SMART BUILDINGS AND CONSTRUCTION SITES WITH INTERNET OF THINGS

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Abstract. The construction industry is one of the largest and most important industries in the world. Despite its significance, the industry is known for being slow to adopt new technologies, which has led to many inefficiencies and challenges. However, the emergence of the Internet of Things (IoT) is changing that. IoT is transforming the construction industry by providing new ways of managing job sites, improving safety, and increasing efficiency. The main focus of IoT today in the building sector is to assist facility and project management with supervision of real estate. Sensors that send information about the state of devices decreases the time of operating technicians.

Introduction. The Internet of Things (IoT) is transforming the construction industry by providing new ways to improve efficiency, safety, and project management [1, 2]. IoT technology enables real-time data collection, analysis, and communication between construction equipment, workers, and project managers. Here are some key roles and applications of IoT in the construction industry: IoT sensors attached to construction equipment, such as bulldozers, cranes, and excavators, can monitor equipment health and performance in real-time. This data allows for predictive maintenance, reducing downtime and costly repairs; IoT sensors can be deployed throughout construction sites to monitor safety conditions. They can detect hazards such as excessive noise, vibrations, temperature extremes, and the presence of toxic gases, helping to prevent accidents; IoT-connected cameras and sensors provide real-time surveillance of construction sites. They can monitor progress, security, and compliance with safety regulations, IoT-enabled construction equipment can be semi-autonomous or fully autonomous; IoT solutions facilitate real-time data capture and reporting, reducing paperwork and streamlining compliance documentation and reporting processes; IoT sensors can monitor energy usage on construction sites and optimize lighting, HVAC, and other systems for energy efficiency.

Fundamentals of IoT. IoT is the interconnection of devices that collect and exchange data all over the world [3-6]. These devices are created with sensors and software that enable them to communicate with each other and with other systems. When determining the optimal communication method, the performance characteristics and energy consumption for wireless networks should be taken into account. Generally, a high-performance communication method uses more power.

Network of sensors that send information to each other without direct contact with the hub called mesh computing. This method reduces the number of required hubs in a system and the communication range.

Huge construction companies are beginning to realize benefits of IoT technology and are exploring ways to integrate them. There are some of the top-used cases of IoT in construction:

1. Fleet Management (introducing automated tracking of both vehicles and essential equipment) IoT technologies are steadily redefining fleet management, changing traditional methods by introducing automated tracking of both vehicles and essential equipment. This advancement is improving safety measures and elevating site monitoring effectiveness.

This technological advancement in fleet management, powered by IoT, represents a significant progress in how construction companies manage their fleet of vehicles and machinery.

2. Tools and equipment (tracking tools, equipment, and machines on construction sites). IoT devices enhance productivity and reduce operational costs by enabling precise monitoring. GPS trackers equipped with IoT sensors are strategically used for accurate location and supervision of equipment and vehicle fleets.

3. Machine control is a major aspect of IoT in construction, offering a new decision in machine operations and real-time updates on progress, movement and status. This connectivity allows us to use strategic planning and synchronization of various construction tasks, improving productivity and reducing time. Mainly used in heavy civil construction.

4. Construction site safety. The advent of IoT technology in construction has increased the safety standards of the site. IoT sensors can actively monitor worker health and safety, monitor site condition and generate real-time maps to update potential risks. Smart wearable technologies, such as helmets and boots connected to IoT systems, track vital signs and positions, alerting workers to dangerous situations and even effectively monitoring staff.

These safety sensors can play an important role in accident prevention:
• Alert operators or stop heavy construction machinery when approaching workers.
• Monitoring of environmental hazards such as toxic gases, soil deformation or extreme temperatures.
• Alert staff when environmental measures indicate safety levels. Project Management and site monitoring.

Fig. 1. IoT technologies in construction and IoT sensors on construction site [3-6]

Integrating IoT technologies into established additive manufacturing processes opens up opportunities for companies looking to increase productivity along with improved quality assurance. Compared to traditional methods, IoT-based methods can help reduce overhead costs throughout the additive manufacturing industry. In general, the integration of the Internet into additive manufacturing can significantly contribute to the construction of the new era of Industry 4.0 (figure 3), which is a technological future with intelligent factories.

According to the Boston Consulting Group, there are nine main technologies that make up Industry 4.0 [7]: autonomous robots, simulation, horizontal and vertical system integration, industrial Internet of Things, cyber security, cloud, additive manufacturing, data and analytics, and augmented reality (Fig. 2).

Smart buildings and homes. In a nutshell, a smart building is a type of construction where multiple sensors collect needed information automatically. Sensors are usually connected with the

help of the IoT technologies and enable remote monitoring and management of the smart space (Fig. 3).

These sensors allow us to measure humidity and temperature level in inner part of the building over a specified period of time. It`s usually called smart temperature and humidity. The received data is fed into the central control system, which activates heaters, chillers or humidifiers depending on the specified settings.
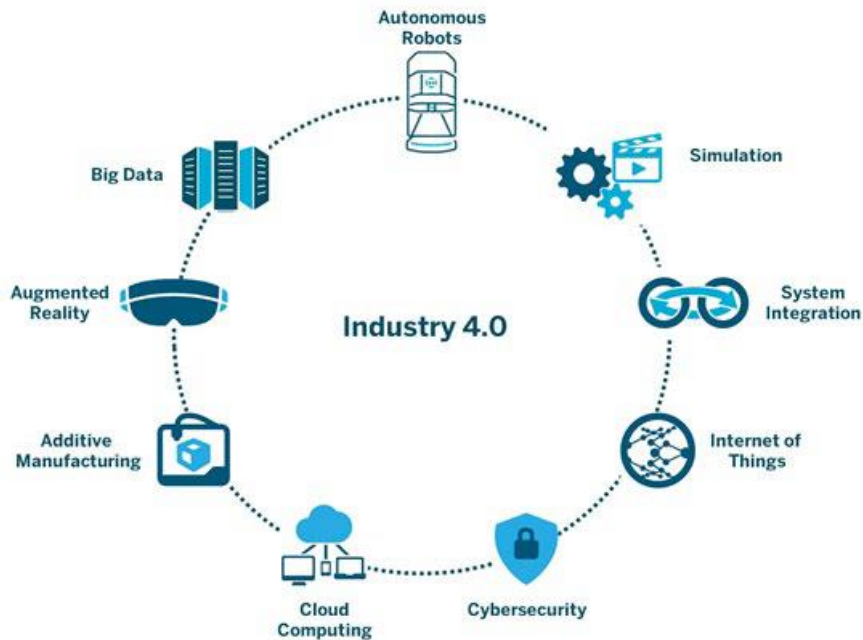

