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Artificial Intelligence in the Construction Industry

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Abstract: Construction activities contribute a lot to our society economically. The construction industry is undergoing a significant transformation, driven by the rapid adoption of digital technologies. Among these, artificial intelligence (AI) stands out as a powerful tool reshaping how construction projects are planned, executed, and managed. Artificial intelligence is where machines exhibit their own intelligence through using algorithms to solve problems. Construction is growing at a rapid pace as digitalization continues and AI stands to deliver a number of advantages to the industry.

Artificial intelligence has become integral to construction processes, offering efficiency, precision, and innovation. From optimizing the design process to reducing energy consumption, AI has significant implications for the construction industry, making it more efficient and sustainable. AI in construction helps the industry as a whole overcome some of our toughest challenges, including safety concerns, labor shortages, cost, and schedule overruns. This paper aims to unravel AI applications in modern construction industry.

Keywords: *Construction Industry, Artificial Intelligence, Machine Learning, Ai, Generative Ai*

I. INTRODUCTION

The term artificial intelligence (AI) is used since the 1950s of the last century. It is an aggregative term for describing when a machine mimics human cognitive functions, like problem-solving, pattern recognition, and learning. It can be regarded as the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. As a branch of computer science, AI drives computers to sense and learn inputs like human-being for perception, knowledge representation, reasoning, problem-solving, and planning. You may have experienced AI in a voice search with Amazon's Alexa or Apple's Siri. Figure 1 shows AI symbol [1]. Artificial intelligence (AI) has become unavoidable for most industries, with construction being no exception.

Figure 1: AI symbol [1].

Construction is one of the least digitalized industries in the world. The construction industry is undergoing a significant transformation, driven by the rapid adoption of digital technologies. At the heart of this transformation is AI. The construction industry in North America is increasingly adopting AI-driven solutions to improve operational efficiency, project management, and safety. The key factors driving growth include the demand for sustainable and smart construction practices, the need for cost reduction, and a supportive regulatory environment. AI-powered solutions encompass a range of technologies and tools designed specifically for the construction industry. These solutions typically include machine learning algorithms, computer vision, natural language processing, robotics, and data analytics platforms. These solutions have successfully been applied in other industries to achieve increased profitability, efficiency, safety and security.

II. WHAT IS ARTIFICIAL INTELLENCE?

The term "artificial intelligence" (AI) is an umbrella term John McCarthy, a computer scientist, coined in 1955 and defined as "the science and engineering of intelligent machines." It refers to the ability of a computer system to perform human tasks (such as thinking and learning) that usually can only be accomplished using human intelligence [2]. Typically, AI systems demonstrate at least some of the following human behaviors: planning, learning, reasoning, problem solving, knowledge representation, perception, speech recognition, decision-making, language translation, motion, manipulation, intelligence, and creativity.

The 10 U.S. Code § 2358 define artificial intelligence as [3]:

1. "Any artificial system that performs tasks under varying and unpredictable circumstances without significant human oversight, or that can learn from experience and improve performance when exposed to data sets.
2. An artificial system developed in computer software, physical hardware, or other context that solves tasks requiring human-like perception, cognition, planning, learning, communication, or physical action.
3. An artificial system designed to think or act like a human, including cognitive architectures and neural networks.
4. A set of techniques, including machine learning, that is designed to approximate a cognitive task.
5. An artificial system designed to act rationally, including an intelligent software agent or embodied robot that achieves goals using perception, planning, reasoning, learning, communicating, decision making, and acting."

AI provides tools creating intelligent machines which can behave like humans, think like humans, and make decisions like humans. The main goals of artificial intelligence are [4]:

1. Replicate human intelligence
2. Solve knowledge-intensive tasks
3. Make an intelligent connection of perception and action

4. Build a machine which can perform tasks that requires human intelligence
5. Create some system which can exhibit intelligent behavior, learn new things by itself, demonstrate, explain, and can advise to its user.

AI is not a single technology but a range of computational models and algorithms. The concept of AI is an umbrella term that encompasses many different technologies. AI is not a single technology but a collection of techniques that enables computer systems to perform tasks that would otherwise require human intelligence. The major disciplines in AI include [5]:

- *Expert systems*
- *Fuzzy logic*
- *Neural networks*
- *Machine learning (ML)*
- *Deep learning*
- *Natural Language Processors (NLP)*
- *Robots*

These computer-based tools or technologies have been used to achieve AI's goals. Each AI tool has its own advantages. Using a combination of these models, rather than a single model, is recommended. Figure 2 shows a typical expert system, while Figure 3 illustrates the AI tools. These tools are gaining momentum across every industry. Analytics can be considered a core AI capability.

