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LIBRARIANS APPLICATION OF INTERNET OF THINGS (IoT) IN LIBRARIES.

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Abstract

The rapid advancement of Information and Communication Technologies (ICTs) has transformed library operations and service delivery worldwide. Among emerging technologies, the Internet of Things (IoT) has become a significant innovation capable of enhancing library efficiency through intelligent automation, real-time monitoring, and seamless communication between interconnected devices. This paper reviews the application of IoT in libraries, highlighting its role in improving collection management, circulation services, security, resource tracking, user identification, environmental monitoring, and smart library services. It also examines the technological infrastructure required for successful implementation, the benefits of IoT, and the challenges affecting adoption. The paper concludes that strategic planning, institutional support, and continuous professional development are essential for successful IoT integration in libraries.

Keywords

Internet of Things, IoT, Smart Libraries, Library Automation, RFID, Digital Libraries

Introduction

There have been rapid developments in information and communication technologies (ICTs) in the 21st century. These developments have impacted on human endeavours, operations and services of industries and institutions including libraries (Aharony, 2014). Arguably, the advent of the internet is the most important and influential development in ICT. The internet now has a distinctive influence in various aspects of human life including relationships, interactions, manufacturing and services.

Apart from providing a veritable platform for the 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. In this regard, the advent of mobile devices and social media has made internet use a part of life for a good number of the world's population. The availability of broadband internet connection, more devices with Wi-Fi capabilities, affordability at lower cost and proliferation of smart phones have also contributed to the growth of the internet. For libraries, the internet now makes it possible for electronic packaging and virtual acquisition of information resources, online reference services, electronic cataloguing, as well as online dissemination of required information resources among others.

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

The current rapidly changing digital environment has enforced the libraries to adopt the new technology. Considering the trends in the digital environment the librarians must start thinking about the development of new skills and assume the new roles support technology-based services. Hence, the librarian must have the knowledge and skill of accessing and should be able to assist the users in digital information. Technology has created an impact on every aspect of library work. These new trends and development in the ICT have enabled the librarians to rethink on their goals of providing excellent information services to the users. . That is to say, the current form of information technology has made this a reality. Instead of keeping a record of how many users are coming to the library nowadays, it is being considered how much of the library's resources are being used as this work is being done very accurately with time, energy, and money savings.

Despite its enormous potential, IoT implementation in libraries faces challenges including high installation costs, cybersecurity concerns, inadequate infrastructure and shortage of technical expertise. Addressing these issues requires strategic investment, institutional commitment and continuous professional development. This paper examines the concept of IoT, its evolution, applications in libraries, benefits, implementation challenges and future prospects for smart library services.

Concept of IoT

As with many concepts in ICT, there is no one definition for IoT; it means different things to different people. However, one major convergence of all descriptions of IoT is that it requires very minimal or no human intervention. Whatis (2015) describes it as "a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-computer interaction; it is an evolvement of the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the internet". The Internet of Things (IoT) is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human interaction." (TechTarget 2018) . Pujar and Satyanarayana (2015) considers IoT as a system that enables any natural or man-made object to communicate with each other and transfer data using assigned internet protocol (IP) address with or without human intervention. Sharma (2015) observed that IoT requires a set of technologies to promote connectivity and interaction among objects. Each object requires a unique identification, sensors, internet and central server among others.

Other authors posit that the basic set of technologies needed for IoT to happen include Radio Frequency Identification Device (RFID), wireless communication devices (such as Beacons), sensors, energy harvesting technologies, cloud computing and advanced internet protocol (IPv6). The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals, or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Advantages of IoT:

There are many advantages of IoT which is given below

- Better tracking and management -Whatever the institution is, IoT makes tracking and management a breeze for organizations. it is now also about smart offices, smart warehouses, and smart anything else.
- Efficient resource utilization -Electric Devices are directly connected and communicate with a controller computer, such as a cell phone, resulting in efficient electricity use. As a result, there will be no unnecessary use of electrical equipment.
- Automation and control -IoT devices are connected with each other through a wireless infrastructure, they are able to operate on their own with little or no manual intervention. It is useful for safety because it senses any potential danger and warns users.
- Comfort and convenience -Personal assistance can be provided by IoT apps, which can alert you to your regular plans.
- Saves time and money - By automating activities, it saves us a lot of time and money.
- Reducing human labor - Internet of Things devices performs a variety of functions without the need for human intervention, thus greatly reducing human labor.
- Better customer service - You no longer need to ask anyone because they will automatically inform you through their mobile app or website. So, whenever anything happens, you will always be informed.
- Improve security - It enhances security and offers personal protection in the comparison of humans.

