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# Emerging Trends and Impact of Internet of Things in Academic Libraries

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**ABSTRACT**

*The advent of smart new technologies, smart mobile connections and online services has a great impact on all aspects our life and activities. Also this advancement has many impacts on the world around us. Today, libraries and library services have great impact on the world. The aim of the current study is to introduce readers with new technologies applied to Internet of Things (IoT) that can help libraries to improve their services and increase users' satisfaction. This study also tries to present about the possible areas of implementing the concept of IoT in academic libraries and user satisfaction on the IoT based library services and resources. Online survey from selected Educational Institutions was conducted and Data collected from a survey of a sample of 183 library users to analyse the importance and satisfaction of IoT based services and resources. Possible areas for implementing IoT in libraries - improve access to the library and its resources, collection management, recommendation service, location-based service, appliances management, usage statistics, and information literacy. The IoT technology will notify and fulfils the user-related queries through on internet i.e., self-check-in, self-check-out, overdue reminders, online fine payment, misplaced books on shelves, etc. The study observed that the maximum number of respondents used WhatsApp and Facebook respectively. Meantime, the libraries should concentrate more on interaction through videoconferencing like, Google Meet, Zoom etc. and library tutorial. 73% of the respondents are highly using the Swayam and the second highest is e-Pathshala with 48%. The institutes provide remote based library resources and services through cloud-based access on the basis of IoT i.e. Deep knowledge – remote access, BookshelF - Mobile App and Ezproxy –Server. Most of the higher educational institutes prefer to subscribe the Deep knowledge portal on the basis of users' satisfaction. In IoT based modern library services, it is understood that three parameters such as Academic Performance Support and Infrastructure are having significant association with the satisfaction level of 5% and training is having significant association with the satisfaction level of 1% respectively. IoT based library services and resources can be implemented in the all sections of libraries functions and services i.e. collection management, Library Marketing services, Information literacy programs, effective utilization of online learning portals, accessing of library resources, etc. ICT and Information literacy should be compulsorily included as part of the curriculum in order to equip the students and faculties for face the current digital IoT environment efficiently.*

**KEYWORDS:** *Internet of Things, IoT, Academic Library, Educational Institute, Indian Universities, Collection Management, Machine to Machine Communication*

## 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, "Modern libraries: Moving from a transactional to a relational library, 2018). For Librarians and Librarianship, Technologies of the past, current, and future are not and will not be strange. History has shown us that 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 library services and resources (Abdoulaye & Ramaiah, 2019). Today, especially after the Pandemic we are rapidly adapting to the 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, data transfer and VoIP telephony etc. (Canuel, 2015). In the 1990s, not only the connectivity of the Internet began to increase, and it became much better in the 2000s (Nag & 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 (Ashton, 2009). He stated that, "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) Strongly 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".

In the current scenario, with the upcoming 5Gconnectivity, 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, Wifi, Bluetooth and other technologies, IoT has the ability to connect all devices and transfer data between them. Certainly, IoT technologies offer many opportunities for library professionals not only from monitoring and management of books, Management of user, it can be used for monitoring and management of various other applications like tracking of room usage, managing and monitoring various electrical applications, security systems and program attendance to monitoring humidity levels for special collections, and many more.

As per the words of S.R. Ranganathan that, "the library is a growing organism". Hence, it is essential for the librarians update themselves and upgrade their skill sets to make use of these important technologies for providing better and efficient services to the users of the library. The Internet of things (IoT) technology has the ability to connect different things and allow them to communicate and exchange data and information (Mahdi & MehriEzadi , 2018). 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, rooms, air conditions, 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. 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, 2016).

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.

**Internet of Things (IOT)**

Currently, IoT is referred through many more phrases are used in the literature like the term Internet of everything, machine-to-machine communication, the pervasive computing device, the smart device, the ubiquitous device, etc. (Pujar & Sathyanarayana, 2015) (Makori, 2017). Kevin Ashton, the father of the Internet of Things IoT was not able to give a clear and specific definition for the term but he 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. According to Techopedia, the IoT is a new concept that describes a future where every day physical objects will be connected to the Internet and be able to identify themselves to other devices (Techopedia,, 2015).

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 & Watson, 2017).


**Figure 1:** IoT ability to connect different objects (Adopted from (Linnik, 2019)).

Currently, IoT changes all activities that have been done by human and machine hence it would be changed many aspects of the human's cycle life.

**The Opportunity of IoT Applications in Academic Libraries**

The IOT can be used to improved library services. (Bayani, 2017)Using Internet of Things and new technologies can improve libraries, both on collecting information and user services. The intercommunication between objects in IoT technologies can make easier decision making and management process in libraries. According to the idea of smart building, libraries can be equipped by IOT devices.