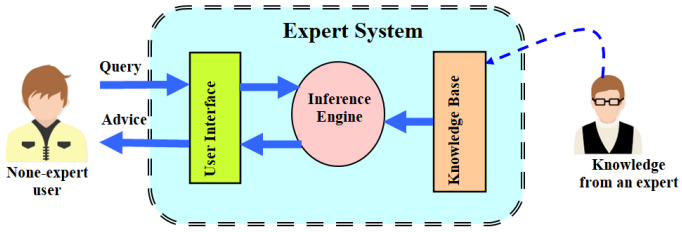

Figure 2: A typical expert system.

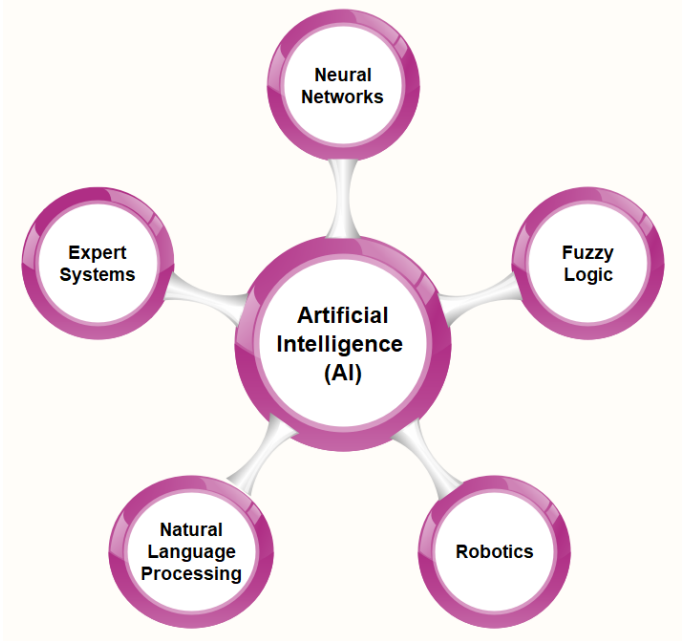

Figure 3: AI tools.

III. GENERATIVE AI

Artificial Intelligence (AI) is increasingly a part of our world and it is rapidly changing our lives. Generative AI (GenAI) is a subset of artificial intelligence that uses generative models to produce text, images, videos, or other forms of data. Generative AI (GenAI) is a term for any type of AI system capable of using generative models to create new forms of humanlike creative content, like text, images, music, audio, video and more. GenAI models include various algorithms able to learn the various patterns and structures of input training data before generating novel outputs with similar characteristics. It is essentially a narrow type and application of the broader artificial intelligence umbrella of technologies. It describes algorithms (such as ChatGPT) that can be used to create new content, including audio, code, images, text, simulations, and videos. It is specifically designed and trained to generate new content. The versatility and potential of GenAI to transform various aspects of business operations make it an attractive investment for companies across industries. GenAI uses neural networks, machine learning, deep learning models, complex algorithms, and large and varied training datasets to produce original content based on user input and how to reason in ways akin to a human brain. The technology is built on AI tools shown in Figure 4 [6]. It uses neural networks to identify the patterns and structures within existing data to generate new and original content.

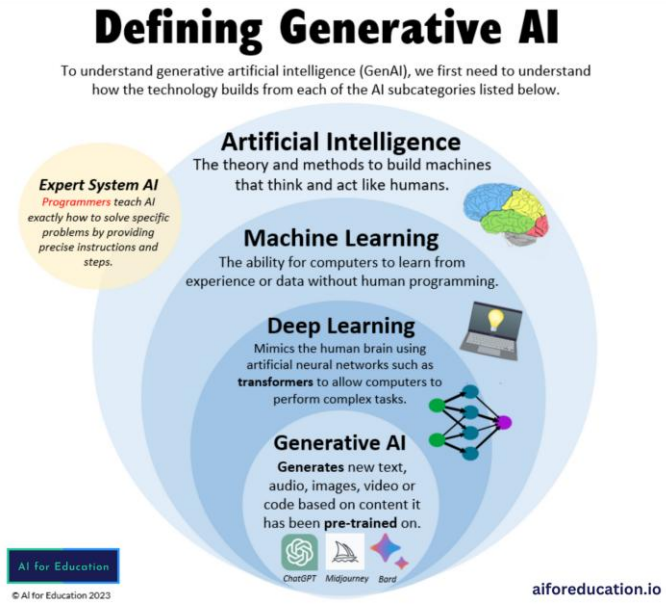

Figure 4: GenAI built on AI tools listed above [6].