Other benefits include;

- Improves operational efficiency by automating routine library processes.
- Enhances accuracy in inventory management and resource tracking.
- Strengthens library security through real-time monitoring and theft detection.
- Reduces waiting time and improves users' access to library services.
- Supports evidence-based decision-making through real-time data collection.
- Promotes better utilization of library resources and staff productivity.
- Improves user satisfaction through personalized and remote services.
- Facilitates smart library environments that support teaching, learning and research.

Overall, IoT enables libraries to provide faster, smarter and more user-centred services. Its application contributes to improved resource management, efficient service delivery and better learning experiences for library users.

Challenges of Internet of Things (IoT) Adoption in Libraries

- Privacy and Security: One of the major concerns associated with IoT adoption in libraries is the protection of users' personal information and institutional data. Since IoT devices continuously collect and transmit information through interconnected networks, they may become targets for cyberattacks, unauthorized access and data breaches. Libraries must therefore establish appropriate security policies, encryption mechanisms and access controls to safeguard sensitive information.
- High Implementation Cost: The deployment of IoT infrastructure requires substantial financial investment in RFID tags, sensors, wireless communication devices, servers, software, internet connectivity and system maintenance. For many libraries, particularly those in developing countries, inadequate funding remains a significant barrier to successful implementation.
- Inadequate ICT Infrastructure: Reliable internet connectivity, stable electricity supply and modern information technology infrastructure are essential for effective IoT implementation. Libraries with outdated equipment or poor network facilities may experience difficulties in deploying and maintaining IoT-enabled services.
- Shortage of Skilled Personnel: The successful operation of IoT systems requires librarians and information professionals with knowledge of networking, database management, RFID technologies and digital systems. The shortage of technically skilled personnel may hinder effective adoption and management of IoT applications.
- Lack of Standards and Interoperability: IoT devices are often produced by different manufacturers using different communication protocols. The absence of universally accepted standards may create compatibility problems between devices and software systems, thereby limiting seamless integration within library environments.
- User Acceptance: Some library users and staff may initially resist IoT technologies due to privacy concerns, fear of technological change or inadequate digital literacy. Continuous awareness programmes and user education are necessary to encourage acceptance and effective utilization of IoT services.

Internet of Things; Libraries Perspective, Application and Implementation

As library is a complex organization which has embedded constituents linked together and a large number of interactions take place be it with man to man or man to machine,machine to man, and with IoT object with object interaction has a great possibility. Libraries can have some futuristic applications. These applications are probable, but with supporting technologies associated with IoT these can to put in action. Some of the potential applications for libraries are:

• **Inventory Control:** Apart from books, journals, magazines, various other library sources such as microfiche, video, audio, etc., can also be controlled by applying sensors on them. With IoT, the movements of each item can be tracked. Though RFID already serves bit of the same purpose for books, but with IoT since internet is involved, so it provides all the real time data on mobile of the

librarian/manager and hence better inventory control is possible and ultimately the library personnel require to do less work for stock verification.

