Awareness and Application of Internet of Things in Universities Libraries in Kwara State, Nigeria

Saliu Abdulfatai*

ARTICLE INFO

ABSTRACT

The study was conducted on the awareness and application of internet of things in universities libraries in Kwara State, Nigeria. the study formulated used four research questions and used eighty five (85) samples as the population using total enumerative sampling techniques. A survey method was used in undertaking the study, in which answers were sought on the level of awareness of the internet of things in universities libraries in Kwara State, the extent of application of the internet of things in universities libraries in Kwara State, the benefit of internet of things in universities libraries in Kwara State, the challenges faced in the application of internet of things in universities libraries in Kwara State. The data collected from the study were analyzed using frequency tables and percentage. The study discovered that there the students are aware of the internet of things in universities libraries in Kwara State and the benefit of internet of a things include: Device in the IoT platforms are heterogeneous and are based on different hardware platforms and networks, It gives the high level of interoperability and interconnectivity, IoT platform has sensors which detect or measure any changes in the environment to generate data that can report on their status or even interact with the environment, IoT comes with the combination of algorithms and computation, software & hardware that makes it smart and Anything can be interconnected with the global information and communication infrastructure and the study identified data interpretation problem, Lack of skilled and specialized workers, Cost and Challenges in online security as well as Software complexity are major challenges faced in the application of internet of things in universities libraries in Kwara State. In conclusion the study made some recommendations which include that: Future libraries should be equipped with new technologies and networking devices as soon as possible. As this will be essential for users and librarians to have sufficient knowledge about IOT technologies.

1. Introduction

Internet of things (IoT) is a new revolution of the Internet that is rapidly gathering momentum driven by the advancements in sensor networks, mobile devices, wireless communications, networking and cloud technologies (Bahga & Madisetti, 2014). They are interrelated networks that allow devices to receive and send data with each other via Internet. IoT is defined as "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual 'Things' have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network" (Kranenburg, 2008).

The term IoT was first coined by Kevin Ashton in 1999. Firstly, the term was introduced to describe how IoT was created by adding RFID and other sensors to everyday objects (Simões, Filipe, & Barbosa, 2019). In IoT the things function like smart and living entities by sensing and communicating through embedded devices which interact with sensors. IoT consists of the networks of physical objects, the traditional network of the Internet, and various devices (gateway, border router etc.) that connect these networks (Tkachenko & Brezhniev, 2019). Xu, He, and Li (2014) stated that RFID and WSN are the foundational technologies of IoT and service-oriented architecture as a key technology in integrating heterogeneous systems or devices that can be applied to support IoT. The identification and tracking technologies, communication technologies, networking technologies and service management form the four-layer architecture of IoT (Liang, 2019).

Internet of Things (IoT) is a connection of a wide variety of devices with internet ranging from equipment with sensors (Kreische, Ullrich, & Ziemann, 2015). It is an interrelated embedded system that brings proximity of two technologies which are wireless connectivity and smart sensor. These joined embedded technological systems are based on small microcontroller computers where the human intermediary is not needed. Instead of connecting and interacting with people, these systems have a mechanism of detecting object which is advanced technologically and uses different sensors (Grindvoll, Vermesan, Crosbie, Bahr, Dawood, & Revel, 2012).

The fast-growing network of physical objects offers numerous opportunities for the construction industry and organization despite its barriers to its implementation (World Economic Forum, 2015). Presently, the IoT have become famous and widely spread in its use in different sectors. It was noted that in 2010, over four billion digital and electronic devices are been connected by the internet globally. Cisco Internet Business Solution Group (IBSG) noted that 12 billion devices are been connected in 2015 and were forecasted that 30 billion will be connected this year (Rose, Eldridge, & Chapin, 2015). The usage of IoT is increasing due to the decrease in the prices of the IoT hardware making more users having a wider range of IoT applications.

This represents a compound annual growth rate of 13% and will effectively change the way the university libraries is been executed and how we experience life generally (Chris, 2014) In the university libraries, equipment with sensors gives merit for maintenance, movement and security. When there is an abnormal movement of malfunction of equipment's it brings signals to the library management which is been rectify quickly (Iwuagwu & Iwuagwu, 2014). The IoT also aids us to know whether machines are off or in operation. With the help of IoT, a sustainable and smart

building is enhanced, i.e. building that can conserve energy which reduces the cost spent on the building. IoT enhances the use of prefabricated component which reduces the time used in the completion of the project. These modules connect by the use of IoT sensors attached to them. Also, IoT sensors installed on the wall collect data and analyze the trend and pattern of building usage (Jacqi, 2017). It was noted that IoT influences design production which reduces valuable time and resources that are spent on design.

However, Pujar, and Satyanarayana (2015) observed that in recent times 'the internet has taken a leap forward from "internet of communication" to "internet of things", making it possible to connect objects and transfer data with or without human intervention'. The 'internet of communication' promoted better communication and improved services, but with some form of human interventions. Herein lies the distinctiveness of the 'internet of things' - connecting objects using sensors and networking capabilities with very minimal or no human intervention.

Therefore, Internet of things (IoT) can only be applicable in the libraries if librarians are aware of the existence and have access to them as at when required. Ezema (2018) described awareness as a state of consciousness and purpose. Awareness is the condition of being aware and able to understand what is happening around one (Chinedu, 2019). Awareness depicts a person's ability to perceive, feel, or be conscious of events or objects. or generally having an idea of the existence of something. Obande (2019) equates awareness with either knowledge, understanding, appreciation or recognition of attention to the perception of something. Omini and Ayanlade (2019) posited that awareness is an essential factor that determines the application of Internet of things (IoT). The extent of awareness of Internet of things (IoT) among librarians will determine the extent to which they utilise it in universities library. Librarians in tertiary institutions are to some extent aware of Internet of things (Iwu-James, Haliso & Ifijeh, 2020).

So therefore, the first IoT application was the Trojan Room coffee maker, which led to the creation of the term IoT. The phrases "Internet" and "Things," which allude to intelligent devices or objects, are combined to form the phrase "Internet of Things," often known as IoT. The IoT ecosystem is made up of web-enabled smart gadgets that use integrated systems including processors, sensors, and communication hardware to gather, send, and act on data (Laghari et al., 2021). The IoT refers to the use of intelligently connected devices and systems to collect data from embedded sensors and actuators in machines and other physical objects (GSM Association Copyright, 2014).

