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# AI and Civil Engineering

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**ABSTRACT**

Learning, Upgrading, and working are the basic behavior of human and without this one can be a robot. The AI is a development of technology which can help to convert robot in to human like creature. Working and product of civil engineering will fulfill one of the basic needs of the human to survival. Integration of AI and Civil engineering can help to simplify the repetitive work and reduce the workhour of the civil engineer on role. This paper aims to collect the data from professionals working in field regarding AI and them work. The challenges of the future and scope for development is the outcome of this study.

***Keywords*:** AI and Civil Engineering, Scope of Civil Engineering, Artificial Intelligence, Civil Engineering, and challenges.

## Introduction

Learning and work is a continuous process. A person needs to learn, work take a break, Update self to be in advance professional practices and survival of jobs. In general, a working capacity of average person serving in the society in any field is around 30 years for which he used to develop nearly equal years since birth to develop set of skills [1]. What if one says that a set of skills can be teach and effectively and nearly error less can be executed by one is possible only be few months or few days.

Is it possible? Yes, it is. Artificial intelligence is a way to do so. In the current state of evolution of artificial intelligence, it will soon develop the nearly same set of skills to analysis and design based on the knowledge gather by humans in all the forms of documentation and records.

The Civil Engineering is a field where 70% of skills and thumb rules has been taught by a person to person on the execution site. It is one the major unorganized section of society which contributes maximum part in countries GDP and growth [3]. The Job creation and allocation in this sector is the backbone of the Countries body to provide employment. This field consist mainly hard work since 20th century but with the development of time it also advances its nature and make the shoulder to shoulder with other sectors of the industry. Innovations are quite hard to implement on the filed but researchers are developing many ways to reduce the hard work by smart work through the implementation of technology in the field. Technological advancement in the field started with the use of computer to use to remote sensing. The technologies like robotics, Virtual reality, augmented reality, BIM, and many more are quite advance in the field of the Civil Engineering.

## Artificial intelligence and Robots

The AI and Robotics are the two different field. To understand the robotics, a different logics and physics need to understand, analyse, and implement. In the other hand to implement the AI need to understand the working principle of human mind and based on the research one can develop AI for different use.

The robot can be simplified as a machine which can be design for specific purpose or to complete the specific task repeatedly. A robot can perform different task at a time or it can be design to perform number of tasks in parallel. An AI can be simplified a child who just become at a stage where he will start to walk. To be in the position the caretaker must have to train him after few attempts and time a child will walk, run, and perform different task with his lags. An AI must be developed, few protocols must be added via coding but there is a loop which is always open for learning and string data. In short it is a mathematical, logical model behaves like self-learning based on experience and protocols added to it.

The advanced version of the robots loaded with the AI technology can modify them self-according to work and improve the task efficiency and way to doing the task. It is necessary to understand that as like human, AI enabled robots can analyse them self, can suggest Nassery arrangement

in them. This process will continue to improve with time, thus they may as same as human in the form of life but never tired or required off to duty accept the maintenance.

## Civil Engineering as Profession

A civil Engineering is a one of the oldest branches of Engineering or Mother of the core engineering. The knowledge and data set of this has root up to the evolution of human who starts to build his shelter from caves. The project of Civil Engineering and challenges with the project are always new and differ with project to project and place to place.

The major work profile of civil engineer after specialization can be classified as shown in the Diagram.


Figure 1. Civil Engineering as Profession

As the diagram shows the core engineering can be further classified as structural engineering, geotechnical engineering, construction engineering and management, hydrology, surveying, Transpiration based on the specialization and type of work associated with the project. Most of the case civil engineering projects are associated with all the engineering disciplines and vice versa. [6] each engineering specialization was firstly developing the logics and reasons based on experimental and research studies which can be converted into the set of instructions with limitations can be further design and simplified as a set of tools or softwares which can help humans to understand and analyse the collected data easily. [5]

The work can be further controlled by the different management tools with the help of Planning, scheduling, and control tools. [2] The safety management is a part of the execution for safe and health work experience on the site of execution. [7] The controlling techniques used to control the time of execution and control the cost of execution for growth of company and maintain the budget of client can be handled through different philosophy of manufacturing industry like lean management, six sigma management etc. [4]

## Prospective of Civil Engineers Regarding AI and them work.

The perspective of regarding accepting new technologies in the industry is quite low as compared to manufacturing industry. [8] The concluded outcome of some experts regarding them works having experience more than 10 years has mention here when no discussion with them regarding AI or anything, “As a Civil Engineer my work is to observe the site, check the quality and implement the work according to the drawing prepared by designers according to the standers and specification of the country. As 80% of my work profile is at open environment I do not need to worry about my job. AI or robots cannot replace me.” By a site incharge and quality check team. “As a designer I need to talked with client, client will change his requirements at the time of execution so my job cannot be replaced by any robot” by design engineer. “As a surveyor I need to be on

ground, I need to work at a place where there is no infrastructure at all, none of robot can work at my place, I need to do adjustment as per site so none of AI can replace me. My job is totally dependent as per site conditions" by a surveyor.

