

## Research Paper

# How can We Equip Academic Libraries with IOT Technologies: Practical Guidelines

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### Abstract

**Background:** The advancement of information technologies has many effects on library services and collection management. Most of the librarians and library managers would like to work in libraries with a focus on modern devices and technologies. **Purpose:** The purpose of this study is to examine applying new devices of IOT technologies in different parts of libraries and changing library environment and services according to these new technologies. **Method:** The present research has been using library study. In fact, equipping libraries with modern technologies would improve library services and increase users' satisfaction. **Findings:** Librarians should be aware of important aspects of IOT in library services. The IOT will continue to affect libraries and their services through the building, collection management, instruction, data security, data mining, and information literacy. In this study authors try to design a practical model for academic libraries based on IOT devices to improve the quality of services, increase user's satisfaction and reduce costs. **Conclusion:** It is expected that this new technology, in addition to improving services, can greatly reduce the additional costs of libraries and help the library get closer to green and environment- friendly libraries.

**Keywords:** IOT technology; Academic library; Library services.

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## **Introduction**

The advancement of information and wireless communication technologies has a great impact on library roles in the society and educational centers. According to Cisco report the number of objects connected to internet has exceeded the number of human beings in the world PCs, mobiles, tablets, wireless sensor network, and house hold appliance (CISCO, 2015).

The Internet of Things (IOT) is a global technology of interrelated physical devices. This new system collects and delivers data via the Internet, and it has changed the way we live and work. The concepts of Internet of Things (IOT) refer to the use of Internet connected objects and systems to obtain data gathered by embedded sensors, actuators in machines and other physical objects (Nag, 2016). Things, in the IOT, can refer to a wide variety of devices and people.

Today, people are hoping to experience more different situations than the past. They want to match new technologies to traditional areas. In new generation, these conditions will be even more excited. Libraries especially academic libraries are the places, which most educated people including students, professors, and researchers tend to use. In a period of time that most libraries are suffering from low cost, lack of enough spaces, and lack of human resources; library managers and designers are trying to find some useful ways to deal with these challenges. They hope to design a library by matching the features of both online and traditional libraries. Applying IOT devices as new technologies can help designers to create a library with a different and more attractive atmosphere for users.

The intersection and culmination of several effects of networks, spaces, and data are poised to disrupt technologies within libraries as so-called internet of things (IOT). According to Gartner industry “the IOT is a network of physical objects that contain embedded technology to communication and sense or interact with their internal and external environment. IOT products and service suppliers will generate incremental revenue exceeding \$300 billion, mostly in services, in 2020. It will result in \$1.9 trillion in global economic value-add through sales into diverse and markets” (Gartner, 2013).

The idea of computing anywhere anytime was introduced in 1988 by Mark Weiser (Friedemann & Floerke Meier, 2010; Weiser, 1991). CISCO sees the IOT as the networked connection of people, data, process and things that brings them together in a more valuable

way, turning the information they have collected into action with richer experiences. Libraries face challenges in twenty-first century. Some of the challenges related to changes in the networked information, including the massive and direct availability of information.

Today, there are examples of Internet of Things (IOT) applications in different types of industries and buildings such as home, hospital, library, school, etc. IOT is applied to libraries in order to monitor users' activities, to get feedback from users, to increase the effectiveness of services, etc. It also plays an important role in two aspects of information analysis and control (Mohmmadi and ezadi, 2017). IOT has deeply rooted itself into library system, yet this study tries to demonstrate that would this new technology bring more significant changes to different parts of libraries?

### **Internet of Things (IOT)**

Internet of Things (IOT) is a concept which has emerged since the late 1990s (Wojcik, 2016). Now people are excited to know more about this new technology and use it in different walks of their lives. They want to know about smart homes, smart cities, smart universities, smart government, etc. As mentioned before; IOT is a giant network of connected things and people. In IOT, the relationship will be between people-people, people- things and things- things (Morgan, 2014).

According to Techopedia" the IOT is a concept which can reveal future where every day physical objects will be connected to the Internet and they will be able to identify themselves to other devices or people (Techopesdia, 2015). Now, IOT changes all activities that have been done by human and machine, hence it would be influenced almost all aspects of human's life cycle.

Atzori et al described IOT as a "novel paradigm that rapidly gaining ground in the scenario of modern wireless telecommunication" (Atzori et al, 2010). According to Xia et al "IOT refers to the networked interconnection of everyday objects, which are often equipped with ubiquitous intelligence" (xia et al, 2012).

IOT is a current phenomenon that is estimated to have a significant effect on not only the business world, but everyday life as well. McKinney estimates that the monetary impact created by IOT will be

equivalent to approximately 11 percent of the world economy by 2025 (Obodovski, 2014).

