



# AI: A Game Changer in the Construction and Infrastructure Domain

## MRP Advisory

India | November 27 2024

### Executive Summary

The construction and infrastructure sectors are witnessing the advent of a new chapter in productivity, safety, and technology through the power of artificial intelligence (AI). This paper examines the evolution of AI in these important sectors, including its applications, benefits, challenges, and emerging trends. AI enables numerous facets of the industry to realize greater efficiencies, from project management to the design phase to predictive maintenance. It aims to facilitate smarter, sustainable construction that will form the basis for the cities of tomorrow and the infrastructures within them.

### Introduction

The construction and infrastructure sectors are key facilitators for economic growth and urbanization, yet they have systematically struggled with delays, budget costs, safety issues, and inefficiencies in work processes. With unmatched capabilities in data analysis, bootstrapped AI can benefit industries that are primed for enormous advancements.

From the application of design and maintenance, AI will be simplified to an easy transition of our existing practices with new technology. Awareness of change, combined with an understanding of how new machines work alongside human talents, will transform the evolution of design and construction, opening up endless possibilities. AI accessibility will improve productivity across multiple aspects, while human safety will be engineered and explored for brighter futures. This article shows current processes of AI throughout construction, while placing initiative for our build environments to become systems of co-creations.

### AI Applications in Construction and Infrastructure

#### Design and Planning

The utilization of AI in the field of design and planning has greatly propelled the **change of the conventional methodologies**. **Generative design** with the help of **deep learning** can be the way of creating new unique and non-trivial solutions for architects and engineers. These AI systems can **review design solutions** at a much **faster rate** because they are able to receive and process specific input such as site conditions, budget and performance. Besides, this not only opens up **new perspectives for creative work** but also enables the likelihood of adjusting and improving the designs in many aspects – from their functional characteristics and costs to aesthetic features.

Already a central procedure in current construction preparation, **Building Information Modelling (BIM)** is now taking leaps forward with the application of AI. Implementation of AI in BIM tools allow for collection as well as interpretation of large data sets and this means enhanced design results in good building designs. This powerful combination makes it easy for the stakeholders to **visualize and design around the conflicts and come up with superior and sophisticated solutions to the problem** compared to physically solving them on site.

#### Project Management

What we are witnessing is the progressive assimilation of AI into conventional project management frameworks as a means of delivering construction projects. ***Biomimicry Machine Learning Driven Analytics*** is one of the new trends and has potential innovations in risk management and decision making. The historical data, current data of the project, weather conditions, and real-time results help the AI system to build the forecast of possible risks and possible delays almost to the minutest detail. It helps the project managers to take preventable measures that would help to avoid the risks becoming big problems.

It also is doing wonders in project scheduling with intelligent systems automating the task. ***Computer-based scheduling algorithms*** are capable of handling and evaluating more than one variable at a time, for example availability of resources, interrelated tasks and possible interferences. This entails the development of very efficient project scheduling that is not only precise but also possess the ability to flex as required by existing project situation hence improving on project flow and costs.

### **Construction Site Operations**

Automation by robots and Artificial Intelligence (AI) is at the head of most changes expected to occur within the construction site. ***Mobile intelligent robots or drones*** that have autonomous features are used increasingly in construction to perform construction tasks like developing brickwork requirement, automating the layout process and inspection of an entire construction site. They ***enhance accuracy*** in construction task and ***reduce the cost of labor*** during construction works and ***improve the safety*** of the job sites greatly. Due to robotics that have applied artificial intelligence, the process of construction is greatly shortened thus freeing the human workforce to engage in more of 'thinking' on aspects of value addition, innovation and solving of problems.

Another revolutionary use of the AI on construction site has to do with ***surveillance***. By integrating such sensors, smart cameras and conducting AI on site, an accurate assessment of the site conditions, equipment usage and conformance to safety standards is scientifically possible and can be performed continually. Such continuing flow of information may let the humans on the job site know what metrics are measured, the monitoring of their work efforts; and when analysed in real time with the help of the AI, may flag conditions of concern on work in the future, safety and other legal and compliance related issues.

### **Maintenance and Asset Management**

Maintenance and asset management is defining a new sphere of AI application which is already showing its potential in ***increasing life span of infrastructure*** and often zeroing the operational cost. Over time, predictive maintenance has been shifting and so is the use of AI algorithms that alter the way maintenance is approached for buildings, bridges, roads and other structures. AI systems are capable of ***real time analysis of data*** collected from sensors and observing monitoring equipment and are in a better position to ***predict the happening*** of failure based on slight variations, deviations and other symptoms which a human being cannot decipher from these arrays of information.