## Adoption of AI in different field of Civil Engineering

The adoption of technology in any field is must to make self in paragon of the competition. When one deal with the most versatile and most uncertain industry where cost overrun and time overrun is common and quite difficult to manage at given specification.

The adopted technologies and them usages by the industry at present which has support by AI can be listed below based on the industry practices can be,

*Planning and visualization:*

Planning is one of the bases of any project. Visualization is a process by which one can virtually see thing which may complete after few years without expenditure over it. Initially it was done with the help of cardboard models and had made sheets with the help of different pen, pencils, colors and stencils which consume hundreds of work hours of a engineer. It was done with in short time with softwares like Autodesk family, google SketchUp, blender or other similar.

*Structure design and simulation:*

Structure design is one of the complexes works of any project. As project is large number of drawings increases with time. a common infrastructure project may have drawings more than 1000. [9] when one think to make it by self so amount of work hours can be easily calculated. The softwares can be used to simulate actual work and other factors like earthquake, storms, havey rain, load tests etc. without making actual structure can be executed with the help of software like Ansys, Autodesk Revit, SYAAD Pro, Etabs, Tekla structures, Risa tech etc. which can save time and money.

*Hydrology:*

The work of hydrology is associated with measurement of discharge of river, canal and other hydraulic structures, collecting and analyzing rain or snow fall, designing of dam and supportive structure of family like spillway, barrage etc. the simulation of water is one of the keys to achieve accuracy in this field, which can be Achieved by Hecras, Watergem, Mike, Storm gem, Epanet, Modflow, Prms, Hechms etc.

*Surveying:*

Work cannot start without collecting data of surveying and preparing maps based on the data, handling of maps on a single platform is one of the difficult tasks due to different Representation factors or scale of map. Softwares like GIS family, remote sensing, arial photography etc. can be replaced with modern tools like auto level and total station for preparing maps.

*Environmental engineering:*

As an environmental engineer quality assessment of environment and impact of the project on environment must be consider for sustainable development. For such a purpose softwares like MATLAB and R - simulation and modelling. SPSS and SAS -to identify trends and patterns, AERMOD, CALPUFF, and ISCST3 - to model air quality and pollution dispersion. QUAL2K and WASP - to simulate water quality in natural and engineered systems. Environmental Management Systems (EMS) - ISO 14001 - to manage environmental impact and regulatory compliance.

Adoption of the softwares in the industry in this 21st century is one of the first step toward adoption of the adoption of technology in the field of civil engineering. Based on the professional practices and interview of more than 30 Professionals working on the field of the civil engineering under different scopes, the general outcome can be given as "No claim has been raised that AI can be directly helps them in working" based on direct question. When question was replaced with indirect question like which kind of features has been added in updated version of the softwares to accept the partial acceptance and use of AI in the industry can give different result which can be generalized as "Suggestion of features and suggestion in the errors are easy as compared to previous version of softwares which shows some king of intelligence in the software"

Based on study of the professional practice the conclusion can be reached in the favor of hypothesis that "*Civil engineering is flexible enough to changes and can adopt the AI as other Industry*"

## Challenges of Adoption of AI in Civil Engineering

Data is a key to use the Artificial intelligence. In the field of civil engineering there are several issues which must be discuss before take any discussion and development of AI in Civil engineering. Few of challenges of adoption of AI in civil engineering can be,

- *Data availability and quality*

The availability and caliber of data is one of the biggest obstacles to the adoption of AI in civil engineering. To make reliable predictions and choices, AI significantly relies on high-quality data, yet the data used in civil engineering is frequently fragmented, fragmentary, and of inconsistent quality. This can make it difficult to effectively train AI models and produce accurate predictions and insights. The availability of data for developing and testing AI models may also be constrained by data privacy concerns and data silos, which can make it challenging to get the data required for AI applications. Organizations involved in civil engineering must give data management top priority and spend money on data integration and standardization projects to address these issues. This entails designing frameworks for data sharing and addressing privacy issues, as well as developing methods for data gathering, cleansing, and validation. Civil engineering organizations may fully realize AI's potential to revolutionize the sector by addressing issues with data availability and quality.

