

DIGITIZATION IN CIVIL ENGINEERING

¹Adiraju Durga Architha, ²Chava Srinivas

¹Student, ²Professor and Head of the Department,
¹Civil Engineering,

¹Velagapudi Ramakrishna Siddhartha Engineering College, Vijayawada, India.

Abstract : Considering the importance of construction industry, it is surprising that innovation and digitization were neglected over past years. Digitization, innovation and industrialization are the steps which lead to efficiency, effectiveness and new opportunities. Presently, digital experts are ruling the world. In contrast, the construction industry is the least digitized one and innovation in this sector will result in cost reductions, new business opportunities, enhanced safety and effective resource utilization. Moreover, in future, advances in technology will alter the way in which professionals plan, design, build, address risk and increase profits. So far, digital engineering has partly revolutionized the infrastructure sector with precision being the key factor. This revolution which is also called Fourth Industrial Revolution also marked the beginning of the information age. This article provides a broad classification and through discussion of existing digital technologies and feasibility of their application in construction industry.

IndexTerms - Digitization, Big data, Internet of things, Artificial intelligence, Virtual Reality, Augmented Reality, Mixed Reality and Robots.

I. INTRODUCTION

Construction industry is mainly concerned, with the improvement in quality of basic needs of human civilization of the naturally and humanly built environments through planning, designing, construction, operation and maintenance. The burgeoning journey of digitization in the world also started taking roots in the construction industry. The technology enables us to integrate data about building design, construction and future function to develop most efficient methods of delivery. Digitization of construction process will significantly reduce risks and enhance bankability of infrastructure projects, besides improving their viability and asset life cycle. However, construction industry is one of the late bloomers to reap the benefits of digitization.

The present trend of digitization makes the dynamic flow of data between office and site then bridges the gap, allowing the digital world to better represent and interact with reality. It can help us to deliver the project on time, at reduced cost, and with a quality and precision that changes the way we operate and manage truly smart infrastructure. Innovation and technological process make this hugely exciting time to be a civil engineer.

The fourth industrial revolution is the digital revolution. Industry 4.0 refers to the next step in industrial technology, with robotics, computers and equipment becoming connected to Internet of things. Focusing on construction industry, as it is our main concern the babies of digitization already started crawling into it. Advances in sensor technology and connectivity modules have allowed more parameters to be measured and monitored. With this accessibility, managers and executives can improve the efficiency and productivity of whole operation. It is important for the construction industry and the related people, to grow in the tech space as it might result in role exchange as the time passes. Those who don't would pick their own bone very soon. The rest of the paper is organized as follows. In section 2 important digital technologies are described. In section 3 different innovations for smart construction are discussed in terms of complexity, performance and feasibility. Finally conclusions are made in section 4.

II. WHAT HAPPENS WHEN TECHNOLOGY ENTERS THE CONSTRUCTION WORLD?

After computers, technologies such as Internet of things, Big Data and Artificial Intelligence made a big impact on industry, communication and economic environments. Many do not know how these technologies are linked, or how they have paved the way for the technological progress. Well, these technologies have also stepped into the construction world, to provide smart homes for the smart living of the people.

Internet of things

Internet of things can be defined as the inter-connection between the computing devices embedded in everyday objects, enabling them to send and receive data. In short internet meets the things i.e. the physical world meets the internet. There are a few sensors for sensing air, temperature, motion, water flow, size etc. These sensors are like the human body sensory organs. Once the sensors are connected to internet, all the information sensed by the sensors will be accessible, thus enabling the user to monitor the physical world. In construction field, the physical world includes job sites, workers, air conditioners, wearable devices and various instruments used in the construction and maintenance of the building. By using IoT on site scenarios can be monitored in real time.

