Enabling Technologies of IoT and Challenges in Various Field Of Construction Industry in the 5G Era: A Review

Sriparna Paul¹, Bibekananda Naik¹, Dilip Kumar Bagal²

¹Department of Civil Engineering, Bhubaneswar Institute of Technology, Bhubaneswar, Odisha, India
²Department of Mechanical Engineering, Government College of Engineering, Kalahandi, Bhawanipatna, Odisha, India

E-mail: bibekcivil10@gmail.com

Abstract. In this new age, the Internet and its usefulness became the backbone of people in our everyday lives and developed a corresponding wave of technological developments. One of the latest technological upgrade developments is the Internet of Things (IoT), which attracted researchers with great interest. Using this upgraded technology, we can interact with devices via Internet Sensors, actuators, or computers. The Internet of Things (IoT) is not a new concept in my research. We have been introducing it for decades, but incorporating IoT in the construction industry is a new exciting subject that leads us to the next Construction Industry 4.0 revolution. This paper offers an overview of IoT technology, tracks and classifies IoT Technology's position in various fields with exclusive studies and statistics. This analysis paper also focuses on various IoT applications in contemporary -day production strategies and addresses issues related to IoT implementation in production. This study paper also identifies key points to recognise the use of virtual technologies for building operations and lays a good basis for future studies for smart construction works. Researchers are also doing their best to introduce IoT technology in the field of civil engineering in order to provide trouble-free work in construction industries and to improve productivity, as the construction industry is least digitised.

1. Introduction
The Internet of Things (IoT) is now being considered as the next stage of the internet revolution and has become one of the trend-setting research for academic and commercial organisations Singh et. al [1] claimed that, after collaborating with IoT technologies, it is primarily possible to communicate face-to-face interface interactions or vehicle-to- vehicle interactions through the Internet by authorising innovative software programmes to assist sensors, actuators or devices according to their vision and needs. Condoluci et. al [2], Gupta, et. al [3] and Al-Fuqaha et. al [4] addressed the instability of expectations and fluctuations in launched technologies, but presents considerable problems in accessing large communication links This causes complex difficulties [5] as it is one of the key challenges. Several IoT creation attempts have been made, but something is still missing in one IoT vision conveyed by Sarkar et. al [6] and Kim et. al [7].
2. IoT Overview
Initially, Kevin Ashton, the founder of the MIT auto-identification centre in 1999, presented the idea of IoT [8, 9]. Ashton said, "The Internet of Things, like the internet, has the power to change the world or maybe even more" [8]. In 2005, the International Telecommunications Union (ITU) officially presented the IoT (ITU, “The Internet of Things” (2005)). Many organisations and researchers suggested many definitions of IoT.

Figure 1. The IoT can connect anything in anywhere using any path

2.1. Features of IoT
1. Ubiquitous Connectivity: IoT has become very famous due to its ubiquitous connectivity which is one of the important features of IoT because of this feature, it is being widely used. For example, using the two mobile phones, we can transfer the data, which was once upon a time a science fiction. We have not even thought that we could have smart phones today in our hands specially when the initial sets which we call GSM handsets or CDMS sets. We have not even thought about these things, but later on, Bluetooth was invented which enables us to communicate with another mobile phone.
2. Internet Protocol (IP)-based networking: IP based networking has helped in connecting and communication between the two electronic components using internet, the IP-based networking and it plays a very significant and important role.
3. Computing Economics: IoT is driven by industry investment in Research, Development and Manufacturing. There is something called Moore’s Law. It is one of the important feature that we need to consider here. Moore’s Law states that in a dense integrated circuit continues to deliver greater computing power at lower price and lower power consumption and doubles the number of transistors about every two years.

Many researchers continued their studies and resulted that by 2020, over 20 billion devices use IoT allows the device to control in lower expenses on the radio. With the help of IoT services, all the things can be connected in order to gather information and enable the devices to interact with each
other over standard and different protocol domains and applications. IoT Technology establishes advanced connectivity with the help of the internet in order to make the surrounding areas automated little by little among the devices or systems or devices, which are increasing day by day.

