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Abstract:

This paper aimed at examining the prospects and challenges of the application of internet of things technology in library services. The internet has become a norm of contemporary way of life as everyone wishes to be connected to the internet. Besides providing a veritable platform for effective and efficient promotion of workflow and services, the rapid growth of the internet globally lies in its ability to foster and shape human relationships and communication. 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 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. The concept of internet of things, basic features of the **IoT** platform, architecture, prospects and challenges of deploying the **IoT** technology in library services was considered. The paper concludes that internet of things has a great prospect for libraries and recommended that relevant ICT skills should be embedded in all LIS programmes at the graduate and post-graduate levels. This is aimed at equipping the professional with the requisite skills for effective service delivery whereas practicing professionals should be trained or retrained to keep them abreast with relevant ICT skills for effective service delivery in the IoT enabled environment.

KEYWORDS: Internet of things, features, architectures, prospects, challenges

Introduction

The 21st century has no doubt witnessed a massive development in information and communication technology (ICT). This development has affected virtually all aspects of human endeavors, operations and services of industries and institution including the libraries. Arguably, the emergence of internet is the most important and influential development of ICT. The internet has become a norm of contemporary way of life as everyone wishes to be connected to the internet. Besides providing a veritable platform for effective and efficient promotion of workflow and services, the rapid growth of the internet globally lies in its ability to foster and shape human relationships and communication (Yusuf, Ifijeh & Owolabi, 2019).

The proliferation of the internet is made possible with the availability of broadband connection devices via the internet at minimal cost, availability of more devices with network capabilities, and emergence of smart technology such as the smart phones. Technology enabled capabilities, has made it possible for us to access as well as render variety of services such as communication, information dissemination, email, online shopping, booking of flight tickets and geographical navigation. Rajguru(2019) states that 2020 will be a decade of Internet of things. In consonance to this view, 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 with some form of human intervention has advanced the course of communication and improved services. Nonetheless, it is imperative to state that, with the swift development of ICT enabled gadgets and devices all kinds of sensing device such as the Radio Frequency Identification (RFID) device, infrared sensors, global positioning systems laser scanners and other sensors like the smart phones. The next generation of internet will be tending toward the, development of the internet of things (IOT).

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 is 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 at the . 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: (1) people to people (2) people to machine and things and machine and things (3) 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.

Pujar and Satyanarayana (2015) states that it is called the "internet of things " (IOT) connecting any object , which may include everything from the cell phones, coffee makers, cars, washing machines, air conditioners, lamps wearable device and almost anything else one can think of. Objects in the IoT platforms uses sensors and have networking capabilities that enables them to communicate with each other. It should be noted that the objects or things in the internet of things platform could be person or an animal or a physical object such as a washing machine or car. In consonant to this view, Pujar and Satyaranarayana(2015) posit that a heart monitor implant installed in human body could be able to send message to doctors to define the state of a person to avoid any emergency hospitalization and a car having inbuilt sensors could be able to alert the driver about low or high pressures to avoid any possible accident.

Chandrashekhar (2016)states that information that is collected by the IoT devices goes through five phases of IoT lifecycle. Firstly, ***create*** phase, where devices or sensors collect information from the physical environment around them. The data from smart connected devices can be used to generate insights that can help businesses, customers and partners; secondly, ***communicate*** phase, where the data and events generated are sent through the network to the desired destination; thirdly, ***aggregate*** phase, where data collected are aggregated by devices itself; fourthly, ***analyze*** phase, where, upon further sophisticated analytics the aggregated data can be used to generate basic patterns, control and optimize processes and finally, ***act*** phase, where suitable actions are performed based on the information created.

