

Scope and Impact of Internet of Things (IoT) and Artificial Intelligence (AI) in the Global Construction Industry

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Abstract: Construction Industry projects for buildings are typically unique designs that are rarely imitated in terms of their arrangement, pattern, and structure. Smart manufacturing systems benefit from network performance optimization and the ability to reconfigure projects. The Global Construction Industry is changing in 195 countries because of advancement in digital technology. The Global Construction Industry are currently revolutionizing with synchronized communications, ecommerce and production with AI and IoT. Construction Industry is also strategically vital on a provincial, a national, and an international scale. The construction sector faces numerous challenges and significantly restrict its ability to grow, such as budget overruns, concerns about health and safety, productivity issues, availability, optimum utilization of skills and abilities of labours. Along with resolving the complicated issues systems built on IoT and AI capabilities will open up new business prospects, cost reduction and revenue increase possibilities and as well as innovative business models. AI and IoT is impacting in positive way used and use for real-time tracking and communications of labours, equipment and things on the site. It can also enhancing the quality of design and planning, project management and scheduling and alert managers of potential safety concerns, construction faults, and output concerns. Artificial Intelligence (AI) and Internet of Things (IoT), two highly developed digital technologies having Vast Scope and Impact for making life easy, comfortable, hygienic and safe. Lowering the risk of accidents, avoid of expensive mistakes, improved operations, intelligent tasks such as speech recognition, language understanding, language translation, self-learning, reasoning, problem solving, perception, user interface, jobsite image handling, knowledge representation, predictive ability to be carried out by AI and IoT assisted home automation with or without human intervention. Digital sensors, Smart machinery, Mobile platforms, Cloud-based apps and new software system applications empowers the IoT and AI Construction Industry and home automation capabilities in several folds. India has hug scope of growth in Global Construction Industry using AI and IoT. This paper provides a concise literature analysis of AI and IoT use in the Global Construction Industry. The deployment of IoT and AI emerging technologies has had a significant positive long term impact with new scope on the construction industry's profitability.

Keywords: *Construction Industry, Internet of Things, Artificial Intelligence, home automation, Smart manufacturing, Emerging Technologies.*

1. Introduction:

Glob is nothing but along with 195 countries which consist of the United Nations member 193 countries and 2 countries that are non-member observer states. When we talk about Global Construction Industry it mentions to the engineering branch of manufacturing, trading, repairing, renovating, and maintaining infrastructures of mainly three categories that is Building (residential and commercial or non-residential), Infrastructures, and Industrial construction at global level.

As per the Statista Global Consumer Survey report of year 2022, the Global Construction Industry rose to a spending value of close to 12 trillion U.S. dollars before the Covid-19 pandemic in year 2019. It is expectable to continuous raise by three percent per year and may reach to about 19.2 trillion U.S. dollars by year 2035. This contains building projects in real estate (residential or commercial), infrastructure and industrial constructions. Construction spending data consist of cost of workforce and materials, architectural and engineering work, and duties. Statista Global Consumer Survey report also shows that, China lead in world ranking of the year 2020 among the list of 100 largest construction companies with the first four entries. With New Zealand topping the rankings, India has ranked 56th in GlobalData's Construction Risk Index (CRI) released in May 2021, which has been released for 92 countries and Larsen & Toubro Ltd (L&T) is currently the first construction company in India on the criteria of turnover and market capital. This also shows, India has hug scope of growth in Global Construction Industry using AI and IoT.

The Internet of Things (IoT) can be define as a system or network of interconnected intelligent devices, sensors, mechanical and digital machines, objects, animals, plant human with Unique Identifiers (UIDs) and processing systems, which communicate data

or information with each other, without human interventions and sometimes or in some case with human interventions with several decision options and abilities.

Artificial Intelligence (AI) is nothing but replication of human intelligence with help of machines or computer expert systems with numerous abilities such as self-learning, natural linguistic handling, image processing, visualisation, dialogue investigation and recognition, decision making and executing.

Artificial intelligence (AI) is an emerging technique that is influencing our daily lives. AI and IoT is impacting in positive way used and use for real-time tracking and communications of labours, equipment and things on the site. It can also enhancing the quality of design and planning, project management and scheduling and alert managers of potential safety concerns, construction faults, and output concerns.

A human ingenuity that can understand reason, manage, perceive, or analyze natural language is what AI wants to achieve. In practically every field, AI is providing cooperative answers to issues. Technology based on AI has the capacity to offer answers to issues in the construction sector [1]. On the construction sites, modern technology such as internet of Things (IoT) is gradually being implemented. The use of smart phones and cloud-based apps to access information such as jobsite images, materials utilized, worker hours, resource utilisation and so on has expanded tremendously, allowing for better study. Synchronizing AI and preconstruction modeling would help the construction sector go even more digital and automated.