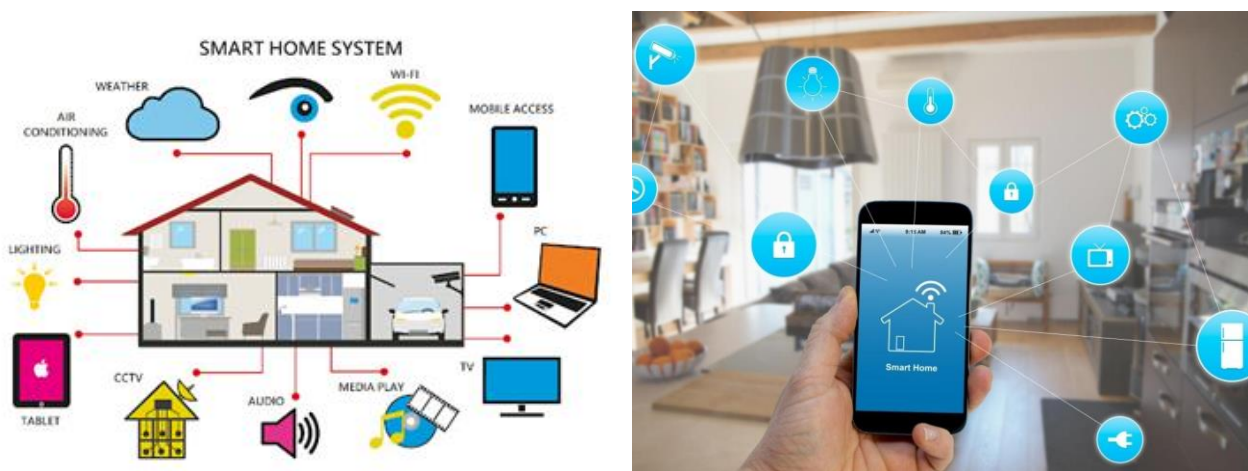Fig. 2. Components in Industry 4.0 [7]

Fig. 3. Example of Smart Home system [8]

This variant adapts to the traditional vision of an intelligent building where users can configure the light intensity at certain times of the day, set alerts and video recordings when people knock on their door or activate the kettle, as soon as they open the door. Many other features, such as interactive voice assistants and artificial intelligence-based home hubs, can guide you.

Sensors and IoT devices in the construction industry include a wide range of devices to measure and control various aspects of the built environment. These include the following:

- Temperature sensors, monitor and regulate the heat inside.
- Meters and submeters are important for keeping track of power consumption.
- Occupancy and CO_2 sensors are essential to control indoor air quality and optimize space utilization.
- Volatile organic compound sensors (VOCs) and thermostatic valves also help to improve air quality and thermal comfort.

- Brightness sensors adjust the lighting according to real needs, saving energy and improving the user experience.

Setting up an IoT system at your home lets you control air conditioning, light and important security settings from a smartphone or control panel. This way you can enjoy a comfortable living environment and sleep well as your smart system reduces the air temperature for the night. Home IoT networks also help control the integrity of your home by recording the faces of visitors who knock on your door or turning on cameras after someone has entered your lawn.

Conclusions. Integration of IoT in construction sphere is revolutionizing the industry bringing significant improvements in project management, safety and efficiency of building processes. Despite the launch challenges, the compelling advantages of the IoT are undeniable.

Looking ahead in the future, IoT solutions will become very important for success of construction projects, positioning huge building companies at the forefront of industry innovation.

References:

1. Syed Najam us Saqib "IoT in Construction Industry", 2023 https://www.linkedin.com/pulse/iot-construction-industry-syed-najam-us-saqib-uvk1f/

2. Ankit Katiyar, Pradeep Kumar A Review of Internet of Things (IoT) in Construction Industry: Building a Better Future International Journal of Advanced Computing Science and Engineering Vol. 3, No. 2, 2021, pp. 65-72

3. Robert Ringwall, "The impact of Internet of Things on building services engineering", 2017

4. IoT in Construction: Top Benefits, Use-Cases & Application, URL: https://toolsense.io/equipment-management/iot-in-construction-top-benefits-use-cases-application

5. IoT in Smart Buildings: Benefits, Use Cases, and Tips, URL: https://www.wattsense.com/blog/building-management/iot-in-smart-buildings-benefits-use-cases-and-tips/

6. IoT Applications for Smart Buildings: Benefits and Use Cases, URL: https://artkai.io/blog/iot-applications-for-smart-buildings-benefits-and-use-cases.

7. Вашпанов Ю.О. Сучасна мехатроніка в будівництві. Навчальний посібник. - Одеса: ОДАБА, 2023.- 236 с

8. Smart Home Solution for Housing Project Developer Malaysia https://m.idlk.com.my/index.php?ws=latestnews&nid=120748.