IMPLICATION OF IOT AND ITS IMPACT ON LIBRARY SERVICES: AN OVERVIEW

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Abstract

All facets of our lives and activities have been significantly impacted by the introduction of clever new technology, smart mobile connections, and online services. The world around us is also greatly impacted by this development. In the modern world, libraries and library services are very influential. The current study's objective is to investigate how Internet of Things, a novel technology, is used in libraries and educational facilities. Librarians should be aware of the various features of IOT in libraries and services since new technologies have raised user expectations from library services. They should also receive training on user behavior and IOT security concerns in libraries. Libraries and their services will continue to be impacted by the IOT in a variety of ways, including construction, collection management, instruction, data security, information literacy, and more. This study also aims to familiarize readers with emerging IOT technologies that libraries might employ to enhance user satisfaction and provide better services.

Keywords: Internet of Things (IoT), Library services, Emerging Technologies, Library Technology

Introduction

The Massachusetts Institute of Technology's (MIT) Auto-ID Labs first introduced the idea for the Internet of Things in the early 1990s (Khanna & Kaur, 2020). The first IoT application was the Trojan Room coffee maker, which led to the creation of the term IoT. The phrase "Internet of Things," commonly referred to as "IoT," is composed of two essential words: "Internet" and "Things," where "Things" refers to intelligent machines or objects. An IoT ecosystem is made up of web-enabled smart devices that collect data, send it, and take action on it utilizing hardware like CPUs, sensors, and communication networks (Laghari et al., 2021). The majority of libraries still struggle to sustain a constant flow of information in a real-time system, despite the fact that several ICT technologies have paved the way for this process. This knowledge gap has been closed because to the expansion of the electronic collection, which has made content accessible on a number of different platforms, including the internet. The Internet of Things is a brand-new idea that has already shown to be a very successful cutting-edge technology in the commercial sector in terms of user happiness, such as smart equipment like air conditioners that can be accessed and managed remotely (Asif et al., 2019; Iqbal et al., 2023; Khan et al., 2023; Mumtaz et al., 2023; Sinha & Brar, 2024).

In order to maintain a relevant presence in modern society and integrate a lot of technological innovation, libraries had to adapt. The transition from the Internet of Communication to the Internet of Things, or IoT, is one of the most significant later transitions in innovation. By adding sensors to common objects that aren't computers themselves, this fascinating and evolving breakthrough makes it possible to use them. In order to maintain a relevant presence in modern society and integrate a lot of technological innovation, libraries had to adapt. The transition from the Internet of Communication to the Internet of Things, or IoT, is

one of the most significant later transitions in innovation (Mondal et al., 2021).

Scope of the study

The scope of the study is to determine the implication of the IoT and its impact on libraries. In a technology-enabled environment, information saturation is a common issue. IoT facilitates users with relevant information ubiquitously in real-time. IoT creates an autonomous network of objects in which identification and service integration has an important role. IoT in the best possible way can make resources available to the user and reduce the burden of library staff involved in circulation. IoT creates self-potential, independent and information awaken users, as users are aware not just to use technology but also become an active part of it. The study would attempt to understand the behavior of the students, perception towards usage, factors influencing in implementation of IoT, and the prominent challenges in its execution.

Objectives of the Study

The study has been conducted on the basis of following objectives.
1) To understand the fundamentals of IoT.
2) To understand the importance of IoT in libraries.
3) To determine the potential IoT-enabled library services.
4) To be aware of IoT's benefits.

Literature Review

Muhamad and Darwesh (2020) designed a model based on IoT and RFID technology to improvise library services and deliver better services in different sections of libraries. They classified their reference services according to different sections i.e., shelving reference, where if book placed on shelf green light gets turned on the other-wise red light will glow, the system can also generate theft alarm, time management at circulation section, provide GSM (Global System for Mobile) navigation to keep track of the due date and user privacy. Devi, Mirudhula, and Devi, 2021 proposed and designed advanced library management system using RFID technology for book circulation and reduce manpower. Maepa and Moeti (2021) tried to develop an IoT-based smart library seat occupancy and reservation (IoT-SLSOR) prototype, using the RFID and Force Sensitive Resistor (FSR) technologies at Tshwane University of Technology. The web application enables users to monitor occupancy at their mobile phone anytime. User can reserve their seat through login and differentiated through colors like unoccupied seats are presented by a green color, undefined seat by a grey color, reserved seats by an orange color, and occupied seats by a red color. IoT and libraries have a fair relationship in terms of heterogeneous systems and interoperability, they are indirectly correlated to manage various systems and operations. The IOT system connects readers and books, providing users with a comprehensive set of reader services. The IoT can provide intelligent management, reader behavior analysis, intelligent self-borrowing and returning books and materials, long-term preservation, and other conveniences for the smart library, which helps with intelligent library management (Khan & Ullah, 2024; Wang et al., 2021). IoT-enabled libraries could aid in the efficient management of library infrastructure in a variety of ways (Rahman & Islam, 2019) provided examples such as automatic book renewal, a penalty for excessive resource use, and book tagging using borrowers' fingerprints.