IOT includes an unusual number of objects of all shapes and sizes. Simply, the Internet of Things is made up of devices – from simple sensors to smart phones and wearable – connected to each other. The term IOT includes everything connected to the internet. In other words, it can be described as real world objects connected to the Internet, sending and receiving data, these devices can communicate with each other or with people, collect and analyze data and use them in suitable situations and purposes (Hess, 2016).

IOT is about much more than this . It is intended to create intelligent, connected systems, smarter than the sum of their parts, that provide real time analytics, useful projections, and tangible value from that data and interactivity.

### **IOT and Libraries**

IOT can be used to improved library services. Librarians also face innovative challenges, concerns, and opportunities for development in regard to the emergent technologies such as IOT (Bayani et al, 2017). Matching IOT with library and information sciences will improve libraries, both on collecting information and user services. The intercommunication between objects in IOT devices can make easier decision making and management process in libraries. According to the idea of smart building, libraries also can be equipped by IOT devices. Nowadays, management of temperature or alarm systems would not be a problem for modern library architecture.

IOT technologies can also help librarians to build smart libraries. In smart libraries all objects and devices can connect to each other and can gather information from the entire things inside and outside of libraries. These new technologies are called Linked Data technology (Roy, 2015). They can also present some golden opportunities for libraries to connect their resources and services to more users, and more devices, at any time of the day. WorldCat work Project is an example of Linked Data technology. It contains 197 million bibliographic work descriptions such as authors, titles, descriptions, subjects, years, pages, etc. (Kumar, 2016).

A historical survey in library management and services shows that the main library services are still access to information. Providing access to digital collections is the main subject of library services. It is

a fact that nowadays, the role of reference librarians in libraries especially in academic libraries is based on interaction between users, collection and librarians.

IOT will enable libraries to minimize loss and introduce safety techniques. Libraries will be able to add more value addition to their services. Librarians are those specialists that already familiar with new technologies in their libraries owing to the user of RFID, which does the similar thing of interacting with machines, tags software, and updates library management system with entries of books issued to a user, but in IOT, only the difference is” the Internet interaction with a thing or object such as books “(Pujar, 2015).

As regards organizations, the university library activities are toward the goals of the university. There are different sections in a university library such as reference rooms, DVDs rooms, theses rooms, journal rooms, management department, and reading rooms. IOT could help libraries to improve their collections and services in different parts of libraries. Also this technology will enable libraries to market their services. As we move forward into the digital age, the libraries must not only modernize their physical appearance but also their marketing and should take advantage of new technologies (Nag, 2016).

Security of library materials is the important aspect of library services, but more important is the safety of patrons and staff (Parashar, Khan, and Neha, 2016). As IOT applications collect more and more confidential data and provide accessibility to them over the Internet, the security becomes a major challenge. So libraries must become more aware with regard to their collection and patron privacy and security (Massis, 2016). Librarians should help their patrons learn about the IOT, especially those concerned about protecting the privacy of the information collected by such systems (Hess, 2016). They should show their users how to use IOT properly to achieve their goals and meet their needs as soon as possible.

The smart devices will certainly affect libraries and their services including buildings, collections, management, instruction, and security. Smart technologies can allow librarians more time to dedicate to tasks that require human inventiveness, for example, North Carolina University library has employed a bookBot, a robotic book delivery system, that allows students and faculty members to access any of the two million items held in climate controlled storage with a

click on the catalog. The space-saving shelving (which uses 1/9 of the space of traditional shelving) allowed the library to offer many more learning and meeting spaces for their patrons (Hess, 2016).

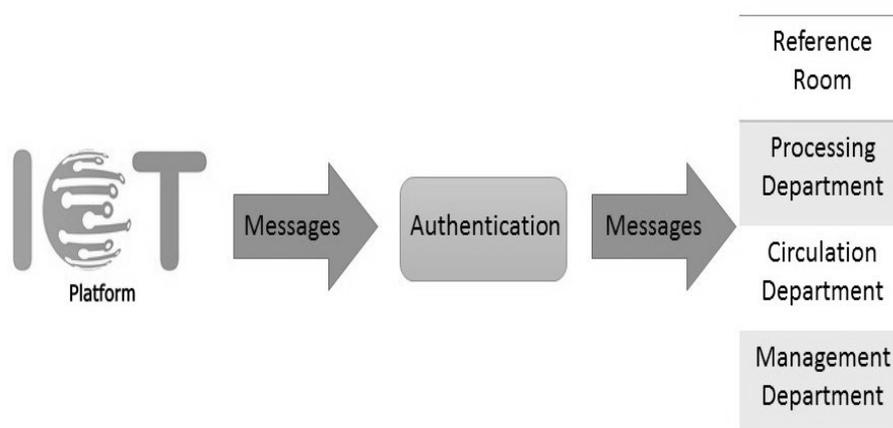
Clearly, IOT could lead to dramatic changes in library services as soon as possible. It is important to understand the capabilities, uses, and even risks of these items. Libraries often play as translators of new information concepts and technology. They should provide resources to help them understand the mean of the IOT. Libraries must be aware of the potential of IOT to disrupt services and alert patrons to potential vulnerabilities when using their networks, their hardware and software (Massi, 2015). Different components in a smart library have been shown in fig.2.



