Perception and Awareness of Ph.D Students Towards Execution of Internet of Things (IoT) in Library Services: A study of IIT Madras

Priyanka Sinha, Ayan Panja and Khushpreet Singh Brar

Aim/purpose: The purpose of this paper is subjected to the perception and awareness of Ph.D. students regarding future application of IoT in library services and prominent challenges faced in its execution.

Research Methodology: Quantitative research approach involved survey of Ph.D. students from Indian Institute of Technology (IIT) Madras. The data collected through structured questionnaires from stratified random samples and was analyzed using JASP and excel applications.

Findings: The findings showed that most respondents were in favour of implementing new technology, specifically the IoT, in library services. A number of respondents were even conversant with the IoT both generally and in relation to library services. The study on IoT application in library space is a major breakthrough, and with its potential benefits in user authentication, easy remote monitoring of library resources, using IoT applications in libraries will reduce the delivery time of services and reduce the time of book issue/return process, but also pose some challenges that must be acknowledged as deduced, including a lack of staff with domain-specific training, a lack of infrastructure and budget, compatibility issues while installing.

Research implication: The aim of this paper is to understand the perspective and acceptance of students towards introduction of new technology IoT in library services and the potential challenges faced during or after its implementation in library services. The empirical results of this study provided a more accurate picture of libraries' readiness to introduce IoT-enabled services and a detailed interpretation of that readiness.

Introduction

The expanding function of information professionals has been redefined in part by the use of technological platforms in academic and research institutions to alter and broaden knowledge and learning. Information professionals today have new opportunities to manage knowledge in enterprises, particularly in the IoT. IoT has significant effects on libraries (Wojcik, 2016), yet the traditional library ecosystem has not yet fully embraced it (AlEnezi et al., 2018).

Kevin Ashton first used the term in 1999. The IoT is an extension of Mark Weiser's vision of ubiquitous computing (UbiComp), which intends to create a global network that supports UbiComp and device context

awareness. The emergence of wireless sensor networks (WSN), mobile computing (MobiComp), ubiquitous computing (UbiComp), and information technologies provides the foundation for IoT (Shammar & Zahary, 2019; Khanna & Kaur, 2020).The first IoT application was the Trojan Room coffee maker, which led to the creation of the term IoT. The phrases "Internet" and "Things," which allude to intelligent devices or objects, are combined to form the phrase "Internet of Things," often known as IoT. The IoT ecosystem is made up of web-enabled smart gadgets that use integrated systems including processors, sensors, and communication hardware to gather, send, and act on data (Laghari et al., 2021). The IoT refers to the use of intelligently connected devices and systems to collect data from embedded sensors and actuators in machines and other physical objects (GSM Association Copyright, 2014).

The IoT is a global information and knowledge gateway or hub that academic and research institutions can use to their benefit strategically and gain a competitive edge. IoT and associated information technologies are widely employed in a variety of domains, including businesses, manufacturing facilities, and industries, for the sharing, free circulation, and on-demand usage of resources and capabilities (Fei Tao et al., 2014). Healthcare (Karahoca et al., 2018), tourism (Pizam, 2017), education (Lei et al., 2021), food production (EA et al., 2021), transportation (Tahaei et al., 2020), agriculture, and other human endeavors have all benefited from the deployment of IoT. (Haque et al., 2021; Kumar et al., 2021).

This study will present recent research on IoT developments that are motivated by the need for the fusion of many interdisciplinary technologies and novel applications. This study can help with IoT development and research in the future.

This paper is organized as follows: Section 1 will explore the IoT concepts and visions through introduction. IoT evolution in terms of academic library services will be presented in Section 2 in the related literature review part. Section 3 will explore the research methodology and design involved in this survey study. The collected data will be analyzed and discussed in detail in Section 4. Section 5 represents IoT trends like research output discussion and some of the valuable suggestions by respondents, and Section 6 consists of conclusions.

2. Objectives of the Study

i.   To assess the satisfaction levels of students with the present library services.

ii. To examine the extent of awareness and perception towards IoT-based library services among students of IIT Madras.

iii. To find out the potential challenges of application of IoT in the existing library services.

3. Major Research Questions

i.   Are the students satisfied with library collection, facilities, and services to satisfy their information needs?

ii.   What is the extent of awareness and perception towards IoT-based library services among IIT students?

iii.   What are the potential challenges of application of IoT in the existing library services?