- **Theft Management:** With tags on each item of the library inventory (scanners, printers, hard disk, CDs, etc.), a kind of tracking can be made all-time. To prevent theft the library gate can be enabled with high-end sensors and transponders, which apart from signaling the authorities on their mobiles or by loud alarm, can alsonblock the theft with taking the automatic prompt action like shutting the door, etc.Another application can be that it lets the library staff remotely see camera views of theirnhomes, send a warning when something isn't right and they can approach the emergency service people to take action.
- **Circulation Desk:** Circulation desk in libraries involves activities such as issue and return of books and other library material, maintain records, creation and updation of library cards, overdue, reminders, etc. RFID technology helped to ease out some of these activities like issue and return. But with IoT, online connectivity can be provided through mobile apps to the users, which can automate rest of the circulation jobs such as records' maintenance, creation and updation of library cards, overdue, reminder. With IoT, the users need not stand in the queues on circulation desk, can check for the books overdue on his/her mobile. Also if someone has demanded any book which is already issued, when the book is returned then with IoT an automated message will be received by the demanding user. In case of ebooks, the required book will be issued automatically. So IoT will help not only save efforts of the staff but also will save the time of the users. Also if someone comes at circulation desk then without any library manpower present at the circulation desk, the sensors at the desk can sense a library user who requires assistance. The computers at the desk can provide options for his/her preferences/needs and take action accordingly.
- **User Identification:** The sensors at the library gate can do face recognition of all visitors and will match the face with the available databases and then the gate will allow only the authorized users to enter. Otherwise an electronic message will be sent to the librarian in charge who can be any where and at anytime. The librarian incharge can take action from distance whether to open the door for the unknown face or not.
- **Reservation of Books:** One potential use of the IoT can be that the patron can search the desired book from the OPAC of the library available on internet through his smart phone and reserve the book through smart phone. Then the desired book, available in the shelf of the library, which is enabled with sensors through network can show its presence through a beep or may start flashing light. This way the book itself will identify its location. Then there won't be any need to physically search the book on the shelves of the library. Then the librarian can easily identify the required books and then can issue them to the patrons. This way the IoT will help in saving the manpower and time of both the librarians and the users.
- **Fire Detection and Prevention:** Suppose ther is fire in the library and there is no one to notice it. The fire detection devices may alarm and sensors in the library with the associated networks will authomatically send the message to the Fire Department. And not obnly this but the concerned person of the library (say Fire Officer) who could be available any where and is responsible for taking action can also receive a message. This way IoT will help in taking action automatically at early stage and prevent further damages.

- **Mobile Reference:** Since IoT allows each and every activity of the library to be connected to the internet. So, with just a single app on mobile, one can refer the library without even physically being present there.
- **Tracking movement of Resources and Inventory:** With IoT, users can be categorized based on the criteria for accessing library resources. As some libraries offer different accessing rights to faculties, students, staff, regular and non-regular students, etc. Suppose in case a book/magazine is wrongly issued to a non-authorised user. With IoT, the tracking is possible on mobile of the librarian that where the library resource is physically present (inside or outside) the library. Many times the library items are sent outside the library for repair, etc. With IoT, it is possible to track the location of the inventory outside the library.
- **Assistive Technology:** Today smart phone are also providing the features such as text to speech, touch navigation, hands free operations, especially for the person with disabilities. IoT adopts this feature of the mobile phones and provides services to such library users. With IoT such persons can request the required resource (say book, which will have tag) with speech and once they want the resource physically, they can find directions to that book in the library by voice communication in the mobile.
- **Virtual Library and Book Tracking:** IoT through the mobile apps will allow its users to not only have the virtual tour of the library on their mobile devices, but also keep and track the availability of the book on the respective shelves or check the other resource availability despite the location wherever they are.

Future Directions of Internet of Things (IoT) in Libraries

As digital transformation continues to reshape information services, the future of IoT in libraries appears promising. Emerging technologies such as artificial intelligence (AI), machine learning, cloud computing, big data analytics and blockchain are expected to complement IoT applications and create more intelligent library environments. Smart libraries of the future will increasingly rely on predictive analytics to understand users' information needs, automate resource management and support evidence-based decision-making.

Future IoT applications are expected to include fully automated circulation systems, intelligent recommendation services, smart study spaces, energy-efficient library buildings, advanced environmental monitoring, and improved accessibility services for persons with disabilities. Integration with mobile technologies will further enable users to interact with library services anytime and from any location.

To realize these opportunities, governments, educational institutions and library management should invest in ICT infrastructure, strengthen cybersecurity measures, develop institutional policies for IoT implementation and provide continuous professional development programmes for librarians. Collaboration among librarians, information technology professionals and system developers will also be essential for sustainable adoption of IoT technologies.

Conclusion

The Internet of Things (IoT) has emerged as a transformative technology with the potential to redefine modern library operations and service delivery. By integrating technologies such as RFID,

sensors, cloud computing, and wireless communication, libraries can improve inventory management, automate circulation services, strengthen security, enhance resource tracking, and provide more responsive, user-centred services. These developments support the evolution of libraries into smart learning environments capable of meeting the changing information needs of their users. Despite these benefits, successful IoT adoption requires adequate technological infrastructure, sustainable funding, effective cybersecurity measures, institutional commitment, and continuous professional development for librarians. Addressing challenges such as privacy concerns, interoperability, implementation costs, and technical expertise will be essential for realizing the full potential of IoT in libraries. As digital transformation continues, libraries that strategically adopt IoT technologies will be better positioned to improve operational efficiency, support research and learning, and remain relevant in the knowledge society.

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