ROLES OF ARTIFICIAL INTELLIGENCE AND ROBOTICS IN CIVIL ENGINEERING

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Abstract- **The growth of the construction industry is severely limited by the myriad complexchallenges 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 hasmade it difficult for it to tackle the problems it currently faces. An advanced digital technology, Artificial Intelligence (AI), is currently revolutionizing industries such as manufacturing, retail, and telecommunications. The subfields of AI such as machine learning, knowledge-based systems,computer vision, robotics and optimization have successfully been applied in other industries to achieve increased profitability, efficiency, safety and security. While acknowledging the benefitsof AI applications, numerous challenges which are relevant to AI still exist in the construction industry. This study aims to unravel AI applications, examine AI techniques being used and identify opportunities and challenges for AI applications in the construction industry. A robot is areprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions for the performance of variety of tasks.It is an autonomous machine that is capable of mobility, dealing with large forces, harsh environment and is equipped with some cognitive skills. Robotics is the science of designing, building and using robots. It is the physical extension of computer technology. The greatest incentive for robotization on construction sites is in the cost of labor, of meeting environmental, safety and health regulations and avoidance of disruptive effects of strikes. These machines perform high-volume, simple and repetitive tasks most economically. The robot requirements forconstruction tasks and its applications are in inspection, maintenance, spraying, cleaning, welding,tunneling, demolition, site clearance, underwater work and nuclear plant construction.**

CHAPTER 1
INTRODUCTION
1.0 INTRODUCTION.

In the current situation, there is a tremendous rise in the living standards and economic level of the population leading to a gradual increase in competition between industries. The construction industry is key to India's economic development and its status affect the national overall economy. With individuals pursuing an improved quality of life, there is a rise in the rewards of natural civil engineering construction technology. The framework of the civil engineering projects is far more complicated owing to the field's diversity. According to the current construction situation, there are still many unresolved issues in the construction technologyof civil engineering, (Hai-chao, L. 2021)[1]. Hence forth, reasonable solutions should be crafted to counter the problems and propagate rapid development of the field's construction technology. Effective construction technology does not only create high levels for the industry but also accrueseconomic benefits which allow quality improvement at a reduced cost. Extensive technological innovation research should be conducted with the full participation of relevant professional staff. Higher- performance construction technologies will create more entrepreneurship opportunities inthe industry. To guarantee quality post incorporation of innovative technology, personnel should be educated and trained on their respective application.

A broad extension of entrepreneurship knowledge in the Civil Engineering sector can allowa bunch of business. Civil Engineers can drive their own business as entrepreneurs. However, a good start is often not a guarantee to a happy future in this field. According to Oswald (2015)[2],risk of breakdown in future, additional competition in marketplace and asymmetrical working timetable are top three obstacles seen in any start-up business curriculum. So, besides of proper planning, scheduling of work is also a very essential aspect to get success in this field. For successful entrepreneurship in civil engineering, an individual should have a good grasp of engineering principles coupled with problem-solving skills and aptitude to embrace innovative technologies. Innovative entrepreneurship is the key driver in today's engineering world, and thepush for sustainable products, services and technologies is needed now more than ever. Science, Technology, Engineering and Math (STEM) skills are an absolute necessity to running a successfulbusiness in Civil Engineering.

There is a strong connection between Technological development, Innovations and entrepreneurship. It is noteworthy that, entrepreneurship forms the sub structure upon which science and technology are built. As we understand it, technopreneurship is, by a large part, still entrepreneurship. The difference is that technopreneurship is either involved in delivering an innovative hi-tech product or makes use of hi-tech in an innovative way to deliver its product to the consumer or both (Fowosire & Idris, 2017)[3]. The latest technologies and advancements in the building construction industry such as Artificial Intelligence and robotics are the recentoutstanding forms of technopreneurship. However, the construction business is way behind in adopting robotics, automation and digital technologies as it is one of the least automated industriesof all. This is despite the industry being labor-intensive. Implementation of such technologies facilitates accuracy and quicker construction, saving time, money and other resources.

1.1 ARTIFICIAL INTELLIGENCE

Artificial Intelligence (AI) is a specialized system that can recognize intelligent entities, make decision-making easier, faster, and more efficient. Artificial intelligence is concerned with the roboticization of intelligent behavior that thinks and acts the same way people do. As a result,artificial intelligence is a discipline of science concerned with the study, design, and implementation of time-saving technologies. AI is concerned with machines that carry out tasks. Artificial Intelligence is mostly used in civil engineering applications like construction management, building materials, hydraulic optimization, geotechnical and transportationengineering, and is also useful in developing robots and automated systems.

AI models in civil engineering can be used for accurate, cheaper, and less disruptive construction projects. In modern structures, artificial intelligence is being utilized to plan the routing of electrical and plumbing systems. Artificial intelligence (AI) is being used to track real-time interactions between personnel, machinery, and items on the job site and supervisors for potential safety hazards, construction errors, and productivity concerns (Samui, & Kothari,2012)[4]. Simulated intelligence makes it simpler for those who engage with the development business by making it more sensible. It gives more open doors in a structural design by making itan appealing field of work.