4.   Scope of the Study

The scope of the study is to determine the application of the IoT in libraries of IIT Madras. In India, presently there are 23 IITs established under the Institute of Technology Act, 1961. Prof. Humayun Kabir, Union Minister for Scientific and Cultural Affairs, formally inaugurated the Institute in 1959 (IIT MADRAS, 2020). The Central Library, IIT Madras began operations in 1959 from the Department of Civil Engineering, moving to an independent building in front of the Institute's Main Guest House in 1965. In addition, the Central Library has integrated RFID technology, smart cards, ISO-9001:2015 standards, a contactless smart card enabled access control system, a virtual reference desk etc. (IIT Madras Central Library, 2020).

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. 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.

5.   Review of the Related Studies

5.1   IoT based academic library services

In terms of heterogeneous systems and interoperability, IoT and libraries have a decent rapport; they are indirectly associated to manage diverse systems and processes. The IoT technology connects readers and books, offering users a comprehensive set of reader services. The IoT can help with intelligent library management by providing intelligent management, reader behavior analysis, intelligent self-borrowing and returning books and materials, long-term preservation, and other conveniences (Fu, 2021). Rahman & Islam (2019) gave several instances of how IoT-enabled libraries could help with effective administration of library infrastructure, including automated book renewal, a fine for excessive resource use, and book tagging via patrons' fingerprints. Qin (2018) studied prospective IoT-based library services. The results showed that IoT technology may be helpful for marketing and promotion as well as curating, describing, managing, and choosing collections in libraries. Book tracking, self-guided tours, special collections exhibits, and directory information were among the services they hoped libraries would offer. A methodology for installing IoT-based library automation and monitoring systems was put forth by Bayani et al. (2018). According to the authors, the application of IoT in self-check-in/check-out system and the discovery of the book at its spot can make the circulation system in libraries as simple as sliding off. Bansal et al. (2018) listed a few IoT applications for library services, including inventory control, theft management, circulation, user identification, book reservations, and mobile references. They anticipate that, despite the early difficulties of IoT installation, libraries will get used to it just like other library automation operations. IoT deployments

in libraries reportedly comprise both tangible objects (things) and digital resources, according to Gupta and Singh (2018). It can be used to check the availability of other library services as well as virtual library tours, shelf guides, user orientation, and online payments. Some of the areas where IoT can be used are circulation, reference services, user authentication, library security, and seamless access to traditional collections. Using RFID, proximity sensors, and ultrasonic sensors, libraries can assist users in navigating collections, obtaining orientation, and monitoring occupancy in real-time (Sinha & Brar, 2022). By providing a strong reader circle, real-time resource monitoring system, easy location, and a service-oriented experience, it has changed the user's view of the library. The IoT could help libraries provide ubiquitous self-contained virtual journeys. A number of libraries have installed remote devices called reference points. When users access the authentic part, a video or audio will start playing on their phones to provide further information and instructions on how to make the most of it. By offering a range of options, it can even enhance the experiences of users (Muthumari et al., 2021). The best proximity sensors to utilize in a library circulation system are those that send out prompt notifications in the instance of theft or system evasion. Beacons installed carefully throughout the library can readily communicate with mobile devices, improving the virtual tour experience (Igbinovia and Okuonghae, 2021). Ultrasonic sensors, which serve as a grid system in IoT architecture, can be used to monitor room occupancy (Upala and Wong, 2019). In order to investigate the possibilities for more affordable and useful solutions, (Maceli, 2020) presented an exploratory research that involved the design, development, and usability testing of an open source IoT-based environmental monitoring system for archivists. The developed system was widely appreciated for being user-friendly, efficient and advancement over previous systems because it satisfied the needs of archivists. This suggests that an IoT-based library services presents plenty approach that can meet the needs of librarians as well as users.