Generative AI can be thought of as a machine-learning model that is trained to create new data, rather than making a prediction about a specific dataset. Since its inception, the field of machine learning used both discriminative models and generative models, to model and predict data. A generative AI system is constructed by applying unsupervised machine learning or self-supervised machine learning to a data set. The most common way to train a generative AI model is to use supervised learning. Generative AI can also be trained on the motions of a robotic system to generate new trajectories for motion planning or navigation. Generative AI models are used to power chatbot products such as ChatGPT [7].

Generative AI is transforming nearly all aspects of the pharmaceutical industry, revamping the way companies operate and potentially unlocking billions of dollars in value. The pharmaceutical-operations value chain encompasses sourcing, manufacturing, quality, and the supply chain—and gen AI is expected to improve them all

IV. AI IN CONSTRUCTION

At its core, construction is an inherently human enterprise, a domain where the personal touch, expertise, and innovative

spirit of individuals are irreplaceable. Construction, as a large sector of the economy, plays prominent roles in driving economic growth and long-term national development. Globally, individuals and businesses spend over $10 trillion per year on construction-related activities. Construction projects create a broad range of job opportunities for 7% of the world's working population. Despite its economic importance, an obvious issue is poor labor productivity during the construction procedure, negatively leading to the waste of manpower, material resources, and financial resources. Figure 5 shows construction site [8], while Figure 6 shows construction workers [9].

Figure 5: A typical construction site [8].

Figure 6: Construction workers [9].

The growth of the construction industry is severely limited by the myriad complex challenges it faces such as cost and time overruns, health and safety, productivity and labor shortages. Also, construction industry is one the least digitized industries in the world, which has made it difficult for it to tackle the problems it currently faces [10].

AI in construction is an umbrella term that describes a wide range of AI-powered tools and machinery designed specifically for use in the construction industry. It includes specialized software that utilizes machine learning algorithms as well as advanced industrial robots. AI in the construction industry has emerged as a technology that is poised to transform the industry. Its components are depicted in Figure 7 [11]. It has the potential to help players realize value throughout project lifecycles, including design, bidding, and financing; procurement and construction; operations and asset management; and, business model transformation. AI can help construction companies to optimize the use of resources, manage timelines, and overall achieve better efficiency. Imagine an industry where project delays are predicted with uncanny accuracy and workplace injuries are anomalies. Construction AI companies are key drivers of this revolution. Figure 8 shows a typical use of AI in construction [12].

Figure 7: Components of AI in construction [11].

Figure 8: A typical use of AI in construction [12].

To make AI live up to expectations, more and more companies are actively investing in various AI technologies. Major companies operating in the AI in construction market include [13]:

- Alice Technologies Inc.
- Autodesk, Inc.
- Bentley Systems Inc.
- Dassault Systemes SE
- IBM Corporation
- Microsoft Corporation
- NVIDIA Corporation
- Oracle Corporation
- Predii
- PTC Inc.
- SAP SE
- Smartvid.io Inc.

V. ARTIFICAL INTELLIGENCE IN CONSTRUCTION

Artificial Intelligence is concerned with smart machines or a system due to which machines are capable of solving engineering problems and performing the various tasks that require human intelligence. It is currently revolutionizing industries such as manufacturing, retail, and telecommunications. The construction industry has been adopting AI technologies to automate and optimize processes, improve site safety and security, and extract insights from complex data. The potential applications of AI in construction are vast. Common application areas of AI in construction include the following [8,14]:

1.*Construction Engineering and Management* (CEM): Construction projects are recently becoming larger and more complex, i.e. encompassing more and more participants focusing on diverging interests while the given frames of time and budget are getting tighter. Construction management is used to establish an efficient organization of all these issues and able to predict the result with a high degree of precision and certainty.