Practicing civil engineers, contractors, and service providers have all been using AI to solvea whole range of problems. For instance, Artificial Intelligence in Civil Engineering has become more sophisticated, with efficiencies feeding directly into construction processes. AI is also applied in the initial stages of many projects in design optimization, risk control, and improving productivity. It is imperative to realize construction companies that have already started implementing AI practices are 50% more profitable, (Lu, Chen, & Zheng, (2012)[5]. More importantly, Artificial Intelligence as a whole has a range of functions in civil engineering. In an age where machines can think rather than just do, engineers can make better judgments while discharging their services more effectively.

1.2 ROBOTICS

Computer technology is already assisting the construction industry in many areas, notablyin computer aided design, knowledge-based design, communication, scheduling and financial control. Robotics is the only area of this technology that has not significantly penetrated the industry, because of high level of investment required. However, introduction of robots inconstruction industry to avoid ever-rising accidents in hazardous operations is justifiable. It is reasonable to expect financial benefits from machine capable of working in foul weather, darknessand hazardous areas without problems of motivation and administration. The introduction of robotic technology into the construction industry is slow because of slow mobility and lack of manipulation tools (Kumar, etl., 2016)[6]. Technical problems associated with the application of robotics are being solved and the comprehensive range of mobility, vision and manipulation toolsmaybe expected by the end of twentieth century.

The principal advantage of robots lies in the remote operations which are tele operations by human is a principle likely to be adopted for the construction sites where the plant in dangeroussituations maybe controlled by an operator situated safely away from the hazard. Laser and fiber optic technologies are a paramount importance in the teleoperations and to assist the microcomputer for the data transmission. Tele robotics is such a technology which is a mixture oftwo technologies where a computer is programmed and constrained to carry out certain simple repetitive tasks, leaving the operator to attend to the main control. The computer aids are becomingmore and more sophisticated, including models of the physical task and advisory aids based on theexpert system.

1.2.1 Critical characteristics required for construction robots

a. Sensing and Control - The biggest problem in development of robots for construction lies in the sensing and control, particularly in location and navigation. For control, the mobile robot constantly needs position and heading information. Obstacle avoidance and object location will bepossible with the use of video and image recognition techniques. Present robots for construction, use prelaid guidance tracks. Obstacle avoidance by use of touch sensors and ultrasonic is in use onseveral prototypes.

b. Mobility and Manipulation - Equipment mobility on construction sites depends on several factors such as varying surface materials, type of tasks/jobs to be carried out and type of workingspace. Rail-mounted robots have sufficient mobility for many finishing operations and wall inspection tasks. Manipulative tasks will be divided among various robots classified by their load carrying capacity, length of arm and type of grip.

c. Human and Task Factors - Human factors are especially important in tele operation. Automation decreases manual workloads, but increases cognitive and mental work. The man- machine interface is very in control and display of machine. Safety is the primary reason for developing construction robots to work in harsh environments, high and deep places, boiler-seas,and in radiation zones. In these applications, the robots could work alone or a tele robot could workremotely with its operator in a place of safety. For safety reasons, either man or machine must haveoverall control. To avoid the delay problems in difficult tasks and feedback of manipulation to theoperator, it is relevant to consider the current state of telecontrol.

d. Expert System and Task Flexibility - Robotics alone will bring little benefit to the constructionindustry. Only with total organization of the construction process will real progress be made. For civil engineering applications, expert systems, CAD/CAM and database technology are very important in robotics for task flexibility. A computerized work-control system for robotic work will be essential for their optimal use; this would have to include site organization and sophisticated handling of materials from factory to robot.

1.3 OBJECTIVES

The specific objectives for the PCL are the following.

1. To incorporate technology in improving the quality of building designs through automationof construction processes.
2. To employ Artificial intelligence in the risk identification and mitigation strategies.Robotics to be used where working conditions are not suitable for people.
3. To minimize cost and time overruns in construction projects.
4. To increase precision in construction

