International Journal of Emerging Science and Engineering (IJESE)
ISSN: 2319–6378 (Online), Volume-14 Issue-5, April 2026

Review and Introduction of Automation and Robotics in Construction Industries

Poonam Sunil Sutar

***Abstract:** In the Indian construction industry's contribution to the gross domestic product (GDP) in developing countries, it is around 10%. It is expected that $1,000 billion in infrastructure investments will be completed in the next few years. In terms of automation, the construction industry is one of the least practised fields today. In developed countries, the importance of construction automation has grown rapidly. In developing countries like India, the construction industry needs automation technologies such as new machinery, electronic devices, and automation for road, tunnel, and bridge construction, as well as earthwork. Robotics technology developed rapidly during the 1980s, particularly in Japan, to address labour shortages caused by an ageing workforce and younger workers' reluctance to perform hard physical labour. Injuries are more severe among older workers, and compensation costs increase with workers' age. It is expected that robots can perform all high-risk tasks (like lifting, demolition, and working at height) and help address labour shortages in construction-specific skilled tasks. In India, the construction industry, being labour-intensive, requires more skilled labour, high-quality work, and increased productivity. The problems associated with construction work, such as declining quality, labour shortages, and safety and working conditions on projects, can be overcome by new, innovative technologies, such as automation, which have the potential to improve the quality, safety, and productivity of the construction industry. Today, it is evident that the level of automation in Indian construction is very low in comparison with current technological advances. Therefore, we must make new efforts to increase the automation level in this important sector to enhance productivity and quality, as well as economic growth.*

***Keywords:** Automation, Robotic Construction, Safety, Building Works, Reduce Labour, High Risk.*

Nomenclature:
NSC: National Safety Council
AR: Augmented Reality
BIM: Building Information Modelling
GDP: Gross Domestic Product

I. INTRODUCTION

A robot is an automated device used to perform construction tasks on a construction site. It can also be defined as "automatically operated machines that replace human effort. In other words, a robot is a mechanism guided by automatic control.

Manuscript received on 02 January 2025 | First Revised Manuscript received on 06 February 2025 | Second Revised Manuscript received on 09 March 2026 | Manuscript Accepted on 15 April 2026 | Manuscript published on 30 April 2026.
*Correspondence Author(s)

Poonam Sunil Sutar*, Department of Civil Engineering, Government Polytechnic, Daman (U.T.), India. Email ID: poonamsssutar@gmail.com, ORCID ID: 0009-0002-5722-8594

Over the last two decades, the use of robotic construction has generated much interest in the construction community. Robotic concepts began to emerge and were even tested over 20 years ago. The construction industry employs a large number of labourers, next only to agriculture. The development of the construction industry in India, like in other countries, was very slow and less systematic until the 19th century. The construction industry in India has undergone large-scale mechanisation, with rapid changes and advancements in construction practices and the management of construction works. Shimizu Corporation of Japan began its research and development of robotics in 1975 to advance innovation in construction production. The construction industry of India is an important indicator of the development. It is visualised to play a powerful role in economic growth. Automation and robotics are the hot new trend in many industries. Businesses are looking forward to automating repetitive, time-consuming, and dangerous tasks to enhance efficiency and improve worker safety. Automation in construction is an excellent solution for builders to increase operational efficiency and reduce labour and machinery costs. The scope of automation in the construction industry is broad, extending from initial planning stages through to the operation and maintenance of the final structure. Early on-site robotised concepts began to emerge and had even been tested over 15 years ago. Atomization and Robotisation of the industry started in the 1980s in Japan. The first ISARC (International symposium on automation and robotics in construction.

A. Challenges and Limitations

i. *Cost:* The initial investment and maintenance costs associated with robotic construction can be substantial.
ii. *Skills Gap:* There is a shortage of skilled workers who can effectively operate and maintain robotic construction systems.
iii. *Complexity:* Integrating various robotic technologies and ensuring their seamless collaboration can pose technical challenges [1].

B. Prospects for Robotic Construction

i. *Automation Advancements:* Ongoing advancements in robotics and AI will lead to more sophisticated and autonomous construction processes.
ii. *Sustainable Solutions:* Robotic construction will play a crucial role in sustainable infrastructure development and resource optimisation.