The IoT is a global information and knowledge gateway or hub that academic and research institutions can use to their benefit strategically and gain a competitive edge. IoT and associated information technologies are widely employed in a variety of domains, including businesses, manufacturing facilities, and industries, for the sharing, free circulation, and on-demand usage of resources and capabilities (Fei Tao et al., 2014). Healthcare (Karahoca et al., 2018), tourism (Pizam, 2017), education (Lei et al., 2021), food production (EA et al., 2021), transportation (Tahaei et al., 2020), agriculture, and other human endeavors have all benefited from the deployment of IoT. (Haque et al., 2021; Kumar et al., 2021).

2. Statement of the problems

The concept of IoT has not been widely used in the Nigerian construction industry because of the low level of awareness and understanding of the importance and benefit of IoT amongst Nigerian universities (Arowoiya, Oke, Aigbavboa, & Aliu, 2020). This poses a great challenge in the adoption of the Internet of Things in the universities. According to Atzori, Lera, and Morabito (2010), despite the benefits of IoT, this seems advanced and ambiguous to most professionals which makes it invisible to the universities and clients.

Wang, Altaf, Al-Hussein, and Y. Ma. (2018) examined the framework for IoT based shop floor material management system for panelized university libraries and revealed that IoT can capture dynamic data in real-time and effectively synthesize it along the supply chain. Rad and Ahmada (2017) did a systematic review of trends, opportunities, and challenges of IoT in Malaysia. In Nigeria, there are limited studies and usages of IoTs in different areas, even though a lot of studies and usages of IoTs have been carried out in various areas like educational institutions, smart homes, smart cities, public relations firms and agencies (Adejuwon, 2018; Amodu, Omojola, Okorie, Adeyeye, & Adesina, 2019; Iwayemi, 2018; Yusuf, Ifijeh, & Owolabi, 2019). Ndubuaku and Okereafor (2015) noted that Africa has a slow rate in the adoption of IoT compared to other continents, but that Nigeria which has the largest population and economy in Africa has large prospects in IoT if it is effectively implemented. However, in the light of previous research carried out on the IoT, this research work focuses on the Awareness and application of internet of things in universities libraries in Kwara State, Nigeria.

3. Objectives of the study

The main objective of this study is to investigate the awareness and application of internet of things in universities libraries in Kwara State, Nigeria. The specific objectives of the study are to:
  (1) determine the level of awareness of the internet of things in universities libraries in Kwara State;
  (2) examine the extent of application of the internet of things in universities libraries in Kwara State;
  (3) find out the benefit of internet of things in universities libraries in Kwara State; and
  (4) determine the challenges faced in the application of internet of things in universities libraries in Kwara State.

3.1 Research questions

The following research questions guided the study:
(1) What are the level of awareness of internet of things in universities libraries in Kwara State?
(2) What is the extent of application of the internet of things in universities libraries in Kwara

State?

(3) What are the benefit of internet of things in universities libraries in Kwara State?

(4) What are the challenges faced in the application of internet of things in universities libraries in Kwara State?

3.2 Review of Related Literature Concept of internet of things

The concept of "internet of things" was popularize by the Auto - ID centre at Massachusetts institute of technology (MIT) which in 1999 started to design and propagate a cross - company Radio Frequency Identification Infrastructure. Kelvin Ashton one of the founders of the original Auto-ID center is credited as the inventor of the phrase "IOT" while working for the procter and gamble improve supply chain management. He established that if people and objects in daily life were equipped with unique identifiers, then computers could readily manage those using Radio Frequency Identifications, Barcodes, Q R Codes and Watermarks can also be used for machines (Bansal, Arora, & Suri, 2018).

IOT refers to an ecosystem in which application and services are driven by data collected from devices that sense and interface with the physical world. The internet of things devices and objects has common communication connectivity, either a direct connection to the internet or mediated through local or wide areas networks (OECD, 2016). The internet of things exists as part of an emerging technology ecosystem with cloud and big data analytics. Interactions occur among and between people and objects in computer aware environment that can avail themselves of new and innovative services delivered through the cloud and supported by an ever more powerful set of analytical tools.

Patel and Patel (2016) states that IOT can be defined into three categories as stated below: internet of things is an internet of three things: people to people, people to machine and things and machine and things as well as things and machine to things, and machine interacting through the internet. The basic idea that the internet of things (IoT) concept is a model that consider pervasive presence in the environment of different things and objects that communicates via wireless and wired connections with unique addressing schemes and that work together to create new applications or services targeted towards a common goal. The general idea of the IoT is that everyday objects, make themselves recognizable and they obtain intelligence by making or enabling context related decisions having an ability to communicate information about themselves.

3.3 Level of Awareness of IoT among librarians in Nigeria

A review of literature and developments in libraries have shown some levels of awareness of IoT among librarians in the United States and a few other countries (Swedberg, 2014; Wojcik, 2016); however, nothing in literature has provided any clue about the IoT awareness levels of librarians in Nigeria. Awareness is the first phase in technology acquisition and application. Generally, Nigeria like most developing countries, is far behind in terms of ICT application in industries, institutions and libraries.

Ifijeh (2014) observed that in an era when libraries in developed countries are adopting more advanced technologies in their operations and service delivery, Nigerian libraries are still battling with automation and internet access. Adeleke and Habila (2012) in their study on internet awareness and usage in Nigeria reported a very low level awareness of internet facilities and services among Nigerian librarians; they concluded that internet application to library services is still at its formative stage in the country. Akpan-Atata (2014) attributed librarians' low level awareness and adoption of ICT to a diverse mix of technological (lack of facilities, computer and internet phobia, and digital illiteracy) and sociological (time, funding and human attributes) factors.

