ACADEMIC LIBRARIES IN IOT ERA: MOVING TOWARDS SMART SERVICES

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Abstract

Over the years, libraries across the globe have been using Information and Communication Technology (ICT) for effective library service delivery which has now brought about the use of more dynamic global technologies that could enabled users to be served with or without human intervention like the Internet of everything popularly known as Internet of Things (IoTs). IoT is about enabling objects to collect data and transfer them over a network without human intervention with the help of: Internet, Sensors and Radio-Frequency Identification (RFID) in accordance with the ways it is being used by other services oriented organisations such as: insurance companies, hospitals, schools, restaurants, filling stations where various innovative solutions are deployed. This paper reviewed relevant literature on IoTs; discussed its application in customer service oriented organisations of which libraries are not exempted; identified its merits and demerits; and recommended future challenges and proffered solutions to the identified challenges. The paper concluded by encouraging libraries in developing countries Nigeria in particular to automate their resources and formulate policies that will fast track the full adoption of the IoT otherwise the use of IoT in Nigerian libraries may be more of a mirage; the authors recommendee that security of users' data while sharing data with third party must be squarely addressed; all academic libraries must ascertain the cost implication of starting; implementing and sustaining IoT in their organisations; staff training should be organised on a regular basis; there must be stable power supply in all academic libraries and the government at all levels must support the efforts of the libraries to facilitate their journey towards having the desired Smart libraries in the country.

Keywords: Internet of Things (IoT); Smart Services; Academic Libraries;Era of

INTRODUCTION

Technology has pervaded all aspects of human endeavour including library services with the ultimate aim of providing better and faster services. Information services in form of information delivery and dissemination in academic libraries are not exempted especially with the advent and the growth of the

ubiquitous technology of the age called the Internet. Nowadays, robots are being used for library operations and services such as: reference services, temperature monitoring tool, statistical tool, information organisation tools and other smart services are being deployed as evident from the niversities of Lagos and Pretoria libraries to mention but a few. Robots are deployed to collect and share data among themselves without human intervention thereby cutting down the resources in terms of time, energy, salaries and wages and many more. The application of such technology has brought about what we call smart libraries, this no doubt has affected various aspects of our everyday life including but not limited to transportation – where a car would alert its owner whenever there is high traffic or danger ahead and would recommend an alternative road to follow. The most alarming type of the smart technologies is the Internet of Things, what is it that makes it to be called the Internet of Things? It is its ability to use wireless communication devices for data collection, processing and dissemination of information either through robot to robot or robot to human. The robot to robot communication is also known as "Machine-to-Machine (M2M)" form of communication. Bayani, Segura Alvarado and Loaiza (2018a). The previous studies of Hahn (2017), defined the IoT as the "network of physical objects that use embedded technology to communicate and sense or interact with their internal states or the external environment" this is in-line with the assertions of Xueling, (2018); Olson et al., (2015); Li et al., (2015); Wojick, (2016); Liu et al., (2017) as cited by Liang (2018) who opined that IoT is 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, that are seamlessly integrated into the information network".

In a nutshell, the authors were of the opinion that IoT is a network of interconnected things/ devices that are embedded with sensors, software, network connectivity and other necessary technologies that fine tune the collection and sharing of data to make the system responsive. The IoT works with smart technologies through users' intelligent interfaces to interact, sense, process and disseminate information to recipients. It is worth knowing that for any device to be called SMART, the components must be able to sense signals from compatible devices from the environment; process data; store information for future use and share information for prompt response. This is to say that in a smart library, a sensor/device must be able to identify, see, interact, share or receive data from networked devices within or around the library environment through connections like bluetooth, wireless fidelity (WiFi), wide area network (WAN) or cellular networks etcetera. The beauty of these smart technologies in academic libraries is their ability to work with or without human assistance in order to reduce the workload for library personnel.

In a similar view, IoT according to Nag and Nikam (2016) is about "the use of intelligently connected devices and system to obtain data gathered by some embedded sensors, actuators in machines and other physical objects. IoT uses connecting media such as wireless sensor network and physical objects to connect devices to each other and the Internet, with minimal direct human intervention to deliver service that meet the needs of wide range of users". Nowadays, application of IoT in various organisations such as: manufacturing, health, commercial, logistics etc has revolutionised the way and speed at which data are collected, processed and disseminated. In service oriented organisations of which libraries are not exempted, IoT is being applied in order to monitor consumers'/ clienteles' activities for effective transactions and service delivery. It is likely to play a bigger role in areas like: information analysis, information organisation, automation and control. For example, it is possible to track movement of academic library resources and monitor interaction between library users and these resources through real time events and sensor driven analytics.