C. Future Trends and Innovations

i. *Advancements in Artificial Intelligence and Machine Learning:* The integration of AI and machine learning algorithms enables robots to adapt, learn, and perform complex tasks with increasing autonomy in construction environments.

ii. *Potential for Aerial and Underwater Construction Robots:* Developments in drone and submersible technologies open up possibilities for robots to assist in construction tasks in difficult-to-reach areas, such as tall structures and underwater installations.

iii. *Integration of Robotics with Other Emerging Technologies:* The combination of robotics with technologies like Augmented Reality (AR) and Building Information Modelling (BIM) holds the potential to revolutionise construction processes and enhance collaboration [2].

D. Advantages of Robotic Constructions

i. *Increased Efficiency and Speed:* The precise, automated processes reduce construction time and costs. Robotic construction eliminates human limitations, enabling faster project completion and increased productivity.

ii. *Enhanced Precision and Accuracy:* - Robots can perform repetitive tasks with precision, resulting in higher accuracy in measurements and joint connections. This leads to improved overall quality and reduces rework.

iii. *Improved Safety for Workers:* Robotic construction reduces workers' exposure to hazardous conditions, minimising accidents and injuries. Robots can handle heavy lifting and dangerous tasks, ensuring the well-being of construction personnel [1].

E. Disadvantages of Robotic Constructions

i. *High Initial Cost:* While robotics is cost-effective in the long run, the equipment and machines require a significant upfront investment [3].

II. LITERATURE REVIEW

Journal of Building Engineering, Robotics and Automated Systems in Construction: Understanding Industry-Specific Challenges for Adoption. The construction industry is a major economic sector, but inefficiencies and low productivity plague it. Robotics systems for construction were developed in the 1960s and 1970s, at the same time as other industries began automating. Robotics and automated systems have the potential to address these shortcomings; however, adoption in the construction industry remains very low. This paper presents an investigation into the industry-specific factors that limit the adoption in the construction industry. A mixed-methods approach was employed, combining a literature review with qualitative and quantitative data collection and analysis. Three focus groups with 28 experts and an online questionnaire were conducted. Principal component and correlation analyses were conducted to group the identified factors and find hidden correlations. The main identified challenges were grouped into four categories and ranked in order of importance: contractor-side economic factors, client-side economic factors, technical and work-culture factors, and weak business case factors. No strong correlation was found among factors. This study will help stakeholders to understand the main industry-specific factors limiting the adoption of robotics and automated systems in the construction industry. The presented findings will support stakeholders in devising mitigation strategies.

Robotics in Civil Engineering Associate Professor in Civil Engineering, SSN College of Engineering, Kalavakkam, Chennai-603110., India International Journal of Scientific & Engineering Research Volume 8, Issue 10, October-2017 127 ISSN 2229-5518: A robot is a reprogrammable, 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 capable of mobility, handling large forces and operating in harsh environments, and equipped with some cognitive capabilities. Robotics is the science of designing, building and using robots. It is the physical extension of computer technology. The greatest incentive for robotisation on construction sites is the cost of labour, the need to meet environmental, safety and health regulations, and the avoidance of the disruptive effects of strikes. These machines perform high-volume, simple and repetitive tasks most economically. This paper reviews the robot requirements for construction tasks and its applications in inspection, maintenance, spraying, cleaning, welding, tunnelling, demolition, site clearance, underwater work, and nuclear plant construction.

A Review on Automation and Robotic Technology in the Construction Industry Muffakham Shareef Department of Civil Engineering, Deccan College of Engineering and Technology, Hyderabad, Telangana State, India. International Journal of Science and Research (IJSR) ISSN: 2319-7064 SJIF (2022): 7.942: Automation and robotics are the use of computers, control systems and information technology to manage various tasks, replacing manual labour and improving efficiency, speed, quality and performance. Multiple researchers have worked and are working in the construction industry to implement robotics technology. Growth in the utilisation of automation and robotics technology is more apparent in the Western world. Such technologies are developed to reduce labour populations, diminish the need for skilled workers, eliminate dangerous jobs for labourers, and promote safety and security in construction. The aim and purpose of this review was to study and analyse the ongoing consciousness, desirability, usefulness, acceptability and adaptability of robotics and automation in the construction industry. The implementation of robotics has been extensive on-site, mostly targeting low-rise buildings. The general perception among practising construction industry professionals is that robotics and automation are similar and beneficial for a developing country. A systematic search of IEEE, Web of Science, and Scopus was conducted. The systematic search shows that 6 researchers in the USA played a leading role in robotics and automation in the construction industry, followed by Switzerland and Germany.