Librarians must employ innovative thinking to determine how to exploit IoT technology to its fullest potential in order to make resources and services valuable in both the present and the future (Kaushik, 2019). By automating several regular operations in the library, the IoT has the potential to make the employment of library staff members easier. IoT adoption may help to reduce inefficiencies in normal operations by continuously tracking appliances and resource usages (Khan et al., 2021). IoT has a great deal of potential and can be used to maintain archive materials, track collections, offer consumers consolation services, and advertise traditional library items online (Wójcik, 2016). In order to accept new technology, one must first assess its advantages, returns on investment, and application's drawbacks. Students, researchers, instructors, and library professionals can utilize IoT technology by becoming more aware of how adaptable and simple new technologies are to use in libraries (DaLbehera, 2018).

3.4 Application of IoT in academic libraries

Fernandez (2015) put forward the concept of IoT and stated that the libraries have a role to play to implement the IoT in their own environments in ways that align with their values. Pujar and Satyanarayana (2015) projected the various applications of IoT in libraries viz energy management, virtual library card, smart digital shelves, real time data of patron's requests, IoT enabled mobile devices to locate favorite books etc.

In an OCLC survey it was found that many librarians were familiar with IoT technologies (Hoy, 2015) and listed different methods of integrating IoT tools to library activities. These included inventory control, mobile reference, resource availability etc. Wójcik (2016) proposed a theoretical model of IoT usage in library services after reviewing related literature of IoT implementation in libraries. Nag and Nikam (2016) proposed IoT technologies like cloud computing, magic mirror, pressure sensor pads through wireless sensor for better management of services in the academic libraries.

Miorandi (2012) recommended that IoT-enabled technologies can be used to greatly enhance the performance of current solutions, providing cheaper and less invasive alternatives to the widespread deployment of cameras while at the same time preserving users' privacy. Makori (2017) noted the power of IoT in transforming and changing academic and research information organizations as the source of knowledge in addition to expanding access to education, data, information and communication anywhere anytime through hyper connectivity and networking.

Kim et al (2017) analysed academia perception of IoT using the analysis of words frequency,

co-occurrence, and distance. Abuarqoub et al (2017) explored the possibility of IoT applications in academic libraries. Academic libraries use IoT-enabled real-time recording of environmental data to reduce the use of energy and to improve the user's comfort. Several foreign universities developed smart building providing better energy savings, monitoring and alarm systems. Patel (2019) proposed an energy efficient system providing technical solution to conserve energy in library and other buildings using two main sensors to detect human presence. The technology effectively controlled usage of electrical devices when not in use. Most of the studies showed that IoT can be effectively integrated into the physical space of the library.

3.5 Benefits of IoT to library service delivery

The applicability of IoT to libraries has become a subject of discussion among professionals. Libraries cannot afford to be left behind in the provision of improved services to patrons. Potter (2014) posited that though IoT is still in a stage of infancy, it holds a great potential for libraries. The IoT can help with intelligent library management by providing intelligent management, reader behavior analysis, intelligent self-borrowing and returning books and materials, long-term preservation, and other conveniences (Fu, 2021). Rahman & Islam (2019) gave several instances of how IoT-enabled libraries could help with effective administration of library infrastructure, including automated book renewal, a fine for excessive resource use, and book tagging via patrons' fingerprints.

Pujar and Satyanarayana (2015) discussed the IoT's possible impact on libraries, including access to library and its resources, collection management, information literary, recommendation services, location-based services and appliances management, and proposed innovative approaches, such as a virtual library card, smart digital shelve, cloud services, integrating of RFID tags into member cards to access to library and its resource, fine collection management and better inventory management.

Wojcik (2016) opined that 'IoT has the potential to improve library services by providing users with tools that allow easy use of libraries, constant contextual help, and personalization processes'. Wojcik further noted that IoT can also be useful for sharing information, consultation and training, provision of access to spaces and equipment, gathering, description, storage, analysis and selection of collections, marketing and promotion. A survey carried out by OCLC (2015) indicated that practitioners opined that IoT is an emerging technology that can be used in such library operations as inventory control, access and authentication and monitoring of collection storage. There are very few known IoT applications in libraries currently. The first known initiative of IoT application in libraries is the BluuBeam application implemented by the Orlando Public library in the United States of America (USA).

Hoy (2015) analyzed the IoT benefits for libraries in inventory control, mobile payments, mobile reference, resource availability, room configuration, etc., and discussed that Beacon as an available IoT device can provide location information, event announcements, way-finding and item recommendations. Hahn (2017) explored the IoT role in libraries location services via mobile technology, library mobile app, library automation, Internet of Everything, service development and innovation, and possible business opportunity.

Massis (2016) explored IoT and its potential impact on the library from the security and privacy

points of view, and proposed the Security of Things, security management approaches and the IoT potential disrupt services for libraries. Libraries can benefit from IoT in saving staff time, improving patron service, tailored service and recommendation service by collecting real-time data. Kamalrudin et al. (2018) analyzed the IoT-related business application, the security requirement for IoT application in libraries, and proposed a method to identify the security concern with IoT application.

3.6 Challenges of the application of IoT in libraries Services

The internet of things no doubt is a potent technology that will change the service structure and pattern of libraries in the coming years. However researchers have identified a number of issues as possible challengers that libraries will face in adopting this novel technology. Bansal, Arora, and Suri (2018); Echedom, Kakiri, and Oyadonghan (2020) and Brian, Arochiam and Malarchelvi (2014) identified the following possible challenges in the application of internet of things in library services:

> ➢ Privacy and Security: The privacy of patrons' document is under serious treat since IoT has a possibility of having access to connected and enabled devices, which could lead to hacking. In 2011, the water treatment system in Illinois was shut down. A hacker managed to remotely disable a utility's water pump used to pipe water to thousands of homes in Illinois. The hacker broke into a software company's database and obtained user names and passwords of control systems (Rushe, 2011).

> ➢ Budget Cut and High Cost of IoT Installation: With the attendant problem of budget cost confronting a number of libraries and the increase in the price of ICT enabled devices and network services, most libraries may not be able to provide adequate fund to cater for the establishment of IoT enabled library services. Again, since IoT is a progressive innovation most libraries may not be able to cope with the evolving trends in the IoT infrastructure, given that IoT requires time and technically competent manpower.