Some of the currently available commonly used IoT Technologies applications in Libraries are

**1) Collection Management**

**a. Self-Service Kiosk for Issue and Renewal & Intelligent Shelf for Return**

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 & Addepalli, 2014).

**b. Automatic Sorter**

Using robotic devices controlled through RFID and IoT and equipped with an automatic sorter device.

**c. 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 & Sathyanarayana, 2015).

**2) Management of Facilities, Equipment and Appliances**

With the help of IoT librarians can 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 & Sathyanarayana, 2015); (Qin, 2018); (Abo-Seada, 2019).

**3) Resource and Services Access**

Libraries can provide IoT enabled mobile apps 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 (Guo, Liu, & Bielefield, 2018); (Wei, Chang, & Cheng, 2015); (Hahn, 2017); (Hu & Zhang, 2016); (Kerr & Pennington, 2018).

**4) 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 anywhere and at any time. The librarian in charge can take action from distance whether to open the door for the unknown face or not.

**5) 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.

**6) 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.

**7) Library Marketing through Information Literacy**

Information literacy "recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information through Internet of Things" (ALA, 2005). Marketing the library through Information Literacy means first to educate the library users about the library, resources, and services.

## OBJECTIVES

In this study, it focuses mainly on the possible areas for implementing IoT in libraries to improve access to the library and its resources, collection management, user friendly services of the library such as self-service services, recommendation service, location-based service, appliances management, usage statistics, and information literacy (Pujar & Sathyanarayana, 2015). This study examines how the selected institutional libraries are serving and satisfying their customers using internet of things concept.

## METHODOLOGY

The study is based on comprehensive review of related literature and data collection through a questioner circulated among a random of 500 library users and library professionals from various government and private law institutions selected through simple random sampling method. The questioner consisting of 9 questions were framed through Google form and circulated through mail and the feedback on the availability and usefulness of the library facility and services are collected. Along with that the feedback on the challenges of library facilities was also collected. The questioner is framed to explore the perceptions, opinions and observation regarding the problems and challenges confronted by the library professionals due to changing information landscape. Available material on the Internet was also explored.

**Table 1:** Data Collection

| Description | E-mailed | E-mail Bounced | Primary data | Response Not Received | Responded | Valid Questioners | Invalid Questioners |
|---|---|---|---|---|---|---|---|
| Users | 500 | 63 | 437 | 241 | 196 | 183 | 13 |
| % | 100.00% | 12.60% | 87.40% | 48.20% | 39.20% | 36.60% | 2.60% |

Among the 500 questioners circulated through email, after data cleaning we have received valid responses from 183 respondents.

## DATA ANALYSIS

### 1. Collection Management

Majority of the selected institutional libraries are automated with library management software's and some of them are integrated with institutional ERP (Enterprise Resource Planning). The physical resources of the library and books are enables with RFID tags (contains the bibliographical data) and the user are provided with smart Identity Cards. The tags are synchronized with library management software. The data are read through computers and RFID devices. The library collection process and activities are notifying through internet using IoT Technology. The user-related queries are notified and fulfilled through IoT technology on internet i.e., self-check-in, self-check-out, overdue reminders, online fine payment, misplaced books on shelves, etc. Out of the 4

institution libraries 2 institutions use smart shelves technology and none of the institutions have automatic sorter facility.

## 2. Library Marketing

The institution libraries use various sources for Marketing the Library through Information Literacy for the purpose of educating the library users about the library, resources, and services. The user responses with regard to the awareness of various library services and the sources of library marketing by the institution libraries are given below.

**Table 2:** Source of Awareness of Library Resources & Library Services

| Sl. No. | Description | No. Of Responses | Percentage (%) |
|---|---|---|---|
| 1. | Library Orientation | 49 | 26.78% |
| 2. | Video Monitoring Display | 5 | 2.73% |
| 3. | Social Media | 19 | 10.38% |
| 4. | Library Tour | 8 | 4.37% |
| 5. | Email | 21 | 11.48% |
| 6. | Library Website | 49 | 26.78% |
| 7. | Library Tutorial | 6 | 3.28% |
| 8. | Video Conference | 12 | 6.56% |
| 9. | Library Hours | 14 | 7.64% |
| | Total | 183 | 100.00% |

Libraries use various channels to market their library services both through offline and online as well for their users. Most of the libraries do physical presentation periodically; apart from this the libraries also promote their library services and resources through various digital resources and internet of things i.e. video display, library website / webpage, e-Mail, social media, video conferencing etc. The above Table-2 shows the source of awareness about the library resources and services. The maximum response with regard to the source of awareness about the library resources and services is for Library Orientation and Website with more than 26.78% responses each. E-Mail with 11.48% and Social Media with 10.38% of responses respectively.