IoT technologies are used in education sector for lectures, training and seminars to be conducted and attended by using interactive displays embedded with multi-touch, dry - erase and natural writing technology, plus personalised cloud-based lesson delivery software for mostly educators and students. All these burn down to the fact that the inevitable change has brought about doing what we have been doing in a traditional way in a more automated manner for smart library service delivery to our end users using smart technologies. Auto insurance companies can introduce vehicle telematics in some smart cars to enable them assess the drivers' behaviour and accordingly fix the rate of premium based on the risk factors. The same type of implications can be seen in other types of insurance policies, not depending completely on historical information, thus giving a chance for better risk management. IoT will ultimately enable industry to minimize loss and introduce safety techniques in each and every type of insurance they sell to the public.

THE CONCEPTS OF IOT AND TECHNOLOGIES

The IoT

The concept of Internet of Things (IoTs) was coined to mean the "Internet" of "Everything" where things could mean a human being walking with a sensor to either monitor the heart performance or general health status of such person, or a motor vehicle using sophisticated sensor to monitor everything around the vehicle or happenings on the road for effective decision making or it may even be a home placed on a surveillance to monitor movements within or around the building or prevent any danger from striking the owners or home itself through the use of smart technologies.

The IoT development has over the years gone through several evolutionary stages – the earlier stage (pre-internet era) is the first stage and has been characterised by the use of World Wide Web (WWW) also known as the Internet of contents, which is a network of linked html for information sharing from human to human; the second stage was an advanced version of the www which is otherwise known as the internet of services (Web 2.0) and is characterised with the use of relevant technologies and social networking sites like linkedIn, facebook, twitter, blogs, Instagram, delicious etc. the stage brought about a paradigm shift in the way libraries operates and transacts; the third stage consists of Web 3.0 also known as Semantic Web which makes direct communication between machine to machine easy via the Internet. This third stage was responsible for the machine and search engines intelligence performance which makes human thinks that machines are intelligent. The stage according to Whitmore et al., (2015) has nurtured the IoT which stands as the next evolution of the Internet (Evans, 2011). The trends is now moving towards the 5G technologies which are expected to match the needs of the future IoT application (Li et al., 2018).

Figure 1:   Technology Evolution
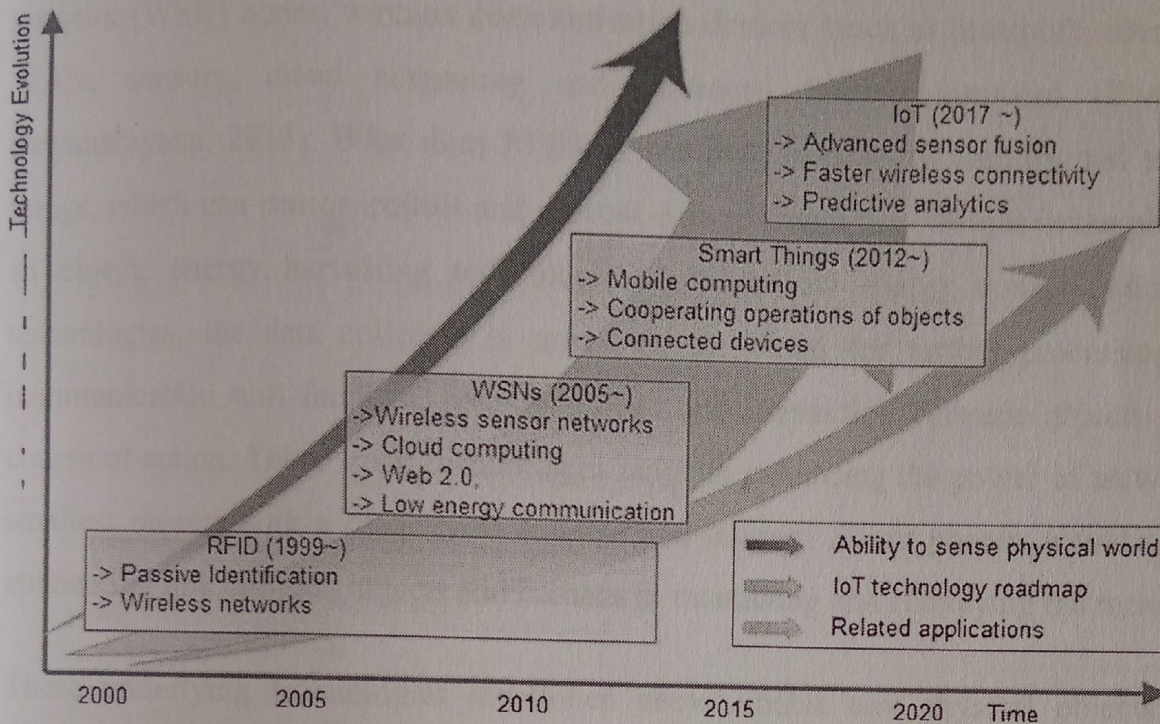
The duo traced the history of the IoT back to year 2000 as indicated by the researchers of this present work, with reference to the role played by the RFID up till 2005 where wireless sensor network (WSN) was used to power cloud computing and web 2.0 with low energy consumption; this era brought a pragmatic approach to how smart things became the order of the day using machine-2-machine (M2M) applications to facilitate data gathering and sharing process.