> ➢ Technology Inclined Users/Users Training: Though a very innovative technology the IoT will require users who are tech-inclined to be able to utilize adequately the resources and services of IoT, otherwise the whole essence of establishing IoT will be an exercise in futility. Hence, budgetary provisions should be made for continuous training and re-training of users owing to the ever evolving nature of IoTs. This training will also involve the library staff due to the ever changing nature of IoT.

> ➢ Programme Malfunction: There is a possibility of the system or a unit of the infrastructure to malfunction; thereby doing what it was not originally programmed to do. i.e. A vehicle might stop responding to the driver's actions, a valve could liberate too much fluid and increase pressure in a heating system, and a medical device could report inaccurate patient monitoring data or inject the wrong amount of medicine.

> ➢ Decline in the use of Physical Manpower and Library: Since IoT is technology based, the services previously done by humans can be taken over by Robots or machines with inbuilt routine service intelligence and this may lead to progressive downsizing of human's (Professional

and Para professional librarians) working in the library. Similarly, since most resources can be retrieved through network enabled devices and appliance, most library users may not need to visit the library physically, as these resources can be access just anywhere within the network.

4. Methodology

Descriptive survey design was adopted for this study because of its appropriateness to studies of this kind. The population of the study consisted librarians in three selected universities in Kwara state included university of Ilorin has 63 librarians, Al-Hikimah university has 9 and Kwara state university has 13, hence, 85 form the population of this study and the staudy adopt total enumerative sampling techniques. Questionnaires was instruments of data collection used in this study. Eighty five questionnaires were distributed to respondents in their offices within various unit. Out of which 82 were completed and retrieved. Resulting in as response rate of 96%. The result of the responses was interpreted using simple percentage and frequency tables.

4.1 Demography of the respondents

The data in table 2 shows the percentage of respondents by Gender. It was revealed that out of 82 respondents, the female respondents have the higher percentage of 45 (54.9%) while the remaining 37 (45.1%) were male. From this result it can be inferred that the population of female librarians are more than that of the male librarians in universities.

Table 1. Frequency distribution of respondent by gender

Gender	Frequency	Percentage
Male	37	45.1
Female	45	54.9
Total	82	100

The table shows the distribution of the respondents by categories of participant. A total of 69 (84.1%) of the respondent were professional, 11 (13.1%) of the respondent were Para-Professional, while 2 (2.4%) of the respondent were Non-Professional. This implies the majorities of respondent were professional.

Table 2. Frequency distribution of respondent by categories of participant

Categories of participant	Frequency	Percentage
Professional	69	84.1
Para-Professional	11	13.1
Non-Professional	2	2.4
Total	82	100

The table above shows the distribution of the respondents by their Highest Educational Qualification.

A total of 2 (2.4%) of the respondent have DLS, 4 (4.9%) hove OND, 5 (6.1%) have HND. Furthermore, 31 (37.8%) have BLIS while 32 (39.0%) have MLIS and 8 (9.8%) have PhD. essentially, the largest percentage of the respondents for this study has MLIS followed by BLIS.

Table 3. Frequency distribution of respondent by Highest Educational Qualification

Educational Qualification	Frequency	Percentage
DLS	2	2.4
OND	4	4.9
HND	5	6.1
BLS	31	37.8
MLS	32	39.0
PhD	8	9.8
Total	82	100

4.2 Analysis of the data on research questions, interpretation and discussion of findings.

- Research Question 1: what are the level of awareness of the internet of things in universities libraries in Kwara State?

Table show the level of awareness of the internet of things in universities libraries in Kwara State, it was revealed majority of respondents 82 (100%) indicated they are aware of Internet of Everything (IoE) which is an extension of IoT that includes people, process, data and things in network connections, The Internet of Mobile Things (IoMT) is used to communicate the devices using inbuilt mobile sensors and Internet of Nano Things (IoNT) a Nano Technology in which the communication exist between nano scale devices, followed by The Internet of Mission-Critical Things (IoMCT) is used in critical missions such as rescue operations, battlefields, etc 71 (93.3%).

Table 4. The level of awareness of the internet of things in universities libraries in Kwara State

STATEMENTS	A		NA		Total
	NO.	%	NO.	%	%
Internet of Everything (IoE) which is an extension of IoT that includes people, process, data and things in network connections	82	100	-	-	100
The Internet of Mobile Things (IoMT) is used to communicate the devices using inbuilt mobile sensors	82	100	-	-	100
The Internet of Mission-Critical Things (IoMCT) is used in critical missions such as rescue operations, battlefields, etc	71	93.3	11	6.7	100
Internet of Nano Things (IoNT) a Nano Technology in which the communication exist between nano scale devices.	82	100	-	-	100

(Keys: A= Aware; NA= Not aware)

- Research Question 2: what are extent of application of the internet of things in universities libraries?

Table show the extent of application of the internet of things in universities libraries in Kwara State. It was revealed that Providing access to current information sources to a very great extent 78 (93.7%), followed by Electronic resources 77 (92.3%) while 70 (81.7%) indicated it aid communication (answer query) to a great extent and 47 (56.3%) it aid research to agreat extent and 43 (49.0%) it aid environmental monitoring to a very great extent. This suggest that there's no restricted to the use of internet by librarians in university libraries and all individual irrespective of their profession can use them.

Table 5. The extent of application of the internet of things in universities libraries

STATEMENTS	5	4	3	2	1	0	Total
To aid research	47 (56.3%)	29 (33.7%)	3 (5.0%)	3 (5.0%)	-	-	100
Computing resources optimization by balancing edge and cloud in the smart grid	28 (35.3%)	38 (41.3%)	11 (15.7%)	-	-	5 7.7%	100
To aid confidentiality and integrity of technology	29 (36.3%)	31 (37.7%)	15 (18.0%)	7 (8.0%)	-	-	100
Electronic resources	77 (92.3%)	5 (7.7%)	-	-	-	-	100
To aid communication (answer query)	70 (81.7%)	6 (8.3%)	3 (5.0%)	3 (5.0%)	-	-	100
To aid environmental monitoring	43 (49.0%)	28 (35.3%)	-	11 (15.7%)	-	-	100
Providing access to current information sources	78 (93.7%)	4 (6.3%)	-	-	-	-	100

0 = not at all 1 = to a small extent 2 = to some extent 3 = to a moderate extent 4 = to a great extent 5 = to a very great extent

• Research Question 3: what are the benefit of internet of things in universities libraries?