2.2. IoT Application

![IoT system](image)

2.2.1. Environmental Monitoring
Nowadays, most of the cities and university campuses are implementing IoT technologies in order to exchange the data and thus helps in emerging IoT network advances on computing and wireless communication technologies. The main objectives of advancements on emerging IoT networks are to simplify the administration process, manage real-time access control, monitoring the safety of the environment, and so on.

Marstijepović and Williams [10] described that in the surrounding area, any activities can be monitored with the help of IoT implementation that leads to environmental monitoring i.e. it monitors the quality of air, water, and soil and thus, creates a smart environment. In order to monitor the quality of the environment, applications of sensors are typically utilized so that a risk-free environment can be assessed to the individuals.

Palma et al. [11] studied that the Internet of Things connects all object to the web and make it accessible at any time. This paper also stated that most of the environmental monitoring system is using a distributed framework based on wireless sensor networks (WSN) in order to implement IoT Technology. For example: When we surf the net, we can find that on the right section, similar content page appears which are near to your favourite which is possible due to the embedded computing system in order to improve our life style.

2.2.2. Infrastructure Management
With the help of IoT devices, critical infrastructures can be controlled and also can schedule repair and maintenance activities by co-ordinating between different service providers and users of the facilities [12]. Meola, A. [13] stated that the application of IoT devices for infrastructure monitoring is likely to improve the quality of service and reduce the cost of infrastructure in emergency conditions. Zhang, Q. [14] stated that IoT Technology can be implemented in the field of waste management automatically and can be optimized as required.

2.3. Industrial Applications
In Industrial Applications also, the advanced IoT technology can be implemented in order to investigate the worth of products in real-time and boosts up the marketing. With the help of smart technology, the record will be automatically updated on asset placement in industrial storage and saves the labour time and money both at the same time within a short period.
2.4. Medical and Healthcare Systems
Da Costa et. al. [15], Sternberg et. al [16], Kricka, [17], Gatouillat et al. [18] stated that the IoT Technology also plays an important role for health and medical related purposed, data collection and analysis for research and monitoring. Other consumer devices such as wearable heart monitors or connected scales in order to encourage healthy living can encourage healthy living, which is only possible after the implementation of IoT Technology. IoT platforms can also monitor end-to-end health for chronic patients and can also help in managing medication requirements.

2.5. Building and Home Automation
IoT allows connect everything in a home that have the potential to monitor and remote control thus ensuring comfort, security and low energy consumption. The integration of smart devices in the built environment with IoT has helped the life easier for all.

2.6. Large Scale Deployments
Example of a large deployment is the one completed by New York Waterways in New York City to connect all the city's vessels and be able to monitor them live 24/7. The network was designed and engineered by Fluid mesh Networks, a Chicago-based company developing wireless networks for critical applications. The NYWW network is currently providing coverage on the Hudson River, East River, and Upper New York Bay. With the wireless network in place, NY Waterway is able to take control of its fleet and passengers in a way that was not previously possible. New applications can include security, energy and fleet management, digital signage, public Wi-Fi, paperless ticketing and others.

3. Application of IoT in Civil Engineering

3.1. Ready Mix Concrete

With the help of IoT Technology, the sensors can monitor concrete temperature, its maturity, relative humidity and communicate to our cell phones and computers wirelessly through the cloud while the concrete is being placed at the construction site, the concrete producer, contractors and engineers can monitor the concrete performance and make decision in real-time throughout the entire job.

![Figure 3. IoT application in concrete mixer](image)

Companies have developed the IoT technology in order to track the dispatched trucks to the delivery location and communicate real-time data on anything that changes to the concrete mix before delivery. The trucks are complete with a stainless steel probe and sensors including thermometer and accelerometer in order to transmit data to the on-board computer (OBC). The computer can then calculate slump and concrete volume for concrete monitoring. Sensors are available to monitor rebar...
corrosion rate, half-cell corrosion potential, electrical resistivity of concrete and many more, example – Smart concrete.

3.2. Structural Health Monitoring
Its leads to continuous monitoring of buildings for human safety, furnishes information about the alteration in a single part or in the whole structure caused by action of the environment, materials aging or accidental events. Typically, SHM systems monitors humidity, accelerations, temperature, compressive stress, tensile stress and building materials degradation. It leads to deployment of sensors (smart objects) in checkpoints. SHM System includes sensing and data acquisition subsystem, data management system and data access and retrieval system. IoT enabled-SHM System offers advantages in reduction of monitoring costs thus maintaining structural integrity for longer periods and reducing costs related to demolition and rebuilding.