CHAPTER 2
APPLICATION

2.1 APPLICATION IN ARTIFICIAL INTELLIGENCE AND ROBOTICS

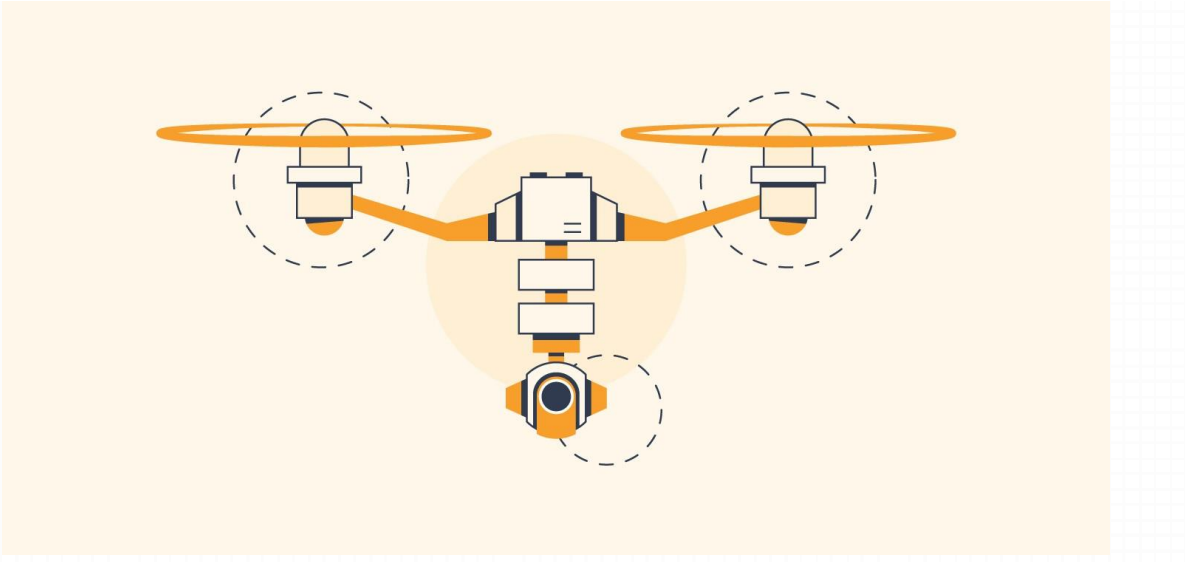
Each and every civil engineering project is associated with risks and uncertainties. This can includethe risks regarding task force allocation, mile stone achievement, project costing and overall construction management (Siau, & Wang, 2018)[7]. Machine learning which is a branch of Artificial Intelligence (AI) is widely used in the domain of civil engineering**.**

Current applications of artificial intelligence and robotics in civil engineering include the following.

2.1.1 Visualization with drones

The quadcopter distinguishes itself by being the optimal choice of the construction industry (DeYoung, 2018)[7]. The drone's domination is due to its pricing, simplicity, maneuverability, and flight times around 30 minutes (DeYoung, 2018)[7]. Drones have already made an impressive contribution to construction, and their influence is set to grow in the coming year. Small, camera-mounted flying drones can reduce the costs of processes that used to be extraordinarily expensive

Figure 1: Visualization Drone



Drones have increased construction efficiency through;

i. **Topographic maps:** Mapping is vital during the preconstruction phase. Aerial dronessurvey large amounts of land quickly, reducing mapping costs by as much as 95%.

ii. **Equipment tracking:** Purchased or rented equipment can quickly get misplaced on a vastjob site, but drones can automatically keep track of all equipment on site.

iii. Security surveillance: Job sites are vulnerable to theft of materials and equipment whenno one is working, but drones can monitor a site even when no humans are around

2.1.2 Artificial Intelligence-based soil profiling

Ensuring soil strength, as well as preliminary construction cost and duration prediction, is a very crucial in any construction project, (Sharma et. Al., 2021)[9]. Similarly, building strong structuresis very important in geotechnical engineering to ensure the bearing capability of structures againstexternal forces. Hence, in this first-of-its-kind state-of-the-art review, the capability of various artificial intelligence (AI)-based models toward accurate prediction and estimation of preliminaryconstruction cost, duration, and shear strength is explored. Similarly, soil moisture is an integral quantity parameter in hydrology and geotechnical practices. Satellite remote sensing has been widely applied to estimate surface soil moisture. The AI technology of learning from an existing knowledgebase is used to automate various civil- and geotechnical-related applications, such as the estimation of compressive strength of concrete, shear strength of soil, project pre-cost and duration, structural health monitoring, crack detection and pothole detection. Machine calculationof parameters allows not only lowering the cost and time required but also enhancing the accuracyin their calculation by eliminating any type of human error.

2.1.3 Steel-Beam Positioning Manipulator

Steel-Beam erection work is one of the most dangerous tasks on the construction to be robotized.Steel-Beam positioning manipulator lifts two or three steel beams and sets them in the correct position by teleportation. While setting beams, the manipulator grasps the top of the columns andthere is no need to be lifted by a tower crane. This means that the tower crane can be used for theother jobs while the manipulator is working. It weighs a total of 1,900 kg with a hanging load capacity of 2,100 kg and one degree of freedom, (Jung, et al., 2009)[10].

So, we will developing SM15-01 Steel Section Manipulator Specifically developed for handling and installing OLE masts this powerful manipulator will handle, erect and precisely position any steel section post or mast from 200mm to 650mm.

