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# A Review of Internet of Things (IoT): Implementations and Challenges

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**ABSTRACT**

Internet of Things (IoT) or Internet of Everything is regarded as the third wave of technological innovations. IoT also can be considered as a global network which allows the communication between many things including human and things. It is the network of physical devices which is embedded and connected to allow for data to communicate. IoT project can be commercialized in the area of electrical controlling such as light, fan and any electrical device. The main objective of this paper is to provide an overview of Internet of Things, by examining the literature, describing implementations, identifying technology used and IoT challenges. It was found that the area for the implementations of IoT are including medical and healthcare, industry, home, building and city, communication, education and agriculture.

**Key words:** Challenges, Implementations, Internet, IoT, Technologies.

## 1. INTRODUCTION

The Internet is always an important tool at the moment. Therefore, many people would argue that the main features of the Internet are in line with national development. The widespread of Internet brought countless benefits to the world. It is not just a powerful tool for communication but also be said to be the strongest force for the purpose of learning [1], [2]. In education sector, the internet enabled students to learn easily through electronic learning without cost, time and space constraints [3]. This is also able to increase students' motivation to continue learning [4]. Having the internet in everyday life is also capable of taking and producing data in real-time. It is due to the development of smart phone technology and mobile communication standards [5]. It promises something useful and gives us a way to expand our perceptions and the ability to change the environment. The internet of things (IoT) is a mutually compatible computing device system to transfer data over the network without the need for human-human or human interaction to the computer. The Internet of things is a type of network used to connect devices using the internet with the purpose to monitor, to control, to predict and logistics [7] the things around. According to [8], the goal of the IoT is to enable things to be connected anytime, anyplace, with anything and anyone ideally using any network and any service. Through the implementation of IoT, everything can be handle smartly including the management of living, home, building, cities, energy, transportation, healthy and industry. IoT also offer specific object identification, connection capability and sensor. The purpose of this study is to review about the implementations and challenges of Internet of Things. This work is organized as follow: Section 1 for Introduction, Section 2 presents about Literature Review and Section 3 for Implementation of IoT. Meanwhile Section 4 discuss about Technologies Used for IoT Implementations, Section 5 for IoT Challenges and Section 6 for Conclusion.

## 2. LITERATURE REVIEW

Sensors commonly require a connection to the sensor entrance which can be provided by Local Area Network (LAN) or Personal Area Network (PAN) or using Area Network (WAN). Local Area Network (LAN) provides connectivity for Ethernet and Wi-Fi connection. Meanwhile Personal Area Network (PAN) provides for ZigBee, Bluetooth and Ultra Wideband (UWB) and Wide Area Networks (WANs) provide services like GSM, GPRS and LTE. IoT have been widely used for energy-saving [9], [10], enterprise information systems, water resource management and people with disabilities. According to [7], the implementation of IoT was discuss by clustering using application domain: monitoring [11]– [17], control[18], logistics and prediction. Among IoT applications that categorized in the monitoring domain are plant monitoring, air monitoring, , animal monitoring and water monitoring. IoT applications also can be categorized in the control domain, for example Illumination control, access control, irrigation control, Fertilizer and pesticide control. It also divided by sector: medical and healthcare [14], [19]–[23] manufacturing [7], [11], [13], [15]–[17], [24]–[26], automation, smart thing [9], [25], [27]–[30], communication [31]–[33], education and agriculture [7].

## 3. IMPLEMENTATIONS OF IoT

Implementation of IoT can be seen clearly now in any sector. It includes the implementation of IoT in the health and medical sectors, manufacturing, automation, residence, city as well as in the agricultural sector.

**Medical and Healthcare**

Having the internet for smart healthcare and medical also become benefit for society. However, it is also quite challenging with the present situation. The procedures for patient monitoring currently are executed manually by nursing staff. Using IoT, it can help in monitoring conditions of patients, control organic elements, medicines or vaccines. IoT implementations also can give an useful information for dentist or other people at the same field. According to [20], real-time monitoring, patient information management and healthcare management can be applied in modern health care environment. The need of care services that may reduce the time and costs is a primary issue which can be solved by using IoT technologies [23]. The implementations of IoT concept in the Medical and Healthcare sector can bring a positive impact and good implications. It encompasses overall health management that helps reduce healthcare costs and time, and at the same time improving outcomes [14]. According to [35], IoT based healthcare system also enable long term monitoring of personal health status, which the data can be stored, processed and transmitted for further processing and diagnosis.

**Manufacturing, Automation (Smart Industry)**

The industrial sector usually involves the automotive, supply chain management, transport and logistics. Industry areas are usually exposed to various pollution issues involving the environment. Through the use of IoT project, industrial sector also beneficial. It all are including detection of leakage and gas levels, chemical and underground mills, gas and oxygen levels monitoring, water level monitoring, maintenance and repairs. The implementations of IoT in these field may improve the service quality thus able to reduce the maintenance and operation cost [35].