TECHNOLOGIES
There is no gain saying that, no single object can function as a complete system without the support of other components whether in-built or adjunct, so the case of IoT is; for IoT to function as a smart system of service delivery, it needs a set of technology to connect to objects. First and foremost, IoT must have a device for identification which will generate a unique identification code for each object. Then, another device needs to sense the object and measure various aspects of such object. IoT needs another facility to control the communication through Internet or other similar objects. More importantly, there must be a central server where data from all these objects will be collected and analyse by the user of the system.

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Amongst such technologies use by IoT to function as a complete system, includes Radio Frequency Identification Device (RFID), energy harvesting technologies such as the ones found in implantable medical devices, wearable electronic devices, traffic alert signs, wireless sensor network (WSN) nodes, wireless communication devices (such as bluetooth, iBeacons), internet, WAN, sensors, cloud computing and advanced Internet protocol (IPv6) (Pujar and Satyanarayana, 2015). What does RFID do for IoT? It helps to identify and track all data of things, which can sensor, collect and process data to detect the changes in the physical status of an object, energy harvesting technologies help in low energy consumption of associated technologies, the data collected is stored on the cloud for further processing and wireless communication will facilitate communication and interaction between objects to take further course of action. These smart technologies helps in enhancing the power of network and enable smallest objects with a capacity to connect and interact. Smart phones would act as the main connecting link between objects and humans in interacting and conveying the messages.

These underlying technologies mentioned above enable any physical objects connected to Internet to link up with each other for effective communication. In some cases, there may be a central hub, which helps in connecting each of the objects to one another and more so, the cloud services helps in the collection and processing of data and provides users with the opportunity to find out what is happening and take necessary action through their mobile apps.

Figure 2: Three-layer architecture of an IoT scenario
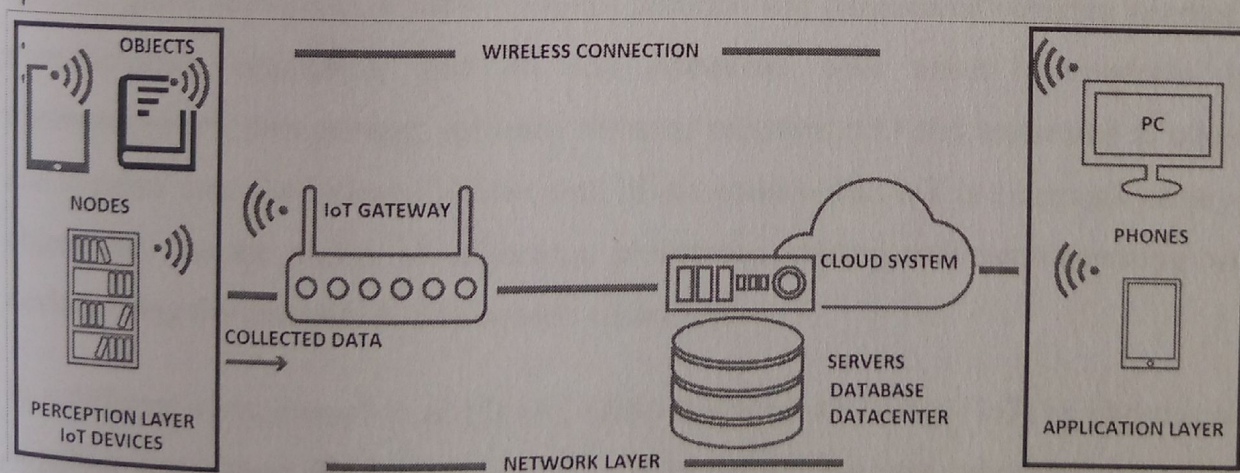
Source: Bayani, Segura Alvarado and Loaiza (2018b)