5.2 Awareness about the IoT in Libraries

Professional librarians are always at the forefront of implementing new technologies and on the search for tools that might facilitate workflow. They must employ innovative thinking to determine how to exploit IoT technology to its fullest potential in order to make resources and services valuable in both the present and the future (Kaushik, 2019). By automating several regular operations, the IoT has the potential to make the employment of library staff members easier. IoT adoption may help to reduce inefficiencies in normal operations by continuously tracking appliances and resource usages (Khan et al., 2021). IoT has a great deal of potential and can be used to maintain archive materials, track collections, offer consumers consolation services, and advertise traditional library items online (Wójcik, 2016). In order to accept new technology, one must first assess its advantages, returns on investment, and application's drawbacks. Students, researchers, instructors, and library professionals can utilize IoT technology by becoming more aware of how adaptable and simple new technologies are to use in libraries (DaLbehera, 2018).Wang et al. (2018) studied the information, people, and information environment pillars of the technological acceptance model (TAM) and the effects of these factors on long-term IoT based mobile library services. It provides seamless learning without the requirement for human interaction; mobile library services encourage ubiquitous learning

and will lead to improvements in library services. The IoT idea is still relatively new in developing nations, but South Africa and Nigeria, two nations that are open to accepting new technologies, suggest that governments should take steps to promote IoT. It is a delicate technology that transmits a lot of sensitive personal data, is vulnerable to data theft, and necessitates a high level of privacy and security (Igbinovia, 2021).

5.3 Advantages and Disadvantages of IoT System

To accomplish highly complex tasks, the IoT can acquire, transmit, and process information from IoT end-nodes (such as RFID devices, sensors, gateways, intelligent devices, and so on) via network.

Energy efficiency- A variety of sensing devices and lighting are included to control lighting and temperature in the library, thereby improving energy efficiency.

Personalized services can be provided based on big data information collected by user terminals and various sensors in the library. It can also be used to expand library collections (Noh & Ro, 2021).

Risk warning system- Structure of IoT risk warning system with case-based reasoning and enhanced fuzzy sets that can automatically monitor the status of all types of devices as well as reader activities.

Disadvantages

Despite significant progress in IoT applications in smart libraries, there is still room for improvement. In terms of smart services, the evaluated performance of existing solutions for innovative recommendation-based scenarios, such as accuracy and recall, is comparatively low. The large-scaled data generated by massive IoT devices emphasizes the importance of privacy protection. Particularly in smart library scenarios, the heterogeneous and multi-source collected data includes a significant amount of personal and privacy data (e.g., facial image data), and the leakage of such critical data will have a significant impact on people's lives (Bi et al., 2022).

IoT systems are typically resource constrained, with limited power and capacity. Attacks on IoT networks may increase energy consumption by compromising the network and consuming IoT properties through redundant or bogus service demands (Algarni et al., 2021).

Because of their heterogeneous structure, the exponential growth of IoT networks may contribute to the degradation of IoT services. It entails developing a tamper-proof framework for a large number of IoT networks as well as implementing alternative fault-tolerant network strategies.

As far as Indian libraries are concerned, application of the IoT is not given significant emphasis. Although libraries are aware that ICT is used in varied degrees to provide library services, it is frequently assumed that there is still a dearth of IoT use in libraries. Therefore, it becomes imperative to develop a thorough understanding of the various aspects of IoT in library setup and also keep in mind the role of IoT in the seamless dissemination of information to encourage digital literacy and life-long learning. Therefore, the

present study will also make an effort to deal with the user community's rapid growth and its varied needs, which librarians must quickly and accurately meet.

In light of the above, the problem under study is stated as:

Perception and awareness of Ph.D. students towards execution of Internet of Things (IoT) in libraries: A study of IIT Madras.

6.   Research Methodology and Research Design

The present study pursuit to investigate the perception and awareness of Ph.D students toward implementation and future applications of IoT in library services. The authors chose the quantitative method to achieve the main goal of the proposed research problem. For this study authors conducted a survey study in hybrid mode with stratified random sampling (Weinger et al., 2022) approach on 200 research scholars of various departments of IIT Madras through structured questionnaires with 15 open, close-end and likert scale based questions (range from highest to lowest, 5-1), we received (N=132) duly filled responses with response rate of 66%. The data was collected through Google form through personal Mail ID and Linkedin platform between March to May 2022 to determine the demographic distribution and perception of Ph.D. students of IIT Madras towards advantages and challenges in adoption of IoT in library services. The collected data were analyzed using percentages and mean and for analysis we used JASP software and Microsoft excel (JASP, 2017).