Fig.1. Different components in a smart library

Also, it is possible to establish a global link which can facilitate the access to the unknown valuable scientific resources around the world. Furthermore, the creation of a global library link among other collections, leads to build an open online global library that enables a global access to the big treasure of knowledge in the human history ( Bayani et al, 2017).

In smart libraries all objects and devices can connect to each other and can gather information from the entire thing inside and outside of libraries. These new technologies called Linked Data technology (Roy, 2015). IOT technologies also present golden opportunities for libraries to connect their resources and services to more users, and more devices, at any time of the day. A complete smart system needs hardware, software, connectivity and user interface. IOT Platforms can facilitate communication, data stream, device management and functionality of applications. Recently, many companies try to create IOT platforms according to needs of their clients such as Microsoft Azure IOT, GoogleClud Platform, Watson IOT, Samsung Electronics Launched Artik, Thing Worx IOT Platform, Amazon Web Services (AWS) IOT. Fig. 2 shows the suitable IOT platform for academic libraries.



**Fig.2. IOT Platform**

### **Designing an IOT library**

Designing smart model for libraries the same as monitoring, registering, circulating, establishing security, managing, and self servicing is a favorite subject for researchers. A library model is the way in which “create, delivers and captures value” (Osterwalder and

Pigneur, 2010). Thus, it describes what a library does (what kind of services offers), how the library does it (how delivers its services to users), and how the library makes money (by advertising or delivering additional services).

So far, many designers have tried to design different models based on IOT technologies, tailored to the needs of libraries. Bayani et al, (2017) proposed a theoretical model, related to the IOT-based automation library system, to provide a suitable awareness on the library system designs. In this model they tried to design a model according to IOT's smart elements that can meet the needs of patrons. This designed smart library system was based on the system hardware architecture and the software development (Bayani, 2017).

Nisha et al. designed an IOT system for library management based on the Near Field Communication (NFC) technology. NFC is designed to be a secure form of data exchange, and an NFC device is capable of being both an NFC reader and an NFC tag. This unique feature allows NFC devices to communicate peer-to-peer. NFC readers are used to read tags on books, as well as the user cards (Nisha et al, 2017).

Srinivasan and Vanithamani (2013) proposed an alert's system model for book borrowing system using the RFID and GFM mobile technology (Srinivasan and Vanithamani, 2013).

In fact, in the IOT applied model variety of people would involve in different fields such as: Information specialists, electronic engineers, Architects, librarians, library managers. Sometimes designing a model can help great deal to increase safety, quality and economy of system. Modeling can also cost in different domains. Some necessary components to design an IOT model are as follows: Requirements, IOT system design, and system integration.

After designing each section of the model, the result of the work should be carefully analyzed by experts. If it's possible, a trial test at the end of each step seems necessary. The first and often the most important step for designing IOT model, is to establish a clear goal for the model. In other words, what is the model for, what is its purpose, and what does it need to communicate.

Yet, none of the academic libraries have been able to fully implement the IOT technology. In this section, authors tried to design a comprehensive IOT library for reference section,

circulation desk, and information management section of academic libraries.

### **Discussion:**

#### **Using IOT in different parts of libraries:**

**Reference desk:** Reference desk is one of the most important sections in each library. According to library policy, it has a variety of collections and services. Generally, the reference collection should not leave the library, so users should study them in the library or prepare a printed/ digital copy. IOT is an ideal emerging technology to influence the patrons by providing new evolving and efficient services. This technology can increase profitability by improving resources utilization and development of management services in libraries.

Embedding Wi-Fi sensors on the bulbs can help reduce power consumption. With this method, the lamps will only be bright when there is user in the room. Sensors will send signals to the server by Wi-Fi; therefore lamps will be on/off. Heating / cooling systems will also work the same by IOT technology. IOT technology in the libraries focuses on the energy efficiency, so it can also be called as a Green technology.

