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The Internet of Things: Opportunities and Challenges for libraries

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Abstract

With the necessity to be connected to the Internet, the Internet of Things (IoT) will receive more and more attention. By using RFID technologies, IoT will be able to connect everyday devices and transfer data between them. Like other service providers, IoT technologies will offer many opportunities for libraries, from tracking room usage and program attendance to monitoring humidity levels for special collections, and many more applications. In this paper, we are discussing about the nature of IoT, opportunities and challenges of using IoT in libraries. Despite of having challenges, IoT will contribute effectively to the transformation and innovation of library resources and services.

1. Introduction

As stated by Mogens Vestergaard and cited by Petra Paraschiv, "it is the library's obligation to be at the edge *of different uses of culture and uses of technologies*" (Paraschiv, 2018). Technologies during the past, the current, or the future technologies are not and will not be strange to librarians and librarianship. History teaches us how librarians and information specialists have used technologies, such as computers, Library automation, the Internet and networking technologies, to reshape librarianship and bring transformation and innovation to the provision of library services and resources. Today, we are using the emerging latest technologies not only to improve library services and resources, but also to create future libraries.

At the beginning of its introduction, the Internet was mainly used for various forms of communications such as ~~through~~ email, chat, and VoIP telephony (Comer, 2015). In the 1990s, the connectivity of the Internet began to increase, and became much better in the 2000s (Nag and Nikam, 2016). Kevin Ashton, a British technology pioneer and cofounder of the Auto-ID Center, first used the term "*Internet of Things*" in 1999 during a presentation at Procter & Gamble Company(Ashton, 2009). According to him, "*People have limited time, attention and accuracy, all of which means they are not very good at capturing data about things in the real world*"(Ashton, 2009). Ashton (2009) believes that by using "computers that knew everything there was to know about things, using data they gathered without any help from us, we would be able to track and count everything, and greatly reduce waste, loss and cost. We would know when things needed replacing, repairing or recalling, and whether they were fresh or past their best".

Today, connecting to the Internet has become a necessity rather than a luxury. As a result, the Internet of Things (IoT) receives more and more

attention(Paraschiv, 2019). By using RFID technologies, IoT has the ability to connect all devices and transfer data between them. Certainly, IoT technologies offer many opportunities for library professionals from tracking of room usage and program attendance to monitoring humidity levels for special collections, and many more.

As stated by S.R. Ranganathan, "the library is a growing organism", therefore, librarians have no choice but to make use of these important technologies. The Internet of things (IoT) technology has the ability to connect different things and allow them to communicate and exchange data and information. The term "things" can be anything you may think of, therefore, the thing or object can be human beings, animals, the airplane, classrooms, cellular phones, tables, car parking, you name it. As a basic requirement for IoT services, an object must have a sensor with a networking device in order to communicate and interact with other objects. For instance, many football players have died while playing on the pitch. This kind of sudden death could be avoided with a heart-monitoring device installed in the player's body to alert the medical team about the health status of the players. A smart house with sensors and networking should be able to alert people about any upcoming danger related to smoke, fire, water, and electricity.

Certainly, IoT technology has revolutionized the way we provide resources and services, the way we do business and transactions, and the way we are living. Therefore, many governments and organizations are spending a lot of money on IoT related projects, infrastructures, and facilities to improve resources and services, business, and improves the standard of our life. This paper broadly discusses about the nature of IoT technology, and the various opportunities and challenges of using IoT in libraries.

2. The Internet of Things

Today, the term Internet of everything, machine-to-machine communication, the pervasive computing device, the smart device, the ubiquitous device, and many more phrases are used in the literature to refer to the Internet of Things (Pujar and Satyanarayana, 2015; Makori, 2017). Kevin Ashton, the father of the Internet of Things was unable to give a clear and specific definition for the term but made an attempt to define it and said:

> *"The fact that I was probably the first person to say "Internet of Things" doesn't give me any right to control how others use the phrase. But what I meant, and still mean, is this: Today computers—and, therefore, the Internet—are almost wholly dependent on human beings for information. Nearly all of the roughly 50 petabytes (a petabyte is 1,024 terabytes) of data available on the Internet were first captured and created by human beings—by typing, pressing a record button, taking a digital picture or scanning a bar code. Conventional diagrams of the Internet include*

servers and routers and so on, but they leave out the most numerous and important routers of all: people. The problem is, people have limited time, attention and accuracy—all of which means they are not very good at capturing data about things in the real world".

The above statement is a description of the IoT concept rather than definition. The term "Internet of Things" is defined as the pervasive presence of a variety of things or objects through a unique addressing schemes to interact with each other and cooperate with their neighbors to reach common goals (Atzori et al., 2010). According to Linnik (2019), IoT is about connectivity between different objects and their ability to transfer the data over different networks. It is an extension of the Internet in which things, including human beings and animals, can share, communicate, and interact with one another (Ryan and Watson, 2017). Beside RFID technology, IoT technology needs sensors or devices, connectivity or networking, data processing, and user interface.