7.   Data Analysis and Interpretation

7.1 Demographic distribution of respondents

After determining the research question the next step was to collect and analyze the proportionate data based on lead-down objects. On observation of Figure 1 and 2, it represents the gender-wise and age group distribution of respondents. Figure 1 reveals that out of (N=132) respondents most of them were male respondents 89.39% and female only 10.60% , most of them belong to the age group of 23-25 years with 53.78% followed by 26-28 years, i.e. 34.09%, according to figure 2.
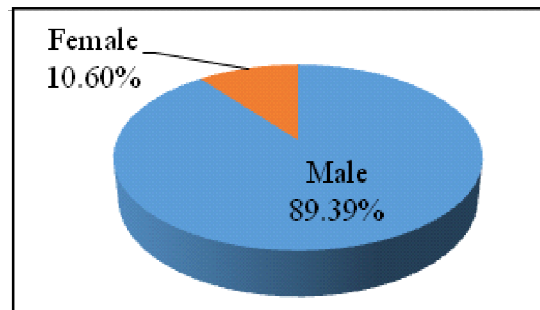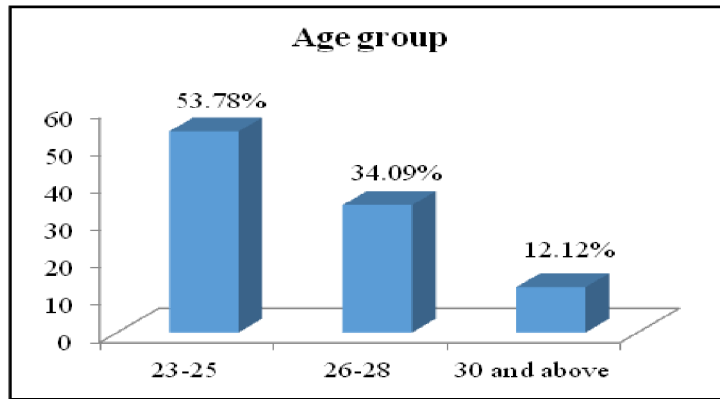

Figure 1: Gender-wise distribution of respondents

Figure 2: Age-wise distribution of respondents

7.2 Department-wise distribution of respondents

The department-wise distribution of respondents will represent the interest groups contributing to the data set and further responses can be concluded based on their subject knowledge base. On observation of table 1, the survey responses revealed that most of the respondents belong to the computer science and engineering department (20.45%), followed by the electrical engineering department (17.42%) and the least number of responses from biomedical engineering departments (1.5%).

Table 1: Population distribution department-wise

S.No.	Departments	Respondents	Percentage
1.	Aerospace Engineering	4	3.03
2.	Applied Mechanics	3	2.27
3.	Biomedical Engineering	2	1.51
4.	Biotechnology	5	3.78
5.	Chemical Engineering	7	5.30
6.	Chemistry	5	3.78
7.	Civil engineering	14	10.60
8.	Computer science and engineering	27	20.45
9.	Electrical engineering	23	17.42
10.	Engineering design	7	5.30
11.	Management	5	3.78
12.	Mechanical	17	12.88
13.	Metallurgical and materials engineering	4	3.03
14.	Ocean Engineering	5	3.78
15.	Physics	4	3.03
	Total	132	

7.3 Frequency of visiting library space

Figure 3 represents how often does respondents visits library space for various purposes. On examination, the results confer that most of the respondents visit library once a week 34.09%, followed by others category 28.03% (I don't visit, Never, rarely, I rarely visit library these days, etc.), once in a month 15.15%, once in two months 12.12% and daily 10.60%.
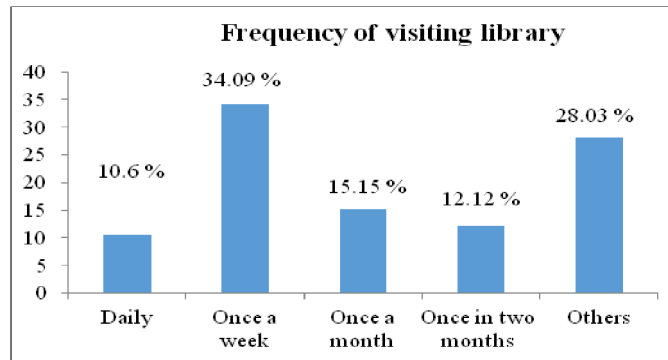
Figure 3: Frequency of visiting library

