Study on Implementing Smart Construction with Various Applications Using Internet of Things Techniques

Harish Gopi Reddy, Venkatesh Kone

Abstract: ***In general, the construction industry lacks the change resistance due to which, there is no improvement in innovative style of construction, control over the assets and optimization of the construction process for better energy usage, resource allocation and assets management. Digital transformation is an ongoing challenge in the construction industry. Utilization of digital technologies to improve business process i.e. digitalization has enabled companies to reach great savings and earnings during the past decades. IOT is one such robust system which helps in rectifying the above problems. The future is Internet of Things which will transform the real-world object to the virtual world object. The purpose of this paper is twofold, first to identify and study the IOT applications relevant to construction industry and second investigate the factors which have hindered the implementation of IOT. The IOT sensors can use various types of connection devices such as Global Positioning System, Radio Frequency Identification, ZigBee Module, Wireless Sensor Network etc. It allows objects to be sensed and controlled remotely across existing infrastructure. The main aim is to identify different technologies in IOT to support Civil Engineering. Utilization of IOT applications to achieve smart design, Real time control, Safety working environment***

Index Terms: IOT, Smart Construction, Real Time Monitoring

I. INTRODUCTION

Internet of things in construction is ultimately about every day building materials thinking reacting, processing, and participating together as a completely intelligent, smart building organism. The phrase the Internet of things means any object or machine components connected with sensors to monitor operating conditions, performance levels and physical states in the construction industry. The Internet of Things (IOT) is an emerging concept that was first introduced by Kevin Ashton in 1999 to describe emerging global, Internet-based information service architecture. THE Internet of Things (IOT) is an ongoing innovation in which the objects of regular day to day existence will be furnished with microcontrollers, handsets for advanced correspondence. IT IS EXPECTED that around about 50% of the total population, will live in urban areas and surrounding regions by 2050. So, cities need to be smart, by utilizing latest technologies in construction. IOT uses sensors, actuators, and data communication technology in which the digital world is connected to the physical world forming a global network that enables the objects to be tracked, and controlled across a system life cycle [1]. Disposal of construction waste and recycling has become a serious issue in almost every country. Plasterboard waste management system was introduced to waste disposal management system where RFID sensors play a major role [2]. Smart construction not only offer improvements in the quality of life of the inhabitants, but also greatly improve efficiency regarding asset management, including intelligent transportation system, smart grids, street lighting management, traffic light management, waste management, environmental monitoring, water management, surveillance, and smart services [3]. Smart construction is that one uses information and communications technologies to make the construction services and monitoring more aware, interactive, and efficient. Smartness of a city is driven and enabled technologically by the emergent Internet of Things [4]. Wireless technique was developed to manage the drainage line, garbage collection, power supply and water distribution supply in smart city [5]. The damage process of the concrete structures was identified by using latest cement –based piezo-electric composite sensor [6]. Fig.1 explains the applications of IOT.

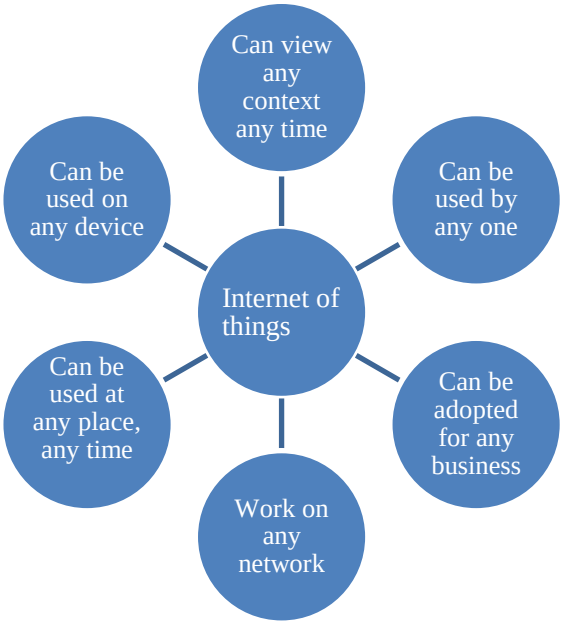

Fig.1: IOT

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Harish Gopi Reddy, Department of Civil Engineering, Koneru Lakshmaiah Educational Foundation (Deemed to be University), Vaddeswaram, Guntur, A.P, India.