Figure1: IoT ability to connect different objects (Adopted from Linnik, 2019).

IoT uses identification sensors for collecting data from various things or objects. The collected data can be simple or sophisticated and complex. Simple data can be collected through a single sensor, while it needs multiple sensors for collecting complex and sophisticated data. For instance, drones use accelerometer, tilt sensors, current sensors, and magnetic sensors to collect complex data from the surrounding environment. By using networking software, sensors will be able to communicate and transfer data to a cloud infrastructure. This transfer will allow the system to process the existing data, and then a user interface will be able to help to communicate and interact with other devices. The following sections explain how libraries can use IoT to improve library resources and services.

3. IoT Application in Libraries: Opportunities

As defined earlier, IoT is about connecting things or objects and allowing them to communicate and transfer data to achieve a task. Libraries, being service

providers, contain print and electronic information resources such as books, journals, online databases, etc. they also contain facilities and equipment, including shelves and racks, tables and chairs, study rooms and discussion rooms, computers and printers. Accordingly, many libraries are already using IoT technology for managing their collections; facilities, equipment, and electronic appliances; user education; and accessing their resources and services.

3.1 Managing Collection(s)

The Radio Frequency Identification Device (RFID) is a technology that helps IoT to identify and track data of objects (Pujar and Satyanarayana, 2015). Since its introduction in the 1940s (Pal and Sharma, 2017), libraries have been using RFID as a replacement for EM Security Strip and Barcodes. For collection management nowadays each item in the library is equipped with an RFID tag containing bibliographic information, transaction logs, and virtual representations. By integrating the library card with RFID tags, collection circulation, overdue, and fines can be connected. Therefore, by using IoT technology, libraries will be able to inform the users about overdue items and pay fines online (Addepalli and Addepalli, 2014). In addition to these, with the use of smart shelves, libraries will be able to effectively market library collections based on the user's movements in the library and transaction logs. This can be done by informing the user about the new arrivals in a subject area in which he or she was looking for during the previous visits to the library (Pujar and Satyanarayana, 2015).

For instance, a state library in Russia is using robotic devices controlled through RFID and IoT and equipped with an automatic sorter device for collection management. For instance, when a customer returns a book, the system detects it, confirms its acceptance, and then puts the book into the right bin. In addition, if a library user finds a book in the catalog, but showing the status as borrowed by anther user, the second user can reserve that book. When the reserved book is returned through the automatic station, it goes to a special bin allocated for reserved books. At this stage, the system will send a message or an email to the user to confirm the availability of the book (Purnik, 2019).

Figure2: *Book return station with an automatic sorter* (Adopted from Purnik, 2019).

Similarly, in 2011 the University of Chicago come-up with a new library building consisting of the large reading area with the latest facilities and equipment; and a huge hidden underground book depository. The Library helping in the scholarly productivity by allowing the users to request the delivery of library items while in the library. When a reader orders for a book, the system sends a robot to the exact stack to deliver the book upstairs. Delivery time is only several minutes and the efficiency of space usage is maximum. This process does not cause any disturbance to library visitors in the reading areas (University of Chicago 2019; Purnik, 2019).

3.2 Managing Facilities, Equipment, and Appliances

IoT will help librarians to manage better their facilities, equipment, and appliances. Library facilities such as multimedia rooms, discussion and study rooms, seminar or conference rooms, computer and printing labs can be transformed into IoT enabled devices to quickly and easily determine the status of rooms as free or busy; the number of computers and printers in use, and reserve rooms and other facilities. In addition, reading tables equipped with IoT devices may help librarians to identify less used tables and the most preferred location by users. Similarly, library computers, electronic imaging equipment, and multimedia equipment connected with IoT devices may produce an important usage report which is needed by the librarians for the improving of library services. Likewise, IoT can help libraries to control power, lighting, air conditioning, and Wi-Fi appliances inside the library (Pujar and Satyanarayana, 2015; Qin, 2018; Abo-Seada, 2019).

3.3 User Education

User education refers to activities aimed to improve the user's knowledge, skills, and information seeking behavior. Therefore, these activities include orientations and information literacy, professional development, workshops and trainings, seminars and presentations organized by a library. IoT together with mobile apps has contributed significantly to user education in libraries. IoT has enabled libraries to provide self-guided virtual tour inside the library, and play a video or audio how to use a particular database or digital content (Pujar and Satyanarayana, 2015). With the support of IoT technology, Massis (2015) explained how virtual and augmented reality apps can help libraries to improve user education. According to him, libraries must consider these technologies as value addition to library services and can be used to engage users with a proper approach to teaching user education.

3.4 Accessing Resources and Services

Nowadays, mobile apps are the basic necessities rather than luxuries for service providers and libraries are no exceptions. IoT enabled mobile apps providing an opportunity for libraries to improve access to information resources and services. With these mobile apps, library users have full access to library OPAC, e-books

and e-journals, digital magazines and newspapers, and personal library. For services, users can use library mobile apps for identifying resource's location, reserve books and study rooms, register the library events, and attend activities related to user education (Wei et al., 2015;Hu and Zhang, 2016; Hahn, 2017; Kerr and Pennington, 2018; Guo et al., 2018). A report by Canuel and Crichton (2015) found that the members of the Association of Universities and Colleges of Canada (AUCC) provided mobile apps to the users to help in their ~~for~~ reading (69%), apps for citation management (50%), apps for the bibliographic database (42%), and apps for cloud based services (28%).