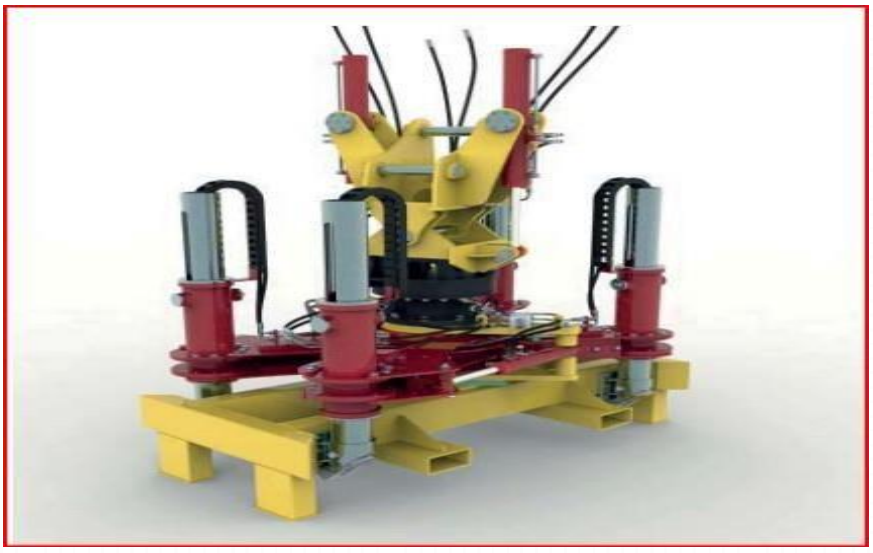


Figure 2: Steel Beam Manipulator

2.1.4 Fire Proofing Spray Robot (SSR-3)

Robot system used in building construction sites can efficiently reduce construction time and increase safety by replacing human in dangerous operations. Construction robots are defined as field robots and while operating in dynamic environment. Rock wool spray work for fireproofingsteel structural members is a hazardous construction job. The SSR-3 was developed to provide a safer work environment for spray workers. While spraying, the SSR-3 moves parallel to a steel beam at a constant distance measured with a pair of ultrasonic sensors.

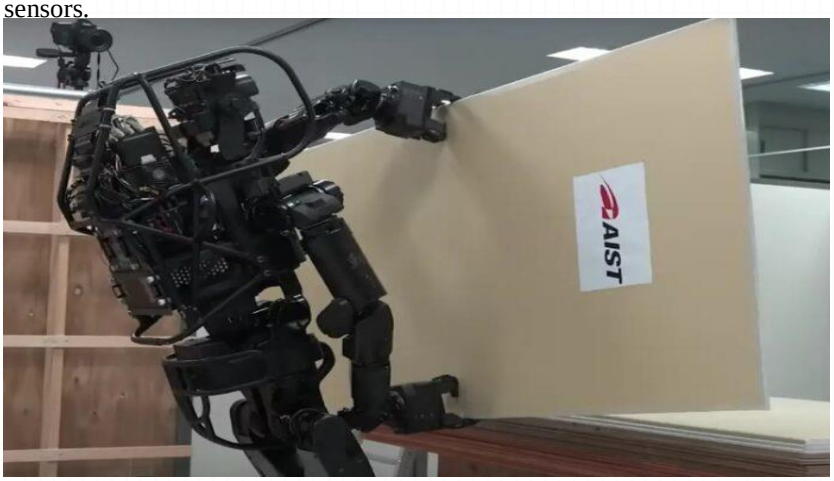


Figure 3: Interior Finish Spray Robot

2.1.5 Attention-guided analysis of infrastructure damage with semi-supervised deeplearning.

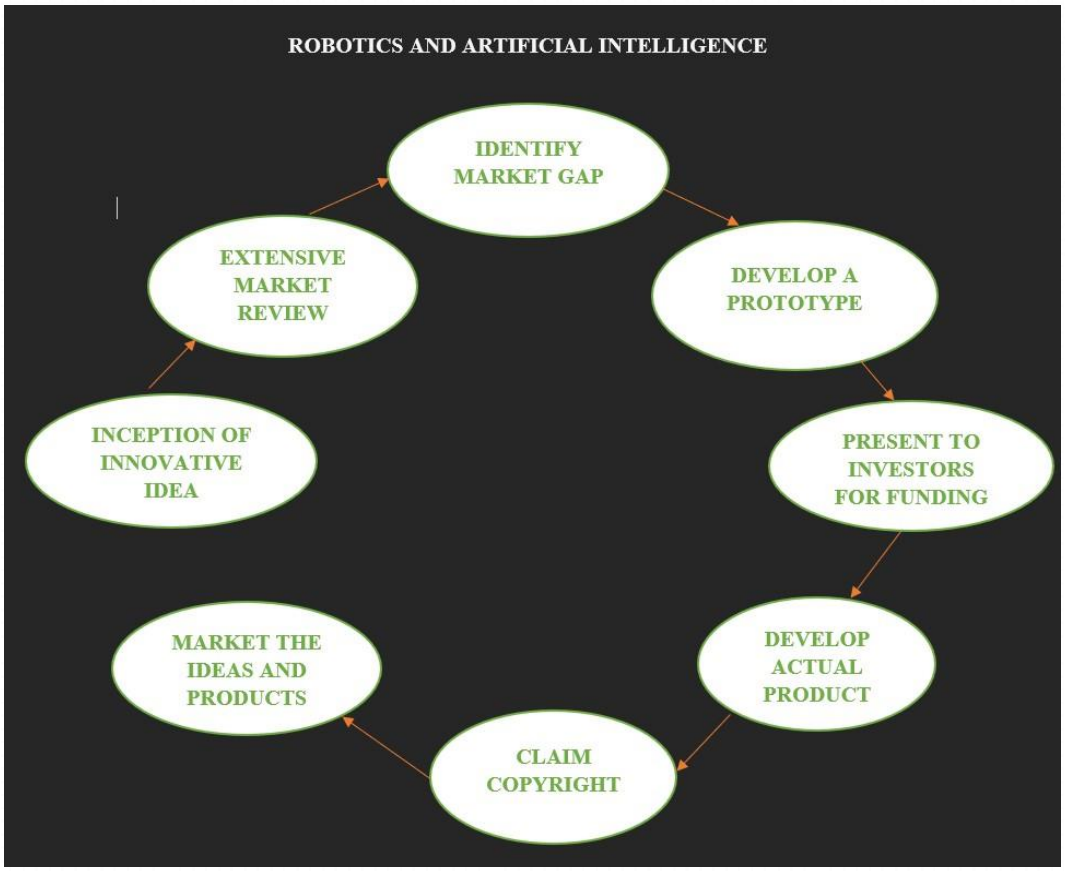
In the field of civil infrastructures physical inspection is needed to ensure safety. However, it is difficult to inspect some structures by human beings. In such cases computer vision and machine learning based software techniques are used to detect damage in place of manual observations. Inrecent years, a novel method to improve the accuracy of the damage quantification (detection + segmentation) using attention guided technique has been developed. In the proposed method a fastobject detection model is used (Abioye, et al., 2021)[11]. It is a Single Shot Detector (SSD) method, trained on VGG-16 base classifier architecture. This model performs a real-time crack and spall detection along with inspectors' verification. The detected region is used for further analysis. This initial region of interest selection reduces the computational cost, required amount of training data. The proposed attention-guided infrastructure damage analysis technique provides 30% more precision with a very minor amount of decrease in computational speed.