![Structural Health Monitoring System](image)

Figure 4. Structural Health Monitoring System

4. Conclusions
Various studies have been conducted using IoT and its feasibility have been investigated in the field of civil construction. With the help of IoT Technology, Ready mix concrete temperature, its maturity, relative humidity can be monitored remotely which will help the concrete producer, contractors and engineers to monitor the concrete performance and make decision in real-time throughout the entire job. Structural health monitoring can be done for continuous monitoring of buildings for human safety and maintenance cost reduction. IoT enabled drone cameras can also help in mapping and also surveillances the construction site for better building of the structures. IoT comes up as a promising technology, which can help construction sector to work more efficiently.

References:
[1] Singh D, Tripathi G and Jara A J 2014 A survey of Internet-of-Things: Future vision, architecture, challenges and services. In: 2014 IEEE world forum on Internet of Things (WF-IoT): IEEE) pp 287-92
[2] Condoluci M, Araniti G, Mahmoodi T and Dohler M 2016 Enabling the IoT machine age with 5G: Machine-type multicast services for innovative real-time applications *IEEE Access* 4 5555-69

[3] Gupta A and Jha R K 2015 A survey of 5G network: Architecture and emerging technologies *IEEE access* 3 1206-32

[4] Al-Fuqaha A, Guizani M, Mohammadi M, Aledhari M and Ayyash M 2015 Internet of things: A survey on enabling technologies, protocols, and applications *IEEE communications surveys and tutorials* 17 2347-76

[5] Palattella M R, Dohler M, Grieco A, Rizzo G, Torsner J, Engel T and Ladid L 2016 Internet of things in the 5G era: Enablers, architecture, and business models *IEEE Journal on Selected Areas in Communications* 34 510-27

[6] Sarkar C, SN A U N, Prasad R V, Rahim A, Neisse R and Baldini G 2014 DIAT: A scalable distributed architecture for IoT *IEEE Internet of Things journal* 2 230-9

[7] Kim M, Ahn H and Kim K P 2016 Process-Aware Internet of Things: A Conceptual Extension of the Internet of Things Framework and Architecture *KSII Transactions on Internet and Information Systems* 10 4008-22

[8] Ashton K 2009 That ‘internet of things’ thing *RFID journal* 22 97-114

[9] Joshi G P and Kim S W 2008 Survey, nomenclature and comparison of reader anti-collision protocols in RFID *IETE Technical Review* 25 234-43

[10] Marstijepovic S and Williams S 2016 Environmental monitoring and field surveillance reference guide. pdf Available at http://www.undp.org/content/dam/montenegro/docs/publications/ee/WBEPandENVSEC/

[11] Palma D, Agudo J E, Sánchez H and Macías M M 2014 An internet of things example: Classrooms access control over near field communication *Sensors* 14 6998-7012

[12] Istepanian R S, Hu S, Philip N Y and Sungoor A 2011 The potential of Internet of things “m-IoT” for non-invasive glucose level sensing. In: *2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society*: IEEE) pp 5264-6

[13] Meola A 2016 Why IoT, big data & smart farming are the future of agriculture *Business Insider* 20

[14] Zhang Q 2016 *Precision agriculture technology for crop farming*: Taylor & Francis)

[15] da Costa C A, Pasluosta C F, Eskofier B, da Silva D B and da Rosa Righi R 2018 Internet of Health Things: Toward intelligent vital signs monitoring in hospital wards *Artificial intelligence in medicine* 89 61-9

[16] Engineer A, Sternberg E M and Najafi B 2018 Designing interiors to mitigate physical and cognitive deficits related to aging and to promote longevity in older adults: a review *Gerontology* 64 612-22

[17] Kricka L J 2019 History of disruptions in laboratory medicine: what have we learned from predictions? *Clinical Chemistry and Laboratory Medicine* 57 308-11

[18] Gatouillat A, Badr Y, Massot B and Sejdić E 2018 Internet of medical things: A review of recent contributions dealing with cyber-physical systems in medicine *IEEE internet of things journal* 5 3810-22