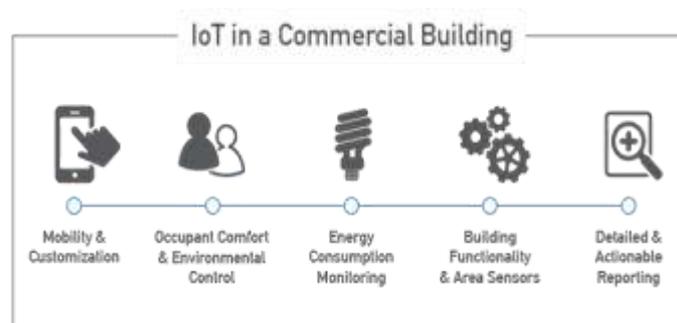


Fig.1

The advantages of real time monitoring through IoT include:

- Risk evolved on site can be mitigated and jobsite productivity can be increased.
- The information regarding energy consumption shall be provided and altered to save energy without compromising efficiency.
- In building information modeling, all the information required is acquired by IoT sensors.
- Building owners can attract good tenants and tenants can be benefitted with low operational costs
- When buildings are enabled with IoT, it increases the level of comfort for the people who live in them.

Big Data

Big Data is a term used to describe a collection of data that is huge in size and yet growing exponentially with time. It is a massive volume of both structured and unstructured data that's so large that it is difficult to process using traditional techniques. In construction industry, huge quantities of information are stored in the past and that information must be acquired today. Storage and transformation should happen quickly for the construction organization to achieve its goals in time. Traditional information systems are good at recording the information yet they have their limitations in their ability to work with certain kinds of information. This calls for the requirement of big data in construction industry. Big data from weather, traffic, and community and business activity can be analyzed to determine optimal phasing of construction activities. Big data from sensors built into buildings, bridges and any other construction makes it possible to monitor each one at many levels of performance.

Artificial Intelligence (AI)

Artificial intelligence is the ability of a computer or computer-controlled robot to react like humans. It is mostly used in decision making, risk analysis and prediction. Many problems that arise in construction industry are complex and are quite difficult to solve correctly and quickly. Through AI, the extent of understanding a problem is explicit. In all the stages of the project AI can generate plans by considering all the parameters. Therefore, it can reduce the cost and efforts in construction and management.

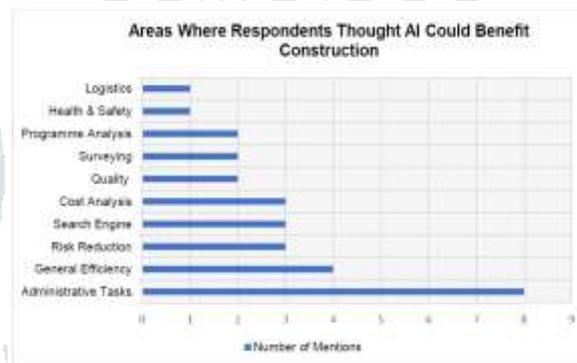


Fig.2

Few advantages of AI in the construction industry are

- Helps to complete and deliver the project within the budget.
- AI and machine learning will reduce the risk on the job site.
- By performing the repetitive tasks more efficiently than humans such as concrete pouring, bricklaying, welding and demolition, it thus makes job sites more productive.
- It addresses labor shortages.
- AI monitors the developing problems in the structure and offers solutions to prevent them.

Virtual Reality, Augmented Reality and Mixed Reality

Virtual reality and augmented reality are two ways in which technology can change the way we look at world. They have a remarkable ability in altering our perception. Virtual reality enables the customers see their design with a good perspective. Multiple monitors form large screen in which the user can visualize the location, orientation of the site and three-dimensional representation of the plan.

Unlike virtual reality, augmented reality doesn't shut the world out completely but enables the user to see an enhanced version of reality. Through augmented reality we are creating exposure to the project before actual construction, this gives the client better perception and will also let the inexperienced employees learn and understand better.