The authors described the three layer architecture as follows;

a. The perception layer which is the physical layer includes the sensors (RFID, WSN etc.), the event parameters or identity existence of the object.

b. The network layer provides Internet connectivity between the objects, network devices, wireless or cable connections, cloud system, database, server system that transmits and processing the locally obtained data. It also includes the gateway component to receive the data sensed from the perception layer.

c. The application layer is in charge of providing applications and services to the human or non-human users (i.e. Machine to machine case). It can specify various processes, programs, and applications in which the IoT can be positioned as a smart library management system for effective library management.

Review of related literature

In the study of Pujar and Satyanarayana (2016), IoT was defined "In simple terms, Internet of things enables, any natural or man-made objects to communicate each other and transfer data using assigned IP address with or without human interventions. The duo has simply defined the Iot as the network of things that permits the sharing of information with other things without any interference from human ware.

Similarly, Miller (2018), defined IoT as a "network of physical objects (such as wearable devices, home appliances, security systems, personal and commercial vehicles, nanotechnology, manufacturing equipment, and so on) embedded with smart components (such as microprocessors, data storage, software, sensors, actuators etc.) and connected to other devices and systems over the Internet." Miller was of the opinion that IoT is a network of any tangible object that has the ability of collecting, processing, storing and communicating with other devices using the wearable or implantable technologies.

In a different view, Bansal et al. (2018), viewed Internet of Things (IoT) in libraries as a mind boggling association which has inserted constituents connected together and an enormous number of collaborations happen be it with one man to another or man to machine, machine to man, and with IoT object with object compatibility brings about extraordinary chance. Bansal et

al. were detailed in their definition of the Iot based on the fact that they viewed how Iot works from M2M and M2H. meaning that machine can communicate to machine, or machine can communicate to human or vice versa.

In a study conducted by Poslad (2009) had explained that smart technology is an electronic device, generally connected to other devices or networks via various wireless protocols, such as Bluetooth, Zigbee, Wi-Fi, LiFi, 3G, 4G network which can operate interactively and autonomously to some extent. In this study, smart devices are all modern artefacts that are made smart with computing power and linked to the Internet to form the Internet of Things (IoT). They range from small devices to wearable asset tracking devices that can be deployed to library services such as acquisition, circulation, cataloguing, reference services and other library operations. Using sensors, smart devices capture physical data such as light, temperature, presence and deliver the data to be analyzed and used. Such applications have a minimal collection of physical components and can be used irrespective of geographic location. They often come in different types, since they usually consist of a hardware layer (including a radio transmitting signals), a network layer (through which devices communicate with each other), and an application layer (through which end-user' order receives).

In the study of Qin (2018) IoT can be applied to library digital services and activities. Its application in the services cut across the provision of access to analogue and online collections, consultation, training, information sharing, provision of reference services, and provision of access to space and equipment while its application to activities were viewed in respect of marketing and promotion of library resources; storage; analysis; and selection of record; gathering of information and processing of information.

Bayani et al.(2018) listed among "other services that can be offered by the IoT in digital libraries, to include inventory control; theft detection; self-service; smart segmentation and shelf; book tracking; intelligent alert system; e-copy; smart gate; online waiting list; customer-relationship-management (CRM) for the library systems". This is a true assertion, because many academic libraries in Nigeria and other countries have either one or more of these facilities in place. A typical example can be seen in Abdullahi Fodiyo Library Complex of the Usmanu Danfodiyo

University, Sokoto where the Radio Frequency Identification system has been deployed to take the statistics of the users that visits the library on daily basis, it can track any unauthorized removal of library sensitive materials, perform the circulation activities by charging and discharging materials, support the OPAC services and generate the reports. In other state and private owned academic libraries, other

Similarly, Gupta and Singh (2018) viewed the IoT from the earlier stage of Internet were Internet were done in traditional ways for browsing and searching of information but now in a new dimension, "second life which is called Internet Plus. The word "Internet Plus" was first used by Chinese Prime Minister Li Keqiang in the Government Work Report in March 2015 which has attracted high attention from all walks of life. It is a new concept in which various facets like Mobile Internet, Cloud Computing, Big Data or Internet of Things are included. "Internet Plus" strategy means integrating Internet with other industries including traditional industries through Internet platform and information and communication technologies. It aims at creating a new ecology in new areas". The duo opined that IoT is not different from the way cloud computing and big data are used.