- *Lack of standards and interoperability:*

Lack of standards and interoperability is a major obstacle to the use of AI in civil engineering. Data integration and sharing between civil engineering projects can be difficult since various projects may employ various data formats, software, and hardware. As a result, data silos may form and AI applications may become less effective since AI models could not have access to the data, they require to make reliable predictions and judgements. Furthermore, the absence of standards can make it challenging to compare and benchmark AI applications, making it difficult to pinpoint best practices and potential improvement areas. Civil engineering organizations must give interoperability priority and provide standard data formats, software interfaces, and hardware configurations to address these issues. By making data sharing and integration easier, AI will be able to benefit the market more significantly. Organizations involved in the field of civil engineering can enhance collaboration and speed up innovation by addressing the absence of standards and interoperability.

- *Limited technical expertise:*

The lack of technical skills in the field is a key barrier to the use of AI in civil engineering. Data science, machine learning, and programming are just a few of the specialized knowledge and abilities needed to develop and deploy AI solutions. However, it's possible that civil engineering experts lack the knowledge and training needed to create and apply AI solutions successfully. This may make it challenging to incorporate AI into current workflows and processes and cause a lack of knowledge of the technology's potential and constraints. In order to overcome this obstacle, civil engineering companies must make an investment in upskilling their staff, which includes giving them the tools and resources they need to become technically proficient in AI. Collaborations with institutions and AI professionals can also aid in addressing the industry's lack of technical skills. Civil engineering organizations may fully utilize the advantages of AI and enhance project outcomes by tackling this obstacle.

- *Ethical and legal concerns:*

Additionally, there are moral and legal issues raised by the use of AI in civil engineering that need to be addressed. Processes for making decisions using AI could lead to concerns around bias, transparency, and accountability. AI solutions run the risk of reproducing current social and economic inequality or producing unfair results. The acquisition and use of personal data needed for AI applications may also be restricted by privacy and data protection laws. Organizations involved in civil engineering must make sure that their methods for developing AI take ethical and legal factors into account. This entails creating frameworks for openness and accountability, assessing how AI solutions might affect social and economic inequality, and adhering to privacy and data protection laws. Civil engineering organizations may foster public confidence and guarantee that AI is applied properly by addressing ethical and legal issues.

- *Resistance to change:*

Adopting AI in civil engineering faces numerous obstacles, not the least of which is resistance to change. The business community has a reputation for conservatism, and its long-standing practices and procedures can be resistant to change. Some professionals may be reluctant to adopt new technology because they worry about losing their jobs or control as a result of the introduction of AI, which can be perceived as a challenge to existing working methods. Despite having the potential to completely change the civil engineering sector, this may slow down the adoption of AI. In order to meet this challenge, civil engineering organizations must place a high priority on change management, which includes stakeholder involvement in the decision-making process, communication and education on the advantages of AI, and assistance and training to ensure a smooth transition. Civil engineering organizations can embrace AI's potential and enhance project outcomes by overcoming change aversion, all while addressing worries about job displacement and ensuring that technology is utilized properly.

- *Cost:*

Another major obstacle to AI adoption in civil engineering is cost. Significant hardware, software, and specialized human investments may be necessary for the development and implementation of AI systems. The expense of creating and implementing AI solutions may be prohibitive for smaller civil engineering businesses and projects, discouraging uptake. The cost of using AI technologies may also increase due to potential ongoing maintenance and updates. To get around this obstacle, civil engineering companies should look into joint ventures and collaborations to split the

expenses and rewards of developing and using AI. Additionally, spending money on open-source AI platforms and solutions can help smaller businesses get access to these technologies at a lower cost. Civil engineering organizations can unleash the potential of AI to enhance project outcomes and revolutionize the sector by tackling the cost barrier.

- *Concerns about security:*

Security issues are a major barrier to the adoption of AI in civil engineering. To make decisions and forecasts, AI systems rely on data, and this data may contain private or sensitive information regarding civil engineering projects. As a result, there are worries about the likelihood of cyberattacks or data breaches that could jeopardize the security of this information. There are also worries about the possibility of AI systems being hacked or influenced, leading to inaccurate predictions or judgements. Organizations involved in civil engineering must give cybersecurity a high priority and make substantial investments in security systems and methods to address these issues. This entails putting encryption and access controls in place, performing regular security audits, and educating personnel on data security best practices. Civil engineering organizations can increase confidence in the use of AI and guarantee the protection of critical data by solving security issues.