There is a lot of AI behind such smart infrastructure concepts in today's time. There is always ***a need to track the health and status of assets as infrastructure*** such as bridges, tunnels, water supply networks and power grids among others. The smart systems will also look for gradual changes that may be historic and alert the authorities to emerging conditions to provide any potential failure eventualities at an early stage when the situation is not hazardous to the public. In general AI systems create technology to measure when structures change in significant ways over time to improve all Structural Integrity Assessments that increase public safety or otherwise enable better resource allocation over time.

### **Benefits of AI in Construction and Infrastructure**

The use of AI technologies in construction and infrastructure industries has many advantages. The most significant enhancements remain in the **efficiency improvement** across all the phases of construction projects. Intelligent systems automatically **enhance the way of performing a task**, using resources and **cutting down unnecessary time** which a human cannot. This efficiency is then converted into **quicker delivery of projects, low operating expenses** and **increase in the rate of production**.

Many other aspects of construction improvement are the **enhancement safety** can be achieved through the help of AI like- Potentially dangerous operations are performed with the help of robotic technologies, and possible hazards to the workers' health are constantly monitored in real-time. Smart sensors as well as computer vision system provide the site managers and the workers with real time pictures of safety infringements or probable hazards that may have occurred. Indeed, this proactive approach of safety not only saves lives but also minimizes project delay and costs which can accrue from incidences of workplace accidents.

It is incredible how the application of AI technology **improves the level of precision and accuracy** in construction process that leads to the **improvement of execution of the project**. The combination of design, planning tools implemented with the help of advanced AI, also BIM systems, contributes to the minimization of errors on the level of further construction. This improves accuracy thereby reducing the negative impacts of having to redo work and using a lot of raw material thus the company saves a lot of cash and preserves the environment.

When it comes to the financial aspect then, the gains via cost-savings effected by AI are real and diverse. Furthermore, AI contributes to the **lowering of operating cost** across the construction and infrastructure projects' life cycle by introducing efficient resource management and planning for project maintenance as well as project scheduling. Predictive analytics help to avoid the budget and cost overruns as the budgeting and cost estimation processes are much more accurate.

One of the most profound opportunities of the use of AI in construction and infrastructure is in **introducing novelties and sustainability**. It is not only about improving the current state of affairs; it **creates new opportunities for design and developing new trends in construction**. Because of these advancements, the building industry is now employing AI systems in an effort to make efficient usage of energy in buildings, minimize use of material when constructing and make infrastructure less sensitive to climate change, hence making the sector more sustainable.

### **Challenge and Consideration**

As demonstrated above, there are vast opportunities of using AI in construction and infrastructure, but the implementation process is not without some limitations. The first major issue which can be identified is related to **protection and confidentiality of the data being collected**. The use of AI in construction therefore requires aggregation, storage and processing of huge data such as project, employee, and clients' data. This causes much concern on the matter of **data privacy** and the chance of **prevailing security threats**. Construction companies, contractors and infrastructure managers have to develop the necessary measures to protect legal and clients' data and to follow the new and upcoming data protection legislations.

The deployment of AI technologies also points at an **enhancing skills gap** in the context of the industry. Some of the **conventional construction jobs** are beginning to be **changed** while other **novel careers** centered on AI, data science, and advanced analytics are being **introduced**. Hence, this change requires organisations to develop robust programmes to train, retrain and develop the current employees. The construction firms' human capital should be trained to work with AI systems; hence, there should be investment in relevant training programs. Besides, the **educational institution has to respond to the changes** and update the curricula for building professionals of the next generation.

Thus, the second crucial issue that need to be addressed is the ***need to incorporate AI solutions in construction management Information systems as well as in construction workflows***. The integration of the 'AI technologies into existing structures has been regarded as a great challenge and a maze task. It will need strategic thinking, possible redesign of activities, as well as frequently the change in the established processes. In addition, there will always be some resistance to change from the employee's and stakeholder's side that may slow down the process of integrating AI technologies. The primary of such resistance is well acknowledged in the literature and overcoming can be antagonistic for AI adoption that mandates the employment entails the development of very efficient project scheduling that not only are precise of change management strategies and reasoned communications of the benefits.

