
Internet of Things (IoT): A Mechanism for Enhancing Teaching and e-Learning in Higher Educational Institutes (HEIs)

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ABSTRACT

Education is an integral part of human being in society. People acquire knowledge and experiences through educational system in forms of formal or informal education. So many enhancements and innovations were introduced to improve quality of teaching and learning such as use of technology especially information and communication technologies (ICTs). Today, computing technologies keep on transforming from one stage to another. There is need to adopt these changes and transformations into education sector so that student can learn using recent innovations and technologies. This paper will explore mechanism to adopt Internet of Things (IoT) within higher educational institutes (HEIs). Student of this century uses smart devices and objects with network connectivity which sometimes tend to deviate their minds and attention from concentration on the studies. However, if HEIs can adopt the use of IoT within educational institutes by exposing the students to using these connected smart devices for learning purpose, it can yield to so many ideas and good results from them. The paper is descriptive and uses unified modeling language (UML) technique to depict the required mechanism for the adoption of the IoT in HEIs. Models were used in presenting the description.

Keywords: Education, ICT, IoT, HEIs, Teaching and Learning

1. INTRODUCTION

Internet technology has brought so many changes and transformation across various sectors and industries. Today, devices and objects are connected to communicate and share information with one another as well as empowered with decision making capabilities. This concept leads to what we have today as internet of things (IoT).

The term IoT refers to scenarios where network connectivity and computing capabilities are extends to objects, sensors and everyday items not normally considered as computers thereby allowing the devices to generate, exchange and consume data with minimal human intervention (Internet Society, 2018). IoT is all about advanced automation and analytics system which exploits networking, sensing, big data and artificial intelligence technology to deliver complete systems for a product or service. It gives system a greater transparency, performance and control when applied to any industry or system.

IoT systems have applications across industries through their unique flexibility and ability to be suitable in any environment. They enhance data collection, automation, operations and many more through intelligent devices with powerful enabling technologies (Internet Society, 2018).

Higher educational institutes (HEIs) are the organizations responsible for imparting knowledge to people. They provide avenues where students interact with the teachers in exhibiting their talents and potentiality. Teaching and learning in these institutions are usually done through classroom interactions. Introduction of IoT into education sector has brought a complete model for smart sharing of information and educational resources in the various institutions of learning. The IoT concept in education will usually provide three (3) dimensional impact model involving stakeholders, applications, and learning methods (Jain and Chawla, 2021).

Innovations and transformations have makes HEIs to adopt technological improvements in teaching and learning. Nowadays, most schools and colleges use ICT innovations in teaching activities as well as managing administrative requirements. The use email, learning management system (LMS), e-learning and management information system (MIS) are some of the innovations adopted in most of the HEIs. Students usually interact with teachers suing email ID, submit assignment and other assessment through LMS and other e-learning platforms (Mohammed *et al.*, 2017).

However, some of these students uses high level smart devices with network connectivity. This at times tends to deviate the minds of the students from giving

proper attention to the studies. They will be using the smart devices inappropriately such as spending too much time on social network or media like Facebook or WhatsApp etc. on things that are not educative.

IoT is refer to a network that connects any objects with the internet based on the specified protocols or procedures through equipment with information sensing capabilities. These equipment or devices conduct information exchange and communication with the view to achieve smart recognitions, positioning, training, monitoring and administration (Patel and Patel, 2016).

The communication media could be through radio frequency identification (RFID), wireless local area network (WLAN), wide area network (WAN) or any other means. Any or everyday objects include electronics and smart devices as well as objects that are not electronics such as food, clothing, chair, animal etc. IoT is a new revolution of internet that make objects recognize themselves as well as to obtain intelligence in making or enabling context related decisions. IoT is divided into three (3) categories which include people to people, people to machine, and machine to machine. It can also be characterized with issues like things-related services, heterogeneity, dynamic changes, enormous scale, safety and connectivity (Patel and Patel, 2016). They identified four different layers of technologies that usually stands as IoT architecture:

- a. **Smart device/sensor layer:** This is the lowest layer of IoT that consist of smart objects integrated with servers. The sensors create connection among the smart objects and devices with real-time information to be collected and processed. Most sensors usually require communication channel or connectivity to the sensor gateways such as local area network (LAN) like ethernet and Wi-Fi connections or personal area network (PAN) like ZigBee, Bluetooth and Ultra-Wideband (UWB). There are sensors that doesn't require connectivity to sensor gateways. In that case, they connect through backend servers or applications using wide area network (WAN) such as GSM, GPRS, and LTE.
- b. **Gateways and Networks:** this is the robust and powerful transportation medium with high performance in a form of wired or wireless network infrastructure.
- c. **Management Service Layer:** This layer handles data and information processing through analytics, security measures, process modelling and management of devices and sensors. IoT creates connection and interactions between objects and systems which in-turns provide

information in form of events or contextual data such as data related to temperature, locations, traffic, etc. This numerous data requires filtering and reordering according to intended recipients. Management service layer (MSL) handles that process and ensure a responsive IoT system.