The construction engineering and management (CEM) inside the scope of the architecture, engineering, and construction (AEC) industry is fraught with its own problems and complications, which covers a set of construction-related activities and processes along with human factors and interactions. With the extensive adoption of artificial intelligence (AI), construction engineering and management is experiencing a rapid digital transformation. CEM is going through constant innovations towards digitalization and intelligence, in order to realize a considerable boost in automation, productivity, and reliability. For the purpose of launching the real digital strategies in CEM, artificial intelligence (AI) acts as the backbone to change the way a construction project performs. There is immense interest in implementing a variety of AI methods in the CEM domain to seize the valuable opportunity of digital evolution for better performance and profitability.

2.*Project Management*: Thus is one primary area of construction where AI can be quite effective. Managing a large construction project can challenge even the most experienced teams. AI technologies are being leveraged to streamline and optimize various aspects of project management. The growth of AI in project management is revolutionizing how construction projects are planned, executed, and managed, leading to improved outcomes and reduced project risks. AI algorithms can analyze vast amounts of data from past projects to predict potential delays, identify risks, and recommend efficient scheduling. AI software designed for construction project management captures photo and video footage on work sites and automatically generates relevant insights, helping construction management track work progress and crew productivity in real-time. AI-powered tools are becoming integral to the design phase of construction projects. Generative design, an AI-driven process, allows architects and engineers to input specific design goals and constraints, such as materials, budget, and building codes, and receive a range of optimized design options.

3. *Estimations and Bidding:* This involves distributing the plans to trades, contractors, and manufacturers for bidding. Construction estimations and bidding have historically been highly manual and time-consuming processes. Once architects and developers come up with a design, a general contractor uses the blueprint to calculate a bid. They then repeat the process with subcontractors: plumbers, electricians, framers, etc. Putting every individual bid together is a laborious process without guaranteed returns for the general contractor.

4. *Robotics:* AI robotics is becoming an increasingly important and rapidly growing field of construction technology. Robotics in the construction sector is taking off. These robots are typically autonomous machines capable of automating tasks on construction sites. AI robots that are already present on sites include: 3D printers, bricklaying robots, painting robots, welding robots, layout drawing robots, rebar tying robots, monitoring drones and rovers, self-operating heavy equipment, and self-driving trucks. Now you can retrofit various heavy equipment machines with artificial intelligence to perform duties like a human worker. AI robots complement the work of human workers, and make it safer and more efficient. For example, bricklaying robot works alongside masons and only completes the literal heavy-lifting part of the bricklaying process. One will find industrial robots in warehouses and construction sites where repetitive tasks are required. The robot "Spot" has proven to be truly disruptive for the global construction industry, with a number of companies using it on their construction sites. Figure 9 shows some robots working along with human workers [15].

Figure 9: Robots working along with human workers [15].

5.*Design and Planning*: AI technologies like machine learning and generative design algorithms can streamline decision-making processes for architects, engineers, and construction professionals involved in design and planning. AI can analyze complex data, including building codes, zoning laws, topographical information, and historical projects, to generate designs that are in line with regulatory requirements.

6.*Predictive Maintenance*: This involves using AI algorithms to monitor equipment health and forecast failures. It helps construction companies extend the lifecycle of machinery, improve on-site safety, and prevent project downtimes. AI can be used to analyze data from building systems, such as HVAC and electrical systems, to predict when maintenance will be needed and prevent equipment failure. Construction equipment and machinery are critical assets that require regular maintenance to avoid breakdowns and costly downtime. AI tools can analyze data from sensors installed on machinery to predict when maintenance is needed, based on factors such as usage patterns, wear and tear, and environmental conditions. This shift from reactive to predictive maintenance can help construction firms minimize downtime, reduce repair costs, and extend equipment lifespan. This is how predictive maintenance works in construction. Machine learning algorithms monitor equipment health by analyzing sensor data (including information about environmental conditions and equipment performance stats) and detect anomalies in real-time. They then diagnose issues and alert operators *before* critical failures occur, suggesting appropriate preventative maintenance action. For example, suppose a construction company is building a large infrastructure project, like a bridge. With the help of machine learning (ML), they

can use predictive maintenance to keep the construction equipment in top shape, reducing the risk of unexpected breakdowns and delays. The company can use ML for quality control by analyzing images and videos of the construction site to ensure that all the materials and workmanship meet the required standards.

