

Internet of Things for the Sustainable Library Development in the Digital World

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More than at any other time in history, sustainable library growth is essential to providing education and research. One of the key pillars of sustainable library development is the use of ICT and research skills to promote library expansion. The adoption of new technology enhances delivery of library services. Library information activities are changing rapidly due to the advent of new technologies. External elements such as developing ICT infrastructure, online, social networking, and mobile technologies, as well as legal concerns such as digital rights management (DRM), have been used to build digital information systems and services. The Internet of Things (IoT) is one of the key developments we can see in the library; the Internet of Things (IoT) is believed to impact how we live significantly. Objects in the Internet of Things could be people, animals, or physical objects like cars. The objects could communicate with one another, connect to the Internet, and communicate with people. IoT applications and sensors will inevitably be implemented in our daily lives. Every day, more systems and linked devices call for their use, enhancing quality of life, health, and safety, among many other uses.

Introduction

The Internet has played a unique role in many aspects of human life. This has been possible because to the rising availability of low-cost broadband Internet connections, more devices with Wi-Fi capabilities, lower-cost technological affordability, and the widespread usage of smartphones. We can currently access a wide variety of services due to the latest technology advancements, such as accessing information, shopping, booking tickets, navigating maps, and interacting via email, social media, and mobile applications. As a result, Internet usage for communication and accessing various services via smartphones has increased. However, the next revolution will occur when the Internet, like smartphones, connects things in the physical world, which is predicted to have a massive effect on how we end up living.

2. Sustainable Library Development

The library has always been and will remain to be the foundation upon which the advancement of tertiary education is developed. More than at any other moment in history, sustainable library growth is essential to the ongoing process of providing excellent education and conducting empirical research. Universities and organizations worldwide, including the United Nations, World Bank, and the World Trade Organization, have made sustainable library development one of their top policy priorities. Guaranteeing the growth of the library through time is a part of sustainable library development. The relationship between research abilities and ICT implementations as the primary tools for achieving sustainable library growth has been acknowledged in numerous literary works in the present era.

One of the foundational principles of sustainable ICT implementation is using ICT and research skills to support the growing needs of libraries and librarians. Sustainable development is growth that satisfies current needs without affecting future generations' capacity to meet their own (World Commission on Environment and Development, 1987). It is the guiding process for ensuring that the goals of human progress are met. At the same time, it protects the natural resource potential that supports the economy and society.

3. ICT Application and Sustainable Development in Librarianship

ICT plays a significant role in library operations. The delivery of library services is made simpler by the advent of new technologies, causing information activities to change dramatically and quickly from traditional techniques. According to Vijayakumar and Vijayan (2011), Word processors, text formatting, text categorization, voice recognition, electronic publishing, storage and backup, multimedia, electronic data processing, artificial intelligence, database management system, information retrieval both ways off-line and online, electronic mail, and online document delivery are some of the ways that ICT has benefited libraries. ICT facilitates accurate categorization, indexing, bibliographic assemblage, and abstracting.

To guarantee that users with complicated demands are satisfied, ICT enables quick transmission speeds and simple access to information resources. ICT reduces the time-consuming barrier of distance, ensuring that the appropriate information reaches the right reader at the right time. ICT encourages comprehensive coordination and the expansion of library networks, assists in the reduction of duplication of work inside a library, enhances the services offered, improves productivity, and elevates the quality of library services.

External elements such as establishing ICT infrastructure, online, social networking, and mobile technologies, as well as legal concerns such as intellectual property rights (IPR), digital rights management (DRM), and so on, all support the development of digital information systems and services. These elements, which frequently play a significant part in every field of sustainability, frequently influence the sustainable development of digital information systems and services.

4. The Concept of Internet of Things (IoT)

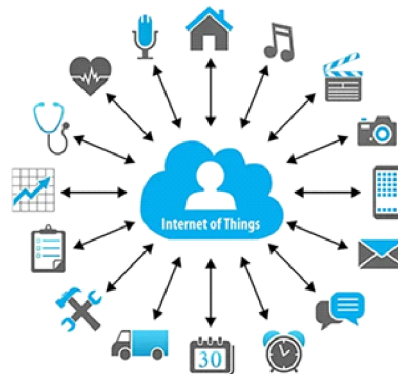


Figure 1: Overview of IoT

Source: <https://justcreative.com/internet-of-things-explained/>

Kevin Ashton first proposed the IoT concept in 1999 and referred to the IoT as uniquely identifiable incompatible connected objects with radio-frequency identification (RFID) technology. However, the exact definition of IoT is still in the forming process created by considering all aspects and perspectives related to IoT. IoT was generally defined as a “dynamic global network infrastructure with self-configuring capabilities based on standards and incompatible communication protocols; physical and virtual ‘things’ in an IoT have identities and attributes and are capable of using intelligent interfaces and being integrated as an information network.”