7.4 Satisfaction with the existing library services

Satisfaction distribution represents the quality of service provided by the library and it can be judged in terms of timely response, providing relevant assistance in response to query and assisting users while facing challenges to use library service **(Pandey et al., 2017)**. On examination of figure 4, it reveals that most of the respondents were satisfied with the existing library services (93.93%) and 6.06% respondents were not satisfied**.**
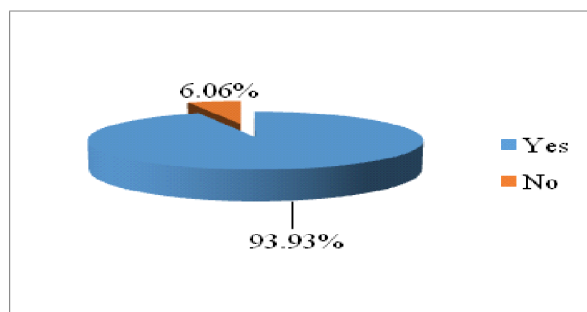
Figure 4: Satisfaction with library services

7.5 Time spent at circulation desk

In response to the longer time spent at circulation desk the findings from figure 5 reveals that most respondents have to spend longer time than usual for getting assistance, services or getting books borrowed at circulation desk with response rate of 90.90%.
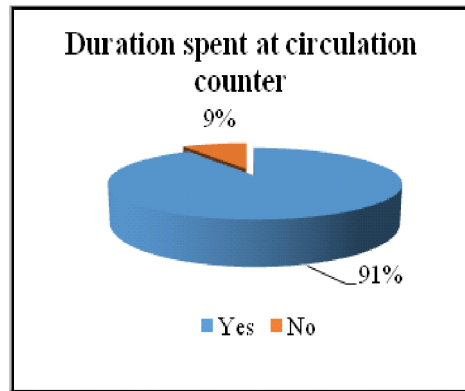
Figure 5: Duration spent at circulation counter

7.6 Perception regarding implementation of new technology in library services

Implementation of new technology requires pre-observation of prevailing conditions of that place, awareness/attitude/perception about that technology and, most importantly, rate of acceptance as we judge through certain parameters defined in Technology acceptance model **(Dalbehera, 2018).** On observation of figure 6 it justifies the perception of respondents towards implementation of new technology in the library. The finding revealed that most of the respondents were positive towards acceptance of new technology in library premises, i.e. 54.54%, and 45.5% were against that.
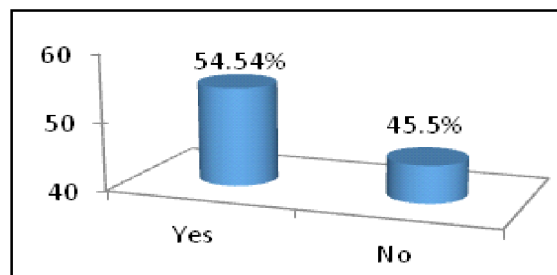

Figure 6: Perception regarding implementation of new technology in library services