Khan et al. (2024) and Qin, Li, and She (2018) investigated potential library services based on IoT technology. The author developed a theoretical model to compare and validate the commercial and library applications 34 Digital Librarianship and Social Media of IoT. According to the findings, IoT technology could be useful in library curating, characterizing, maintaining, analyzing, and selecting collections, as well

as marketing and promotion. They anticipated that library services would include book tracking, self-guided tours, special collections exhibit, and directory information.

Methodology

The Internet of Things (IoT) is opening up new opportunities for library and information science professionals. For this study, data was collected and compiled from websites, blogs, and a few reputable journals. This study relies solely on information found online; no actual observations were made. As a result, this study does not provide all relevant, comprehensive information about IoT.

IoT implication and its impact in Library services

As a complex structure with integrated components that are linked together, libraries experience a large number of interactions, whether they are between people or machines, or between people and IoT objects. Applications for libraries in the future are possible. These applications are likely, but thanks to IoT-related enabling technologies, some of the possible ones for libraries can be put into practice.

Figure No. 1
IoT and Libraries, (Khan, et al. 2022)
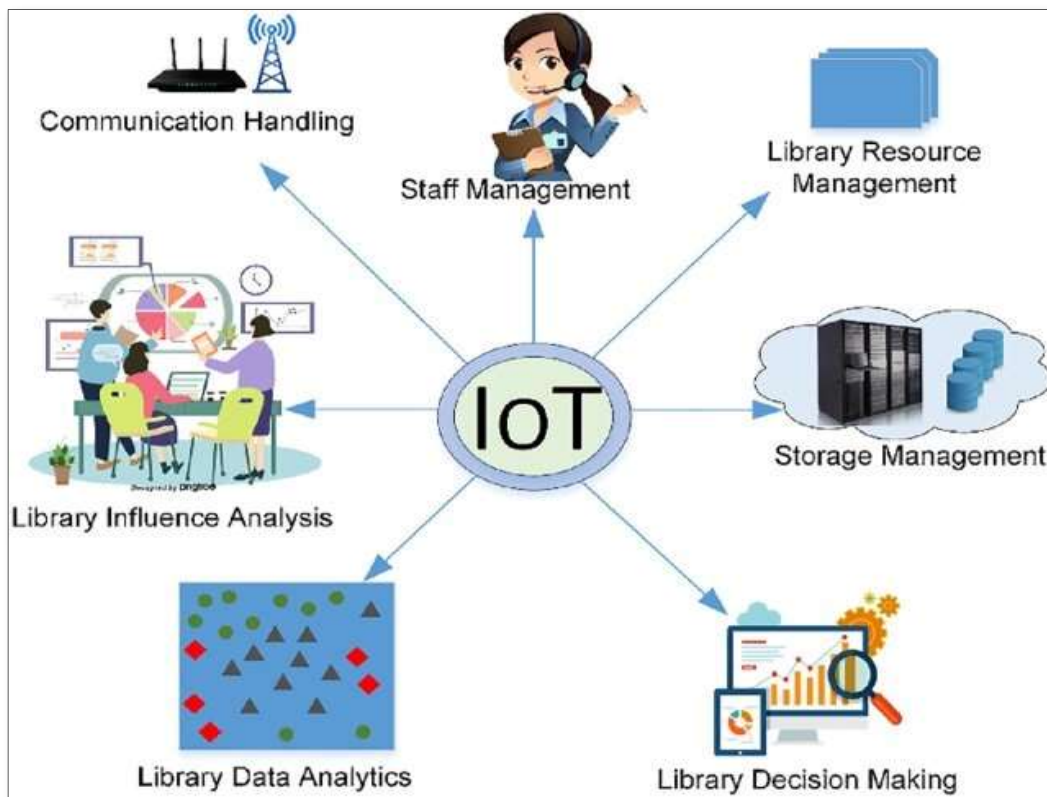
Inventory management

In addition to books, journals, and magazines, a variety of other library resources, including microfiche, video, audio, etc., can also be managed by attaching sensors to them. Every item's motions will be monitored thanks to IoT. Although RFID already somewhat serves the same purpose for books, with IoT because internet is involved, it provides all the important time data on the librarian's or manager's mobile

device, making better internal control possible and ultimately requiring less work from the library staff for stock verification (Bansal, Arora, & Suri, 2018).