The Internet of Things, or IoT, refers to the billions of physical devices worldwide connected to the Internet, all collecting and sharing data. According to Techopedia, “The Internet of Things is a computing concept that describes a future where everyday physical objects will be connected to the Internet and be able to identify themselves to other devices.”

The Internet of Things describes a scenario in which objects, animals, or people are given unique identifiers and the ability to exchange information without needing human-to-human or human-to-computer interaction. The Internet of Things (IoT) arises as a consequence of the integration of wireless technologies, micro-electromechanical systems (MEMS), and the Internet. In other words, the Internet of Things allows any natural or artificial device to interact and transmit information using predefined IP addresses, with or without human assistance. The Internet of Things is trying to make the world around us more capable and responsive by combining the physical and virtual worlds.

5. Internet of Things (IoT) Work System

An IoT ecosystem consists of web-centric smart devices that gather, transmit, and process data from their surroundings using embedded systems such as processors, sensors, and communication equipment. IoT devices share sensor data obtained from the IoT gateway or any other external devices, and the data is either forwarded to the cloud for analysis or accessed locally. These devices occasionally connect with other linked devices and work on the information they obtain from one another. The devices mainly function without human intervention. However, people can interact with them at first to set them up, give them instructions, or check the data.

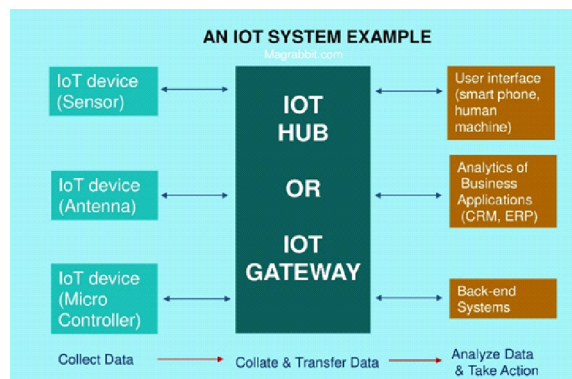


Figure 2: Overview of IoT Work System

Source: <https://www.magrabit.com/news/magrabit-news/internet-of-things>

The unique IoT applications heavily influence these web-centric devices' connection, networking, and communication protocols. IoT may use artificial intelligence (AI) techniques and machine learning to make data collecting more responsive and flexible.

6. Services of Internet of Things (IoT)

6.1 Smart Home

To provide optimum security and convenience, it is the most searched IoT-related feature on Google; smart home systems and gadgets are meant to save valuable time and energy. With a few taps on a smartphone, we can manage everything from the house's temperature to the lights.

6.2 Wearables

Wearable technology is a trademark of IoT applications, and healthcare is likely one of the first areas to use the IoT. As a result, Fitbits, heart rate monitors, and smartwatches are becoming more popular.

6.3 Smart Cities

Many nations, including South Korea, Japan, Spain, and the United Kingdom, are attempting to colonise smart cities by creating better, safer, and healthier living conditions. By gathering data from citizens, a smart city promises to tackle key problems faced by people living in traditional cities, such as water distribution, pollution, crime, traffic congestion, waste management, and so on.

6.4 Transportation and Automotive

Automotive firms such as BMW, Ford, Tesla, and Volvo are experimenting with the Internet of Things technologies to improve the in-car experience. They are releasing autonomous automobiles, which are outfitted with sensors, maps, computer vision, sonar, and the Internet and can run with little or no human help.

6.5 Medical and Healthcare

IoT technology is also being used in the medical business to enhance medical facilities. IoT-powered gadgets are used in the medical business for remote health monitoring and emergency warnings. Doctors can remotely monitor patients' health outside of traditional clinical settings and prescribe medications depending on data obtained.

6.6 Agriculture

Farmers may employ clever IoT farming applications to optimize time-consuming farm activities. It will provide farmers with an opportunity to transform the farming business. Farmers may use IoT to help them determine the best time to harvest crops, create soil chemistry-based fertilizer profiles, and monitor soil nutrient and moisture concentrations.

6.7 Retail

The retail industry may benefit from the internet of things technology in terms of cost reductions, efficiency, and innovation. Retail IoT may assist in a variety of functions, including improving customer experience, accurate and real-time product tracking, improving and planning staff strategy, and overall effective inventory management.

Retailers may also track client shopping habits, such as purchase history, trends, and geographical information, in order to develop better and more successful consumer strategies.