2.1.6 Predicting maximum dry density and optimum moisture content in concrete usingRBF neural networks

The proposed novel approach for the prediction of maximum dry density (MDD) and optimum moisture content (OMC) of soil-stabilizer mix uses radial basis function (RBF) neural networks. RBF neural network is utilized to construct comprehensive and accurate models to be able to relatethe MDD and OMC of stabilized soil to the properties of natural soil such as particle size distribution, plasticity, linear shrinkage and the type and quantity of stabilizing additives. Two separate sets of RBF prediction models, one for the MDD and the other for the OMC, have been developed. A parametric study conducted using the results obtained from the proposed models toevaluate the sensitivity of MDD and OMC due to variation of the influencing parameters. The accuracy of the proposed models is satisfactory when compared with that of the experimental results. The results of RBF models are further more accurate as compared with those of the existingmodels.

CHAPTER 3
METHODOLOGY

Figure 4: Methodology for Design, Development and Marketing



3.2 PROCEDURE

Examination into details will be conducted based on the methodology;

a. Cloud-Based Application: The following considerations will be taken into account as weconstruct the oriented language-based program application for the cloud storage.

i. The data of total work done per day
ii. The total cost of the material and other things also
iii. The risk management data synchronization
iv. The structure and construction detail.
v. The robot machine maintenance and details of daily power consumption.

b. Modelling: In software based on Artificial intelligence only we will be developing the modelvisually and the main purposes is to do designing without any error. The synchronization datawill help us into remove the redolence error and with that we will be designing efficient model.

c. We will be combing the BIM (BUILDING INFORMATION MODELLING) and program based on Artificial intelligence. Most usually the AI software we will use **Augmented reality**(AR) is a digital layer of information that enhances a view of the real world.

i. Automate measurements: By measuring a physical space in real time, ARtechnology can help construction workers accurately follow building plans.
ii. Visualize modifications: By layering potential project modifications directly ontothe job site, contractors can visualize potential changes before committing to them.
iii. Provide safety information: By recognizing hazards in the environment, augmentedreality devices can display real-time safety information to workers.

d. Construction Wearables

i. **Smart boots**: Powered by walking, smart boots can detect workers at risk of a collisionwith nearby construction vehicles equipped with sensors.
ii. **Smart hard hat**: By sensing brainwaves, smart hard hats can detect "microsleeps," whichput workers at risk of injury.
iii. **Power gloves**: When worn on a worker's hands, power gloves increase dexterity andstrength, helping reduce overuse injuries
a. These construction wearables will be monitored by AI Software programs.

3.3 RESOURCES AND SCHEDULES

AI is a game changer in terms of construction scheduling. Traditionally, only one or two schedules were created for large projects. Even this was a challenge, because developing schedules is time-consuming. By using AI, hundreds or even thousands of fully resource-loadedschedules can be developed within hours, along with a clear cost and time impact of each iteration. AI can manipulate the massive number of parameters involved in a project that impactconstruction, including labor, equipment and material availability or construction methods. Thisrapid data manipulation can only happen with parametric software.

Robots are primed to revolutionize the construction industry. Construction is one of the least digitized, least automated industries in the world, positioning robots as an attractive solution forconstruction companies.

CHAPTER 4
RESULTS AND DISCUSSION

4.1 RESULTS OF AI AND ROBOTICS IN CONSTRUCTION

4.1.1 Results of AI in construction

1. **Preventing Cost Overruns** - Cost overruns are almost expected for construction projects, andthe bigger the project, the bigger the overruns are likely to be. By using AI in conjunction withBig Data analytics, you can generate reports for past projects, pinpoint where the overruns were and predict better budgets for future ones. You can also use AI to streamline your supplychain and avoid costly delays with the same method. For instance, if your building calls for a solar panel system, your AI can predict the best time to order and install the system based on projected delays in previous steps.
2. **Improving Worksite Safety** - Not only can Artificial Intelligence gather data from the sensorsin your equipment, it can also manage the flow of people and materials around the site. This reduces accidents by ensuring faulty equipment is identified before failure, that equipment likecranes are not blocking access to critical areas and much more. Your AI can be integrated withsecurity cameras to monitor for unsafe actions or events and use facial recognition technologyto warn affected workers. By using the Internet of Things, your AI can even use RFID chips in building and safety equipment to track site traffic in real-time and redirect it to avoid collisions or delays.
3. **Helping Design Better Buildings** - More design firms are integrating AI with their Building Information Modeling software to provide 3D walkthroughs of their projects and predict potential problems faster than ever. These models can automatically update as each team makes changes to the electrical, plumbing or structure of the building and run predictive analytics on the data to help smoothly integrate key features. 3D modeling is already used to let architects, contractors and designers tour the space at various stages of the design process and Artificial Intelligence units can analyze this data and generate reports on the function of the building while the design team focuses on other tasks.