Improved access to resources and collections

RFID technology might be installed on all library shelves thanks to the Internet of Things, enabling users to locate books fast. Customers might then be taken directly there via a specialized application.

RFID tags and QR codes

Of course, there are also the actual books. By equipping it with an RFID tag, it might be pretty simple to transform a printed book into a connected device. Select information, such as whether the book is accessible or being tested, might be wirelessly communicated via the tag. While waiting, readers who were looking for a new book to read might scan the QR code of their favorite book to get recommendations for books they might also like (Clark & Tilman, 2017).

Collection management

Sensors are applied to library materials to control them. It is possible to follow every item's motions by connecting the sensor to the internet. Real-time data will be provided, improving internal control and making it easier for customers to find what they're looking for. On mobile smartphones, a specialized app might be used to accomplish this.

Protecting rare collections

By monitoring and managing the conditions in which they are stored, larger or more specialized libraries might use the IoT to help conserve their unique collections. In order to protect the priceless artefacts within, humidity, temperature, and lightweight sensors might assess the conditions in rare book rooms in real time and remotely modify them in accordance with predetermined restrictions (Clark, 2017; Ullah et al., 2023).

Advisory & Notification Service

Through Wi-Fi or Bluetooth, smart phones might be found inside the library and used to send patrons specific communications. If a patron has a fine due to the library, for instance, the IoT embedded in their identity card will alert them as soon as they enter the institution. Customers are sent to the payment page using this notification's link. Even while a patron is browsing the fiction aisle of the library, IoT may be used to send them a notification about a new fiction book.

Placement-based services and mobile technology

In order to improve space design or better identify popular library locations, track IoT devices to see visitor traffic patterns. Customers might use sensors on their phones to connect to sensors and receive alerts when goods on their favorite list are nearby. This information could aid in personnel optimization, understanding genre trends, and opportunity spotting.

Mobile reference

Since IoT makes it possible for every single library activity to be connected to the internet. So, without even physically being there, one can reference the library using just one smartphone app (Bansal, Arora, & Suri, 2018; Ullah et al., 2024).

### Using IoT to track the movement of resources and inventory

Users can be classed based on how well they adhere to the rules for using library resources. Because some libraries grant varied access privileges to staff, regular and non-regular students, faculty, and other groups, etc. Consider the possibility that a book or magazine was accidentally issued to an unauthorized user. With IoT, a librarian can track where a library resource is physically located (within or outside the library

premises) using a mobile device. The library's materials are frequently taken outside for repair and maintenance purposes and for some other administrative purposes. IoT makes it feasible to monitor the inventory's status outside of the library premises (Asif & Sandhu, 2023; Bansal, Arora, & Suri, 2018).

Figure No. 2

IoT and Application Layer (Khan, et al. 2022)
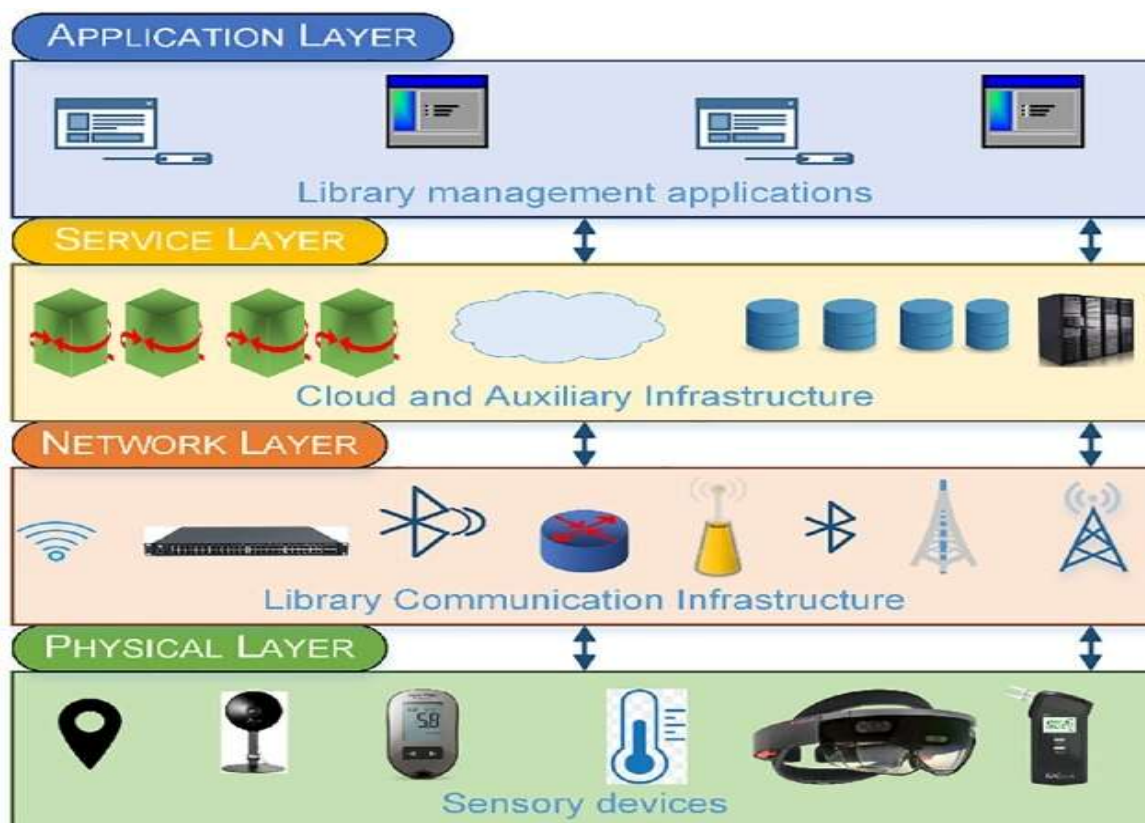
Tracking books and virtual libraries