Table 6. The benefit of internet of things in universities libraries

STATEMENTS	SA	A	D	SD	Total
Anything can be interconnected with the global information and communication infrastructure	56 (64.0%)	3 (4.0%)	12 (16.3)	11 (15.7%)	100
IoT platform has sensors which detect or measure any changes in the environment to generate data that can report on their status or even interact with the environment	64 (76.3%)	-	11 (15.7%)	7 (8.0%)	100
IoT comes with the combination of algorithms and computation, software & hardware that makes it smart	61 (70.3%)	-	18 (25.7%)	3 (4.0%)	100
Device in the IoT platforms are heterogeneous and are based on different hardware platforms and networks.	67 (82.7%)	-	15 (17.3%)	-	100
It gives the high level of interoperability and interconnectivity	65 (80.3%)	7 (8.0%)	10 (11.7%)	-	100

(Keys: SA= Strongly Agree; A=Agree; SD=Strongly Disagree D=Disagree)

From the table above, it is revealed that 67 (82.7%) respondent indicated Device in the IoT platforms are heterogeneous and are based on different hardware platforms and networks, followed by 65 (80.3%) who indicated It gives the high level of interoperability and interconnectivity, more

so, 64 (76.3%) indicated IoT platform has sensors which detect or measure any changes in the environment to generate data that can report on their status or even interact with the environment while 61 (70.3%) indicated IoT comes with the combination of algorithms and computation, software & hardware that makes it smart and 56 (64.0%) indicated Anything can be interconnected with the global information and communication infrastructure.

- Research Question 4: what are the challenges faced in the application of internet of things in universities libraries?

Table above revealed the challenges faced in the application of internet of things in universities libraries. It was revealed that 67 (82.7%) indicated Data interpretation problem and Lack of skilled and specialized workers, followed by 64 (78.7%) indicated Cost, while 61 (76.3%) indicated Challenges in online security and 59 (74.3%) indicated Software complexity. On a contrary view majority 60 (74.7%) disagree with Power supply as the challenges faced in the application of internet of things in universities libraries.

Table 7. The challenges faced in the application of internet of things in universities libraries

STATEMENTS	SA	A	D	SD	Total
Power supply	15 (17.3%)	-	7 (8.0%)	60 (74.7%)	100
Cost	64 (78.7%)	-	18 (21.3%)	-	100
Challenges in online security	61 (70.3%)	-	18 (25.7%)	3 (4.0%)	100
Lack of skilled and specialized workers	67 (82.7%)	-	-	15 (17.3%)	100
Software complexity	56 (64.0%)	3 (4.0%)	12 (16.3%)	11 (15.7%)	100
Data interpretation problem	67 (82.7%)	5 (7.0%)	10 (12.7%)	-	100

(Keys: SA= Strongly Agree; A=Agree; SD=Strongly Disagree D=Disagree)

5. Discussion

The study investigated the awareness and application of internet of things in universities libraries. Four research questions were formulated. Each of the four research questions were based on determine the level of awareness of the internet of things in universities libraries, the extent of application of the internet of things in universities libraries, benefit of internet of things in universities libraries and the challenges faced in the application of internet of things in universities libraries. The findings of study are discus as follows:

Finding to research questions one shows in the that majority of the respondents revealed that librarians are aware of Internet of Everything (IoE) which is an extension of IoT that includes people, process, data and things in network connections, The Internet of Mobile Things (IoMT) is used to communicate the devices using inbuilt mobile sensors, Internet of Nano Things (IoNT) a Nano Technology in which the communication exist between nano scale devices, and Internet of Mission-Critical Things (IoMCT) is used in critical missions such as rescue operations, battlefields,

etc,. It suggested that most of the respondents were familiar with the term IoT and its key components in architecture. This finding substantiates the submission of Atzori et al. (2012) who submitted that the Web of Things, Social Internet of Things cloud computing in IoT, green IoT technologies, context-aware IoT, sensing as a service on the cloud (Xu et al., 2014), the Internet of Nano-Things (Miorandi et al., 2012; Whitmore et al., 2015) and 5G IoT (Li et al., 2018) were discussed. 5G technologies are expected to optimize IoT applications. IoT has a great deal of potential and can be used to maintain archive materials, track collections, offer consumers consolation services, and advertise traditional library items online (Wójcik, 2016). In order to accept new technology, one must first assess its advantages, returns on investment, and application's drawbacks. Students, re-searchers, instructors, and library professionals can utilize IoT technology by becoming more aware of how adaptable and simple new technologies are to use in libraries (DaLbehera, 2018).

The second research question posed was, what are the extent of application of the internet of things in universities libraries? Majority of respondents indicated revealed that the extent of application of the internet of things providing access to current information sources, Electronic resources, aiding communication (answer query), aiding research and it aid environmental monitoring to a very great extent, This finding agreed with with Pujar and Satyanarayana (2015) projected the various applications of IoT in libraries viz energy management, virtual library card, smart digital shelves, real time data of patron's requests, IoT enabled mobile devices to locate favorite books etc and further enumerated potential areas for implementation of IoT in libraries to include – improved access to the library and its resources, collection management, information literacy, recommendation service, location based service, appliances management and usage statistics. In an OCLC survey it was found that many librarians were familiar with IoT technologies (Hoy, 2015) and listed different methods of integrating IoT tools to library activities. These included inventory control, mobile reference, resource availability etc. Kim et al (2017) analysed academia perception of IoT using the analysis of words frequency, co-occurrence, and distance. Abuarqoub et al (2017) explored the possibility of IoT applications in academic libraries. Academic libraries use IoT-enabled real-time recording of environ-mental data to reduce the use of energy and to improve the user's comfort. Several foreign universities developed smart building providing better energy savings, monitoring and alarm systems. Patel (2019) proposed an energy efficient system providing technical solution to conserve energy in library and other buildings using two main sensors to detect human presence. The technology effectively controlled usage of electrical devices when not in use.