In another veiw, Wojick (2016) "developed a theoretical model of IoT application in library service, and explored the potential of the IoT's on library services based on the experiences from commercial sectors, and proposed that librarians being a source of information, particularly in academic libraries, can improve library services by innovative ways, and IoT can provide more tools and opportunities in sharing information, tracking and tracing service, and pushing notification services".

Similarly, 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".

Application of IoT in academic libraries

Despite IoT being on a trial stage, libraries still value its potentials of value addition towards their service delivery and its ability to enhance library users experience, librarians are already familiar with this in libraries owing to the use of RFID, which does the similar thing of interacting with machines, tags and updates library management system with entries of books issued to users, but in case of IoT, the difference is on the Internet's ability to interact with a thing or object such as book and journals with little human intervention. Libraries have books, journals, CDs/DVDs, theses and many more physical objects and IoT can be a blessing in disguise to overcome some of the usual library problems such as misplacement of objects and their usage (Nag and Nikam, 2016b). The study conducted on application of IoT proves that remote access, low software costs, ease of implementation, in-house support and reduced operating costs, flexibility and adaptability, transparency, global visibility of the library resources and services, ease of use of resources, optimal users' satisfaction, and instantaneous delivery of service and effective utilisation of library resources are possible. This was corroborated by the proposals of Wang (2011) and Yan (2010) opined that smart library should be a new mode of future library aiming at achieving interconnection, efficiency and convenience through the IoT, cloud computing, and smart devices.

In a similar study conducted by Yusuf, Ifijeh, and Owolabi (2019) Poslad (2009) explained that smart technology is an electronic device, generally connected to other devices or networks via various wireless protocols, such as Bluetooth, 3G, 4G network, Zigbee, Wi-Fi, LiFi, which can operate interactively and autonomously to some extent. The authors of the study viewed smart devices as modern artefacts that are made smart with computing power and linked to the Internet to form the Internet of Things (IoT). With the aid of sensors, smart devices capture physical data such as light, temperature, presence and deliver the data to be analyzed and used. Such applications have a minimal collection of physical components and can be used irrespective of geographic location. They often come in different types, since they usually consist of a hardware layer (including a radio transmitting signals), a network layer (through which devices

communicate with each other), and an application layer (through which end-user's order receives).

The authors further described "smart technology as those electronic devices that use artificial intelligence to access and process data via internet protocol. Smart technologies can be used in library services such as in collection development, cataloguing and classification, circulation, reference services and other library activities. It is also possible to use smart technology to access social media platforms such as facebook, twitter, google, whatsapp, e-mail, youtube, tiktok, wechat and others to disseminate online information to university library users. The study identified different types of smart technologies used in university libraries as computer system, computer accessories, cellphone or smartphone and other communication devices including video conferencing devices, projector, scanner, printer, photocopying machines, digitizing machines, microsoft printers, radio-electronic copiers and others. Some smart electronic devices such as easy-to-read-books, assistive listening systems and others that can support the deaf or the physically challenged in university libraries are decoder machines with built-in telephones that convert the electronic signals of a closed caption video system into words written on a screen along with the video images for the hearing impaired library. The authors recommend that Nigerian government should play a key role in the deployment of appropriate smart technology infrastructure in the country and librarians in academic libraries 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 (Yusuf, Ifijeh, and Owolabi, 2019)".

Robots in Academic Libraries

IoT has been reported to have been helping librarians in their day to day operations and services in accordance with the teaching, learning and research activities of the parent institution using interactive displays embedded with multi-touch technology plus cloud-based frequently asked questions software customized for library services. A good example of this biggest IT revolution can be found in the University of Pretoria where the Department of Library Services employed the first client-service robot named Libby in May 28, 2019 to work in the Merensky Library like

Reference Librarian that interacts with users to answer their reference queries, provides guidance, conduct surveys, display marketing video to sensitize and entertain visitors and users of the library, Libby can perform other repetitive tasks that library personnel. According to Van der Walt (2019), the robot weighs 19kg and 90cm tall which makes it possible for her to interact with visitors in wheelchairs in English language, although efforts are being made to make her speak other local languages recognised by the institution. The aim of using the robot was not far from the need to evolve in line with the Fourth Industrial Revolution by redefining academic librarianship and fast tracking their movement towards the Blue Ocean through the deployment of latest technologies. Libby the robot has over 60 sensors, cameras and software integrations that enable her to receive and process various commands and requests. No doubt, the robot is able to perform intelligent tasks due to its ability to connect to WiFi of the institution and send information back and forth to answer reference queries or conduct a survey. Her brain has been linked to Watson, IBM's question-answering computer systems which process all queries that are being direct at her using an android-based software. Review of literature shows that Libby has been efficient in delivering library services without any loss of job on the part of library personnel rather it brought about innovations and 21st century service delivery or better still an indispensable tool for Smart libraries. All these burns down to the fact that the inevitable change has brought about doing what we have been doing in a traditional way in a more automated manner for smart library service delivery (https://www.up.ac.za/alumni/news/post_2825427-libby-the-library-robot-is-on-duty-at-up#nogo)