AI is a technology that we use and gain from on a daily basis without even recognizing it. When AI is used in the construction sector, it is anticipated that business models for help, customer relationship management, and transportation would change. By continuous improvement, it also aids in fixing workflow errors. There is a pressing need for skilled workers in the construction sector, which is putting pressure on many enterprises [1, 2]. It is challenging to deploy AI technology into practice and reap their potential advantages. For training, the majority of algorithms need precise data, and initially gathering this data is both expensive and time-consuming. Even though some major construction organizations have already started to reap the rewards of these technologies, AI in construction is still in its adolescence. This has led to more discussion regarding the future of the construction workers and how AI might affect employment [2, 4, 5].

Since the technology has the ability to boost construction productivity and effectiveness, it has become more widely used in the sectors of engineering and management in the construction sector. Long-term changes in construction will result from the technical combination of IoT and AI, which will enable new commercial ventures, income sources, and marketing strategies that make use of IoT and AI technologies. Transportation, support, digitization, and funding are just a few of the business models that AI is predicted to change in the construction sector. Additional AI could aid in creating more real-world training scenarios, lowering the risk of accidents and expensive mistakes, and improving operations. As a result, employers may be able to utilize their current labor resources more effectively, thereby eliminating the skill gap [6, 7].

The Construction Industry is expanding quickly in many countries, and there is significant opportunity for growth through the implementation of emerging new technologies like automation, IoT, and AI [8]. Numerous building projects now include digital sensor, smart machinery, mobile platforms, and new software system applications that are gradually connected with a central Building Information Modelling (BIM) platform. Big data has the ability to quickly transform any way of construction contracting and find solutions to construction difficulties [9, 10].

The construction sector is progressively incorporating AI in all facets of design and architecture, engineering design, and construction services. The advancement and use of different mathematical methodologies, logic, Artificial Neural Networks (ANNs), statistical methods, probabilistic methods, and economic methods, which are all referred to as Architectural Artificial Intelligence (AAI), are currently the main areas of AI research in the construction sector. The development of the construction business has greatly benefited from the sophistication of the diverse technologies [11].

The IoT has seen rapid rise in usage over recent decades, and with it, so have cyber security anxieties. AI is at the forefront of cybersecurity and is used to create intricate algorithms that safeguard networks and systems, like IoT devices. IoT is now commonplace and used in many households and companies [12]. The IoT is difficult to define because it has been developing and modifying since it was first introduced, but it is generally recognized as a network of digital and analog machines and personal computers that have been given Unique Identification (UID) numbers and have the capacity to exchange data without the involvement of a human [13].

Many intelligent tasks, including as speech recognition, language translation and many more things are predicted to be carried out by AI without human intervention. IoT, on the other hand, connects a network of linked devices that transfer data over a framework. IoT gadgets have incorporated themselves into our daily lives and aim to increase our level of comfort [14]. In terms of device connectivity, the IoT concept has improved the world's usability, reliability, security, adaptability, secrecy, and portability [15]. The IoT is concerned with sensors that are built into various types of devices and send big quantities of information to one or more remote destinations over the network. The reasons for sending sensor data are excellent, but it is assumed that the user will benefit from the analysis and application of the information [16]. IoT sensors gather a variety of data from a variety of sources, in a variety of formats. This information is organized and put into an understandable format by AI to the user system.

2. Components of Artificial Intelligence:

AI is a vast field for research and it has got applications in almost all possible domain. The major components of AI such as learning, reasoning, problem solving, perception, user interface, knowledge representation and language understanding [17-20]. Figure 1 shows the components included in AI.