7.*Automating Tasks*: AI has been found to automate and accelerate the process of learning, reasoning, and perceiving from large data. AI drives the process of project management more technically automatable and objective. The use of AI-powered drones and robotics in construction is gaining traction. These trends are driving the industry toward smart and automated construction practices, leading to increased efficiency, productivity, and quality in construction projects. The latest tools help automate mundane tasks like detecting title blocks and sheet names, freeing professionals to focus on more strategic aspects of their work. Technologies aided by computer vision mainly contribute to the automatic and robust vision- based inspection, which gradually take the place of the error-prone, time-consuming, laborious, and dangerous manual observation by people. Computer vision supports the automated process of detecting and assessing the defects and damage (i.e., crack, spalling, corrosion, holes, joint damage, etc.) exiting on various types of civil infrastructure, including buildings, bridges, tunnels, roads, sewer pipes, etc. AI-powered platforms automate routine administrative tasks, such as scheduling meetings or generating reports, freeing project managers to focus on more strategic aspects of their roles. AI-powered construction vehicles such as bulldozers, excavators, and dump trucks can work independently, freeing laborers to focus on other tasks.

8. *Risk Mitigation*: Every construction project has some risk that comes in many forms such as quality, safety, time, and cost risk. AI can monitor, recognize, evaluate, and predict potential risk in terms of safety, quality, efficiency, and cost across teams and work areas even under high uncertainty. Various AI methods can effectively address the limitations of traditional risk analysis, such as the vagueness and vulnerability from specialist experience and subjective judgment. As a result, the AI-based risk analysis can provide assistive and predictive insights on critical issues. AI presents valuable opportunities to realize early troubleshooting to prevent undesirable failure and accidents in the complex workflow. Robots can take charge of unsafe activities to minimize the number of humans working in dangerous environments. AI-powered robots have been directly adopted on the construction site to take over the repetitive and routine construction tasks, such as bricklaying, welding, tiling, and others. They can work continuously without taking a break at almost the same rate and quality.

VI. BENEFITS

AI enhances safety in construction operations through real-time monitoring, hazard detection, and compliance enforcement. It also enables quality control and defect detection, ensuring high construction standards and reducing rework. The growth of AI solutions in construction is driven by their ability to automate processes, optimize resource allocation, enhance safety, and improve decision-making. It can sometimes be overwhelming to manage an entire project single handed, but with the assistance of AI, it is becoming easier. Other benefits include [14,16]:

- *High Efficiency*: One of the most significant advantages of AI is increased efficiency. AI tools can process data much faster than humans, enabling real-time decision-making that can reduce delays and cut costs. Another important use of AI techniques is in optimization problems, aiming to make the construction project run more smoothly and efficiently. Tactical decisions can be made for trouble-shooting at an early stage, driving the improvement of operational efficiency.
- *Predictive Analytics:* AI algorithms can analyze historical data and project future outcomes, enabling construction companies to optimize scheduling, resource allocation, and budget planning.
- *Prevent Cost Overruns:* Most mega projects go over budget despite employing the best project teams. Artificial neural networks are used on projects to predict cost overruns based on factors such as project size, contract type, and the competence level of project managers. AI helps staff remotely access real-life training material which helps them enhance their skills and knowledge quickly. As a result, project delivery is expedited.
- *Project Planning:* One construction intelligence company launched in 2017 with the promise that its robots and artificial intelligence hold the key to solving late and over budget construction projects. Algorithms of the future will use an AI technique known as "reinforcement learning." This technique allows algorithms to learn based on trial and error. It can assess endless combinations and alternatives based on similar projects. It aids in project planning since it optimizes the best path and corrects itself over time.
- *Safety:* Safety is a top priority in the construction industry. AI plays a significant role in enhancing on-site safety. Construction workers are killed on the job five times more often than other laborers. According to OSHA, the leading causes of private sector deaths (excluding highway collisions) in the construction industry were falls, followed by struck by an object, electrocution, and caught-in/between. Computer vision technologies, a subset of AI, monitor construction sites in real-time, identifying safety hazards such as workers not wearing protective gear or machinery operating outside safe parameters.
- *Labor Shortage:* This happens more often in the construction industry. It could be due to various factors such as an aging workforce, declining interest in the industry, or a growing economy leading to more job opportunities in other fields. Labor shortage and a desire to boost the industry's low productivity are compelling construction firms to invest in AI and data science. Construction companies are starting to use AI and machine learning to better plan for distribution of labor and machinery across jobs. A robot constantly evaluating job progress and the location of workers and equipment enables project managers to tell instantly which job sites have enough workers and equipment to complete the project on schedule. Despite the predictions of massive job losses, AI is unlikely to replace the human workforce. Instead, it will alter business models in the construction industry, reduce expensive errors, reduce worksite injuries, and make building operations more efficient.
- *Post-construction:* Building managers can use AI long after construction is complete. By collecting information about a structure through sensors, drones, and other wireless technologies, advanced analytics

and AI-powered algorithms gain valuable insights about the operation and performance of a building, bridge, roads, and almost anything in the built environment.