Finding to research questions three in Table shows the benefit of internet of things in universities libraries majority of the respondents indicated that the benefit of internet of a things to include: Device in the IoT platforms are heterogeneous and are based on different hardware platforms and networks, It gives the high level of interoperability and interconnectivity, IoT platform has sensors which detect or measure any changes in the environment to generate data that can report on their status or even interact with the environment, IoT comes with the combination of algorithms and computation, software & hardware that makes it smart and Anything can be interconnected with the global information and communication infrastructure. This finding align the submission of Hoy (2015) analyzed the IoT benefits for libraries in inventory control, mobile payments, mobile reference, resource availability, room configuration, etc., and discussed that Beacon as an available

IoT device can provide location information, event announcements, way-finding and item recommendations. Hahn (2017) explored the IoT role in libraries location services via mobile technology, library mobile app, library automation, Internet of Everything, service development and innovation, and possible business opportunity. Massis (2016) explored IoT and its potential impact on the library from the security and privacy points of view, and proposed the Security of Things, security management approaches and the IoT potential disrupt services for libraries. Libraries can benefit from IoT in saving staff time, improving patron service, tailored service and recommendation service by collecting real-time data.

The fourth research question stated the challenges faced in the application of internet of things in universities libraries, the finding as indicated in table that data interpretation problem, lack of skilled and specialized workers, cost and challenges in online security as well as software complexity are the major challenges faced in the application of internet of things in universities libraries while majority of respondent disagree with power supply as the challenges faced in the application of internet of things in universities libraries. This finding was consistent with Bansal, Arora and Suri (2018); Echedom, Kakiri,and Oyadonghan,(2020) and Brian, Arochiam and Malarchelvi (2014) identified the following possible challenges in the application of internet of things in library services to include: Privacy and Security, Budget Cut and High Cost of IoT Installation, Technology Inclined Users/Users Training, Programme Malfunction and Decline in the use of Physical Manpower and Library.

6. Conclusion and Recommendations

Based on the findings of this study, the following conclusions were drawn from the outcomes of the study. The awareness and application of internet of things in universities libraries Nigeria. Librarians are awareness on the application of internet of things. The internet of things has a great prospect for libraries. Libraries and librarians need to embrace this smart technology, especially at this evolving stage to compete favorably in the global information service world. As mentioned in the context, IOT technologies can be useful for collection management, online services, education and providing access to spaces and equipment, gathering, analyzing, storage and sharing information. IOT can help libraries by optimizing use of space, enhancing the visitor experience, and preserving valuable collections through smart room management. It is clear that new technologies and devices will bring new opportunities and challenges. IOT can optimize traditional and online collections and services of libraries (especially academic libraries). librarians in Nigeria need to take conscious steps at ensuring understanding of the concept and application of 'Internet of Things' to effective library service delivery. This will enhance maximization of the embedded benefits. Users will obviously gravitate towards smart libraries when they experience quality service resulting from technology adoption.

The following recommendations are suggested based on the findings of the study:

(1) The study identified Lack of skilled and specialized workers and Data interpretation problem is a challenge faced in the application of internet of things in universities libraries, hence, the university authority needs to organize orientation/training for the librarians of universities.

(2) Cost and Challenges in online security, as well as Software complexity is another challenges faced in the application of internet of things in universities libraries, hence, there is need for government interference in developing the library in other to meet up with the vision and mission of it establishment.

(3) The study shows that library should create more awareness on the application of Internet of Things; hence the university librarian need to urgently develop a strategy for creating awareness on application of Internet of Things' to effective library service delivery,

(4) Future libraries will be equipped with new technologies and networking devices as soon as possible. Therefore, it will be essential for users and librarians have sufficient knowledge about IOT technologies,

(5) Designers and professionals should be aware of this issue and they should use new security protocols to safe their collection and user information in this new environment.

References

Abdul-Quayyum G, Oyedele L, Abdul-Majeed M, Habeeb K, Oladimeji O. (2019). The role of the internet of things in delivering smart construction. Paper presented at: CIB World Building Congress, 2019 Hong Kong SAR, China; Jun 17−21; International council for research and innovation in Building and construction, Hong Kong.

Abuarqoub, A. [et.al.]. (2017). A survey on Internet of Things enabled smart campus applications. In Proceedings of the International Conference on Future Networks and Distributed Systems, (pp.50). ACM. Available at DOI: 10.1145/3102304.3109810 (Accessed on 11/07/ 2019).

Adejuwon K. 2018. Internet of things and smart city development: is Nigeria leveraging on emerging technologies to improve efficiency in public service delivery? J Publ Admin, Finance Law. 13(1):7−20.

Akintoye A. (2000). Analysis of factors influencing project cost estimating practice. J Construct Manage Econ. 18(1):77−89.

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, Vol.12 No (3). https://doi.org/10.14569/ijacsa.2021.0120325

Arowoiya V, Oke A, Aigbavboa C, & Aliu J. (2020). An appraisal of the adoption of the internet of things (IoT) elements for sustainable construction. J Eng Design Technol. 18(5):1193−1208.

Ayuba, K. A, Manaf LA, Sabrina, A. H, & Azmin, S. W. (2013). Current status of municipal solid waste management practice in FCT Abuja. Res J Environ Health Sci. 5(6):295−304.

Bahga, A., & Madisetti, V. (2014). Internet of Things: A hands-on approach (p. 11). Atlanta: VPT.

Bamigboye F, & Ademola E. (2019). Internet of things: the present status, future impacts and challenges. Paper presented at: 6th Proceedings of the iSTEAMS Multidisciplinary Cross-Border Conference, held at University of Professional Studies, Accra Ghana. Switzerland: Springer Nature Cham; p. 212−217.

Bansal, A., Arora, D. and Suri, A. (2018), "Internet of Things: Beginning of New Era for Libraries",

Library Philosophy and Practice (e-Journal), 63(1/2), 59-160.

Bayani, M., Segura, A., Alvarado, M. and Loaiza, M. (2018). IoT-Based Library Automation & Monitoring system: Developing an Implementation framework. E-Ciencias de La Información, 1−18.

Bhide H. (2014). A survey on the smart homes using internet of things (IoT). IJARCSMS. 2(12):243−246. DOI: 10.1109/ICCPEIC.2015.7259486.

