31 | 83.8 | 3.84 |
| 4 | Readers services | 0 | 0.0 | 0 | 0.0 | 8 | 21.6 | 29 | 78.4 | 3.78 |
| 5 | Online fine payment | 1 | 2.7 | 3 | 8.1 | 14 | 37.8 | 19 | 51.4 | 3.38 |
| 6 | Determining the availability of different ICT technologies, vacant reading chairs, and tables | 0 | 0.0 | 2 | 5.4 | 14 | 37.8 | 21 | 56.8 | 3.51 |
| 7 | Maintenance of library infrastructure | 0 | 0.0 | 3 | 8.1 | 9 | 24.3 | 25 | 67.6 | 3.59 |
| 8 | Gate registration through biometric identification of users | 0 | 0.0 | 1 | 2.7 | 12 | 32.4 | 24 | 64.9 | 3.62 |
| 9 | Inventory control of library collections | 0 | 0.0 | 0 | 0.0 | 14 | 37.8 | 23 | 62.2 | 3.62 |
| 10 | Theft management | 0 | 0.0 | 0 | 0.0 | 8 | 21.6 | 29 | 78.4 | 3.78 |
| 11 | Alerting services | 0 | 0.0 | 0 | 0.0 | 11 | 29.7 | 26 | 70.3 | 3.70 |
| 12 | Reservation of books | 0 | 0.0 | 0 | 0.0 | 12 | 32.4 | 25 | 67.6 | 3.68 |
| 13 | Fire detection and prevention | 0 | 0.0 | 0 | 0.0 | 13 | 35.1 | 24 | 64.9 | 3.65 |

Source: Field survey, 2022

When patrons reserve items in the library, overdue books, or other items, the IoT notifies them using the alerting service (Shamprasad, Pujar, & Satyanarayana, 2015). The IoT technology also aids in the preservation of books, saving both librarians' and users' time and effort (Bansal, Arora & Suri, 2018). It allows users walking into the library to control the lighting, air conditioning, and Wi-Fi, among other things, and maintain the library infrastructure. It determines the availability of different ICT technologies and vacant reading space using their Internet of Things (IoT)-enabled mobile phones (Gupta & Singh, 2018).

TABLE IV RESPONSE ON FUNCTIONS OF INTERNET OF THINGS TECHNOLOGIES

| Sl. No. | Functions of Internet of Things Technologies | Strongly Disagree | | Disagree | | Agree | | Strongly Agree | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | % | F | & | F | % | F | & | |
| 1 | Intelligent use of library space and facilities | 0 | 0.0 | 0 | 0.0 | 8 | 21.6 | 29 | 78.4 | 3.78 |
| 2 | Increase the visibility of library materials | 0 | 0.0 | 0 | 0.0 | 16 | 43.2 | 21 | 56.8 | 3.57 |
| 3 | Aid unique identification of Library materials | 0 | 0.0 | 1 | 2.7 | 14 | 37.8 | 22 | 59.5 | 3.57 |
| 4 | Use sensors for the identification of different library services | 0 | 0.0 | 1 | 2.7 | 22 | 59.5 | 14 | 37.8 | 3.35 |
| 5 | Enable librarians to make strategic decisions for their patrons | 0 | 0.0 | 1 | 2.7 | 11 | 29.7 | 25 | 67.6 | 3.65 |
| 6 | Connect Librarians to users online | 0 | 0.0 | 0 | 0.0 | 11 | 29.7 | 26 | 70.3 | 3.70 |

Source: Field survey, 2022

Table IV stated that 100% of the 37 respondents indicated that the functions of IoT Technologies in Nigerian University Libraries include; intelligent use of library space and facilities, increased visibility of library materials, and increased users online. While 97. 3 % of the 36 respondents revealed that it enables Librarians to make strategic decisions for their patrons, aids unique identification of Libraries, and uses sensors to identify various library services. This finding aligns with the 2015 OCLC survey. The analysis also reveals that IoT Technologies employ

sensors to identify library services. This is consistent with Hussain's (2019) statement that some libraries are incorporating IoT technology, such as Smart Building technology, into their systems to aid in increased visibility and unique identification of library materials.