- *Sustainability:* AI can improve the overall sustainability of the construction industry. AI tools can optimize the use of resources and reduce waste, helping construction companies adopt more sustainable construction practices. As concerns about climate change and resource scarcity grow, the construction industry faces increasing pressure to adopt sustainable practices. AI can assist in this effort by optimizing material use, reducing waste, and improving energy efficiency.
- *Better Project Planning:* AI systems can streamline scheduling and resource allocation, optimizing the profitability and timeliness of large projects. AI can also recognize structural and functional issues in models, allowing for early course correction and reducing the risk of reworks and waste.
- *Quality Control:* AI-powered cameras and sensors can monitor the quality of construction work, identify defects, and alert workers and managers to issues that need to be addressed.
- *Enhanced Creativity:* AI-powered software assists architects and engineers to think beyond the ordinary. By analyzing vast data sets, AI-driven software generates alternative design options, like digital brainstorming.
- *Recruitment Process:* The use of AI in the recruitment process has shown significant improvements and results. By removing human bias, organizations can make fairer and more objective hiring decisions, leading to a more diverse and inclusive workforce. Using AI in the recruitment process improves efficiency and effectiveness and promotes fairness and diversity within organizations. It helps organizations achieve fair, unbiased, and inclusive hiring by removing human bias, expanding the talent pool, enhancing innovation, conducting objective assessments, automating interviews, and providing personalized onboarding.
- *Project Delays:* The construction industry often faces numerous risks and uncertainties that can impact project timelines and budgets. By adopting predictive analytics with AI technology, organizations can better identify and mitigate potential project delays.
- *Productivity:* With data like job records, cost estimates, project plans, camera footage, and drone surveys all accessible via the cloud, it is possible to analyze this data and take actions that boost productivity. AI will help by ingesting these disparate datasets, providing recommendations that reduce cost and increase efficiency.
- *Soil Moisture:* With the help of AI and machine learning in construction, the moisture present in the soil can be estimated with the help of remotely sensor data or even images taken from the satellite with increased accuracy.

VII. CHALLENGES

While acknowledging the benefits of AI applications, numerous challenges which are relevant to AI still exist in the construction industry. Construction with inherent complexity is regarded as one of the most dangerous industries, which is greatly susceptible to a variety of unpredictable factors, such as participants in different roles, the changeable environment in large uncertainty, struck-by-equipment hazard, etc. Other challenges include [14,17]:

- *Resistance to Change*: One primary obstacle of AI is the industry's inherent resistance to change. Construction has traditionally been slow to adopt new technologies, often due to concerns about cost, complexity, and potential disruption to established workflows. Many construction companies, particularly smaller ones, may lack the resources or expertise to implement AI effectively. In order to successfully adopt AI technology in the construction industry, it is crucial to cultivate a workforce that is ready for change. One of the first steps in achieving this is to develop tailored training programs for employees. In addition to training programs, implementing employee engagement programs can greatly contribute to cultivating a workforce ready for change. These programs foster employees' sense of belonging, motivation, and loyalty, ultimately driving their willingness to embrace new technologies such as AI.
- *High Cost:* The high cost of investment and operation is a significant obstacle hampering AI in construction market growth. Developing and implementing AI technologies in construction projects require substantial financial resources including the cost of acquiring AI systems, hardware, software, and specialized expertise. The high cost of investment and operation makes it challenging for small- and medium-sized construction companies to adopt AI solutions. While the long-term savings and efficiency gains can outweigh these costs, the initial financial outlay can be a deterrent. Figure 10 shows the cost of implementing AI in construction [1].
- *Ethical Concern:* AI-based solutions can pose ethical and legal risks, such as biases, discrimination, accountability, and transparency. Governments play a crucial role in ensuring responsible and reliable adoption of this technology across all sectors.
- *Privacy and Security*: Artificial intelligence thrives on robust datasets. To operate effectively, companies must ensure data quality, accuracy, and accessibility. Sharing data can incur risks, including cyberattacks and privacy breaches.
- *Fatal Accidents:* The construction industry tends to cause a small scale of fatal accidents with higher frequency than other domains, which is even responsible for 30-40% of fatalities worldwide, emphasizing the necessity of construction management for safety guarantee and accident prevention. Construction in China has been regarded as one of the riskiest industries, where the number of fatal accidents exceeds many developed countries without a significant downward trend.
- *Uncertainty*: In the construction phase, a great deal of unknown uncertainty comes from the ground conditions, soil-structure interaction, weather conditions, building material properties, design changes, reliability of suppliers, and others. Uncertainties are unknown before they occur, which can be regarded as unavoidable threats to raise the risk of project failure. Notably, a high level of uncertainty is inherent in complicated construction projects, which is closely related to various factors.