4. **Supervising Project Planning** - Not only can Artificial intelligence help design betterbuildings and prevent cost overruns, but it can also help with other aspects of project planning, such as scheduling and materials sourcing, and train better managers by analyzing past data. Your AI will look at how factors such as the weather and politics have affected your projects in the past to predict the best times to order materials and from whom to get them. The algorithms used in this process learn from past errors to make better choices in the future, all at learning speeds that only a computer can accomplish. You can even find software companies with machine learning data sets designed for planning construction projects, so you do not haveto source the information yourself.
5. **Making Job Sites More Productive** - Self-driving equipment can reduce the need for workersto perform some repetitive tasks, freeing them up for more detailed and hands-on processes and making jobsites more productive. Some tasks being developed include excavation and siteprep, pouring concrete and even welding, giving you the opportunity to focus on more things at once. Your AI project manager can keep track of these equipment pieces and tasks throughyour integrated security system and you can monitor progress and updates through your mobiledevice.

4.1.2 Results of robotics in construction

1. **Easier Demolition** - Breaking down walls and crushing bricks/concrete is no easy task. Without robotics, the demolition process would drag on far longer than necessary due to limited human strength. With robotics, buildings can be demolished and disposed of in one day, saving time and money.
2. **Higher Quality** - With automation comes higher quality. Unfortunately, humans are prone toerror, and this reflects in our work. No matter how often we double check for flaws, there is still a high chance that we will miss something. With robotics, the construction industry and its customers can rest easy knowing robotic machines are ensuring the quality of their product.Automation gets the job done better, faster, and more efficiently.
3. **Total Automation** - Once the construction industry embraces robotics, everyday processes will eventually become completely automated. This means everything from manufacturing towelding to dispensing! More automation means less human error and lots of financial savings.
4. **Job Changes** - Robotics will perform certain tasks that construction workers used to perform.This is one huge reason for why the construction industry has been slow to adopt new technology. Workers have done things the same way for a long time and are hesitant to change and possible job losses. While robotics will not get rid of all jobs completely, it will drasticallychange what workers will be doing day-to-day and, in some cases, will replace the need for human workers.

CHAPTER 5
MARKET REVIEW

5.1 REVIEW

Markets expects the global Artificial Intelligence (AI) in construction market to grow fromUSD 407.2 Million in 2018 to USD 1,831.0 Million by 2023, at a Compound Annual Growth Rate(CAGR) of 35.1% during the forecast period. The rising demand for AI-based solutions and platforms, the need for more safety measures at construction sites, and the capabilities of AI solutions and services to reduce the production costs are expected to drive the growth of the AI inconstruction market. AI in construction solutions plays a vital role in the efficient and effective functioning of construction businesses using Natural Language Processing (NLP); and machine learning and deep learning technologies. AI-based solutions are required to revolutionize the waythe construction industry functions. These solutions also help the construction industry familiarizeitself with advanced technologies and assist professionals in saving their time in the process of decision-making.

The construction robotics market size was valued at $2,450.7 million in 2019, and is expected to reach $7,880.3 million by 2027, registering a CAGR of 23.3% from 2020 to 2027. Construction robotics refers to construction operations that are automatically carried out by usingautomated construction equipment or construction robots. It is used in applications such as building and demolishing of residential, commercial, and industrial infrastructures. Construction robotics has reduced or completely removed human intervention from construction activities. Construction robots are used in activities such as demolition of structures as well as 3D printing of walls & structures. In addition, construction robots can be used for material handling activitiessuch as placing bricks to build wall and transportation of building material vertically or horizontally on construction site. Further, automatic drones are used for surveillance of construction sites that are not easily accessible or need to be remotely monitored.

5.1.1 Novelty

The adoption of robotics is yet to reach the tipping point in construction industry. This translates to a dire need of automation in our industry in terms of demolitions, 3D printing, Brick laying andother functions. Despite there being advanced knowledge on AI and Robotics, adoption in the construction field is limited for factors related to lack of specialization and the costs related to adoption. The cost of robots as per the Construction Robots company ranges between $75000 to $150,000 which is extortionate. The adoption of robotics in construction is on the rise with an estimated growth of 95% in the next five years. The leading in adoption is North America and Europe, followed by Pacific Asia with a very promising growth rate. However, South America andSub-Saharan Africa still depict low levels of adaptability. Moreover, the incorporation of AI is onthe high-rise with an inclination on safety in sites. Clearly, both AI and Robotics in the constructionIndustry are under development and with a promising future. The analyzed benefits range from reduced costs of construction to speed and quality delivery of projects.

