



# IMPACT OF IOT (INTERNET OF THINGS) IN ARCHITECTURAL DESIGN AND CONSTRUCTION

Jayant G. Ingole

Associate Professor

College of Engineering & Technology, Akola.

**Abstract:** It is a well-known fact that the visualization of architectural design in 3D view is very necessary to enhance the execution and deployment rather than educate people. The Internet of Things (IoT) has been beneficial to visualize the things. Aside from traditional information collection from construction field using electronic devices such as telephone, mobile an internet based IoT technology with processed and refined data transfer enhances the system performance. IoT can improve things that contribute to a better decision making on time and also predicting the problems arises in advance. The working environment for architectural design and building construction because of IoT and AI is more realistic in nature also provides security through the use of smart cameras, and climate control is accomplished through the use of smart architectural design software. Smart rendering systems at large effective in providing more energy-efficient visualization. IoT on site means a live connection and a more collaborative future for taking decisions and managing the problems. IoT devices facilitates and made impact on every aspect of construction field and gives better access from remote places through communication channels.

**Keywords:-** IoT, Architectural design, BMI, Ecosystem, Green Building.

## I. INTRODUCTION

The construction industry is one of the oldest businesses that humans developed. Effectively all other industries rely on the construction to create their infrastructure and architecture Even after being so vital and impactful in our daily lives, the construction industry has been comparatively slower than various other sectors so the modernization of the construction industry is heavily needed to transform[5] Today architecture, urban planning, and designing are some of the most promising areas that can impact the economic and environmental future of humanity.

Architects and builders are changing the way they think about designing and building cities by utilizing multiple aspects of IoT app development[11] Technologies like AI, 3D Printing, Robotics, Big Data, and Virtual Reality are being used to bring in the revolution in the construction industry[10]. IoT is being used to solve issues at various levels, from complex multifactorial issues to uncomplicated design alterations. As one education professional said of the IoT, "It is not about the technology; it's about sharing knowledge and information, communicating efficiently, building learning communities and creating a culture of professionalism in all fields."

In this paper we made an attempt to present the impact of IoT on specific field of construction industry. As it is proven that IoT can improve things that contribute to a better decision making on time and also predicting the problems arises in advance. On site working environment for architectural design and building construction required constant supervision this provoke to use IoT and AI which gives more realistic in nature. It also provides security through the use of smart cameras, and climate control which is accomplished through the use of smart architectural design software. IoT on site means a live connection and a more collaborative by connecting more than two users simultaneously this lead to help for taking decisions and managing the problems. IoT devices established on site provides various types of data and also facilitates to refine the data at source. Thus made impact on every aspect of construction field and gives better access from remote places through communication channels.

## II. TRANSFORMING THE CONSTRUCTION INDUSTRY

Building Information Modeling (BIM) can be optimized through generative design, prediction of cost overruns using appropriate features, risk mitigation through the identification of the biggest risk factors on a job site, application of reinforcement learning to project planning, autonomous and semi-autonomous vehicles, labor deployment optimization, off-site construction and post-construction.[3] Several builders and construction companies are using mobile applications to improve efficiency, enhance safety, access real-time data, increase mobility and save time. There are many advantages of IoT in the construction industry because of availability of real-time data.

## 2.1 Tangible benefits of IoT in construction:

IoT and big data are transforming the construction industry in significant ways. These benefits fall into one of three main categories: reduced downtime, improved productivity and increased safety and security.[4]

### 2.1.1 Reduced downtime: With IoT, downtime can be abbreviated by

- Enabling preventive maintenance of assets.
- Leveraging mobile tools workforce management solutions to help reduce the time and costs of sending employees to inspect job sites and facilities.
- Automating time-consuming manual processes.

### 2.1.2 Improved productivity:

Digital transformation in the construction industry frees employees from time-consuming administrative tasks and reduces (or even eliminates) clerical errors by Automating and monitoring processes, machinery and equipment, thus reducing maintenance costs by taking preventive action. Collecting many types of data to facilitate decision-making for the project manager and educate employees on frequently asked questions. Remotely monitoring simultaneous job sites with IoT sensors (sensorization) and cloud analytics.

### 2.1.3 Increased safety and security:

Safety and security on the job are paramount, especially in today's transformed workplace. As job sites and workplaces look to resume business operations safely and securely, physical distancing regulations may be required for some time. With IoT-enabled wearable sensors, preventive warnings can be sent to employees who have compromised physical distance. The sensors can also monitor the environment and even track an employee's health.[6]. Tracking workers on the job ensures safety and improves site security without the expense of additional personnel.