A Study on Automation and Robotics in the Construction Industry E. Iniyan1 and P. A Prabakaran2 P.G Student, M.E (Construction Management), Department of Civil Engineering1 Assistant Professor, M.E (Construction

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Management), Department of Civil Engineering, 2 Kumaraguru College of Technology, Coimbatore, Tamil Nadu, India. ISSN (Online) 2581-9429 International Journal of Advanced Research in Science, Communication and Technology (IJARSCT) Volume 2, Issue 1, June 2022: In this paper an attempt is made to do an in-depth study about the factors influencing automation and robotics in construction industry and what best strategy can be developed to overcome it So, in this research work the progress is going to be Identify the factors influencing automation and robotics in construction industry by literature review study so the different type of factors has been identified for automation and robotics & identify reason for the effective usage of automation and robotics in construction field and conceptual framework will be developed. The conceptual framework can be developed after analysing the survey responses. Automation and robotics technology are expected to improve the productivity of the construction industry and address problems such as labour shortages and safety risks. In this paper an attempt is made to do an in-depth study about the factors influencing automation and robotics in construction industry and what best strategy can be developed to overcome it So, in this research work the progress is going to be Identify the factors influencing automation and robotics in construction industry by literature review study so the different type of factors has been identified for automation and robotics & identify reason for the effective usage of automation and robotics in construction 7 field and conceptual framework will be developed. The conceptual framework can be developed after analysing the survey responses. Automation and robotics technologies are expected to improve productivity in the construction industry and address problems such as labour shortages and safety risks [1][2][3].

III. ROBOTICS AND AUTOMATED SYSTEMS IN CONSTRUCTION

This represents a brief overview of the different types of robotic and automated systems used in the construction industry. These Systems are varied, and there is no consensus on a standardised categorisation. The types of automation and robotic technologies for construction can be grouped in four general categories: off-site prefabrication systems, on-site automated and robotic systems, Drones and autonomous vehicles, and exoskeletons. The first construction robots were developed in Japan to increase the quality of Building components for modular homes. The adoption of these robots was driven by their successful use in Japan's automotive manufacturing sector. Later, construction robots began appearing on construction sites, and automated construction systems were developed. The latest developments have been robots and autonomous vehicles for inspection, monitoring, Maintenance, etc. Lastly, Exoskeletons are wearable mechanical devices that augment the user's capabilities. Note that exoskeletons are not strictly robotic systems because they augment the worker's capabilities rather than replace them altogether. However, it was decided to include exoskeletons here because this study focuses on all hardware technologies that improve construction activities. Also, in the future, this distinction will not be as clear-cut. For example, exoskeletons require a high degree of automation, and considerable potential exists for human-robot collaboration. In this sense, before construction sites are entirely devoid of human workers, it can be expected that robots, automated systems and Augmented workers will work together seamlessly. Drones can be used to sample extreme environments and study harsh, inaccessible sites. For example, drones have been developed to access and monitor mud eruption zones and to support space exploration. The main use cases for aerial drones are surveying and monitoring. But terrestrial drones have also been developed for these tasks. For example, a terrestrial drone has been reported in literature to automate visual bridge inspections. as well as a vehicle that navigates construction sites and collects data to monitor progress. However, the main application of terrestrial vehicles has been in autonomous mining: excavators and drillers have been automated, and GPS-enabled driverless trucks transport the excavated material between locations. The relative simplicity of mining operations, as compared with traditional construction tasks, has enabled the adoption of these technologies. However, for traditional construction sites, there are still many challenges in automating earth-moving machines. Also, there are many challenges to address to enable effective use of drones in construction. including:

(i) high initial Costs; (ii) low battery life, which restricts operations; for example, most Drones have a flight time of fewer than 30 minutes; (iii) complex operability of hardware and software, which requires additional training and increases costs [2][3].

IV. THE FUTURE OF CONSTRUCTION SAFETY

As the construction industry continues to evolve, the trajectory of construction robotics in enhancing safety appears promising. We will explore the future of construction safety, chart its path and discuss emerging technologies and trends shaping this transformative journey.