7.7 Awareness about the term IoT

The notion of accepting new technology can be judged through the valid knowledge about that technology, keen observation and varied notable uses to validate its successful establishment. The domain IoT is already a well known technology being fortuitously accepted in the commercial world. The figure 7 and 8 represents the awareness about IoT among respondents and source of awareness about IoT. The findings revealed that most of the respondents were aware about IoT, i.e. 88.63% , and they got this information from other sources like Youtube, web search, social discussion, Articles, magazine and newspaper (38.63%), followed by as part of their course 22.72% and webinars 15.90%.
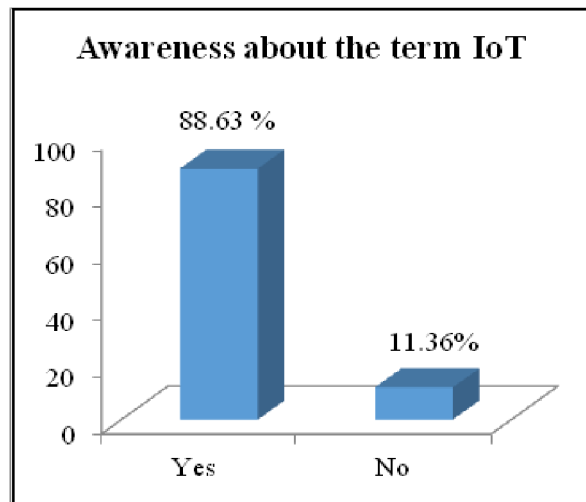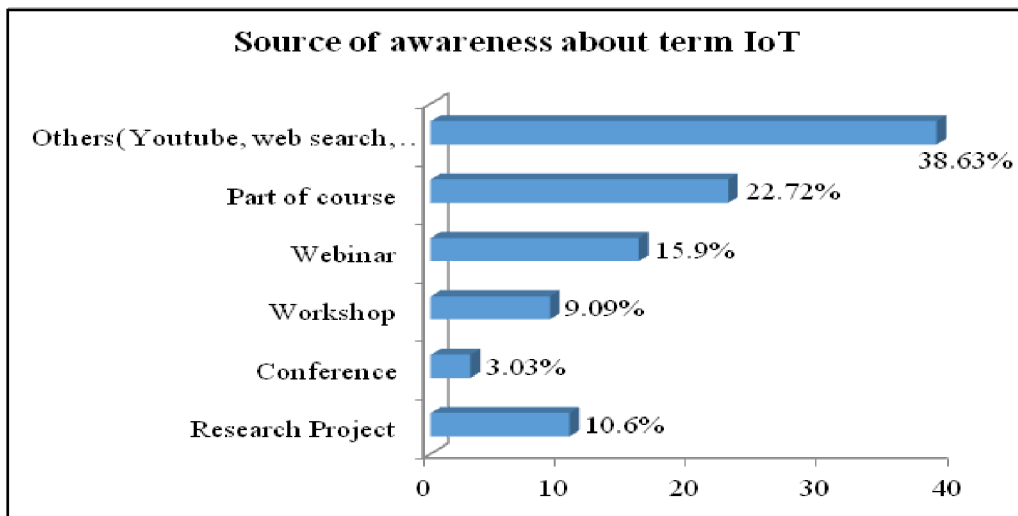
Figure 7: Awareness about the term IoT

Figure 8: Source of awareness about term IoT

7.8 Awareness about the key layers of IoT architecture

Figure 9 represents the awareness among the key layers of IoT architecture. Usually the IoT reference model is distributed in 3 key layers, perception layer, network layer and application layer, its functions are already mentioned in detail in the above section in introduction. Each layer with its specific function is required for IoT architecture to work in coordination to deliver required results. The findings revealed that most of the respondents were aware about key layers of IoT architecture 65.90%.
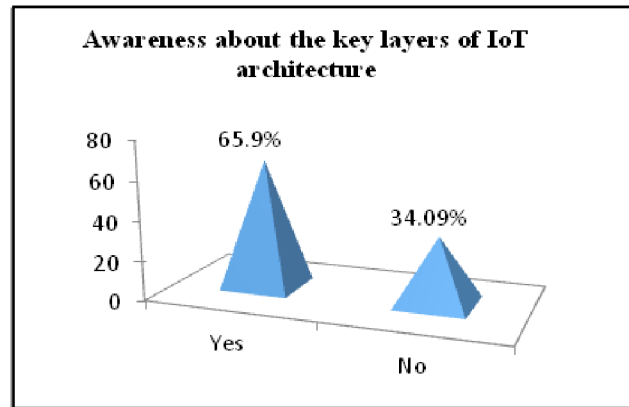
Figure 9: Awareness about the key layers of IoT architecture

7.9 Awareness about the application of IoT in library services

Application of IoT in library service is still at its empirical stage and requires thorough discussion on this topic. IoT has enormous potential and can be used to market traditional library resources online, track collections, provide users with consolation services, and preserve archival collections **(Wójcik, 2016)**. On observation of figure 10, findings revealed that most of the respondents were aware about application in the context of library services (67.42%) and 32.58% were unaware.
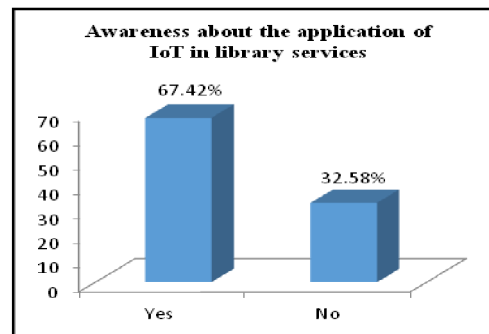

Figure 10: Awareness about the application of IoT in library services

7.10 Areas of application of IoT in library services

There are infinite numbers of applications of IoT in various library services and some of them are discussed in table 2. The mean distribution of responses revealed that most common use of IoT can be for remote monitoring of library resources (Mean=4.19), user authentication and access control (Mean=4.16), followed by Inventory management (Mean=4.08), self issue/return of books (Mean=4), books theft control management and Text to speech convertor (used for archives and visually challenged users) (Mean=3.99) and least number as Google glass for newspaper clippings (Mean=3.71).