### 2.1.4 Real-world use case and future outlook:

By leveraging IoT and big data, construction employees won't notice a significant change to the way they work. With most digital transformation occurring in the background, a steep learning curve can be avoided. The time for this must-have technology in construction is now. As the technology powering IoT-connected devices grows more sophisticated, industries must examine the value of incorporating them in operations and better understand the ROI of such an investment. Learn more about how Verizon can help you transform your business with innovative construction technology solutions

## III. THE INTERNET OF THINGS (IoT)

The Internet of Things (IoT)[1] refers to a network of interconnected computing devices. Mechanical machines, digital equipment, objects, and humans are all included. These are all assigned unique identifiers (UIDs). The ability to transfer data across a network without the need for human-to-human or human-to-computer interaction. The Internet of Things is essentially a network of various devices. This is linked to various software, electronic devices and systems, and network connectivity of various orientations. These are intended for the exchange, transfer, and compilation of various types of information. Many industries, including finance, travel, education, and telecommunications, have successfully implemented IoT.

### 3.1 Architectural Trends and Objectives

There are three components that form the basis of IoT architecture:

- Hardware: It comprises of sensor nodes, its embedded communication and interfacing circuitry.
- Middleware: It comprises of data storage, analysis and handling resources.
- Presentation layer: It comprises of efficient visualization tools that are compatible with various platforms for different applications and present the data to end-user in an understandable form.[1]

The parameters affecting the architecture of IoT are manifold. Hence, current research efforts have been made to devise the most optimized architecture that handles network issues such as scalability, security, addressability, and efficient energy utilization. [9]. As for the future, the number of devices connected to the network will rise. Hence, the architecture of IoT must cater to it. Scalability, energy consumption, and addressing issues are all considered as challenges for successful deployment of IoT. Research is carried out in solving the scalability issues by developing various multi-hop routing protocols covering a larger area and are self-adapting. These fall into three domains: 1) Data-centric, 2) Location-based and 3) hierarchical [2]. The energy consumption issues are addressed by using energy harvesting techniques [13].

### 3.2 Advantages of IoT in Construction [5]

- a. IoT enables real-time inspection of construction sites for easier control of operations
- b. IoT sensors used on construction equipment and vehicles help to locate and monitor them around the clock
- c. Locating and tracking materials and other resources using IoT will improve scheduling and coordination among between different teams involved in construction projects
- d. IoT can be used to generate equipment health data to guide maintenance operations for timely repairs and prevention of breakdowns
- e. Using IoT, paperwork can be reduced through digital record maintenance and real-time reporting which can save your business printing costs
- f. Using wearable tech improves labor health and safety
- g. IoT enables effective resource and asset management, which reduces the cost due to wastage of resources
- h. With the help of IoT devices on a construction site, the site inspector can track the workers on the site and respond to emergency situations aptly and rapidly
- i. IoT can increase revenue by driving cost-savings as well as enhancing overall construction quality

By using IoT in construction, managers and executives can have access to real-time data that can enable them to respond to exigent day-to-day situations promptly. On a broader, strategic scale, IoT data can help construction firms to analyze and improve

their operating procedures for further increase in efficiency, quality, and consequently, profitability. Considering how IoT is transforming businesses in every other sector, there is little doubt regarding the fact that IoT will transform construction companies and the sector as a whole.

#### IV. WAYS THE IOT IS IMPACTING DESIGN AND CONSTRUCTION

The Internet of Things (IoT) is transforming every part of the building construction that to be considered, plan and manage them. There is a big ecosystem around us, and protect the ecosystem. [13]. We plan to examine the trends being driven by IoT across the buildings ecosystem. Since the lifecycle of building begins with design and construction there is need to explore some ways that the IoT is radically transforming building design and construction.

##### 4.1 Building information modeling:

Building information modeling (BIM) is a process that provides an intelligent, 3D model of a building. Typically, BIM is used to model a building's structure and systems during design and construction, so that changes to one set of plans can be updated simultaneously in all other impacted plans. Moreover BIM can also become a middleman for smart buildings projects. [3] While constructing a building and when building is up and running, a required data from IoT sensors can be pulled into the BIM. You can use that with computational data to model things like humidity level, energy usage patterns, temperature trends or people movement throughout a building. The output from these models can then be analyzed to improve future buildings projects. Beyond its impact on design and construction, BIM also has important implications for the management of building operations.

##### 4.2 Green building:

The construction industry is a huge driver of landfill waste – up to 40% of all solid waste in the comes from the buildings projects. This unfortunate fact has generated interest in sustainable architecture and construction.[4] But the green building movement has become about much more than keeping building materials out of landfills. It is very much influencing the way of design and execution of building systems themselves, allowing buildings to reduce their impact on the environment through energy management.

Today's green buildings are being engineered to do things like shut down unnecessary systems automatically when the building is unoccupied, or open and close louvers automatically to let in optimal levels of natural light.

##### 4.3 Useful Prefab:

Using prefabricated building components can be faster and more cost effective than traditional building methods, and it has an added benefit of creating less construction waste. However, using prefab for large commercial buildings projects can be very complex to coordinate. The IoT is helping to solve this problem.