A. Increased Integration of AI and Machine Learning

One significant trend we anticipate in the future of construction safety is the increased integration of artificial intelligence (AI) and machine learning. These technologies will enable robots to become more autonomous and adaptive to dynamic construction environments. AI algorithms can analyse data from various sensors and cameras to identify potential safety hazards and provide real-time alerts to workers, helping to prevent accidents before they occur. This proactive approach to safety is expected to reduce the number of incidents significantly.

B. Collaborative Robotics

Collaborative robotics can play a pivotal role in the future of construction safety. These robots are designed to work alongside human workers, enhancing safety and capabilities. Collaborative robots can assist with physically demanding tasks, such as heavy lifting, by providing additional strength and precision. They are also equipped with sensors to detect the presence of humans and adjust their movements to avoid collisions, ensuring a safe working environment.

Retrieval Number:100.1/ijese.B103914020125
DOI: 10.35940/ijese.B1039.14050426
Journal Website: www.ijese.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

C. Wearable Technology

Wearable technology is poised to become more integrated into construction safety practices. Workers may wear smart helmets, vests, or exoskeletons embedded with sensors and communication devices. These wearables can monitor vital signs, detect fatigue, and provide real-time location tracking. In the event of an emergency or a hazardous situation, they can quickly alert supervisors and colleagues, enabling a rapid response to ensure worker safety.

D. 4. Enhanced Remote Operation and Telepresence

The future of construction safety will see advancements in remote operation and telepresence technologies. Operators will be able to control construction robots remotely, reducing the need for physical presence in hazardous environments. This not only protects workers from immediate dangers but also 14 enables experts to provide real-time guidance and oversight, improving safety and efficiency.

E. Sustainable Construction Materials and Methods

In line with the broader construction industry trends, the future of construction safety will also emphasize sustainability. The use of sustainable materials and construction methods can reduce the environmental impact of construction projects and, by extension, enhance safety. Sustainable practices may include modular construction techniques, 3D printing, and the use of eco-friendly materials that reduce exposure to harmful substances.

F. Data-Driven Decision-Making

Data-driven decision-making will become increasingly prevalent in construction safety. The extensive data collected by construction robots, wearables, and sensors will be analysed to identify patterns, trends, and areas for improvement. This data-driven approach will enable companies to make informed decisions about safety protocols, equipment maintenance, and worker training to further reduce risks. The future of construction safety is marked by the continued integration of robotics and other advanced technologies that prioritise worker well-being and reduce risk. Emerging trends such as AI, collaborative robotics, wearables, remote operation, sustainability, and data-driven decision-making are reshaping the construction industry’s approach to safety. As these technologies continue to evolve and mature, we can expect construction sites to become even safer, with a reduced incidence of accidents and a heightened focus on protecting the health and well-being of construction workers [4].

V. MOST COMMON TYPES OF CONSTRUCTION ACCIDENTS

According to the National Safety Council (NSC) Injury Facts, construction is one of the most dangerous industries in the United States, with a fatality rate higher than the national average for all industries. The Bureau of Labour Statistics (BLS) Occupational Safety and Health Statistics program found that construction site fatalities in 2021 accounted for the second-highest number of workplace fatalities in the US. The most common causes of construction fatalities are falls, being struck by an object, electrocutions, and being caught in/between machinery. Falls are the leading cause of construction fatalities. In 2021, the number of work-related fatalities caused by falls, slips, and trips rose by 5.6%, reaching a staggering 850 fatalities compared to the 805 recorded in 2020. Construction workers also face a high risk of non-fatal injuries on the job. According to OSHA, there were 21,400 non-fatal injuries in construction in 2020. Given the high risk of accidents in the construction industry, there is a growing interest in using technology to improve safety on the job site. Robotics and other forms of automation have the potential to reduce accident risk by taking on dangerous tasks and keeping workers out of harm's way [6].