Through IoT, mobile apps will enable users to do more than just take a virtual tour of the library on their mobile devices. They will also be able to maintain tabs on the availability of the books on the appropriate shelves or verify the availability of the opposite resource regardless of where they are (Bansal, Arora, & Suri, 2018).

Safety

Installing internet-connected fire sensors will allow for faster, safer response to tragic fires outside the library. Detecting and preventing fires imagine there is a fire inside the library but no one is there to report it. The sensors inside the library with the connected networks will immediately transmit the message to the fireplace department if the fireplace detection devices alarm. Additionally, the concerned library staff member (let's say the fire officer), who may be anywhere and is responsible for taking action, can also get a message. IoT in this way will assist in automatically acting at an early stage and preventing additional damage. (Bansal, Arora, & Suri, 2018).

Theft or Lost Management

Every item in the library inventory (including scanners, printers, hard drives, CDs, etc.) has tags, enabling continuous tracking. The library gate will be equipped with cutting-edge sensors and transponders to prevent theft, which in addition to alerting the appropriate authorities via their mobile devices or by loud alarm, can even prevent the theft by taking the automatic immediate action, such as closing the door, etc. Another use is that it enables library staff to remotely check their houses' security camera feeds, issue an alert when something is wrong, and interact with emergency response personnel to request action (Mondal, 2021; Bansal, Arora, & Suri, 2018).

Cost Savings & Appliances Monitoring

Cost saving & Appliances Monitoring either by installing a smart energy system, where energy consumption is frequently managed in accordance with need, or by employing smart lighting, which is controlled by the internet to sense when to have lights on or off.

Drones

There are still ramifications for libraries in this situation, which Amazon is already testing. It would become quite simple to recommend items to clients who are housebound or who reside in far-flung service locations.

Automatically Survey Patrons

When a patron leaves the library, IoT sensors can detect their departure and instantly send them a survey. To determine whether the customer was pleased with their experience, data may be gathered.

Direct patrons to special displays, programs and events

In addition to storing books, most libraries host educational programs for children, teenagers, and adults as well as activities like book discussions and storytelling. The library has beacons installed, making it easy to access information about these events and unique exhibits (Lapointe & Fishbane, 2019).

Information literacy

New users can take advantage of information literacy or orientation to learn more about the library, its resources, and its services. IoT could assist libraries in offering self-guided virtual tours of their facilities. When visitors enter a specific section of a library where beacon-like wireless devices have been installed, their mobile device will start playing a video or audio teaching more about that section and how to get the most out of it. Due to the limited physical access to such materials, it will even be able to give users an enhanced experience of exceptional collections like manuscripts by making them available to them in digital format on their mobile devices (Potter, 2014).

Beneficial Technology

Especially for those with disabilities, modern smartphones offer capabilities like text-to-speech, touch navigation, and hands-free operation. IoT uses this mobile phone function and offers services to these library patrons. When people require the resource physically, they can use IoT to speak a request for a specific resource (like a book with a tag) and then use their mobile device's voice search to locate directions to the library (Bansal, Arora, & Suri, 2018).