**Smart Home, Smart Building, Smart City**

IOT implementation for home, building and city may provide connectivity for embedded devices. Through the implementation, it able to reduce the costs, increase comfort, and also improve safety and security [35]. Monitoring and management in urban areas is difficult to implement. It includes transport management, parking, safety, lightning, traffic and air quality monitoring. However, internet applications in residential, building and city management seem to be a solution to this issue. Everything can be managed more easily and can save time and energy. In addition, IoT can also benefits for waste management by detecting the level of waste in containers to optimize the garbage collection path.

**Agriculture**

Over the coming years, IoT also can play a role in helping farmers to meet the world's food demands. Example of implementation of IoT in agriculture sector is for the purpose of composting. It can be use to prevent fungus and other microbial contaminants. IoT also help the owner for the purpose of animal tracking [7]. Pasture or open-pit farming conditions make it difficult to search, then tracking through the internet make it is easy to find the animals. For field monitoring, it is able to reduce crop damage by better monitoring, obtaining accurate information and managing agriculture. This includes better control for fertilization and watering purposes. Table 1 show about the implementations of IoT.

**Table 1**: Implementations of IoT

| References | Field | Description |
|---|---|---|
| [14], [19]–[23] | Medical and Healthcare | healthcare system, patient monitoring, health status |
| [7], [11], [13], [15]–[17], [24]–[26] | Manufacturing , automation, industry | energy, air pollution, waste management, noise monitoring |
| [9], [25], [27]– [30] | Residential, building, cit | embedded devices, parking, vehicular pollution |
| [7] | Agriculture | farming, water monitoring |

Today's growing application is a smart-based environment. Examples of application are including Smart Home, Smart Healthcare, Smart City, Smart Retail, Smart Farming and Smart Parking [10]. All the mentioned application are with a variety criteria such as network size user, data management, energy, connectivity, IoT devices and bandwidth.

## 4.TECHNOLOGIES USED FOR IoT IMPLEMENTATIONS

Sensor networks are the important key that uses to gather the information needed by smart environments. A sensor network is needed because of easy and fast installation and maintenance. In such applications, running wired is not suitable to implement. Technology of Radio-frequency identification (RFID) and the wireless sensor networks (WSN) are key enablers for the IoT paradigm. RFID is an automatic technology used to identify objects through radio waves and seen as a prerequisite for the IOT purposes. RFID works by automatically identify things attached, to act as an electronic barcode which composed of: RFID tags, application system and reader [36]. It can be used across logistics, engineering, chemical industries, manufacturing, retail construction and many others. The benefits of using this technology are better security, higher productivity, increased revenues, improved quality, lower cost and also can reduced time. Through the connection, the readers can identify, track, supervising and monitor the any objects attached with tags

automatically and in real time [33]. The mentioned technology able to observe repeatedly the particular conditions, observing the move and supervising the activities with timely ordered sequence. Wireless sensor networks (WSN) consist of small nodes that are capable of detecting, calculating, and communicating wirelessly. It typically used for sensors that use low power and low data connection rates. WSN also accommodate more sensor nodes, maintain sufficient battery life and provide large areas coverage. Example of WSN environmental monitoring are indoor and outdoor applications. Four components that make up the WSN monitoring network are middleware, WSN hardware, communication stack and data aggregation.

## 5. IoT CHALLENGES

According to [6], [14], [37], among challenges of IoT development are relating to the security factor, privacy, interoperability, storage management, server technologies, and data center networking. In medical and healthcare area, ultra-low power design and real time constraints are among the challenges [35]. Security matter that involved in IoT are data confidentiality. According to [38], confidentiality refers to protecting information from being accessed by unauthorized parties. It is very important to ensure that the data is secure and only available to authorized users. People who are authorized to do so can only gain access to sensitive data. A breach of confidentiality means that someone gains access to information that shouldn't have access to it. According to [39], the users of IoT must be aware about the data management mechanisms and the process, to ensure that the data is protected. Other challenges that involved in IoT are privacy and trust. For example: providing trust of information in shared medium, providing secure exchange of data and providing protection mechanisms. Other challenges are regarding to interoperability. Traditionally, interoperability is the basic core value to make sure the connectivity between devices. Today, different industries use different standards with a variety of heterogeneous data and devices. Therefore, the IOT system needs to control the level of high interoperability.

## 6. CONCLUSION

As a conclusion, this paper highlight about the review of the IoT, including implementations and challenges. Area for the implementations of IoT including medical and healthcare, industry, home, building and city, communication[31]–[33], education and agriculture. Although it is known that internet applications have been used extensively in all life now, but there are still obstacles and restrictions on their use. Identification of these obstacles and restrictions can be improved and enhanced for a better future.

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