VI. WAYS TO IMPROVE CONSTRUCTION SAFETY

When used properly, automation can help prevent construction accidents and even save lives. They can also boost productivity and streamline site operations. Here are three effective ways that robots, automation, and other smart technology can help reduce injuries, damages, and downtime for the construction industry

A. Remote Operation

Remote-controlled and teleoperated machines allow work to happen wherever it's safest. A remote-controlled excavator, trencher, or bulldozer takes an operator out of the cab to work from a stable location with the best visibility, protecting both the operator and others on site. This can reduce the risk of injury from falling objects or other hazards. By using remote-controlled machinery, construction sites can minimise the presence of workers in potentially dangerous areas. For example, in situations where there is a risk of collapse or unstable ground conditions, operators can control machines from a safe location on-site or even from an off-site location, reducing the need for human workers to be physically present in those hazardous areas.

B. Autonomous Equipment

Autonomous worksite equipment can perform repetitive and strenuous tasks, like lifting or laying bricks. This reduces the need for human workers to be in dangerous positions, such as working in trenches or on high platforms, and for difficult physical labour. Autonomous equipment can be programmed to perform tasks accurately and consistently. The risk of fatigue-related accidents and injuries from repetitive motion is reduced by eliminating the need for human workers to engage in repetitive tasks. This helps maintain a high level of safety and reduces the likelihood of associated injuries. Dangerous tasks that involve working in trenches or on elevated platforms can be assigned to autonomous equipment. These machines can perform the work while keeping human workers at a safe distance. By minimising workers' exposure to potentially life-threatening situations, construction site safety is significantly improved.

C. Wearable Technology

Wearable technology, such as wireless e-stops and smart helmets, can provide workers with real-time feedback and alerts, reducing the risk of accidents and injuries. For example, wireless emergency stop devices can help workers stop machines immediately, reducing the risk of injuries

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

and fatalities. A wireless emergency stop is a wearable device that can be attached to a belt or clothing and worn as PPE (Personal Protective Equipment). In the event of an emergency, workers can trigger the wireless e-stop to stop nearby machines or equipment immediately. This rapid response capability helps prevent accidents and injuries by quickly halting potentially hazardous operations. This can be especially helpful when working around autonomous equipment. By incorporating these measures into construction site safety practices, autonomous systems can be used. Wearable technology can play a vital role in reducing injuries, damages, and downtime on construction sites [4][6].

VII. AI AND MACHINE LEARNING FOR SMART CONSTRUCTION

Artificial intelligence (AI) is an umbrella term for systems that mimic human cognitive functions, such as problem-solving, pattern recognition, and learning. Machine learning is a subset of AI. Machine learning is a field of artificial intelligence that uses statistical techniques to enable computer systems to "learn" from data without being explicitly programmed. A machine becomes better at understanding and providing insights as it is exposed to more data.

The potential applications of machine learning and AI in construction are vast. Requests for information, open issues, and change orders are standard in the industry. Machine learning is like a smart assistant that can scrutinise this mountain of data. It then alerts project managers about the critical things that need their attention. Several applications already use AI in this way. Its benefits range from mundane spam filtering to advanced safety monitoring. • Prevent cost overruns • AI for better design of buildings through generative design • Risk mitigation • Project planning • AI makes jobsites more productive • AI for construction safety • AI will address labour shortages • Off-site construction • AI and big data in construction • AI for post-construction [7].

VIII. THE FUTURE OF AI IN CONSTRUCTION

Robotics, AI, and the Internet of Things can reduce building costs by up to 20 per cent. Engineers can don virtual reality Goggles and send mini-robots into buildings under construction. These robots use cameras to track the work as it progresses. AI is being used to plan the routing of electrical and plumbing systems in modern buildings. Companies are using AI to develop safety systems for worksites. AI is being used to track real-time interactions among workers, machinery, and objects on the site and to alert supervisors to potential safety, construction, and productivity issues. 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. Leaders at construction companies should prioritise investments in areas where AI can have the greatest impact on their unique needs. Early movers will set the industry's direction and benefit in the short and long term [5].

IX. NEED FOR ROBOTS

Fast-changing, field-based industries like construction are severely handicapped by the lack of accurate, timely, and systematic technical, cost, and production data from ongoing operations. The construction work requires highly skilled workers to achieve sufficient and consistent quality. Robots have been designed to support humans by performing tedious and dangerous tasks. The high expectations of building robotics stem from the very serious problems the industry is facing, such as: • A high accident rate. • Low quality. • Insufficient control of the construction site. Vanishing of a skilled workforce [1].