Venkatesh Kone, Department of Civil Engineering, Koneru Lakshmaiah Educational Foundation (Deemed to be University)), Vaddeswaram, Guntur, A.P, India.

A. Smart Construction

Smart construction is building structure, design, construction and task that make full utilization of computerized advancements and industrialized technical strategies to enhance profitability, reduce life cost, increase sustainability and expand client benefits. Along these lines of working not only just change the construction industry, yet in addition expand the advantages of a home for the tenants and give them with a superior personal satisfaction and making more effective utilization of the people and assets accessible using smart sensors [7] In smart city construction it utilizes the available IOT devices or sensors for energy management, smart transportation, smart waste management system, smart lighting, etc.

In the Fig.2 graph the red bars indicate the number of internet users for the period 1995–2020 the blue bars show the number of devices connected to the internet, while the trend lines show a logarithmic growth for human users and exponential growth for number of devices connected.

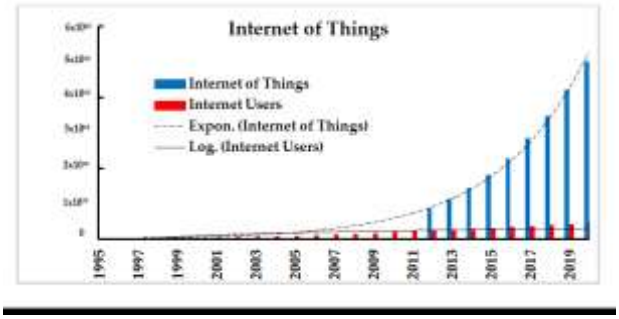

Fig.2: IOT Growth Data
(Source- Research paper [8])

A. Building Information Modeling

In BIM (building information modeling) we provide a digital representation of physical and functional characteristics of building facilities through intelligent AEC firms (architect, engineering and construction) the insight and tools to more efficiently plan, design, construct and manage building and infrastructure. It can provide information of plan in 3D (width, height, and depth) and further dimensions such as 4D (time), 5D (cost), and even 6D (as-built operation). Fig.3 indicates the detailed process of BIM.

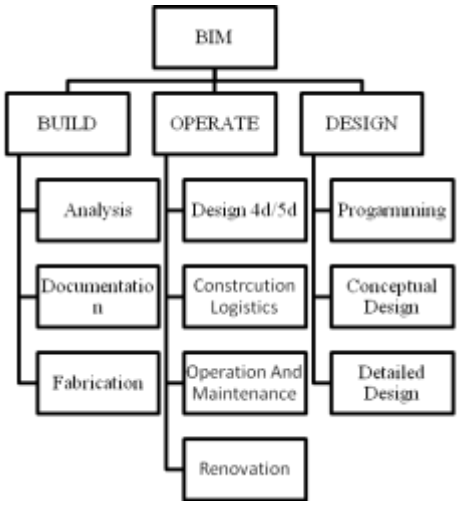

Fig.3: BIM Process

B. Primavera

It is primarily project management software, which has the ability to exchange ideas among the project participants. It is easy to operate and use the information of scheduling and resource allocation in construction projects. It is mainly used for Planning, Monitoring, Controlling and Reporting a project. It is used by the project managers in Construction field.

C. Global Positioning System (GPS)

Global Positioning system is used in many aspects of the construction industry. It comprises of satellites, ground control stations and client collectors. It has the ability of giving 3D arranges including focuses, lines and planes in a quick, precise and productive route under every single climate situation, it has been broadly used in various fields, e.g., geodesy, photogrammetric, marine looking over and mapping [9]

a. Surveying

Construction companies can save time and money in surveying locations when they work by utilizing the GPS units. Instead of training the employees for surveying they can issue GPS devices to their workers, because it's easier to use GPS devices to collect data about an area when compared to traditional surveying. They can obtain accurate and correct data by utilizing the GPS devices

b. Handheld and Vehicle Units

GPS connected vehicles can help drivers to find the location of a work site where they need to deliver the materials. Large projects can use GPS sensors to the vehicles to make sure that they meet the needs of a project

D. Radio Frequency Identification

Radio frequency identification is used to find the specific target through radio signals. It has ability to read and write corresponding data without mechanical or optical contact with the identification system. RFID consists of tags, readers and antennas [9]. Fig.4 represents the smart bin process.