A combination of both virtual reality and augmented reality is the mixed reality. In short, blending of physical world with digital world results in mixed reality. Mixed reality it transforming the way in which construction experts interact with the information. Workers can use this as a leverage to complete the work in due time. Errors can be minimized and projects can be delivered on time. Precise collaboration and project coordination can be achieved by this.

III. INNOVATIONS FOR SMART CONSTRUCTION

Robots

The biggest challenge construction industry is facing today is the shortage of skilled labor. Robots have always proved themselves to be reliable, efficient and cost-effective. For reaping maximum benefits, industrialists started to let in robotics into the construction world. It's a smart move from their perception, because seasonal severities don't hold robots from doing work. Hence it is safe and timely to bring in robotic labor. Traditional construction practices also, can be automated by robotization. The work

will be qualitative and intelligent improving constructability. It also represents significant time and financial savings. In the next five years, mobile robots will be seen, not as a replacement of human being but to work collaboratively, to increase the productivity and decrease the physical strain on workers, so that the best of each kind of skills will be utilized efficiently.

Drones

What's feasible vision? Of course, the most convenient vision. For this purpose, deployment of drones took place, i.e. to visualize the work in progress and work left over. Drones are also used to collect data from the jobsites. Regardless of where drone technology is used across the project lifecycle, construction companies will benefit from cost reductions by automating human work such as site inspection, surveying, and progress tracking.

By using drones work stored material or material used in work site can be monitored. The aerial pictures taken by drones are used to make good estimations about the material. They identify water pipes, sewers, phone lines, fiber optic cables power lines, etc. They capture all this data and feed it into digital planning tools. As the cost and time pressures are increasing so are the quality expectations. So, to keep a check of everything, visualization is an important factor that contributes to efficiency. Usage of drones under industry sector is shown below.

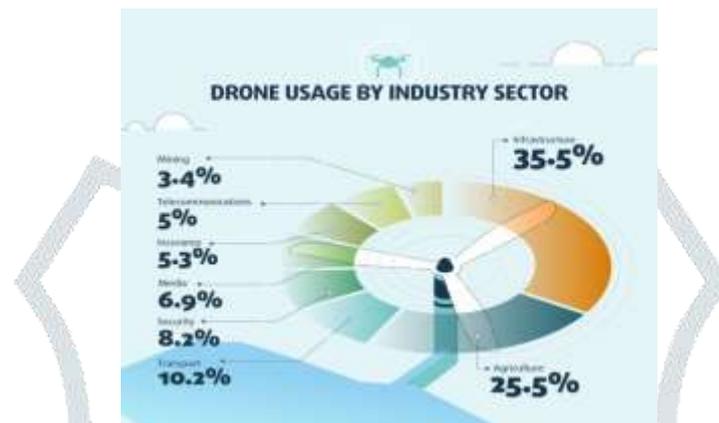


Fig.3

Building Information Modeling

A building information modeling is a digital representation of physical and functional characteristics of a facility. BIM can create an accurate model that is useful throughout the entire life of the building, from initial design period to after occupancy period. Ideally, a BIM would be created in the early stages of the design, then it is updated and refined continuously as the facility is built. Post-occupancy, the BIM would be used by the owner and owner's maintenance team to improve understanding of building operation and to make adaptations, renovations, additions and alterations at low cost when compared to traditional processes.

SAP

SAP is software for designing a mathematical model of, and mechanically analyzing civil structures like everything ranging from cable-stayed bridges to concrete walls. Its significance lies in the fact that, civil engineers can begin with their designs and then they can go for analysis and the software tells them how the structure will behave under the applied conditions set by the operator. The software is able to itself optimize the structure and change the materials used for different parts of the structure from the list provided by the operator while creating the model. All the information regarding to building shall be updated on the dash board. In case of repairs, the dashboard shall be displayed with nearby skilled persons to repair it. Cost estimations, risk alerts, materials, design etc are functions carried out by it. By using SAP seismic behavior of building which easily fail during the occurrence of earth quake can be analyzed.