Among the various mediums / sources with regard to marketing of Library, majority of institutions use medium like Library Orientation, Website, E-Mail, Library Website, and Library Hours. Library Marketing mediums like Video Monitor display are available with few institutions. A Maximum percentage of more than 33.68% of respondents got the awareness on the library services and resources through the Library Orientation. The reason is libraries organize library orientation before the academic year begins. The second-highest channel is Library website, webpage and social media with 27.56%. Only 18.25% of respondents were aware the library resources and services through Video Monitor Display, and library tutorial and less than 15% of the respondents utilise Library tour. The study reveals that the A majority of the institution libraries are providing the orientation through the mentioned channels and practices. The study reveals, out of ten, the entire institute effectively provides information literacy through the mentioned channels i.e. Library Orientation, e-Mail, Library Website, Library Hour, and Online Social Media.

The study reveals that, in terms of IoT, marketing of library resources and services effectively reached the respondents through library website and social media. Among the social media applications most of the libraries are using the Facebook, WhatsApp, LinkedIn, Twitter, Viber and YouTube. The study observed that the maximum number of respondents used WhatsApp, Facebook, and LinkedIn respectively. The time being, it is recommended that the libraries should concentrate more on interaction through videoconferencing like, Google Meet, Zoom etc and library tutorial.

## 3. IoT Based Library Resources and Services

The following IoT based Library Resources and Services are identified in the Selected Institutions and the response towards the awareness of the same is illustrated in Table-3.

**Table 3:** Available of IoT Enabled Library Services

| Sl. No. | Description | Available | Available Percentage (%) |
|---|---|---|---|
| 1. | OPAC | 130 | 71% |
| 2. | Self-service Kiosk | 53 | 29% |
| 3. | Self-intelligent Book Return Box | 52 | 28% |
| 4. | Book Drop Box | 72 | 39% |
| 5. | LMS | 110 | 60% |
| 6. | Mobile Application | 55 | 30% |
| 7. | Remote Access Network | 125 | 68% |
| 8. | Online Journals | 162 | 89% |
| 9. | Online Databases | 168 | 92% |
| 10. | SDI Service | 118 | 64% |
| 11. | CAS Service | 107 | 58% |
| 12. | Access to Institutional repository | 97 | 53% |
| 13. | Access to Open Archives | 72 | 39% |
| 14. | Library Tutorial | 32 | 17% |
| 15. | Digital Library Tour | 24 | 13% |
| 16. | Video Monitor Display | 33 | 18% |

In the survey it is found that a good majority of Institution libraries provide various IoT Enabled Library services and resources as listed above for better user service and benefit a good majority of the respondents are aware of the same. From the above it is found that the above institutions have a good IT infrastructure to library and hence the Libraries have implemented these highly technology based services.

It is found that, most of the above selected institution libraries and users access the e-resources through their institutional library webpage. From the survey, it is found that the users are highly familiar with various Online Databases, Online Journals, LMS, remote access and OPAC etc. Since only a limited number of the selected institutions have mobile apps services on the overall responses the familiarity is showing less. The study exposes that, apart from library website (74.28%), maximum number of respondents (51.95%) are using remote-based access and only mobile app (30%). More than 78% of the respondents are willing to access the library through Mobile App. In institutions which are having LMS facility, at the time of assignment submission and classroom activities, the respondents are accessing the resources with help of LMS.

Most of the institutes provide remote based library resources and services through cloud-based access on the basis of IoT based application such as i.e. Deep knowledge – remote access, Vital Source, Bookshelf - Mobile App, EZ proxy –Server etc. After the Covid-19 pandemic lockdown most of the higher educational Institutions provide access Remote Access network facility to virtually all users of the library for accessing online Databases (92%), Online Journals (89%), Access to institutional repository (53%) and Access to Open Archive (39%). Most of the higher educational institutes prefer to subscribe the Deep knowledge portal on the basis of user's satisfaction.

## 4. Online Learning Applications

A considerable number of the surveyed institutional libraries regularly notify their users

about the online courses, Seminars and conferences conducted by various learning portals. Further, the below table 4 reveals that the 73% of the respondents are highly using the Swayam and the second highest is e-Pathshala with 48%. The least usage is Law Skills and Remote XS. But, compare to Swayam and e-Pathshala, the Law Skills and Remote XS conducts more career-related courses through leading professors from National Law School Bangalore and other eminent personalities.