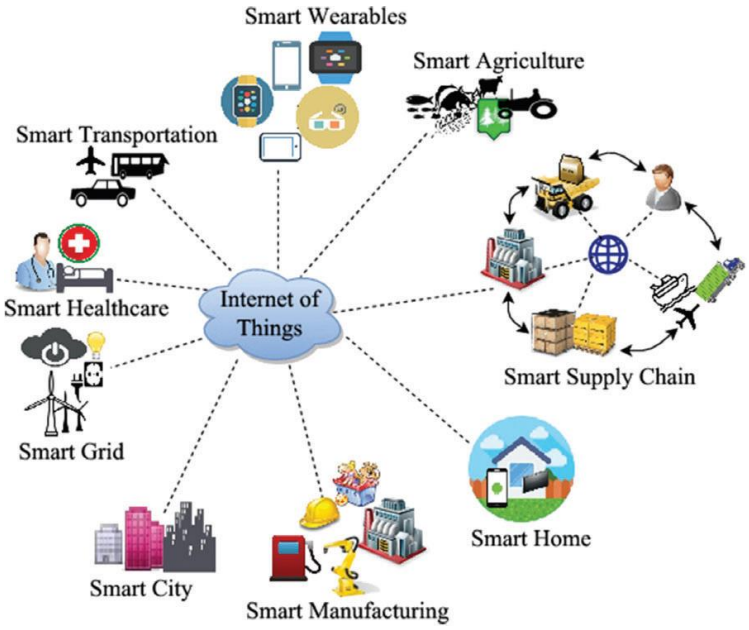

Fig 1: The internet of things **(Adopted** from Samaila, Nato, Fernandes, Freire and Inacio, 2018)

Basic features of IoT platform

The IoT is a complex system with a number of features. Chandrashekhar (2016) and Zennaro (2016) outlined some of the general and basic features of the IoT infrastructure to include:

(1) **Intelligence:** IoT comes with the combination of algorithms and computation, software & hardware that makes it smart. Ambient intelligence in IoT enhances its capabilities which facilitate the things to respond in an intelligent way to a particular situation and supports them in carrying out specific tasks. In spite of all the popularity of smart technologies, intelligence in IoT is only concerned as means of interaction between devices, while user and device interaction is achieved by standard input methods and graphical user interface.

(2) **Interconnectivity**: anything can be interconnected with the global information and communication infrastructure.

(3) **Sensing:** 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. Sensing technologies provide the means to create capabilities that reflect a true awareness of the physical world and the people in it. The sensing information is simply the analogue input from the physical world, but it can provide the rich understanding of our complex world.

(4) **Heterogenerosity**: Device in the IoT platforms are heterogeneous and are based on different hardware platforms and networks. They can interact with other devices or service platforms and networks. They can interact with devices or service platforms through different networks. (5)**Dynamic changes**: the state of devices changes dynamically e.g. connected and or disconnected, sleeping and waking up; the number of connected devices can change dynamically

(6) **Enormous scale**: it has a human cum devices triggered communication scale which will be at least an order of magnitude larger than the device connected to the current internet.

(7) **Security:** Given the high level of interoperability and interconnectivity, there is a high level of transparency and privacy issues with the IoT. Hence, the need to secure the endpoints, the networks, and the data that is transferred across all the devices.

Architecture of IoT

The large nature of device and things (physical, virtual and people) and heterogeneous networks that made up the IoT has generally made it difficult to establish a universal architecture for the IoT. Different architecture has been proposed by different researchers which fall into a five or three layers . However, most researchers' opinion about conventional IoT architecture is based on three layers (Bilal, 2017); Samaila, Nato, Fernandes, Freire and Inacio(2018). In consonance to this view, Pallavi and Smruti (2017) states that three and five layer architecture is proposed by different researchers but the most basic architecture is the three layer architecture namely:

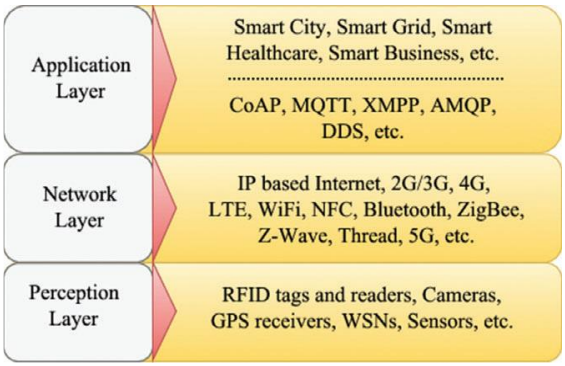

Fig 2. Architecture of internet of things **(IoT) (Adopted** from Samaila, Nato, Fernandes, Freire and Inacio, 2018)

Activities of each layer

a) **The perception layer:** The perception layer is also referred to as the recognition (physical) layer. It is the lowest layer of the conventional architecture of IOT. Its main responsibility is to gather useful information and or data from things or the environment and transforms them in a digital setup (Bilal, 2017). It senses some physical parameters or identifiers other smart objects in the

environment with the aid of Gps, receiver's sensors, RFID, WSNs, Cameras' and other heterogeneous devices.

b) **The network layer**: This layer provides connectivity between the objects, network devices, and wireless or cable connections. Cloud systems, as well as transmitting and processing the locally obtained data. It also includes the gateway component.

c) **The application layer**: 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 process, program and applications in which the IOT can be positioned be it a smart library, smart home (Banyani; et al, 2017).