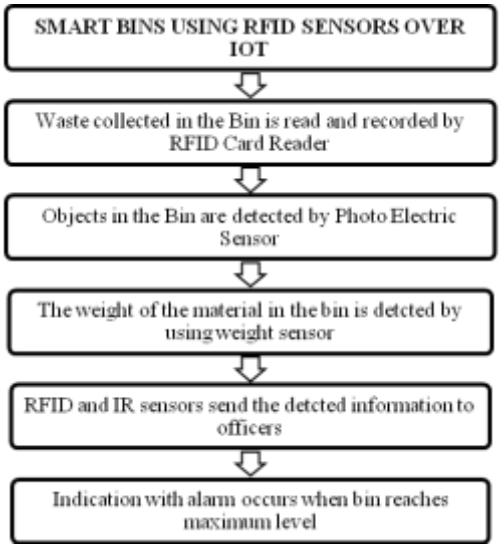

Fig.4: Smart Bin Process

E. Wireless ZigBee module

ZigBee is a new two-way wireless network technique. ZigBee is particularly targets low complexity, low power, low transition speed, low data rate, wireless sensor and low costs. ZigBee wireless mesh technology was developed for self-configuring and self-healing networks that provide a simple, effective cost and battery life for any applications (5) It can be implemented easily and support up to 65000 nodes depending on the topologies. It has a transmission range of 10-100meters. The ZIGBEE implementation process and applications is shown in the Fig.5.

Fig.5: ZIGBEE Implementing Systems

F. Cement Based Piezo-electric Sensors

Nowadays, structural health monitoring technology of concrete structures has a great importance due to which continuous monitoring and evaluating of damage process by means of acoustic emission AE signals.

A new cement-based piezoelectric composite sensor was introduced with latest performance, particularly concentrating on AE signals. Such sensors were installed in the foundation of reinforced concrete frames during construction, and used to monitor the damage of the concrete structures (6). Fig.6 shows the installed piezoelectric sensor in the column.

Fig.6: Installed Cement-Based Piezoelectric Sensor

II. RESEARCH SIGNIFICANCE

The research on IOT (Internet of things) in construction industry shows the difference between the traditional construction and smart construction. We know in the traditional construction general problems like delay in work, resources allocation, wastage in materials, cost over runs which may results in poor quality in construction. To reduce these uncertainties, IOT over smart construction will help in resolving the problems by using smart sensors and innovative technologies.

III. DESCRIPTION OF WORK

As we know conventional construction depends on the activities which are linked with each other activity, which means problem starts from funding, planning, execution, and monitoring. This paper consists of a smart construction technique like smart bins, Global positioning system, Radio frequency Identification, Wireless ZigBee module, Cement based piezoelectric sensors, etc. as a robust and innovative approach of construction project to improve the productivity, reduce the cost over runs, and discuss the importance of implementing IOT sensors in smart construction Different type of sensors are used in different phases. In each phase, commonly occurred errors with respect to the traditional construction are identified, Latest technologies and sensors available are implemented for reducing the errors and increase the work productivity. The implementation of sensors in different phases is shown in Fig.7