In 2020, the Platform Capital donated a robot (RobotScholar) to the University of Lagos. This robot works like that of the UP. The RoboScholar has been programmed to welcome users to the library, measure their temperature, identify users who have registered their details in its databases, interact with visitors to determine what they need, offers direct reference services to the users, help users in locating where library materials are, guide users on how to retrieve materials through OPAC search, play music, dance and play video to entertain guests. The University Librarian in her speech referred to the RoboScholar as a support service that has added value to their day to day operations, the use of robot has been reported to have reduced the

efforts and time used in answering simple ready reference queries in the library. (https://m.youtube.com/watch?v=-rXEVQ2Esqg)

Worthy of note in the literature reviewed is the opportunities that librarians can derive from using the Iot and its embedded technology for effective service delivery to their ever growing users' community. Some potential areas for implementation of the IoT in libraries included but not limited to the following:

Provision of access to information

Libraries provide instantaneous access to information thereby making space and time worriless in the era of IoT, this is simply because the era is characterised with the Internet of everything where information acquired in the library are made available to users instantly irrespective of the location or state of residence of the patrons. Libraries using a mobile app can create an interface for users to access all the available digital resources using Internet and other relevant technologies such as beacon for easy access to their numerous resources.

Information resource management

Libraries using RFID technology have RFID tags on each of their library materials to enable their virtual representation which can only be recognised on the library PC and RFID readers. Libraries can streamline the circulation services and fine collection through the integration of RFID tags in library users card. The IoT will be able to alert the affected users about overdue books and the amount of fine they owe to the library, to enable them return the overdue books and online payment without necessarily coming to the library to queue up.

Information retrieval

Libraries using mobile app, may provide virtual library cards to their users, which will enable them gain access to library facilities and use their resources. When a user accesses the library catalogue to locate the required resource(s), the library app stored on his or her mobile, will provide a map of the library guiding users to the location of resource(s). It can also provide additional information about a resource by connecting to a site such as Amazon, Oakleafbooks and other booksellers' websites so that users have detailed information about the information bearing resources.

Books reservation

Libraries provide users with the opportunity of making virtual reservation of library materials via the Internet. This is one of the beauties of the IoT in the library, library users can search for a book of his/her choice from the library WebOPAC using his/her smart phone with Internet access. After which the identified book will become accessible on the library shelve, with help of sensors the particular book shows signal or may begin blazing light. This way the actual book will distinguish its area for identification; there will be no any need to search through the books on the library racks looking for the books again, with that the librarian on duty will identify the book and hand it over to the library officer who will discharge the book.

Circulation management

The library collection with RFID tags on each of the items enables their virtual representation, which can be identified using computers and RFID tag readers. Through integration of RFID tags into member cards, circulation of items and fine collection can be streamlined. The IoT will be able to tell users about overdue books and how much fine they owe the library, to enable them return the overdue books and pay the fine online without coming to queue in the library circulation desk for payment.

Inventory control

Libraries have various other sources apart from books, journals, magazines such sources included but not limited to microfiche, video, audio, etcetera., can also be controlled by fixing sensors on them. With IoT, the development of everything can be followed. Despite the fact that RFID as of now fills piece of similar need for books, however with IoT since web is included, so it gives all the constant information on portable of the curator/supervisor and subsequently better stock control is conceivable and eventually the library faculty need to accomplish less work for stock confirmation Internet. IoT will also help in better inventory management (stock verification) as it will be easy to locate misplaced books.

Smart digital shelve

Smart digital shelves may be able to promote the contents based on users borrowing records and search history; it can also track the movement of the available resources within and outside the library. IoT through its applications allows its users not just to have the virtual visit through the

library on their cell phones, but also to keep and track the accessibility of the book on the separate retires or check the other asset accessibility notwithstanding the area or any place they are.