X. OBJECTIVES OF ROBOTIC CONSTRUCTION

• To identify possible applications of robotics to the various building construction tasks. • To specify the robot requirements necessary for the performance of these tasks. • To examine the general feasibility of robotic application at the • present and future state of building and robotic technology, • To outline a procedure for detailed planning and evaluation of • robotic application to the performance of the desired activities. • The general objective is to determine the scope of application of robotics in building construction. In more specific terms, the objectives are: • To review the literature for the implementation of robotics in building construction. • To identify the feasibility of using robots in building construction. • To reduce time and save cost in building construction using robotic applications • To reduce time and save cost in building construction using robotic • applications. • To conclude the extent of success of building robots. • Automated personnel and equipment tracking. • Automated materials handling trucks, loaders, conveyors, sizers: • Smart drills-automated drilling of holes and recognition of material characteristics. • Accurate and automated movement and positioning of all construction equipment. • Automated mechanical construction systems. Remote supervision from distant locations. • Intelligent and integrated control over all construction processes to optimise resource value [3].

XI. APPLICATION OF ROBOTIC CONSTRUCTION IN CIVIL WORK

A. **Construction of Large-Scale Infrastructure Projects: -** Robotic construction is revolutionising the development of large-scale infrastructure projects such as bridges, skyscrapers, and tunnels. The precise trend automated processes enable faster construction and improved structural integrity.

B. **Modular Building Construction: -** Robots are used in the efficient assembly of prefabricated modules for residential and commercial buildings. This method reduces construction time and allows for greater flexibility in design and functionality.

C. **Renovation and Restoration Projects: -** Robotic construction is utilised in the assessment, repair, and restoration of existing structures. Robots can

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

inspect, clean, and perform precision tasks, enhancing the efficiency and quality of renovation projects.

D. Demolition: - Remote-controlled demolition robots. Concrete Sawing Demolition Water-based concrete demolition and recycling.

E. Surveying: - Drones for aerial mapping and surveying construction sites. Allow for real-time surveying, improve logistics and collaboration across construction teams

F. Paving: - Robots pave roads with bricks or concrete. Relieve workers from physically straining work and improve efficiency.

G. Concrete Finishing: - Automatic concrete trowelling and paving. Automates repetitive, hard-for-humans-to-do tasks, such as paving. Automates tasks that are repetitive and hard for humans to do well. 24 • Welding: -Welding of 3d structures, steel beam assembly and steel cutting.

H. Bricklaying: - Works in tandem with construction workers, but lays down 3x as many bricks as humans. Can lay bricks in unconventional patterns to achieve novel structures.

I. Drilling: - The robot provides accurate, efficient drilling in concrete ceilings and promises far less strain on workers.

J. Mass Tiling: - Robotic production of tiling work. Allows for the existence of tiles with unprecedented detail. Otherwise, these tiles would be economically unfeasible.

K. Inspection: - Non-destructive technical diagnostics of bridges, tunnels and other structures.

L. Exosuits: - Exosuits and exoskeletons help construction workers handle heavier loads without hurting their bodies.

M. Prefabricated: - Robots manufacture prefab parts of buildings. In this case, the panels are designed to fit within the robot's spatial constraints.

N. Recycling: - Robots help sort construction materials and waste for easier recycling.

O. Autonomous Trucks: - Autonomous trucks are being developed to increase safety in construction areas.

XII. OTHER APPLICATION

• Concrete transportation/distribution • Positioning of steel • Fire resisting • Painting • Excavation/Earthmoving/Tunnelling 30 Emerging Technology

1: - Contour Crafting (CC) is a layered fabrication technology developed by Dr Behrokh Khoshnevis of the University of Southern California. Contour Crafting technology has great potential to automate the construction of whole structures as well as subcomponents. Using this process, a single house or a colony of houses, each with possibly a different design, may be automatically constructed in a single run, embedded in each house all the conduits for electrical, plumbing and air-conditioning" Source: http://www.contourcrafting.org/ Emerging Technology

2: - D-SHAPE "D-Shape is a new robotic building system using new materials to create superior stone-like structures. This new machinery enables full-size sandstone buildings to be made without human intervention, using a stereolithography 3-D printing process that requires only sand and our special inorganic binder. D- Shape is a new building technology which will revolutionise the way architectural design is planned, and building constructions are executed." Source: http://www.d-shape.com/cose.ht

A. Robotic Construction in Architecture

i. *Enhanced Precision:* Robotic arms can precisely fabricate complex architectural components, allowing for intricate designs and precise assembly.

ii. *Time Efficiency:* Automated processes enable faster construction, reducing project timelines and increasing overall efficiency.

iii. *Sustainable Solutions:* Robotic construction enables the use of sustainable materials, reducing waste and environmental impact.