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, Vol. 22 No.(8), 29-91. https://doi.org/10.3390/s22082991

Brian, A. L. A., Arockiam, L., & Malarchelvi, P. D. S. K. (2014). An IoT based secured smart library system with NFC based book tracking. International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE), 11(5), 18-21.

Bryant FB, Yarnold PR. 1995. Principal-components analysis and exploratory and confirmatory factor analysis. In: Grimm LG, Yarnold PR, editors. Reading and understanding multivariate statistics; p. 99−136.

Cheng, H. [et.al.]. (2016). Design and implementation of library books search and management system using RFID technology. In 2016 International Conference on Intelligent Networking and Collaborative Systems (INCoS) (pp. 392-397). IEEE. Available at DOI: 10.1109/INCoS.2016.35 (Accessed on 11/ 07/2019).

Davies D. (2017). The internet of construction. Retrieved from Construction Executive: https://constructionexec.com.

Ea, N., Tamilarasi, D., Sasikala, S., Nair, R. R., and Uma, K. S. (2021). An Efficient Food Quality Analysis Model (EFQAM) using the Internet of Things (IoT) Technologies. Microprocessors and Microsystems, 103-972. https://doi.org/10.1016/j.micpro.2021.103972

Elkhodr M, Shahrestani S, & Cheung H. (2015). A smart home application based on the internet of things management platform. Paper presented at: Data science and data intensive systems (DSDIS): Institute of Electrical and Electronics Engineers, US International Conference, vol. 2(5); p. 491−496.

Erik K, & Ericsson M. (2015). A study of the adoption of the internet of things among Danish companies. Everything Connected. 16(3):17−18.

Fernandez, P. (2015). Through the looking glass: thinking through the Internet of things. Library Hi Tech News, 32(5), 4-7.

Grindvoll H, Vermesan O, Crosbie T, Bahr R, Dawood N, & Revel G. (2012). A wireless sensor network for intelligent building energy management based on multi communication standards a case study. World of Computer Science and Information Technology Journal, 2(1), 18-21.

Gupta, J., & Singh, R. (2018, February). 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. Available at DOI: 10.1109/ETTLIS.2018.8485234 (Accessed on 11/07/2019).

Hahn, J. (2017). The Internet of Things: mobile technology and location services in libraries. Library Technology Reports, 53(1), 1-27. 9.

Hajduk S. (2016). The concept of a smart city in urban management. Bus Manage Educ. 14(1):34‒49.

Haque, M. A., Haque, S., Sonal, D., Kumar, K., & Shakeb, E. (2021). Security Enhancement for IoT Enabled Agriculture. Materials Today: Proceedings. https://doi.org/10.1016/j.matpr.2020.12.452

Haykin S. (2005). Cognitive radio: brain-empower wireless communications: IEE. Sel Areas Commun. 23(15):200‒220. DOI: 10.1109/JSAC.2004. 839380.

Hook J. (2017), Buildssoft making construction easier. Retrieved from what does the internet of things means for construction: https://www. buildsoft.com.

Horrow S, & Sardana A. 2012. An identity management framework for cloudbased internet of things. Paper presented at: Proceedings of the First International Conference on Security of Internet of Things, SecurIT '12; p. 200‒203. New York (NY): ACM.

Hoy, M. B. (2015). The Internet of Things: What it is and what it means for libraries. Medical reference services quarterly, 34(3), 353-358.

Hucanu R, & Georgescu M. (2016). Small steps or big changes in actual society: the impact of the internet of things. J Publ Admin, Finance Law. 10: 132‒141.

Idowu AO, & Aligamhe VI. (2015). Causes and effects of rework on public building projects in Edo state. A NIQS Research Conference 2 presented on 1st‒3rd of September, 2015 held at Federal University of Technology, Akure. Abuja: Nigerian Institute of Quantity Surveyors; p. 99‒109.

Igbinovia, M. O. (2021). Internet of things in libraries and focus on its adoption in developing countries. Library Hi Tech News, Vol.38 No(4), 13‒17. https://doi.org/10.1108/lhtn-05-2021-0020

Igbinovia, M. O., & Okuonghae, O. (2021). Internet of Things in contemporary academic libraries: Application and challenges. Library Hi Tech News, Vol.38 No(5), 1‒4. https://doi.org/10.1108/LHTN05-2021-0019

Iwuagwu U, Iwuagwu M. 2014. Adopting intelligent buildings in Nigeria: the hope and fears: Paper presented at: 2nd international conference on emerging trends in engineering and technology, J Informat Technol Construct (ITcon). 17(3):43‒62.

Jacqi L. (2017). Internet of Things blog. Retrieved from 4 BIG ways the Internet of Things is impacting design and construction. Library Hi Tech,34(1), 20‒37.

James F. 2015. Digital electronics "internet of things" (IoT) and "smart grid technologies" to fully eviscerate privacy, International Journal of Academic Library and Information Science. Vol. 5(3), pp. 92-96.

Ju, D. and Shen, B. (2015). Library as knowledge ecosystem, Library Management, 36(4/5),329-339.

Kamalrudin, M., Ibrahim, A. A., & Sidek, S. (2017). A security requirements library for the development of Internet of Things (IoT) applications. Information and Management, 38(5), 323-335.

Kim, J. H., Yoo, M., Lee, K. N., & Seo, H. (2017). The innovation of the internet: a semantic network analysis of the Internet of Things. Asian Journal of Technology Innovation, 25(1), 129-139.

Kreische F, Ullrich A, & Ziemann K. (2015). Internet of things using sensors for good: how the internet of things can improve lives, federal ministry for economic cooperation and development

(BMZ). Berlin, Germany; Bonn: Deutsche Gesellschaft f€ur Internationale Zusammenarbeit (GIZ) GmbH; p. 1‒25. Institute for Economics and Peace. 2014.

Liang, X. (2018). Internet of Things and its applications in libraries: a literature review. Library Hi Tech. Available at https:// doi.org/10.1108/LHT-01-2018-0014 (Accessed on 11/07/2023)

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.

Massis, B. (2016). The Internet of Things and its impact on the library. New library world, 117(3/4), 289-292.

Miorandi, D., Sicari, S., De Pellegrini, F., & Chlamtac, I. (2012). Internet of things: vision, applications and research challenges. Ad Hoc Networks, 10(7), 1497-1516.