Users' orientation

Information literacy or orientation is offered to fresh users of the library to educate them about the library, its resources and services. IoT may help libraries in providing self guided virtual tour of the library. Libraries having setup beacons like wireless devices at various sections of the library, when users visit the particular section, their mobile phone will play a video or audio explaining more about that section and how one can get maximum benefit out of it. It may even provide enriched experience of special collection such as manuscripts by providing digital format of it on their mobile phones as physical access to such resources is always restricted.

Selected dissemination of information services

IoT can use patrons' data to suggest selected recommendations, using real time data, based on the history of their borrowings and activities. When a researcher searching a database for resources on topic/s of his or her interest, it may suggest other resources, which would be of interest to such user. Even when a user visit the library next time or is he or she is close to the library, IoT would be able to inform the user about the new arrivals in his or her area of interest or about the availability of a book on loan, which he or she was looking for during his/her earlier visit.

Current awareness services

IoT can provide the library users with location based services. If a user having created his favourite list on the library catalogue using his or her account from home or office, walking in to the library with IoT enabled mobile devices, they will be able to get directions for stacks, where favourite books have been shelved and also would be able to help him or her to know interesting titles available on the topic and status of checked out books. It may also enable libraries to provide status of availability of reading rooms, discussion rooms, printers, scanners, computers etc (Pujar and Satyanarayana, 2016), by displaying the peak and non peak hours of their usage on library website for users to check on their library mobile app.

Cost saving

Librarians provide general access for its numerous users through only one subscription platform instead of purchasing many copies of the physical materials for all users. Staff and students do not need to carry heavy books around or buy books and journals for their personal use as the library resources are accessible on their smart devices.

CONCLUSION

It is incontestable that technological advancement especially IoT has brought about a notable, unequivocal, remarkable positive water shell on the overall service delivery in academic libraries with special reference to how libraries and information centres generate, process, store and disseminate information. IoT has numerous features that could be used to enhance library service delivery if properly implemented. It could enhance effectiveness and efficiency in form of value addition to library and information resources and services. It is advisable for the librarians to learn this new technology from those that have effectively applied it to their operations and services to know its pros and cons particularly how it affects libraries. Despite the enormous benefit of the IoT, the full adoption of the system might be a little bit of a mirage in Nigerian libraries due to the fact many library are battling with maintenance issues. For this to take full shape, government at all levels must support the efforts of the libraries to collectively navigate the digital journey towards having the desired Smart libraries in the country.

Challenges/ Demerits of using IoT in academic libraries
- Security/ privacy issues
- Cost of deployment (design, customization and Maintenance)
- Technical know-how
- Lack of standardization
- Problem of infrastructural facilities
- issues of support for mobility
- issues with new network traffic patterns to be handled
- Erratic power supply as a result of high cost of maintaining alternate power supply

Recommendations

The following recommendations are made in the light of the paper.

1. Issues that border on security of users while sharing data with third party must be squarely addressed to forestall espionage of sensitive data. Thus, librarians must collaborate with IoT experts to have a more secured IoT future.

2. Librarians must ensure that they obtain a digital certificate for the IoT if they care to work with more secured data.

3. All academic libraries must embark on necessary requirement gathering statistics to ascertain the cost implication of starting, implementing and sustaining IoT in their organisations.

4. Staff should be given full support to go for in-service training so as to become proficient and versatile in the use of IoT for service delivery in their libraries.

5. Automation of academic libraries from initial stage to completion should be pursued with all figures to pave way for standardization through the adoption and sustainability of innovative technologies such as IoT in Nigerian libraries.

6. Infrastructural facilities such as stable power supply in all academic libraries must be provided and sustained uninterruptedly.

- Librarians must planning properly to provide effective Internet connection to tackle the issues with new network traffic patterns.

7. Libraries must put in place an effective and durable power back up to avoid incessant black out in the library service areas.

References

Ashton, K. (2009). The Internet of things. *RFID Journal*, 22 (7), 97-114. Retrieved December 20, 2021 from http://old.diglib.org/pubs/dlf102/dlfermi0408appa.pdf

Ashton, K. (2009). That "Internet of things" thing. Retrieved December 20, 2021 from http://www.rfidjournal.com/articles/view?4986. In B. XU, (2015). *China Internet Plus Strategy*, SESEC III Report.

Azolo, E. M. & Nwako, F. A. use of smart technology in university libraries in Covid-19 era. Library Research Journal ISSN – 2636-5952.