B. Robotic Construction Infrastructure

i. *Bridge Construction:* Robotic systems can autonomously construct bridges, reducing risks for human workers and ensuring higher safety standards.

ii. *Underground Excavation:* Robots equipped with advanced sensors and navigation capabilities are used for efficient and precise tunnel excavation

iii. *High-rise Building Maintenance:* Robotic systems are employed for façade maintenance and inspection in high-rise buildings, enhancing worker safety and efficiency [5].

XIII. TYPES OF ROBOTS USED IN CONSTRUCTION AUTOMATION

A. Teleoperated Robots: -The term teleoperation refers to the remote control of machines and systems. The machine does not operate autonomously; it is under human control.

B. Programmed Robots: -The operator of this type of machine can vary the task to be accomplished within certain constraints either by choosing from a preprogrammed menu of functions or by teaching the machine a new function.

C. Cognitive Robots: -Cognitive robots sense, model, plan and act to achieve working goals. Cognitive robots serve themselves in the manner of teleoperators but without human controllers, and they are their own supervisors [2].

XIV. THE ROBOTIC REQUIREMENTS FOR CONSTRUCTION TASKS

•It should work in hazardous situations to replace men from Fatalities. • It should work in foul weather, darkness, and hazardous areas without problems of motivation and administration leading to financial benefits. • It should be designed to maximise benefits in several application areas. • It should be autonomous, mobile and cognitive. •It should work in hazardous situations to replace men from Fatalities. • It should work in foul weather, darkness, and hazardous areas without problems of motivation and administration leading to financial benefits. • It should be designed to maximise benefits in several application areas. • It should be autonomous, mobile and cognitive [1].

Retrieval Number:100.1/ijese.B103914020125
DOI:10.35940/ijese.B1039.14050426
Journal Website: www.ijese.org

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

XV. CHALLENGES AND GOALS IN CONSTRUCTION ROBOTICS

• Perform goal-driven tasks whose contingencies defy preplanning • Strategic, tactical, and reflexive paradigms for generic work tasks, • Complex, perceptive sensing in random and dynamic environments. Domain-specific tooling and operating procedures. • Extremes of ruggedness, reliability, and intrinsic capability. • Larger working forces and softer base compliance than typical factory operations • Navigation and mobility around the work site. • Protocols for communication among humans, data servers, hosts, and robot peers. • Safety Considerations: Ensuring the safety of human workers when working in proximity to robots is crucial. Proper training and risk assessments are essential. • Integration with Existing Construction Processes: Integrating robots into established construction workflows requires careful planning and coordination to ensure seamless collaboration and efficiency. • Cost and Investment Considerations: Robotic systems can involve high upfront costs, but they offer long-term benefits in terms of improved productivity and reduced labour requirements. • Skilled workforce: Another consideration is the need for a skilled workforce capable of operating and maintaining robotics systems. Companies can address this challenge by providing training and upskilling opportunities for their existing employees. Collaborating with educational institutions to develop robotics training programs can also help bridge the skills gap. Furthermore, many robotics manufacturers offer comprehensive training and support to help companies effectively implement and use their technology. • Resistance to change: Resistance to change within the workforce is a common challenge when introducing new technologies like construction robotics. Companies should proactively involve their employees in the transition process by providing clear communication, training, and opportunities for feedback. Demonstrating the benefits of robotics, especially improved safety and reduced workload, can help alleviate resistance and foster acceptance. • Technical challenges: Construction sites can be harsh environments, and robotics systems must withstand adverse conditions. Ensuring the durability and reliability of robotics equipment is essential [1].

XVI. SCOPE FOR FUTURE WORK

It is important to understand the current state of building robotics to decide on future directions for the field. The robot has to be "site-friendly", i.e., well adapted to the particular conditions of the building site. This involves: - Its performance as a system. All aspects of operation, movement, materials feeding and transfer must be taken into account in further development. Ensuring that its weight load. does not exceed the permitted level and can work in restricted spaces. Its ability to perform multiple tasks increases its use. The ability to operate in the rough conditions of the building site with minimum maintenance requirements [8].