Using identification sensors, individual prefab parts can be tracked throughout the supply chain. Since the building occupies a relatively small footprint but required large prefabricated components, it was a logistically complex task to coordinate the installation. An electronic devices having RFID data was used to help mitigate the effects of any downstream delays in construction. In addition, the data was the fed into the BIM once parts were installed, allowing for real time rendering of the building in progress, as well as establishment of project controls and KPIs.[4]

##### 4.4 Construction management:

Well planned and systematic execution always save time and ultimately saves money, so any delays on a construction project can be costly. So how do you prevent your critical heavy equipment from going down and backing up all the other trades on site? With the IoT![6]

Heavy construction equipment is being outfitted with sensors, which can be remotely monitored for key indicators of potential maintenance issues like temperature fluctuations, excessive vibrations, etc. When abnormal patterns are detected, alerts can trigger maintenance workers to intervene early, before critical equipment fails. Performing predictive maintenance in this way can save time and money, as well as prevent unnecessary delays in construction projects using IoT.[8]

#### V. CONCLUSION AND FUTURE SCOPE:

Now a day the objects around us are becoming smarter due to the innovations in technology. The Internet of Things (IoT), the new technological paradigm is connecting various objects around us. Below is a summary of some IoT technologies that are improving outcomes on the construction job site. The construction industry bring the real time information into process that are 50 years old, IoT devices and sensors are collecting on job site required data which is processed, refined, efficient, also more cheaper and effective way than previously used traditional way.

These are now realizing the significance of introducing technology, especially IoT. Very soon, many companies will have IoT embedded into their day-to-day activities. This Internet of Things integration into the architectural design and construction brings them to new horizon to cater the need of developing and developed countries. It can be effectively use to enhance accuracy also save money, and for other specific needs. Our understanding of Construction must shift if we want to integrate IoT into them. Therefore, the IoT can have a significant impact on Architectural design and construction education in the long run.

Future scope includes simulation testing smartphones functionality and ease of use, small construction sites and can be extended for the use of disaster management.

## REFERENCES

- [1] Al-Qaseemi, S.A., Almulhim, H.A., Almulhim, M.F. and Chaudhry, S.R. (2016), "IoT architecture challenges and issues: lack of standardization", in 2016 Future Technologies Conference (FTC), IEEE, pp. 731-738.
- [2] Bari, N., Mani, G. and Berkovich, S. (2013), "Internet of things as a methodological concept", in 2013 Fourth International Conference on Computing for Geospatial Research and Application, IEEE, pp. 48-55.
- [3] BIM Engineering U.S (2018), "Top 8 applications of IoT in construction industry", available at: <https://medium.com/@bimengus2017/top-8-applications-of-iot-in-construction-industry-d08dc3fbe2a6>
- [4] Chandanshive, V.B. and Kazi, A.M. (2017), "Application of internet of things in civil engineering construction projects-a state of the art", in Proceedings of the 11th INDIACom, 4th International Conference on Computing for sustainable global development, Vol. 4, pp. 1836-1839.
- [5] Da Xu, L., He, W. and Li, S. (2014), "Internet of things in industries: a survey", IEEE Transactions on Industrial Informatics, Vol. 10 No. 4, pp. 2233-2243.
- [6] Ding, L.Y., Zhou, C., Deng, Q.X., Luo, H.B., Ye, X.W., Ni, Y.Q. and Guo, P. (2013), "Real-time safety early warning system for cross passage construction in yangtze riverbed metro tunnel based on the internet of things", Automation in Construction, Vol. 36, pp. 25-37.
- [7] Gershenfeld, N., Krikorian, R. and Cohen, D. (2004), "The internet of things", Scientific American, Vol. 291 No. 4, pp. 76-81.
- [8] Dave, B., Kubler, S., Främling, K. and Koskela, L. (2016), "Opportunities for enhanced lean construction management using internet of things standards", Automation in Construction, Vol. 61, pp. 86-97.
- [9] Matharu, G.S., Upadhyay, P. and Chaudhary, L. (2014), "The internet of things: challenges and security issues", in 2014 International Conference on Emerging Technologies (ICET), IEEE, pp. 54-59.
- [10] Perera, C., Liu, C.H. and Jayawardena, S. (2015), "The emerging internet of things marketplace from an industrial perspective: a survey", IEEE Transactions on Emerging Topics in Computing, Vol. 3 No. 4, pp. 585-598.
- [11] Syamsul, H.M., Laromi, A. and Rashidul, I. (2018), "Potentials of internet of things (IoT) in malaysian construction industry", Annals of Emerging Technologies in Computing (AETiC), Vol. 2 No. 4.
- [12] Tang, S., Shelden, D.R., Eastman, C.M., Pishdad-Bozorgi, P. and Gao, X. (2019), "A review of building information modeling (BIM) and the internet of things (IoT) devices integration: present status and future trends", Automation in Construction, Vol. 101, pp. 127-139.
- [13] Wei, C. and Li, Y. (2011), "Design of energy consumption monitoring and energy-saving management system of intelligent building based on the internet of things", in 2011 international conference on electronics, communications and control (ICECC), IEEE, pp. 3650-3652.