5.1.2 Feasibility for Business

The construction industry is a labor-intensive industry. The construction business is way behind in adopting robotics, automation and digital technologies as it is one of the least automated industries of all. The latest technologies and advancements in the building construction industry such as Artificial Intelligence and robotics are currently the talk of the town. Implementation of such

technologies facilitates accuracy and quicker construction, saving time, money and other resources. With a fast-paced construction process, the incorporation of robotics technology in construction facilitates construction professionals with quality-assured outcomes and reduced human errors.

5.1.3 Expected Demand

The value of the global construction robot market was clocked at US$ 91.2 Million in 2021. The market is likely to expand at a CAGR of 15.3% during the forecast period, from 2022 to 2031. Theglobal market is anticipated to attain value of US$ 359.6 Million by 2031. In terms of use of robotsin construction industry, the sector is falling behind and the sector heavily relies on human labour. The global deployment of sophisticated construction robotics is now being driven by the demand for more economical and environmentally responsible homes with reduced environmental effects. Few construction companies now use automation, suggesting that there is a tremendous opportunity for service providers and construction robotics companies alike to revolutionize the sector through robotics. Artificial intelligence is projected to improve efficiency across the whole value chain, from the manufacture of building materials to the design, planning, and constructionphases themselves, as well as facility management.

5.1.4 Regulatory Aspects

The prospect of a highly automated construction industry is a medium-term future prospect. Henceit is imperative to proactively understand the regulatory gaps, to support policy interventions to mitigate potential risks. Regulation of futuristic technologies like AI and robotics is challenging in sectors where there is a lack of adequate tacit and applied knowledge. AI regulation is complicated by the massiveness of the construction industry, characterized by a broad spectrum ofactors and activities. We propose a framework to understand the AI and robotics inclusion in the construction industry and identification of risks and regulatory gaps by considering the diverse stakeholders and their risk perception.

5.1.5 Risk identified and management

1. **Ownership** - It is crucial to establish at an early stage who will own the data, know-how or other intellectual property derived from the new technology, and who will take responsibility for it. In cases of partnership between clients and software development companies or start- ups in the race to harness the benefits of AI, disputes tend to rise over the ownership of commercially valuable technologies. This is in particularly to where a party has contributed significant sums to the cost of the project, only to find that they do not have appropriate rightsin the end product.
2. **Data protection** - In order to adapt, machine learning requires large datasets to analyze and train upon. Some implementation models allow users to effectively "rent" a dataset upon whichto train their own systems. Other users prefer to insource their systems, or use AI as a service.In any event, care must be taken before collecting, sharing and processing personal data. Failure to comply with data protection legislation could lead to criminal prosecution and significant fines. Use of AI in facial recognition, sensors or other methods of monitoring individuals on a construction site, for example, could lead to issues in processing data under GDPR. Developing practical policies for managing data and dealing with subject access requests will minimize risk.
3. **Cybersecurity** - The risk of a cyber-attack is evident, given the significant amount of personaldata that can be collected and processed within a construction project, as well as the paymentsbeing made in connection with the project and the potential for ransomware to disrupt time- sensitive actions. Supply chains play a vital part in the security, or vulnerability, of the end system. Ensure appropriate due diligence has been carried out on suppliers and that contracts contain adequate cyber-security protections and audit rights. It is advisable to put in place aresponse policy and ensure all relevant individuals are aware of the steps that need to be taken.
4. **Licensing** - Checks should be carried out to ensure that rights of use can be assigned or sub-licensed to sub-contractors, to allow collaboration across design and build.
5. **5. Liability** - Collaboration through AI systems can also lead to difficulties in establishing who has responsibility for issues. For example, who has a duty to warn where multiple parties haveinputted to the design? Risks must be identified, with appropriate insurance and contractual liability flow-downs to ensure that the costs associated with any liabilities do not impact on the viability of the project. Changes to the regulatory framework should also be closely monitored, as legislators approach liability issues in relation to AI.

5.2 INTER/ TRANS-DISCIPLINARITY

Robotics is a multidisciplinary area that combines electrical engineering, mechanical engineeringand computer science. This area includes embedded programming, control systems, automated decision making, and power electronics. Moreover, Artificial intelligence is a science and technology based on disciplines such as Computer Science, Biology, Psychology, Linguistics, Mathematics, and Engineering.