Bayani, Segura Alvarado & Loaiza (2018 a&b). *IoT-based library automation and monitoring system: developing an implementation framework of implementation.* Retrieved September 3, 2021 from DOI: https://doi.org/10.15517/eci.v8i1.30010

Bansal A. et.al. (2018). Internet of things – impact on insurance industry. Retrieved January 2, 2022 from http:/www.linkedin.com/pulse/internet-things-impact-insurance-industry-bansal?

Evans, D. (2011). The Internet of things: How the next evolution of the Internet is changing everything. Retrieved November 15, 2021 from www.cisco.com/web/about/ac79/docs/innov/IoT

Gul, S. & Bano, S. (2019). Smart libraries: an emerging & innovative technological habitat of 21st century. *The Electronic Library.* 37(5), 764-783, Retrieved August 15, 2021 from DOI 10.1108/EL-02-2019-0052

Gupta. J. & Singh (2018). Internet of things (IoT) and academic libraries: A user friendly facilitator for patrons. 5th international symposium on emerging trends and technologies in libraries and information services.

Hahn, J. (2017). The Internet of things: mobile technology and location services in libraries. Library Technology Reports, 53(1), 5-28 Retrieved August 15, 2021 from www.alatechsource.org

UNILAG Library (2020). How UNILAG library engages its RoboScholar. Retrieved from (https://m.youtube.com/watch?v=-rXEVQ2Esqg)

Liang, X. & Chen, Y. (2017). Libraries in internet of things (IoT) era. Library Hi Tech, 1, Retrieved August 15, 2021 from doi:10.1108/LHT-11-2017-0233.

Li, S., Xu, L.D. & Zhao, S. (2015), "The Internet of Things: a survey", Information Systems Frontiers, 17 (2), 243-259.

Liu, X & et.al. (2017). Application on internet of things technology using in library management. *Communications in Computer and Information Science*, 144 (2), Springer, Berlin, Heidelberg, 391–395.

Li, S., Xu, L. & Zhao, S. (2018), 5G Internet of things: a survey. *Journal of Industrial Information Integration*, 10, 1-9. Retrieved March 5, 2021 from https://doi.org/10.1016/j.jii.2018.01.005

Massis, B. (2018). Artificial intelligence arrives in the library. *Information and Learning Science.* 119 (7/8). 456-459 Doi: 10.1108/ILS-02-2018-0011.

Miller, L. C. (2018). IoT Solution for dummies. Hoboken: John Wiley & Sons, Inc.

Nag, A. & Nikam, K. (2016). Internet of things applications in academic libraries. *Int. J. Inf. Technol. Libr. Sci.*, 6(1), 1–7.

Olson, N., Nolin, J.M. & Nelhans, G. (2015). Semantic web, ubiquitous computing, or Internet of Things? A macro-analysis of scholarly publications. *Journal of Documentation*, 71(5), 884-916.

Poslad, S. (2009). *Ubiquitous computing smart devices, smart environments and smart interaction*. London: Wiley.

Pujar, S. & Satyanarayana, K. (2005). Internet of things and libraries. *Indian National Scientific Documentation Centre*, 52(1) 234-445.

Pujar, S. & Satyanarayana, K. (2015). Internet of things and libraries. Annals of Library and Information Studies, 62(186-190).

Qin, J. (2018). The Research of the library services based on Internet of things. Received July 3, 2021. Retrieved June 19, 2021 from DOI: https://doi.org/10.2991/isss-18.2018.83

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

Xu, et. al. (2014). The Internet of Things technology application and the intelligent library", *Applied Mechanics and Materials*. 571-572.

Xueling, L., (2018). Internet of things and its applications in libraries: a literature review. *Library Hi Tech*. 36 (2). Retrieved from https://doi.org/10.1108/LHT-01-2018-0014.

Wang, S.W. (2011). New pattern of future libraries: the smart library". *Journal of Library Science in China*, 12, (1-5), Retrieve from http//cnki.net

Whitmore, A., Agarwal, A. & Li, D.X. (2015). The internet of things – a survey of topics and trends", *Information Systems Frontiers*, 17(2). 261-274.

Wojick, M. (2016). Internet of Things – potential for libraries, Library *Hi Tech*. 34(2), 404-420.

Yan, D. (2010), "Smart library based on the Internet of Things", Journal of Library Science, 32 (7), 8-10 Retrieved from http//cnki.net

Yusuf, F., Ifijeh, G & Owolabi, S. (2019). Awareness Of Internet of Things And Its Potential In Enhancing Academic Library Service Delivery In A Developing Country Library Philosophy and Practice (e-journal). Retrieved from https://digitalcommons.unl.edu/libphilprac/2831.