Another important factor that might be considered as the challenge of integrating AI solutions in construction and infrastructure projects is the ***expenses*** which are necessary for it. When it comes to implementing AI in an organization there are several disadvantages, main of which are: To reap the benefits of implementing artificial intelligence, one has to ***invest a sizable amount of money*** in acquiring AI technologies, structures, and training. It is necessary to take into account such factors as costs and benefits, and the required time needed to recoup the expenses undertaken in the course of AI application.

### **Future trends**

As we pull into the horizon of AI in construction and infrastructure, the most progressive trend can be the ***integration of AI with Augmented Reality (AR)***. This powerful combination is going to revolutionize the possibilities to conceptualize, design and realise constructions. AR can be of great benefit to architects and engineers by permitting them to project intended designs on the sites through the use of AI, then make modifications in real-time. Construction personnel on site could involve AR headsets which display artificial intelligence instructions and safety information on the construction workers' vision thereby boosting the precision and safety of construction workers in the construction site.

Another trend which is rapidly receiving attention is the application of AI in this area of ***creating smart cities***. AI will therefore be used in enhancing the ***connection of the different systems in the city to enhance planning and running of the city***. Data mining also enlarges its application based on the machine learning technique for the prediction of the traffic flow in urban areas as well as energy consumption and public service. The outcome will be intelligent cities that are able to meet the growing population needs with little effect to resource consumption and the environment.

In the context of construction robotic, we are to enter a new stage of ***higher intelligent robotic machinery***. The future generation construction robots are likely to be endowed with more enhanced AI which would aid them in handling more complicated challenges on their own. It is within this context that as the future unfolds we are likely to experience robotic construction machinery that can move within construction sites autonomously, self-organise, self-configure and or self-adapt to their environment and interactive and co-operate with human construction workers.

***Sustainability*** is yet to prominently feature in utilization of AI in construction and infrastructure and appears set to more prominently feature in future. A utilization of Artificial Intelligence increases to be used in the development of sustainable construction practices. Thus, expecting an ***integration of artificial intelligence in green building designs*** to provide the most superior and effective techniques for energy utilization and to push for the innovative green building materials as well as the reliable infrastructural systems that would be able to withstand climate change consequences.

### **Conclusion**

Artificial Intelligence (AI) is emerging as a transformative force in the construction and infrastructure sectors, offering significant improvements in efficiency, safety, and innovation. As AI technologies evolve, they provide solutions to long-standing challenges in the industry, with great potential for integration into areas such as smart cities and sustainable infrastructure. However, fully adopting AI requires addressing hurdles like data security, workforce training, and system integration. Active collaboration between construction firms, tech vendors, educational institutions, and policymakers is essential to drive AI adoption. Looking ahead, AI will play a pivotal role in shaping future cities, making them smarter, more sustainable, and resilient. Those who embrace AI will lead the construction industry into a new era of development.

## Recommendations

There is a crucial need for construction firms and other industry organizations to offer the required ***emphasis to training and education*** in AI. Hiring new talent is not always effective when it comes to AI adoption, but, creating all-encompassing training programs that would help ***upgrade the current employees*** would be a more suitable approach. These programmes should allow skills as concerns the AI technologies as well as thinking critically and interpreting data. Engaging with educational establishment can contribute towards developing the future workforce in construction business suitable for an influence by AI.

It is crucial to work on the strengthening of the ***data protection*** which could be the very issue and focus of the industry, given that it moves more towards AI and data-based decision making. Another challenge requires ***construction firms and infrastructure operators to protect the data*** in the building process, including employments of enhanced encryption techniques and access controls. The rules of data protection should also be taken into account while planning to use AI driven technologies.

When implementing the adopted AI solutions, integration decision with the existing systems should be strategic. This means that an implementation plan which comes in phases can be useful in ensuring that integration of AI technologies in an organization does not have to be done at once thereby creating havoc in the functioning of the organization. This in turn, ensures that ***AI solutions are properly assessed and integrated within the working processes*** hence a means to ***adapt as well as fine-tune the system in the process***.

Lastly, the application of the stakeholders should centre on the ***use of AI in the enhancement of sustainable construction and infrastructure developments*** on the use of resources. With the focus on sustainable AI implementation, the industry not only reduces its impact on the environment; at the same time, it complies with sustainability goals to meet the expectations and demand on green infrastructure.

Thus, with the implementation of these actions, stakeholders can successfully utilise the maximum advantages derived from the application of AI and advance the cause of the industry profoundly within the construction and infrastructural domains for the creation of a better built environment in terms of effectiveness, safety and sustainability.

MRP Advisory - Roopa Somasundaran and Swara Ghate

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