Table 2: Areas of application of IoT in library services

Areas of application of IoT in library services	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Mean
Self Issue/ return of books	40	61	24	6	1	4.00
User authentication and access control	48	63	17	3	1	4.16
Live virtual library tour	45	50	32	5	0	4.02
Remote monitoring of library resources	52	57	20	3	0	4.19
Inventory management	43	58	30	1	0	4.08
Booking seat in library	36	53	35	7	1	3.87
Books theft control management	45	50	29	7	1	3.99
Text to speech convertor (used for archives and visually changed users)	44	46	39	3	0	3.99
Self sorting of books	43	41	38	9	1	3.87
Google glass for newspaper clippings	33	40	50	7	2	3.71

Strongly Agree=5, Agree=4, Neutral=3, Disagree=2, strongly disagree=1

7.11 Advantages of application of IoT in library

The reason to introduce any new technology is to fetch its maximum number of advantages and deliver its benefits to large masses. IoT is a sensor based technology which requires no or least human intervention. It delivers personalized service to its user with low cost maintenance and easy navigation system **(Noh & Ro, 2021).** Table 3 represents the various advantages of application of IoT in library services, the findings revealed that IoT can be used for remote monitoring of books on shelf (Mean=4.16), followed by Using IoT applications in library will reduce the delivery time of services and reduce time of book issue/return process (Mean=4.09), followed by navigation of books will be simplified and also decrease latency (Mean=3.89).

Table 3: Advantages of application of IoT in library

Advantages of application of IoT in library	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Mean
Using IoT applications in library will reduce the delivery time of services	41	64	26	1	0	4.09
Reduce time of book issue/return process	45	55	31	1	0	4.09
Navigation of books will be simplified	39	56	24	10	3	3.89
Decrease latency	33	53	45	1	0	3.89
Low cost on maintenance	27	36	52	16	1	3.54
Remote monitoring	53	51	25	3	0	4.16

7.12 Challenges in implementation of IoT in Libraries

The technology is boon or bane can be determined by its use. IoT, no doubt, has several advantages, but it also accompanies challenges/impediments before and after its application. Table 4 highlights some of the common potential challenges which may occur with application of IoT in libraries. The results revealed that IoT requires domain specific skilled staff is the most prominent challenge (Mean=4.12), followed by lack of budget and infrastructure (Mean=3.84,3.81), compatibility issues among devices at the time of installation (Mean=3.84), capacity constraint in terms of device storage and energy (Mean=3.77), lack of scalability in terms of adapting according to increase in number of devices addition (Mean=3.68), privacy concerns and compromised interoperable devices (Mean=3.62).

Table 4: Challenges in implementation of IoT in Libraries (N=132)

Challenges in implementation of IoT in Libraries	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Mean
Privacy concerns	30	50	38	11	3	3.7
Requires domain specific skilled staff	48	55	27	1	1	4.12
Lack of budget	33	57	33	7	2	3.84
Lack of infrastructure	32	53	41	3	3	3.81
Compatibility issues among devices at the time of installation	30	58	39	4	1	3.84
Capacity constraint in terms of device storage and energy	32	50	41	6	3	3.77
Lack of scalability in terms of adapting according to increase in number of devices addition	27	50	45	6	4	3.68
Compromised interoperable devices	23	43	60	6	0	3.62

7.13 Perception of students towards willing to contribute in IoT-based library establishment

In response to the view on contribution of users to up-gradation and setup IoT-based library, as observed in figure 11, most of the respondents (51.51%) were willing to contribute and rest (48.5%) were not positive towards contribution as it was expected that they were not aware that IoT can be used in library setup based on their observation on its commercial application and required specific training program.
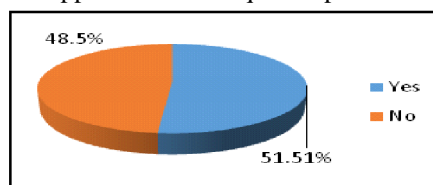

Figure 11: Perception of students towards willing to contribute in IoT-based library establishment

8. Discussion

IoT is used by libraries to increase patron access to resources and increase the effectiveness of service delivery. Academic institutions and academic libraries are working together to provide better services to students through digital innovation (Cao et al., 2018).