6.8 Energy & Utilities

Environmental variables such as humidity, temperature, and illumination may be monitored with IoT sensors. The data produced by IoT sensors may be used to construct algorithms that balance energy use and make the necessary changes, therefore removing the human equation.

6.9 Traffic Management

The Internet of Things (IoT) aids traffic control in major cities. It assists us in updating the data of many routes to the same destination, distance, and projected arrival time. IoT technology enables us to use our smartphones as sensors to collect and share data from automobiles via apps such as Waze or Google Maps.

6.10 Water/Waste Management

Water recycling systems are being used in several places throughout the world. IoT applications demonstrate how much water is being waste, how much is absorbed in each region, and how waste production is managed over time.

7. IoT Technologies in Libraries

All IT innovations have had a significant impact on libraries. IT resources such as hardware, software applications, communication networks, and electronic information sources have always been advantageous in providing improved library services and greater access to the user population. Libraries, as information providers, may influence user culture by changing information collecting practices, enhancing resource availability, and assisting users in accessing resources through communication and training activities.

New IT ideas like digital transformation, cloud computing, and the Internet of Things have been introduced (IoT). Because this has influenced the entire world, libraries have benefited as well. These IT concepts make technology more accessible and often at a lesser cost, so libraries may save significant money on their IT budget by using these innovative techniques. Furthermore, these techniques benefit consumers by allowing them to deliver various services in real-time.

Although IoT is still in its early stages of development, it has a bright future. Libraries may add more value to their services and provide their clients with a great library experience. The Internet of Things is about connecting individually identifiable items over the Internet. Because libraries have previously incorporated RFID technology, librarians are already familiar with this. RFID also interacts with equipment and tags and updates the library management system. The main difference with IoT technology is that the Internet interacts with a thing or object in the library, such as books, journals, CDs/DVDs, theses, and many other physical objects may be a boon in dealing with extensive and frequent library concerns, such as object misplacement and usage. It can even deepen the bonds between books and readers, fulfilling Dr. S.R. Ranganathan's second law of library science, "Every Reader His or Her Book." Libraries can use mobile applications to provide clients with access to and use library resources via a virtual library card. It will be a fantastic platform for libraries to advertise their services and maximize the use of library resources.

8. IoT Services in Libraries

8.1 Inventory Control

Aside from books, periodicals, and magazines, sensors may control various additional library media such as microfilm, video, audio, and so on. We can trace the position of each object using IoT technology. RFID currently provides some of the same functionality for books, but with IoT, librarians/managers may get all real-time data from their mobile devices over the internet. It can handle inventory more effectively and efficiently, thereby saving the efforts of librarians/managers for stock verification.

8.2 Theft Management

By tagging each piece of library inventory (scanners, printers, hard drives, CDs, etc.), we can keep track of it at all times. To avoid theft, we may outfit the library gate with high-tech detectors and transponders, which send signals to authorities via their mobile phones and start a loud alarm. Furthermore, it may provide extra functionality by performing automated prompt actions such as locking the gate to prevent theft.

8.3 Circulation Desk

Library desks conduct tasks such as issuing and returning books and other library materials, keeping records, making and updating library cards, issuing overdue notices, and so on. RFID technology facilitates some of these tasks, such as problems and returns via the self-service kiosk. However, with IoT, additional circulation tasks, including record maintenance, library card creation and updating, and overdue reminders, may be automated via mobile applications. Users may check for overdue books on their mobile devices without visiting the library; they do not need to rely on library staffs.

8.4 User Identification

The detectors at the library's entryway can scan visitors' faces and verify them to existing databases, permitting only registered users to visit the library. Meanwhile, an alarm message will be sent to the in-

charge librarian's mobile phone, which might be anywhere and at any time, and the concerned person can decide whether he wants to allow the stranger to visit the library or not.

8.5 Reservation of Books

One possible use of IoT is that a patron may use his smartphone to look for and reserve a book from the library's OPAC at any time and at any location via remote access. The requested book can be notified as available by a beep sound or blinking light on the library's bookshelf, which is integrated with sensors via the network. The book will be able to spot its place in this manner.

8.6 Fire Detection and Prevention

Imagine a fire in the library, and no one is around to observe it. The fire detection equipment may begin sending signals and raising the alarm. Sensors in the library with interconnected networks will immediately transmit the message to the appropriate authorities, such as the librarian in charge and the fire brigade, and alert the entire institute. In this approach, IoT will aid in taking action automatically and preventing more harm.