**Table 4:** On Learning Portals

| Sl. No. | Description | Available | Available Percentage (%) |
|---|---|---|---|
| 1. | Swayam | 133 | 73% |
| 2. | e-Pathshala | 88 | 48% |
| 3. | Mooc | 74 | 40% |
| 4. | Law Skills | 36 | 20% |
| 5. | Remote XS | 22 | 12% |

## 5. Access of e-Resources

After the Global Lockdown due to Covid-19 Pandemic, majority of higher educational institutes are procuring electronic textbooks and Online Databases and Journals instead of print copies. The textbooks, online databases and online journals are being procured from the leading publisher products and some of the publishers provide online/ digital textbooks along with the printed copy. The e-resources are accessed through Internet and remote access network (individual access code and LMS). The purpose of e-textbook,online databases and online journals procurement and subscription is towards ease accessibility, possible use by users from anywhere and anytime, without depending on anyone.

## 6. Evaluation of IoT Base Library Services

From the above Table-5 analysed using Pearson chi-square test to find out the significant association between the various IoT based Library Services and the satisfaction level. From Statistical analysis, it is understood that three parameters such as Academic Performance Support and Infrastructure are having significant association with the satisfaction level of 5% and training is having significant association with the satisfaction level of 1%.

**Table 5:** Evaluation of IoT Library Services

| Sl. No. | Description | Chi-Square | Signf |
|---|---|---|---|
| 1. | Academic Performance Support | 35.782 | 0.039 |
| 2. | Information Sharing | 30.813 | 0.068 |
| 3. | Training & Counselling | 38.443 | 0.001 |
| 4. | Guiding Resources | 20.055 | 0.421 |
| 5. | Infrastructure | 33.587 | 0.029 |

## 7. Evaluation of Online Learning

The Table-6 describes the evaluation of the online learning. It indicates that Majority of the respondents agreed that Internet plays as a Virtual / Online / Digital Teacher with the mean value of 2.00. This is followed by the challenges faced because not having adequate ICT Knowledge (meaning value of 1.90). The above inferred that Internet-based learning is play as a Virtual / Online / Digital Teacher to the users and it is easy to use/find the solution without anyone help, whenever they need an assistance. Secondly, Majority of the respondents agreed that ICT Knowledge is very essential in the current internet / virtual world and users having lack of technical knowledge in ICT are facing challenges. In order to overcome the above challenge, it is essential to incorporate compulsorily ICT Knowledge and Information Literacy as part of the academic curriculum.

**Table 6:** Evaluation of Online Learning

| Sl. No. | Description | Mean | Std DeV |
|---|---|---|---|
| 1. | Information Literacy | 1.67 | 0.798 |
| 2. | Academic Performance Support | 1.72 | 0.804 |
| 3. | Comfort & Easy to Use | 1.85 | 0.988 |
| 4. | ICT Knowledge | 1.91 | 1.005 |
| 5. | Virtual / Online / Digital Teacher | 2.00 | 1.262 |

## 8. Features / Advantages of Online Learning

The Table-7 illustrates the Features and Advantages of Online Learning from the respondents' perspective. It is found that a majority of the respondents strongly agreed that the online courses are Economical with mean score of 2.22 followed by the possibility of simultaneous and multiple learning opportunities with mean score of 2.03. Moreover, the respondents also agreed that it's purely Self learning with Self Discipline and the flexibility in Time without any Location Barrier and Schedule is a great advantage and it saves the time on productive manner.

**Table 7:** Advantages of Online Learning

| Sl. No. | Description | Mean | Std DeV |
|---|---|---|---|
| 1. | Flexibility-Time, Location, Schedule etc. | 1.95 | 0.958 |
| 2. | Economical | 2.22 | 1.806 |
| 3. | Inculcate self Discipline | 2.00 | 0.021 |
| 4. | Self Learning | 1.97 | 1.032 |
| 5. | Simultaneous / Multiple Learning Opportunity | 2.03 | 1.038 |

## CONCLUSION

Recent development of Internet of Things coupled with the Global Lockdown during Pandemic has completely changes the human lifestyle in every sector and the Global lockdown has accelerated the change. The academic libraries also fulfil the users' needs in the way of implementing the innovative services and resources through IoT as like other sectors. However, our findings on the above study reveal that the surveyed institutional respondents are highly satisfied with IoT based Library resources and services. The study exposes high tech facilities and services have helped and motivate the library users to use the library resources without any barriers. Furthermore, respondents are extremely satisfied with performance of IoT based modern libraries. The study concluded that IoT based library services and resources can be implemented in the all sections of libraries functions and services i.e. collection management, Library Marketing services, Information literacy programs, effective utilization of online learning portals, accessing of library resources, etc. ICT and Information literacy should be compulsorily included as part of the curriculum in order to equip the students and faculties for face the current digital IoT environment efficiently.

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