- d. **Application Layer:** This brings about creating smart environments or spaces for both objects and sensors to interact and share resources or information. It covers domain areas like transportation, building, city, lifestyle, agriculture, healthcare, etc.

Sometimes, educators introduced the use of IoT in educational institutions for safety measures. This is achieved through wearable devices, video monitoring and threat detection within the educational institutions. It can be leads to improvement of learning and quality monitoring of learners and instructors (Palanivel, 2019). IoT can play significant role in improving quality of learning and enhancing performance of the learners, support teachers' daily routine activities, manage school premises as well as regulate school transport systems (Zeeshan, Hamalainen, and Neittaanmaki, 2022).

Therefore, this paper will explore the mechanism to adopt IoT within HEIs so that teachers and student can use their smart devices towards enhancing teaching and learning process. This can be achieved with the following objectives:

- i. To identify the benefits of IoT in HEIs
- ii. To provide stages of IoT implementation in HEIs
- iii. To provide model description of the implementation stages for successful development and deployment.

2. METHODOLOGY

The paper is a descriptive paper that uses model to describe benefits and stages of implementing IoT in higher educational institutes (HEIs). The modelling technique used is Unified Modelling Language (UML). Data were collected from the secondary sources (i.e., journals).

3. RESULTS AND MODEL PRESENTATIONS

This section presents the results of the study, it is presented according to the objectives of the study.

Table 1

Benefits of IoT in educational institutes are stated in the table below:

S/N	Benefits	Discussions
1	Smart Campus	Most campuses in HEIs are connected to the Internet, and consists of multiple objects like windows, doors, projectors, printers, classrooms, labs, parking, and building, etc. Adopting the use of IoT technology using sensors, RFID etc. can convert these multiple objects to smart objectives with high performance. A Smart Campus can be a collection of multiple smart objects in a single system which will turn the campus into intelligent campus containing features like smart E-learning Application with, smart classroom, smart laboratory, sharing of notes and mobile devices through sensors, smart-enabled hotspot for the entire campus. The smart campus can have additional features for smart tracking of students' whereabouts, smart corridors with smart notice boards can also be created for data processing and sharing.
2	Smart Classroom	Smart classroom will create an intellectual environment that is equipped with recent advanced and high-performance learning tools. These smart objects or tools can be cameras, microphones or other sensors that can be used to measure learning outcomes such as student satisfaction regarding the learning process and other classroom activities. It also eases the process of class management with lots of comfort to both teachers and students. For example, it makes it possible for teachers to decide when to speak louder especially when students are losing interest while lessons are going. Smart classrooms also allow teachers to know the learning requirement for each student as well as brings more productivity in HEIs.
3	Smart Classroom Attendance	In conventional classroom management, taking attendance of a class is usually a time-consuming task. Adoption of IoT can save time and enhance efficiency. A smart classroom roll caller system (SCRCS) with IoT architecture will collect or record students' attendance after every period accurately and timely. Sensors or RFID tags will be attached to the Students' ID cards.
4	Real-Time Feedback on Lecture Quality	The quality of lectures given by the teachers usually relates with students' understanding. Therefore, feedback from the students play a vital role to improve lecture quality. IoT-based smart classroom provides real-time feedback on lecture quality which will help to improve the lecture quality.

Source: Asif et al. (2017).

Table 2

Implementation Requirements for Adoption of IoT in educational institutes

S/No	Requirements	Discussions
1	Security & Privacy	In IoT environment, data are usually stored at an internet-based network of connected devices. There is need to provide high security and privacy measures. This will enable the school to have control over the personal information related to students such as medical record, family, financial background or any other private information.
2	Reliable Wi-Fi Connection	Since data are been stored at an internet-based network, there's need to have a high-speed wireless network that can provide bandwidth for audio and video streaming of lessons. This is because, the IoT deals with objects and at times dissemination of data/information will require use of audios or videos.
3	Management Planning	For proper and successful implementation of IoT, educational institutes must ensure that IT equipment as well as teaching approaches and styles support the use of IoT in the classroom.
4	Cost/Financing	Setting up IoT-based environment for learning will be expensive, therefore educational institutes can provide means of financing and maintaining the project. This will involve cost of equipment/devices, service providers, etc.