Community activities supported your interests

Other advantages that beacon technology might provide to library users. Like alerting people to events, workshops, classes, or deals that support their interests; Not only does this showcase the wide range of services available, but it could also assist newcomers to the community in connecting with others who have similar interests. Visitors can receive location-triggered information about library specials and events via the iBeacon app, for instance. Therefore, someone perusing the horror section might be informed about a Halloween-

themed book reading the next weekend in the library. A notice about an upcoming cooking demonstration can be sent to someone who spends a lot of time in the kitchen department (Clark, 2017).

Findings and Discussion

The reviewed literature highlights the potential of IoT and RFID technologies in enhancing library services through intelligent automation and user-centered designs. For instance, Muhamad & Darwesh (2020) implemented IoT-based library systems integrating GSM navigation for due-date tracking and theft alarms, showcasing how technology can improve efficiency and security. Similarly, Devi, Mirudhula & Devi (2021) emphasized reducing manpower with RFID-enabled book circulation systems, demonstrating a practical approach to streamlining operations.

Maepa & Moeti (2021) innovatively utilized IoT-SLSOR for seat occupancy and reservation, reflecting the growing demand for user convenience through real-time occupancy tracking. Other studies, such as Khan and Ullah (2024) and Wang et al. (2021), corroborated the multi-functionality of IoT in libraries, including self-borrowing systems, preservation, and reader behavior analysis. Finally, Rahman & Islam (2019) and Qin, Li, & She (2018) outlined automated renewals and collection curation, affirming IoT's role in creating smart, adaptive libraries.

The study underscores the transformative potential of the Internet of Things (IoT) in modernizing library services, highlighting its multifaceted applications. IoT integration enables efficient management of library operations, including real-time inventory tracking, resource monitoring, and user navigation through technologies like RFID and QR codes. These innovations not only streamline administrative workflows but also reduce the workload on library staff. IoT enhances accessibility and user engagement by offering features such as automated seat reservation systems, virtual library tours, and personalized notifications for events, book availability, and overdue reminders. Moreover, IoT contributes to the preservation of rare collections by enabling real-time environmental monitoring and control, ensuring optimal storage conditions. Security is another critical area where IoT proves beneficial, with advanced theft detection and prevention mechanisms safeguarding library resources. Operational efficiencies are also achieved through smart energy management systems and automated services, resulting in cost savings and resource optimization.

However, the study identifies challenges in IoT adoption, including the need for significant infrastructure investment, technical expertise, and robust security frameworks to protect user data and privacy. Furthermore, the increasing role of users as active participants in IoT ecosystems highlights the necessity for libraries to align their services with evolving user expectations and technological trends. Together, these findings demonstrate the transformative impact of IoT on libraries while emphasizing the importance of addressing associated challenges for successful implementation.

However, in today's world of libraries there are significant service challenges. Some challenges are associated with information resource management which is defined as direct accessibility of data needed for quick decision making. Impact of IoT and implantations of IoT in the libraries are very beneficiary.

Conclusion

The integration of IoT into library services signifies a paradigm shift in the functionality and relevance of libraries in the digital era. By leveraging IoT technologies, libraries can transform into dynamic, user-focused hubs that offer seamless access to resources, personalized services, and optimized operations. The potential for enhanced resource preservation, operational efficiency, and user engagement underscores IoT's value in modern library ecosystems. However, successful implementation requires addressing challenges related to cost, security, and infrastructure.

Recommendations

To effectively integrate the Internet of Things (IoT) into library services, a strategic and phased approach is essential. Libraries should begin by identifying priority areas such as inventory management, resource tracking, and user-centric features like automated notifications and navigation systems. Conducting feasibility studies and pilot projects can help assess the potential impact and identify practical implementation strategies. Comprehensive training programs for library staff are crucial to developing the technical expertise required to manage IoT systems effectively. Similarly, user workshops and orientation sessions can familiarize patrons with IoT-enabled services, enhancing their engagement and satisfaction. Addressing security concerns is paramount; libraries must adopt robust data protection measures, including encryption protocols, regular audits, and compliance with privacy regulations to safeguard user information. Collaborative partnerships with technology providers, academic institutions, and stakeholders can mitigate cost challenges, provide ongoing technical support, and foster innovation tailored to library needs. Additionally, establishing performance metrics and conducting regular evaluations will enable libraries to measure the success of IoT integration and make informed adjustments based on technological advancements and user feedback. By adopting these recommendations, libraries can unlock the full potential of IoT, transforming their services to meet the demands of the digital age while ensuring sustainability and user trust.

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