IV. RESULTS AND DISCUSSION

This paper provides an extensive study of digitization techniques available for adaption to civil engineering discipline especially in the construction industry, with an aim to ease the work and improve the quality of life. It's a well-known fact, that construction is one of the least digitized industries. Productivity in construction industry has grown a mere 6% since 1945 compared to manifold in agriculture or manufacturing. Through the possibilities given by digitization, players in the construction industry have all kinds of ways to boost their productivity. If the "construction firms of the future" use digital tools for material supply, it will result in cost reduction of storage and transportation, thus increasing efficiency. However, despite its potential benefits in terms of improvements in productivity and quality, digitization concept is yet to gain attention and application in the construction industry.

REFERENCES

- [1] Construction trends <https://constructible.trimble.com/construction-industry/2019-construction-trends-8-topics-to-watch-in-the-year-ahead>.
- [2] SAP <https://www.sap.com/india/industries/engineering-construction-management.html>
- [3] Big data, IoT and AI <https://www.seriu.co.uk/iot-big-data-ai/>
- [4] The Future of Construction Is Coming, and It's Driven by IoT <https://constructible.trimble.com/construction-industry/the-future-of-construction-is-coming-and-its-driven-by-iot-infographic>

- [5] Drone deployment <https://viewpoint.com/en-gb/company/news/viewpoint-and-dronedeploy-form-partnership-to-use-new-apis-which-integrate-drone-imagery-with-project-management-software>
- [6] Sumana Rao, "Getting smart on site", <https://constructible.trimble.com/flipbooks/getting-smart-on-site-everything-you-need-to-know-about-iot-smart-construction>
- [7] Benefits of AI in construction <https://constructible.trimble.com/construction-industry/the-benefits-of-ai-in-construction>
- [8] Richard Van hooijdonk (2018) Inspiration series: The future of construction <https://www.richardvanhooijdonk.com/ebooks/de-toekomst-van-de-bouw/>
- [9] 5 takes on the state of AR and VR in construction <https://www.autodesk.com/redshift/ar-construction/>
- [10] Temidayo. O. Osunsanmi et al "Construction 4.0: The future of construction industry in South Africa", International journal of Civil and Environmental Engineering, Volume 12, Issue 3, 2018.
- [11] Remodeling Construction Industry with Digitization, BIM and Reality Capture <https://www.geospatialworld.net/article/how-re-modelling-construction-digitizing-industry/>
- [12] Alexander Jenson "Digitization in the construction industry", Thesis in the Management and Economics of Innovation Programme (E2017:106) 2017.
- [13] A.Prabha "IoT of Civil Infrastructures", International journal of research in advanced technology, Volume 1, Issue 6, 2017.
- [14] YouseokKang "Big Data analytics in Civil Engineering: The case of China", SSRG International journal of civil engineering, Volume 4, issue 10, 2017.
- [15] Akshatapatil et al "Artificial Intelligence as a Tool in Civil Engineering – A Review", IOSR Journal of computer engineering, 2017.
- [16] Somayyamadakam et al "Internet of things(IoT): A Literature Review, A journal of computer and communications, 3, 164-173. 2016.
- [17] Oleg KAPLIŃSKI et al "Big Data in Civil Engineering: A State of-the-art survey", Emirates journal for engineering research, Volume 8, Issue 4, 2016.
- [18] Nikesh Gonchawar et al "IoT based smart agriculture", International journal of advanced research in computer and communication engineering, volume 5, issue 6 2016.
- [19] T. Subramani et al "Earth quake resistant building using SAP", International Journal of Application or Innovation in Engineering & Management, Volume 5, Issue 5, 2016.
- [20] AjangBehzadi "Using Augmented and Virtual Reality Technology in the Construction Industry", American journal of Engineering research, Volume 5, Issue 12, 2016.
- [21] S.M.S. Elattar "Automation and Robotics in construction: Oppurtunities and challenges", Volume 13, Issue 2, 2008.