Source: Asif et al. (2017)

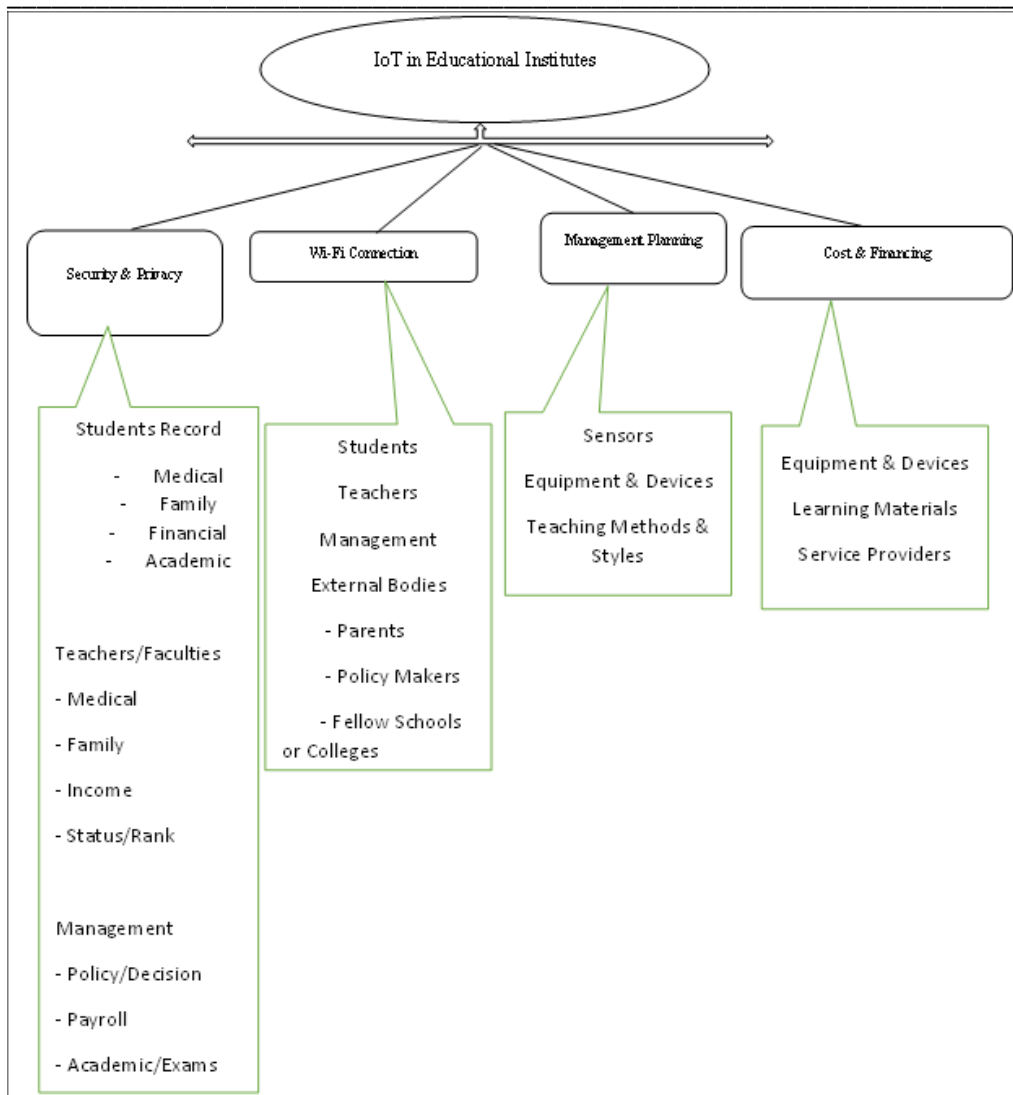


Figure 1: Model of IoT Requirements as Discussed on Table 2

4. CONCLUSION AND RECOMMENDATIONS

Education system is one of the sectors that adopts technological and innovation changes regularly especially in the area of information technology. Most institutes usually use e-learning platforms as well as management information systems for

record keeping within their institutions. However, students use smart phones and other devices while using some of these technological platforms.

Therefore, this paper provides a beneficial framework through which educational institutes can adopt the use of IoT in their respective institutions. This will make them link students with other learning objects in order to have a smart learning environment. The paper also provides the following recommendations:

- i. Institutions should provide learning platforms using smart devices
- ii. Proper orientation and workshop can be organized for critical stakeholders in order to have proper implementation

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