Furthermore, pad pressure sensors are suitable option for reference room floor and book stack floor. When users enter to book stack to find their books or other items, sensors will send signals to server, then server will analysis the received data, and then will sent them to librarian's system. Finally, librarians can be informed of the presence of users and their exact location.

#### **Management department**

In management section, attaching RFID on books and all other items in the library, librarians and clients can be informed of whether or not they are on the shelves. In this model, even if the book is not in place, the error message will be sent by the server to librarian's system. Therefore, using this technology in addition to saving time and energy can also prevent books being lost. Also, in this model, if just a copy of the book remains in shelves; a warning message will be given to the librarian before the latest version is loaned.

IOT model can also be regarded as a valuable contribution to library managers in the collection building. In this model, authors try

to consider both the physical and virtual aspects of the library. A part of the collection building is dedicated to book assignments by faculty members and graduate students. They can browse the collection, and if the book is not in the collection, they can order the book through the online forms available on the library homepages. Orders will send to acquisition librarian. Acquisition librarian will search ordered books in the collection, if the book was not existed in the collection, bibliographic information will send to related publishers (Related publishers are those who specially connected to library through IOT devices). At the end, ordered books are provided by publishers and sent to the library. The process of transferring books may be done physically or virtually. After new books are added to the library, a message will be sent to the library client by the library manager server. In this model, the librarian and client will fully be in the process of book preparing.

In management department, part of the library service is dedicated to the design of Radio- Frequency Identification (RFID) system.

This system uses wireless technology to transfer data from a tag attached to books, library items, and library membership cards. The information about library items and patrons (the item's title, the format, the call number, the patron's full name, the affiliation and...) is encoded on the tags and it is linked to IOT library system and can be read by RFID readers.

In the IOT model, graduate students, Faculty members would have direct access to some international information databases such as Elsevier, Ebsco, Clinical key, and Springer inside and outside of academic library.

### **Circulation department**

In circulation section, when the book holders pass the electronic access gate control, a reader receives the signal of the book's tag as well as the ID-Card. In this section the IOT system sends the information to the central cloud system to analyze and display the user in the monitoring system. According to the model proposed by Bayani et al (2017), IOT system can make a previous registration of the borrowed book to its data base to check the waiting system. By using the WSNs and attaching the micro-sensors on documents, none of the documents or books will be lost. Thus, continuous monitoring of the

objects in a real time and online is other desirable characteristics of using IOT tags.

One of the other benefits of the IOT system is the possibility of connecting to other communication technologies and library management systems (Bayani et al, 2017). According to this powerful technology users can receive all kind of messages coming from the library system. Also, library IOT alert system can send a message informing about the arrival of the requested book to the users' smart phones. Also the time of returning books will be send to the users' smart phones.

Another advantage of IOT system is information literacy. Information literacy is offered to new users to educate them about a library, and its resources. IOT can help libraries to provide self guided virtual tour of the library.

Pujar & Satyanarayana, (20145) suggested that IOT may help libraries and their users in better management of available appliance, thus saving the energy cost will be occurred.

### **Conclusion**

In recent years, with the advancement of mobile and ubiquitous technologies, invisible micro-computers have embedded us in our surrounding environment. IOT can bring about dramatic changes in library services as soon as possible. It is important to understand the capabilities, uses, and even risks of this technology. The potential scope of IOT applications in everyday life is huge. It is clear that libraries will include IOT systems in their service range to follow global trends and better meet users' needs. As mentioned in the context, IOT technologies can be useful for collection management, online services, training and providing access to spaces and equipment, gathering, analyzing, storage and sharing information. Potter (2014) predicted that "the Internet of Things will, hopefully be a big deal in libraries". IOT technologies are the advanced stage of library systems that have benefits for the user enjoys convenient access to traditional and digital items, books, journals and more anywhere and anytime.

Although reducing public funding is forcing many libraries to make cuts to their services, or to be closed. But for many communities, libraries remain as vital resources, providing access to a wealth of knowledge, free computer use, and community activities. IOT can

help libraries by optimizing use of space, enhancing the visitor experience, and preserving valuable collections through smart room management.

IOT is an ideal emerging technology to influence the patrons by providing new evolving and efficient services faster and more convenient. This technology can increase profitability by improving resources utilization and development of management services in libraries.

Although the cost of installing IOT technology (software and hardware) may be too high for many libraries, it should be noted that investing in this field will save a lot of costs. One of the main points to be addressed in the next section is the issue of network security and privacy of users. In future models designed for the library, privacy must be taken seriously. Authorities should pay more attention to equipping libraries with new technologies. Numerous workshops should be held to familiarize librarians and library administrators with the new technology. Finally, it is recommended that libraries pay special attention to increasing marketing activities to cover the cost of purchasing equipment and facilities.

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