The improper estimation of uncertainty will impede the progress of the project.

- *Workforce Adaptation:* This is another significant challenge. The integration of AI tools requires a workforce skilled in construction and comfortable using advanced digital technologies. Ensuring that employees are trained to use AI tools is crucial to maximizing their benefits. This includes technical training and a shift in mindset, where workers see AI as a tool to enhance their capabilities rather than a threat to their jobs.
- *Lack of Infrastructure:* This is another area of concern. Many construction sites, particularly those in remote locations, may lack the necessary connectivity and hardware to support AI solutions effectively. Construction companies need to invest in upgrading their infrastructure to fully leverage AI capabilities.
- *Aging Workforce:* The aging workforce is one more challenge that can hinder the implementation of AI in construction. The construction industry faces serious problems to recruit young workers. The good news is that the rise of digital technologies can help the sector redefining itself and turn to a promising destination for an ambitious and tech-savvy workforce. The UK government has started to focus its efforts on bringing more workers in the industry by 2025, while also investing in training programs for the industry's workforce. Figure 11 shows construction workforce by age in the United Kingdom [18].

Figure 10: Cost of implementing AI in construction [1].

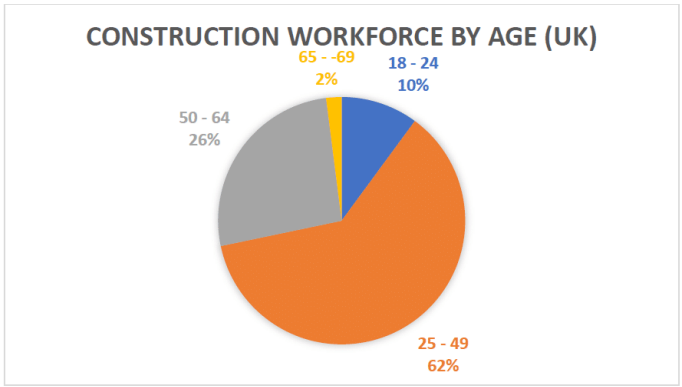

Figure 11: Construction workforce by age in the United Kingdom [18].

Figures p. 65*(welding),94(word cloud for AI applications),231(risks), 276(roads/traffic),

CONCLUSION

The construction industry, generally regarded as a laggard in adoption of cutting-edge technology, has surprisingly been quick to warm up to AI. Recent research indicates that applications of AI technologies are increasingly permeating the construction industry in all areas of architectural design, engineering design, and construction services. As AI continues to evolve, its influence on the construction sector is becoming more profound, bringing about changes that enhance efficiency, safety, and innovation. When AI talents continue to mature, it is believed that AI methods will become the next digital frontier to easily transform massive data into useful knowledge, leading to a high degree of automation and intelligence in both industry and commerce.

One can expect AI to play a more significant role in construction in the coming years. The future of artificial intelligence in the construction industry looks promising, with new developments continuously emerging. In the immediate future, the construction industry is projected to increase more focus and investment in AI. The construction industry may find itself increasingly reliant on AI solutions to stay competitive in a rapidly changing landscape. For this reason, forward-looking contractors should keep an eye on AI. More information on artificial intelligence in the construction industry is available from the books in [19-22] and the following related journals:

- *Energy and AI*
- *The AI Journal*
- *AI Magazine*
- *Journal of Intelligence*
- *Journal of Building Engineering*
- *Journal of Construction Engineering and Management*
- *Automation in Construction*

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