Prospects of internet of things in libraries Services

The Internet of things is a novel and innovative technology that can be applied in library services in a number of ways. Pujar and Satyarayana(2015) and Echedom, Kakiri,and Oyadonghan,(2020) States that the IoT technology can be adopted in the following areas in the library services:

Fig 3. Internet of things in libraries services

- **Access to library and its resources:** The sensors at the entrance of the library gate can do face recognition of all visitors at automated card authentication which will give access to only authorized users to enter, simultaneously a message will be sent to a librarian in charge who can take action via connected virtual and digital devices whether to open the door for unknown face or unregistered user. Libraries using mobile applications can also provide a virtual library card to its members gain access to library and use its resources.

- **Collection Management:** The library collection can be managed by installing Radio Frequency Identification (RFID) tags on each item which enables their virtual representation, and can be identified using computer and RFID readers. By the application of RFID tags to member's cards, circulation of items and fine collection can be streamlined. The IOT can be configured in a way that tells users about overdue books in their custody and how much they are due to pay to the library and similarly payment can be done online via mobile banking/transfer applications to enable members avoid wasting of time. Smart digital shelves may be able to provide the content view of library holdings and better inventory (stock) management as it will be easy to locate misplaced or wrongly shelved books.
- **Inventory**: Bansal, Arora and Suri (2018) posit that apart from books, journals, magazines, other library resources such as microfiche, video, audio etc can also be controlled by applying sensors on them. With IOT, the movement of these resources can be tracked which ultimately will prevent to a very large extent abuse, mutilation, damage or misplacement.
- **Theft Management:** With tags on each library resource (scanners, printers, hard disk, CD, etc.) it will be easy to activate an automatic tracking system. This can be made possible by the installation of high-end sensors and transponders, which other than signaling the authority on members mobile, can as well block any attempt of theft by an automatic shutting door system for unauthorized carriage, entry or exist.
- **User Identification:** The sensors at the entrance of the library gate can do face recognition of all visitors or automated card authentication which will allow only authorized users to enter, simultaneously a message will be sent to a librarian in change who can take action via connected virtual and digital devices whether to open the door for unknown face or unregistered user.
- **Reservation of Information Material:** Registered members of a library can search for information resources that are not in the reserved section from the OPAC of the library available on the internet through their smart phones and reserve a book through their smart phones. The desired book if available will indicate in the user's phone and the library circulation platform.
- **Mobile Reference Services:** With the assistance of IOT enable smart phones with attendant mobile applications, one can easily refer the library without physically being present. Again, smart phones also provide features such as text to speech, touch navigation, hands free operations, especially for disable persons. These smart features of mobile phones are adopted by IOT to provide services, i.e. a physically disable person can request for a particular book with speech which can be identified using appropriate Radio frequency identifications or sensors installed in the library .Mobile reference services can be carried out with the application of IOTs .i.e. information dissemination through whatsapp, youtube, and email.
- **Information Literacy/Library Orientation Services**: Information literacy and library orientation programmes are usually given to freshers in a university system or patrons of a library

to educate them about the library, its resources and services. IOT may be deployed by providing self guided virtual tour of the library. Videos and audios could be deployed which explain to patron more about the activities and functions of the section. Similarly materials in digital formats can also be highlighted on member's mobile phone since such materials are in restricted access.

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.

Conclusion/ Recommendation

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. It is recommended that relevant ICT skills should be embedded in all LIS programmes at the graduate and post-graduate levels. This is aimed at equipping the professional with the requisite skills for effective service delivery whereas those already in the system practicing should be trained or retrained to keep them abreast with the needed skills for effective service delivery in the IoT enabled environment. Efforts should be made by policy makers to provide adequate fund to cater for the financial implication of instituting the Internet of things. Additionally, library managers should collaborate with organizations whose corporate social responsibility borders on educational advancement and promotion to assist in generating the required fund for the project. It is also recommended that effort aimed at minimizing the attendant challenges in the application of IoTs in library services highlighted in this work should be carried out by continuous research and innovation. IoT has emerged and will continue to change the manner library services are done, our option is either to live up to the smart world or come behind.

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