## Scope of AI in Civil Engineering:

The discussion with experts of industry and professionals of the industry as per nature of human psychology demand few features in the softwares which can invite AI introduction in the existing system and working. The main scope of civil engineering can be categorized in the following categories,

- *Design optimization:*

AI can be used to optimize the design of civil engineering structures, such as buildings, bridges, and roads. AI can help engineers identify the most efficient and cost-effective designs, considering a range of factors such as materials, load capacity, and environmental conditions.

- *Project management:*

Project management is an important component of civil engineering projects, and AI can be used to improve project outcomes in a variety of ways. AI can be used to analyse real-time data from multiple sources, such as sensors and cameras, to give project managers with accurate and up-to-date information on project progress, resource allocation, and risk management. This enables project managers to make data-driven decisions, optimize project results, and minimize the risk of delays and cost overruns. AI can also be used to predict potential project hazards and recommend mitigation techniques, allowing project managers to manage project risks proactively. Furthermore, AI can be used to optimize resource allocation, ensuring that materials and equipment are used efficiently and labour costs are kept to a minimum. Civil engineering projects can be performed more rapidly and cost-effectively by utilizing AI for project management, while also ensuring that project outputs meet or surpass expectations.

- *Predictive maintenance:*

Predictive maintenance is critical to ensuring the safety and reliability of civil engineering structures, and AI can help to improve the efficiency of these procedures. AI can predict when maintenance is needed by analyzing data from numerous sources, such as sensors and historical maintenance records, allowing for prompt intervention before problems arise. AI can also be used to optimize maintenance plans, ensuring that resources are efficiently allocated and downtime is kept to a minimum. Civil engineering structures may be kept in optimal condition by employing AI for predictive maintenance, minimizing the risk of accidents and breakdowns, and increasing their lifespan.

- *Quality control and inspection:*

Quality control and inspection are key components of civil engineering projects, and AI can help to increase their efficiency and effectiveness. AI can be used to automate the inspection of civil engineering constructions by detecting faults, anomalies, and deviations from specifications using sensors and cameras. AI can also be used to analyse data from a variety of sources, such as project plans and specifications, to verify that quality control activities are carried out appropriately. Civil engineering projects can be completed more rapidly and cost-effectively by utilizing AI to improve quality control and inspection processes, while also guaranteeing that structures are safe, reliable, and compatible with regulations.

- *Safety management:*

Safety management is an important component of civil engineering, and AI has the potential to significantly improve safety outcomes. AI can analyse data from sensors, cameras, and other sources in real-time to identify possible safety issues, allowing for quick intervention and corrective action. AI can also be used to analyse historical data in order to detect trends and patterns that may suggest new safety issues. AI-powered simulation and modelling can also be used to test and optimize safety protocols and procedures, increasing safety results and lowering the chance of accidents and injuries.

Few features can be work by designer or developers to collaborate with existing practices can be,

Based on the plan and budget one can built the AI to suggest material and quality of work can be achieved

Reduce the complex tracking of the data collected by one to analysis and monitor the Environmental data

Reduce the burden of reading complex codal provision for preparing the designs

Need a AI to check the work as per specification and codal provision for authority approval to improve transparency in system and E-Governance.

Replacement of workforce with automated robots for better quality control and quality assessment

Permanente data collection and suggesting required maintenance based on data via integrated AI enabled BIM model.

Accurate forecasting model to evaluate and suggest the measure to control the project for time and cost overrun issues.

This are the seven main scopes which are highly required by the industry which can be able to reduce the consumption of work hours of the skilled labour of industry. Here the cost of development & use of AI integrated software and training and operation cost of skilled labour may be increase on the benefit of the reduction of the work hours.

## Conclusion

This study is mainly focused on the review the article published under the key word of Civil Engineering and AI, and aims to prepare a summary draft of professional practice and identify the scope of the AI in civil engineering. For Civil Engineering projects uncertainties are certain. To prepare the AI enable software in the industry, it is essential to empower the professional and train them according to the new requirement of industry where many roles of professionals may be eliminated by AI and will reduce the consumption of workhour of the industry. Based on nature of work of industry it is difficult to replace the person from the Job.

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