TABLE V RESPONSE ON BENEFITS OF THE INTERNET OF THINGS

| Sl. No. | Benefits of the Internet of Things | Strongly Disagree | | Disagree | | Agree | | Strongly Agree | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | % | F | % | F | % | F | % | |
| 1 | Prevents library collection misuse and misplacement | 0 | 0.0 | 0 | 0.0 | 8 | 21.6 | 29 | 78.4 | 3.78 |
| 2 | Provide access to library materials virtually | 0 | 0.0 | 0 | 0.0 | 11 | 29.7 | 26 | 70.3 | 3.70 |
| 5 | Organise self-guided tours for users | 0 | 0.0 | 1 | 2.7 | 15 | 40.5 | 21 | 56.8 | 3.54 |
| 6 | Promote a positive image of the library | 0 | 0.0 | 1 | 2.7 | 13 | 35.1 | 23 | 62.2 | 3.59 |
| 8 | It saves the patron's time | 0 | 0.0 | 0 | 0.0 | 9 | 24.3 | 28 | 75.7 | 3.76 |
| 7 | Improve Librarians' work efficiency | 0 | 0.0 | 0 | 0.0 | 11 | 29.7 | 26 | 70.3 | 3.70 |

Source: Field survey, 2022

As shown in Table V above, 100 % of the 37 respondents strongly agreed that the benefits of the IoT in Nigerian university libraries include preventing library collection misuse and misplacement, saving patrons' time, and improving librarians' work. Further analysis revealed that 97.3% of the respondents note that it also promotes a positive image of the library; and helps to organise self-guided tours for users.

IoT benefits Nigerian university libraries by preventing library collection misuse and misplacement, saving patrons time, improving librarians' work efficiency, and providing virtual access to library materials (Mohammed & Yegane, 2018; Bayana *et al.,* 2017). It also enhances the library's image by organising user-self-guided tours and simplifying back-office processes like inventory control, collection organisation, and storage (Wojcik, 2016).

## VI. CONCLUSION

The Internet of Things (IoT) has enormous potential for libraries. If implemented correctly, it may yield the desired results and add value to library resources and services. Undoubtedly, university libraries in Nigeria are exposing themselves to modern technologies to provide quality services to their clientele. Along the line, most library professionals have acquired knowledge about concepts, functions, and benefits of the Internet of Things (IoT) technologies which can be tweaked to improve information service delivery, even though only a few of these Internet of Things technologies exist in the university libraries. However, based on the findings of this study, they have failed to adopt most of the existing Internet of Things (IoT) technologies (Measure the Future, Magic mirror, Spotzer, Bluu Beam, Beacon, among others) to a full extent.

As a result, the study concluded that for IoT technologies to reach their full potential in Nigerian university libraries, library management and staff must work together to raise awareness and source funding for its implementation and use in Nigerian university libraries. IoT has emerged and will continue to change how library services are delivered; our choice is to keep up with the smart world or fall behind.

## VII. RECOMMENDATIONS

This study hereby recommends as follows.

1. The study identified that only a few IoT technologies are available in Nigerian University libraries. As a result, there is a need to increase awareness of other existing IoT technologies available to improve quality service delivery in Nigerian university libraries.
2. The study revealed that Librarians are familiar with IoT technologies in Nigerian university libraries. Therefore, University Library management should implement appropriate measures for its use in various library routines and departments.
3. The study revealed that Nigerian university Librarians have an excellent knowledge of the potential functions of IoT in University libraries. Hence, they should employ it to improve library services and transform it into an intelligent library.
4. The study indicated that Librarians are aware of the enormous benefits of IoT in Nigerian University Libraries. Hence, the need to embrace it to prevent library collection misuse and misplacement; save patron's time; improve librarians' work; promotes a positive image of the library and help to organise self-guided tours for users.

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