4. IoT Applications in Libraries: Challenges

Despite positive IoT contributions to the innovations and transformation of library resources and services, the implementation and application of the technologies cannot be achieved without several challenges, difficulties, and obstacles. These challenges can be administrative and financial, privacy and security issues, and inaccuracy and failure as discussed below.

4.1 Administrative and Financial Challenges

IoT implementation requires lot of financial commitment to acquire all the necessary equipment needed for the implementation of this new technology. Therefore, it is preferred to prepare a financial plan for the implementation before any action. Usually, librarians do not have problems to prepare this kind of plan, or to propose innovative and creative ideas. However, in many occasions they are unable to get approval from stakeholders and decision makers to implement these ideas. The reasons behind the rejection of those proposals can be lack of skills in using effective approach to convince the decision makers about the importance and the benefits of new ideas. On the other hand, the financial status of an organization, especially in the case of private sectors, decision makers are not in ~~to~~ support to these new ideas. This is because most of IoT implementation need huge investment starting from acquiring device, ~~and~~ implementation, and daily maintenance of devices(Bansal et al., 2018).

4.2 Privacy and Security Challenges

Privacy and Security is a major concerned in IoT implementation. IoT functionality requires connectivity, communication, and data transfer among objects. Therefore, a visitor to a library equipped with IoT technology need to enable mobile connectivity. This connectivity allows library staff to control the visitor's mobile phone and access the contents which is considered as infringement of privacy(Welbourne et al., 2009). Meanwhile, since IoT technology is based on networking and communication of different objects, hackers may easily penetrate IoT enable services in the library, access users' profiles, and make it available to unauthorized users. It is interesting to know, the hackers' threat is a global phenomenon which undermines security issues not only in

libraries but also other service providers using IoT technologies, such financial institutions, health care institutions, trade and business institutions (Stolpe, 2016; Shim et al., 2017). Unfortunately, the hackers' threat is expected to increase as long as IoT devices become more advanced, complex, and sophisticated (Makori, 2017).

4.3 Inaccuracy and Failure Challenges

As any ICT device including IoT systems are vulnerable at times to the issue of inaccuracy and failure in functioning due to technical problems or human errors. The issue of inaccuracy and system failure can be very costly both physically and financially. For instance, sending inaccurate instruction to traffic systems, health care systems, and nutrition systems may lead to the death of many people. Therefore today, technology experts are more concerned about the ~~IoT~~ consistency, conformity, and reliability of IoT across mobile networks and through to remote control devices(Abo-Seada, 2019).

5. Conclusion

Although it has been in existence for nearly twenty years now, IoT is still one of important emerging library technologies(Nag and Nikam, 2016; Varnum, 2017; Paraschiv, 2019). In this paper, we have discussed about using of the various IoT technologies in libraries in terms of offering various opportunities for librarians ~~is an to transform and~~ in providing innovate library resources and services however, ~~we have~~ also cautioned challenges that might hinder and obstruct the implementation of IoT technologies in libraries.

In the future, more objects and things are believed to be IoT enabled devices (Abo-Seada, 2019), therefore, librarians should be ready to welcome more ~~IoT enabled~~ such devices in libraries. According to Hahn (Hahn, 2017), the current IoT devices are not good enough to understand what users' engagement with library collection and services points. He believes that, future IoT devices should provide deeper insight into the actual use of physical library spaces. As results, librarians will be able to accurately report about the space usage and take decisions based on the evidences. Recently, Upala and Wong (2019) proposed an IoT solution to support library space management. According to those authors, the results and analysis show that the proposed IoT solution will accelerate the library rooms' availability process without librarians' intervention.

Another possible transformation through IoT technology is to make library-reading tables smart. The smart table should be equipped with IoT technology to allow users to access library resources and services while reading in the library without their leaving the table. For instance, by sitting on the smart table, users will have full access to his or her account; access online databases, read e-books and e-journals; e-magazines and e-newspapers; writ, draw and edit documents; print and scan documents without leaving the table. The provision of this type of smart facilities will support the creativity and active learning. According to

Varnum (2017), investing in active learning will enable the library to become a better resource to users.

It is certain that, despite the existence of multiple challenges, the use of IoT in libraries contributes positively and effectively to collection management; management of library facilities, equipment, and appliances; access to library resources and services; and user education. As a result, it helps librarians to make effective and efficient decisions, to increase productivities and performances of library staff, to have effective interaction with the users, and to improve users' satisfaction. Let's hope the industry will bring out many more such smarter IoT devices by overcoming the existing problems in the present technologies so that all libraries will be able to make use of them for providing better services to their users.

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