Mohideen, Z. A., Kiran, K., & Muhamad, S. (2017). IoT: QoS in the digital library RFID based LIS. In Proceedings of the 5th International Conference on Information and Education Technology (pp. 101-105). ACM. Available at DOI: 10.1145/3029387.3029398 (Accessed on 11/07/2019)

Muthumari, P., Kulkarni, A.M. & Kulkarni, C.M. (2021). IoT Application in Smart Libraries. International Journal of Research in Library Science, Vol. 7 No. (3), 113.

Nag, A., & Nikam, K. (2016). Internet of things applications in academic libraries. International Journal of Librarianship and Administration. 6(1). pp. 45-53.

Nie, W. (2017). The Application of Internet of Things in the University Library. In 2016 7th International Conference on Education, Management, Computer and Medicine (EMCM 2016). Atlantis Press, 24-27 24.

Noh, Y. (2015). Imagining library 4.0: Creating a model for future libraries. The Journal of Academic Librarianship, 41(6), 786-797.

OCLC (2015), Libraries and the Internet of Things, OCLC, Available at www.oclc.org/ publications/nextspace/articles/issue24/ librariesandtheinternetofthings.en.html (accessed on 11/07/2023).

Odulaja G. 2015. Security issues in the internet of things. Computing, information systems. Dev Inform Allied Res J. 6(4):01‒03.

Ogidiaka E, Odion P, Irhebhude ME. (2017). Adoption of Internet of Things (IoT) among organizations in Lagos state, Nigeria. J Comp Sci Appl. 24(2):94‒110.

Pallavi S, Smruti R. 2017. Internet of things. Architectures, Protocols, Appl. 16(4):198‒202. DOI: 10.1155/2017/9324035.

Palma D, Agudo J, Sanchez H, & Macıas M. (2014). An internet of things example: classrooms access control over near field communication. J Comp Inform Sci. 14(4):6998‒7012. DOI: 10.3390/s140406998.

Pujar, M & V Satyanarayana. (2015). Internet of Things and Libraries. Annals of Library & Information Studies, 62(3), 186-190.

Puri D. 2016. IoT decision making improved with impact-sourced human experts. Network World. Journal of Talent Development and Excellence, 12(3s), 385‒392.

Ranger S. (2018). What is the IoT? Everything you need to know about the Internet of Things right now. Benue Journal of Library, Management and Information Science (BJLMIS), 9(1):

91-107.

Ray S, Bhunia S, Jin Y, & Tehranipoor M. (2016). Paper presented at: Security validation in IoT space in VLSI Test Symposium (VTS), IEEE 34th, p. 1‒1. IEEE.

Renold, A. P., & Rani, R. J. (2013). An internet based RFID library management system. In 2013 IEEE Conference on Information & Communication Technologies (pp. 932-936). IEEE. Available at DOI: 10.1109/ CICT.2013.6558229 (accessed on 11/07/2019).

Rose K, Eldridge S, & Chapin L. (2015). The internet of things: an overview. In: Understanding the issues and challenges of a more connected world. Washington (DC): The Internet Society (ISOC); p. 1‒50.

Shammar, Elham Ali, & Ammar Thabit Zahary. (2019) The Internet of Things (IoT): A Survey of Techniques, Operating Systems, and Trends. Library Hi Tech, vol. ahead-of-print, no. ahead-of-print, 5 Oct. 2019, 10.1108/lht-12-2018-0200.

Simões, D., Filipe, S., & Barbosa, B. (2019). An Overview on IoT and Its Impact on Marketing. In Simões, D., Barbosa, B. & Filipe, S. (Eds). Smart Marketing with the Internet of Things (pp. 1-20). Hershey: IGI Global.

Sinha, Priyanka and Brar, & Khushpreet Singh. (2022). Application of Internet of Things (IoT) in Libraries. International Conference on Knowledge Management in Higher Education Institution.199-204.

Stefanidis, K., & Tsakonas, G. (2015). Integration of library services with Internet of Things technologies. Code4Lib journal, (30).

Stephanie B. 2015. Healthcare's application of the internet of things is directly in the FTC's crosshairs, Advances in Computer Science and Information Technology (ACSIT), 1(2). Pp. 43-47.

Sun, M. (2014). The research on the development of smart library. Applied Mechanics and Materials, 571, 1184-1188.

Tarabasz A. (2016). The impact of the internet of things on new approach in network management international. J Contemporary Manage. 15(2): 151‒170.

Tony M, Moller T. (2014). Rethinking visualization: a high-level taxonomy, information visualization. Paper presented at: InfoVis 2004. IEEE Symposium on information visualization; Austin, Texas, USA; Vol. 25(21); p. 151‒158.

Wang, X., Li, J., Yang, M., Chen, Y. and Xu, X. (2018). An empirical study on the factors influencing mobile library usage in IoT era. Library Hi Tech, Vol. 36 No. (4), 605‒621.

Welbourne E, Battle L, Cole G, Gould K, Rector K, Raymer S, Balazinska M, Borriello G. (2009). Building the internet of things using RFID. IEEE Internet Comput. 13(3):48‒55.

Whitley BE, Kite ME, Adams HL(C). (2013). Principles of research in behavioral science. 3rd ed. New York: Routledge/Taylor & Francis Group.

Wójcik, M. (2016). Internet of Things ‒ potential for libraries. Library Hi Tech, 34(2), 404‒420.

World Economic Forum. (2015). Industrial internet of things: unleashing the potential of connected products and services. Geneva, Switzerland; p. 1‒33.

Xu, L.D., He, W. and Li, S. (2014). Internet of Things in industries: a survey, IEEE Transactions on Industrial Informatics, 10 (4), 2233-2243.

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. Libr Philos Pract. (e-Journal). 2831. https://digitalcommons.unl. edu/libphilprac/2831.

[About the author]

Saliu Abdulfatai is currently an assistant librarian in Afe Babalola university Ado Ekiti, Nigeria, he holds a bachelor degree in library and information science in Kwara State University Malete, and furthered his profession to master in the same discipline in University of Ilorin and currently pursuing his doctor of philosophy in the same discipline from the department of library and information science, Federal University of Oye Ekiti.