Inventory control, mobile payments, ticketing and event registration, access and authentication, climate and room configuration, accessibility and way-finding, mobile reference, resource availability for both content and physical objects, smartbooks, gaming, and augmented reality are all discussed in the OCLC newsletter as examples of interactive systems that can be built using IoT (OCLC, 2015). The major findings of the study focus on the perception, awareness, advantages and challenges associated with application of IoT in libraries. The respondents were mostly males belonging to the age group of 23-25 years of computer science and electrical department. The study is discussed below based on the suggested research objectives to address the research problems.

8.1 Satisfaction levels of students with the present library services.

The results revealed that most of the respondents were satisfied with the existing library services; however they ceased to wait for more than expected duration at the circulation counter during the check-in/check-out process as evident from figure 4 and 5.

8.2 Extent of awareness and perception towards IoT-based library services

On close analysis, approximately half of the respondents were willing to introduce new technology in library services of IIT Madras. It suggested that most of the respondents were familiar with the term IoT and its key components in architecture through sources like Youtube, web search, social discussion, articles, magazine, and newspaper and as part of their course **(Kaushik, 2019)**. They were aware that IoT can be applied in various areas of library services such as remote monitoring of library resources, user authentication and access control, followed by inventory management , self Issue/ return of books, books theft control management and text to speech convertor (used for archives and visually changed users) and as Google glass for newspaper clippings **(Makwana, 2021)**.

8.3 Potential challenges of application of IoT in the existing library services.

The prevailing advantages and challenges are easy navigation of library collection, reduction in delivery time in services and remote monitoring of resources and lack of domain specific skilled staff in libraries and compatibility issues with interoperable devices.

The recommendations and discussions made by responders are summarized below, with a focus on the applications for IoT and the obstacles that must be surmounted before it can become a fully functional system.

"There is a similar technique being followed in many famous hospitals to monitor the hospital beds, etc. So by simply having an RFID tag or something similar in each book and other library facilities, we can track them."

"Before implementing IoT it is better to know the target audience. It will work better in a college of 10000 students while it might not work well in region where there is lack of manpower with required skill sets."

"Implementation of IoT in libraries will reduce cost and time significantly. Our library already have implemented certain applications like self issuing of books, icard authentication before entry, but there are many other areas where IoT can be introduced for smart Library."

"IOT may play a very big role in making the library services easier to avail."

"Transparency in systems would help into get more information."

"Indian Institute of Technology has already implemented IOT in the central library. We have virtual access to most of the content in library. Self Issue/return was also functional without any hipcups."

9. Conclusion

Over the past few years, IoT has been incredibly popular in academics and research. By 2025, it is anticipated that there will be over 75 billion IoT devices deployed globally (Liang, 2019). The IoT has potential to transform libraries also from stand-alone systems to a self-communicating system, which has created opportunities for evolving libraries into fast growing dynamic systems, which can easily adapt according to demand of users in supply chain manner. The IoT has a significant impact on the lives of millions of people around the world. It is utilized in a variety of areas of society to eliminate human involvement and orders while providing maximum automation and could visualize its practical benefits in libraries also.

However, the technology has its own set of concerns and challenges when it comes to execution. This paper presents a collective approach to the application of IoT in libraries, further discusses factual information as suggested by respondents regarding associated advantages such as easy navigation of library collection, reduction in delivery time in services and remote monitoring of resources, the prominent challenges need to be taken in observation such as lack of domain specific skilled staff in library and compatibility issues with interoperable devices. From continuously tracking of library appliances and resource usages, IoT deployment will help libraries eliminate inefficiencies in normal operations. The study effectively highlights the associated challenges in the application of IoT and motivates future research to overcome such challenges to designing a library as an active niche for smart users.

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About Authors

Miss Priyanka Sinha
Research Scholar
Department of Library and Information Science, Panjab University, Chandigarh, Panjab
Email: priyankasinha101099@gmail.com

Mr. Ayan Panja
Library Assistant
IIM Calcutta, West Bengal
Email: ayan.shudip94@gmail.com

Dr. Khushpreet Singh Brar
Assistant Professor
Department of Library and Information Science, Panjab University, Chandigarh
Email: khushpreet.singh@gmail.com