XVII. CONCLUSIONS

To enhance productivity and boost profits, Automation technologies are the way forward for the construction industry. The adoption and integration of automation and the widespread use of prefabrication may be the best opportunities for the construction business to thrive in the next decade. A robotic manipulator is combined into a module type to suit various working conditions and building materials. Therefore, it is possible to handle a variety of building materials in various construction sites. To improve the technology of human-robot cooperative manipulation, a lightweight robot link, robust robot force control, a flexible robot arm and teleoperation based on force feedback will be developed in the future. The use of automation technologies in construction work had a major influence on project performance, with greater benefits in improved work quality, time savings, improved working conditions, safety improvements, and higher productivity. The benefits of implementing automation technologies include significantly increasing productivity, improving worker safety, and enhancing the quality of work. Small and medium-sized firms need advances in automation for implementation across various areas. The quality of output has improved significantly, and rework and scrap costs have been reduced by 66.76% through automation. Accidents and lost person-hours are reduced significantly because labour participation in work involving automated machinery is minimal. Robotics and automation, if not to a large extent, can be slowly introduced into the construction sector in the Indian context to keep abreast of foreign technologies. Low-cost indigenous robot use can be promoted, resulting in lower costs and greater public interest in continuing research in the field. Replacement of labourers [5][3][8].

DECLARATION STATEMENT

Some of the cited references are older and are noted explicitly as [2] and [3]. However, these works remain significant for the current study, as they are pioneering in their fields.

I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/ Competing Interests:** Based on my understanding, this article has no conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted objectively and without external influence.
- **Ethical Approval and Consent to Participate:** The content of this article does not necessitate ethical approval or consent to participate with supporting documentation.
- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** The authorship of this article is contributed solely by the author.

REFERENCES

1. Akash S. Tambi, A. R. Kolhe & Upendra Saharkar, 'Remedies over the obstacles in implementing automation in Indian infrastructure projects',

International Journal of Research in Engineering and Technology (IJRET) DOI: https://doi.org/10.15623/ijret.2014.0305111
2. Maalek, R, Janaka R, & Kamal R 2014, Evaluation of the state-of-the-art automated construction progress monitoring and control systems, Construction Research Congress 2014, ASCE 2014, viewed on 15th March 2015 http://sipb.sggw.pl/CRC2014/data/papers/9780784413517.105.pdf., works remain significant, see the declaration
3. M. J. Kim, H. Chi, X. Wang, L. Ding, Automation and Robotics in Construction and Civil Engineering, J. Intell. Robot. Syst. 79(3-4) (2015) 347-350. https://link.springer.com/article/10.1007/s10846-015-0198-5, works remain significant, see the declaration
4. Shareef, M. (2023). A review of automation and robotic technology in the construction industry. International Journal of Science and Research, 12(1), 855–859. DOI: https://doi.org/10.21275/SR23123123333
5. McKinsey & Company. (2017). *Imagining construction's digital future*. https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/imagining-constructions-digital-future
6. Occupational Safety and Health Administration. (2020). Safety and health topics: Construction. https://www.osha.gov/construction
7. Autodesk. (2018). The future of construction: Artificial intelligence and machine learning. https://www.autodesk.com/solutions/construction
8. International Federation of Robotics. (2022). World robotics report: Industrial robots. 👉 https://ifr.org/worldrobotics

AUTHOR'S PROFILE

Poonam Sunil Sutar, M.E. in Structural Engineering, B.E. in Civil Engineering, Lecturer in Civil Engineering, Government Polytechnic, Daman, Years of Experience: 11 Years. (i) **National Journals** (ii) **International Journals** —

a) Earthquake response of the liquid storage tank with various isolation systems: state of the art review-IJAIEM, vol.2, Issue 11, Nov.2013

b) Response of elevated liquid storage steel tank with various frequency pendulum Isolator-IJIES, vol. 1, Issue-11, Oct.2013.

c) "Structural Health Monitoring using smart sensor network or a cable stayed bridge structure" IJRDT, vol.11, Issue-05, May, 2019.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)