8.7 Assistive Technology

Smartphones now have text-to-speech, touch navigation, and hands-free operations, which are very useful for those with impairments. IoT leverages this characteristic of mobile phones to give services to library patrons. With IoT, such customers may request the appropriate resource verbally (say, a book with a tag). Once they desire the item, they can discover instructions to that book in the library using their smartphone's voice navigation feature.

8.8 Information Literacy

The library provides new customers with orientation and user education sessions to familiarise them with its resources, services, rules, and regulations. IoT can assist libraries by offering a self-guided virtual tour of the facility. In order to do this, libraries must install wireless guideposts at various library sections. When visitors enter a specific library area, their mobile phone will start playing a video or audio that provides additional information about that area and explains the best ways to access library resources.

9. Conclusion

Many supporting technologies have been suggested in recent years, including RFID, Open URL, Cloud Computing, and IoT. IoT has advanced swiftly and will be advantageous in the approaching digital era. We might argue that IoT is a trend that the Internet will follow. In the current knowledge society, IoT innovation and accompanying IoT technologies give practical features of gaining sustainable information development techniques. In other words, the Internet of Things has been introduced to generate life-changing situations in our personal and professional lives. Many of the advances have already been applied to some degree.

One thing is sure: there is no turning back. No sector can disregard the IoT's unparalleled level of control and efficiency.

Libraries will have a bright future thanks to IoT. If executed as planned, it may result in the anticipated advancements and provide value to library resources and services. IoT is continually evolving, and numerous IoT-enabled technologies are being released into the market one after the other. It stands to reason for librarians to become acquainted with this new technology. While waiting for it to become more widely acknowledged, embraced, and available for greater use in libraries. Simultaneously, learning from early adopters and developing better methods to maximize the benefits of IoT adoption in libraries would be exciting. Libraries have always been susceptible to change, as history demonstrated. As a result, IoT will be the next big thing after the Internet, bringing about a slew of changes to the library, particularly in how it links and communicates with its users.

References

1. Atzori, L., Iera, A., networks, G. M.-C., & 2010, undefined. (n.d.). The internet of things: A survey. Elsevier. <https://doi.org/10.1016/j.comnet.2010.05.010>
2. Baker, D. (2016). Making sure things can never be the same again: Innovation in library and information services. *Advances in Library Administration and Organization*, 35, 1–44. <https://doi.org/10.1108/S0732-067120160000035007>
3. Chowdhury, G. (2013). Sustainability of digital information services. *Journal of Documentation*, 69(5), 602–622. <https://doi.org/10.1108/JD-08-2012-0104>
4. Clement Ola, A. (2018). Research Skills, ICT Application and Sustainable Library Development. <https://digitalcommons.unl.edu/libphilprac>
5. FEATURE - The Impact of the Internet of Things on Libraries and Users. (n.d.). Retrieved June 5, 2022, from <https://www.infotoday.com/cilmag/jan19/Abo-Seada—The-Impact-of-the-Internet-of-Things-on-Libraries-and-Users.shtml>
6. Igbinoia, M. O., & Okuonghae, O. (2021). Internet of Things in contemporary academic libraries: application and challenges. *Library Hi Tech News*, 38(5), 1–4. <https://doi.org/10.1108/LHTN-05-2021-0019>
7. Internet of Things: What It Is, How It Works, Examples and More. (n.d.). Retrieved June 5, 2022, from <https://justcreative.com/internet-of-things-explained/>
8. Li, S., Xu, L. da, & Zhao, S. (2015). The internet of things: a survey. *Information Systems Frontiers*, 17(2), 243–259. <https://doi.org/10.1007/S10796-014-9492-7>

9. Liang, X. (2020). Internet of Things and its applications in libraries: a literature review. *Library Hi Tech*, 37(2), 251–261. <https://doi.org/10.1108/LHT-01-2018-0014/FULL/PDF>
10. Pico-Valencia, P., & Holgado-Terriza, J. A. (2018). Agentification of the Internet of Things: A systematic literature review. *International Journal of Distributed Sensor Networks*, 14(10). <https://doi.org/10.1177/1550147718805945>
11. Weber, R. H., & Weber, R. (2010). Internet of things. <https://link.springer.com/content/pdf/10.1007/978-3-642-11710-7.pdf>
12. What is IoT (Internet of Things) and How Does it Work? - Definition from TechTarget.com. (n.d.). Retrieved June 5, 2022, from <https://www.techtarget.com/iotagenda/definition/Internet-of-Things-IoT>
13. Wortmann, F., Engineering, K. F.-B. & I. S., & 2015, undefined. (2015). Internet of things. *Springer*, 57(3), 221–224. <https://doi.org/10.1007/s12599-015-0383-3>

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