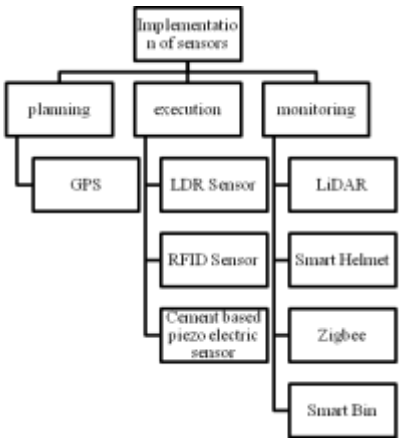

Fig.7: Implemnation of Sensors in Different Phases

IV. RESULTS AND DISCUSSIONS

Implementation of the IOT tools and sensors in the construction will modernize the entire construction industry rather than the traditional construction Smart construction will give more control over the employees, work productivity, Resource allocation, etc. By using sensors in the construction process we can provide a safety working environment in the site. Global positioning System, Radio Frequency Identification will improve the site supervision, tracking of material, etc. The construction project cost, operation and maintenance cost of the project can be reduced and controlled by using IOT tools and sensors.

After the completion of the project the maintenance and management of the energy in the building should be maintained well otherwise it will increase the energy consumption. Table 1 shows the energy management based on the IOT system

Table 1-Energy Management Based on IOT
(Source- Research Paper [3])

Area of Interest	Energy management capabilities facilitated by IOT mechanism
BMS (Building Management Systems)	IOT-based building –wide sensors for environmental control, IOT-oriented analytics for resource management. Provides the ability to measure, predict and define energy optimization actions based on defined parameters and time horizons
HVAC controls	IOT-based environment management based on a plethora of criteria such as but not limited to tenant, floor, heat/AC preferences, time-of-day, day-of-week, seasons, and number of people present. For example, control doors/windows during cooling/heating season, vents management, etc.
Energy consumption controls	IOT-enhanced building appliances that are modulated by Automated Metering Infrastructure – oriented techniques
Smart lighting	IOT based building wide sensors to control lighting based on people presence, time of day, natural light status, etc.
Lighting as a service (LaaS)	IOT based building wide sensors to support smart lighting with IOT oriented cloud-based system for lighting administration
Smart elevator service	Optimal elevator management which allows fast service while minimizing energy consumption
Data center / data closet optimal management	IOT based computer room AC (CRAC) management to optimize energy consumption
Remote/ centralized building management control	Manage a suit of building remotely/ centrally utilizing IOT sensors/ mechanisms there by ascertaining that optimal energy usage is achieved by having a complete dash board of all assets
Management of energy peripherals	IOT based management / monitoring of emergency generators, automatic transfer switches, digital metering, uninterruptable power supply
Integration with smart grid and with smart city	IOT-based effective integration into mechanisms offered under the auspices of smart grid and / or smart city for enhanced efficiency
Building related surveillance/ security	Building related security IOT based sensors and other present sensors, IOT specific analytics Building based access control IOT based access badges that control access to building area based on security level, time of day, etc.

V. CONCLUSION

IOT is a latest technology in which many things are connected with each other through internet. All these technologies tools and sensors are used in construction some of them are BIM, GPS, RFID, ZIGBEE, etc. IOT in construction deliver a change in present quality of life and productivity. The improvement in technologies is bringing great changes in our daily lives which help in making our life simple and comfortable by using various technologies and applications. Construction industry utilizes 60% of available materials in which 33% of wastage is generated and produces 45% of co_2 emissions. So, by using available IOT technologies and sensors we can control the terns.

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AUTHORS PROFILE

Harish Gopi Reddy Received the B.Tech Degree in Civil Engineering from Vikas College of Engineering and technology, Nunna, Andhra Pradesh, India. He is Pursuing M.Tech degree in Construction Technology Management from Koneru Lakshmaiah Education Foundation Andhra Pradesh. He actively participates in workshops and seminars in and around the University.

Venkatesh Kone, working as an Assistant Professor in Department of Civil Engineering at Koneru Lakshmaiah Education Foundation Andhra Pradesh. Since June 2017. M. Tech in Construction Technology and management from Viswasarayya National Institute of Technology, Nagpur, He published 01 (one) research article in International Journal of Computer Engineering and Information Technology (IJCEIT) and presently working on Research area, BIM and IOT applications in civil engineering He actively organized conferences, workshops and Guest Lectures in the Department of Civil Engineering, K L University.