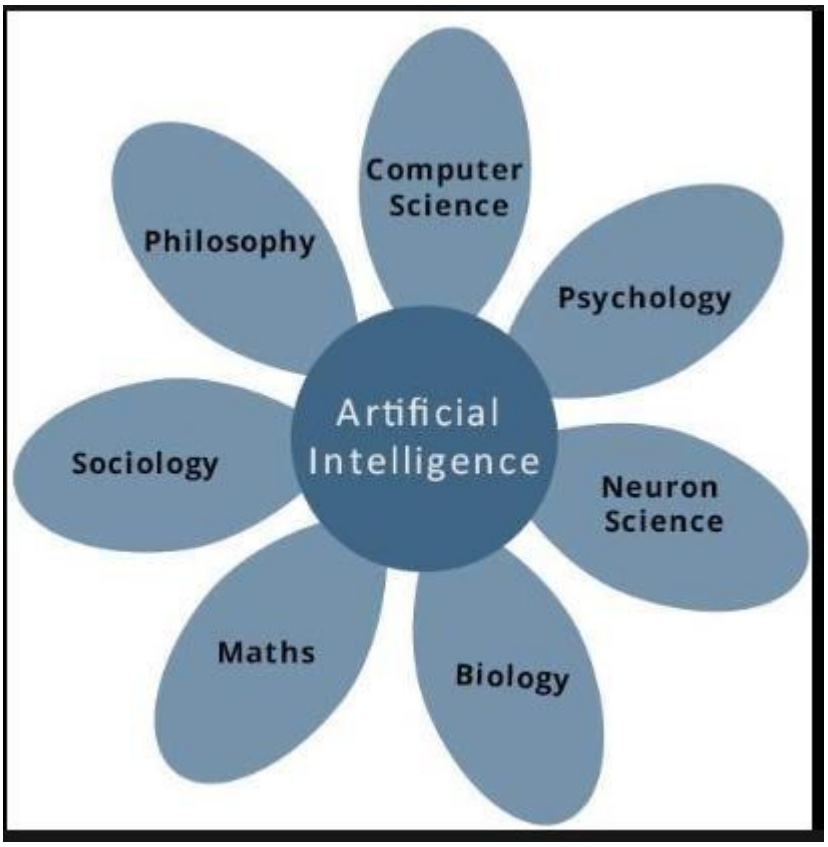


Figure 5: Disciplines of Artificial Intelligence

CHAPTER 6
CONCLUSION AND DISSCUSION

Robotics is the area of computer technology which is now penetrating the construction industry. Robotization of construction sites is very important to replace men for hazardous operations in foul weather, darkness, deep waters, high radiation zones, hazardous areas and at high elevations. It is also useful from the point of view of avoidance of disruptive effects of strikes, problems of motivation and administration, safety and health regulations, shortage of skilled laborsand to carry out repetitive, dirty and dangerous works and completion of projects or tasks with quality control, within the specified time and economy. Though this technology is assisting the construction industry in developed and developing countries, considerable research is required forsensing and control, human factors, task flexibility and the software support to integrate robots into an overall computer aided design and data-based construction management. Robot requirements for construction tasks and various applications of robots in construction industry depending upon the nature of work to be performed.

The use of artificial intelligence will undoubtedly make life easier for humans in the futureand may even encourage humans to expand their skill sets. The work for the constructors and architects is getting much simpler due to AI techniques. Artificial intelligence has been effectivelyapplied in developed countries to a variety of civil engineering applications, including prediction and risk management. Artificial Intelligence used in Civil engineering is important in the construction, maintenance, and management of several components of civil infrastructure.

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REFERENCES:

1. Hai-chao, L. Research on Innovative Practice of Civil Engineering Construction Technology. In *E3S Web of Conferences* (Vol. 248, p. 03030). EDP Sciences, 2021.
2. Oswald Beiler, R. Integrating innovation and entrepreneurship principles into the civil engineering curriculum. *Journal of Professional Issues in Engineering Education and Practice*, *141*(3), 04014014, 2015.

3. Fowosire, A., & Idris, Y. Technopreneurship: a view of technology, innovations and entrepreneurship. *Global Journal of Research In Engineering*, 2017.
4. Samui, P., & Kothari, P. *Artificial Intelligence in Civil Engineering: AI in Civil Engineering*. LAP Lambert Academic Publishing, 2012.
5. Lu, P., Chen, S., & Zheng, Y. Artificial intelligence in civil engineering. *Mathematical Problems in Engineering*, 2012.
6. Kumar, P., Balasubramanian, M., & Raj, J. Robotics in construction industry. *Indian Journal of Science and Technology*, *9*(23), 1-12, 2016.
7. Siau, K., & Wang, W. Building trust in artificial intelligence, machine learning, and robotics. *Cutter business technology journal*, *31*(2), 47-53, 2018.
8. DeYoung, R. E. (2018). An Industrial Overview for The Standardization of Drones in Construction. *Unpublished Masters thesis, Everglades University, Florida*.
9. Sharma, S., Ahmed, S., Naseem, M., Alnumay, W. S., Singh, S., & Cho, G. H. (2021). A survey on applications of artificial intelligence for Pre-Parametric Project Cost and Soil Shear-Strength estimation in construction and geotechnical engineering. *sensors*, *21*(2), 463
10. Jung, K., Chu, Y., Chu, B., Hong, D., Park, S., Lim, M. T., ... & Kim, M. C. (2009).Experimental evaluation of a robotic bolting device in steel beam assembly. In *2009 26th International Symposium on Automation and Robotics in Construction, ISARC 2009*.
11. Abioye, S. O., Oyedele, L. O., Akanbi, L., Ajayi, A., Delgado, J. M. D., Bilal, M.,& Ahmed, A. (2021). Artificial intelligence in the construction industry: A review of present status, opportunities and future challenges. *Journal of Building Engineering*, *44*, 103299.
12. Pour, M. A. K. Presenting a Smart Model of Marketing Status Based on Digital Content in Implementing the Building Management System (BMS) with an Artificial Intelligence Approach.

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