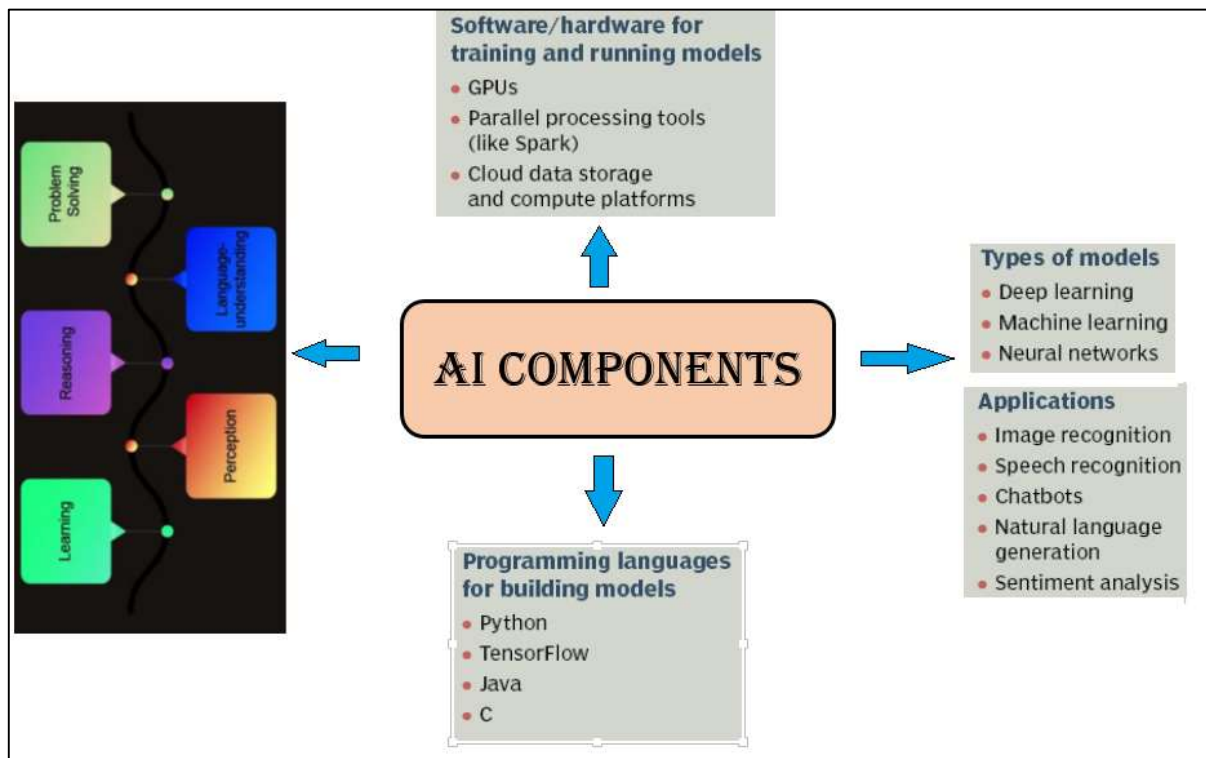


Figure 1: Components of AI

2. 1. Self-Learning Abilities

Artificial Intelligence largely relies on Self-Learning Abilities, which can take many various forms. Learning through doing is the most basic method. In this configuration, the program retains the portion that produced the desired results and abandons the other trial actions, self-learning.

2. 2. Reasoning

Logic and making conclusions based on the information available are other names for reasoning. A rigid rule of validity is used to guide the reasoning as it is applied to a particular activity. Deductive and inductive reasoning both exist. When using inductive reasoning, the reality of the assumptions supports the conclusion but cannot entirely rely on them, unlike deductive reasoning where the truth of the premises assures the truth of the conclusion. Deductive inferences are employed frequently in programming logic. Drawing conclusions that are pertinent to the current issue or circumstance is a key component of reasoning.

2.3. Solving problems

AI offers solutions to a wide range of issues. For instance, planning steps to complete the set objective, determining winning moves in board games, detecting diverse items from provided photos. The two primary categories of problem-solving techniques are special-purpose techniques and general-purpose techniques. Many different types of problems can be solved using general purpose methods. Means-end analysis, which entails reducing the difference between the present state and the intended state step-by-step, is one utilized in AI. Special purpose techniques are developed to address a specific class of issues.

2.4. Perception

Intelligent agents must scan their surroundings and the numerous objects there using a variety of real or artificial sense organs in order to function in it. Employing sense organs like a camera and a temperature sensor, an agent monitors its surroundings. Scientists refer to this as perception. Perceiver analyzes the many objects in a scene after it has been captured to extract their characteristics and interconnections with one another.

2.5. Knowledge representation

It's possible that the data collected from the environment by sensors isn't in the format needed by the system. Therefore, it must be represented in standard forms for additional processing, such as learning different patterns, drawing conclusions, contrasting with previous items. There are many methods for representing knowledge, including first-order logic and propositional logic.

2.6. Understanding of a language

Systems or robots that interpret and process human speech and infer understanding from it are known as Natural Language Processing (NLP). NLP focuses on the text or spoken output from the device or robot, but it also includes full involvement from a system in the form of dialog. An NLP system may accept speech as its input and produce written text as its output.

2.7 User Interface

The user interface serves as a communication channel between a user and the real concern procedures of intelligent machines. If an intelligent system does not have a useful interface, it is not very helpful. It must be capable of validating the instructions entered by the user in a form. It should comprehend the system's generated responses.

2.8 Interface Engine

The program known as the interface engine finds the appropriate data in the data store and, using regular computing and analytical techniques, derives new data.

2.9 Heuristics

Heuristics is a term used to describe the process of selecting one of many precise solutions to a specific problem. Heuristics is a field of artificial intelligence that focuses on problem-solving, learning, and finding methods that are based on experience. All heuristic methods and strategies focus on quickly and effectively identifying the best solution to a particular situation.

3. Cases used in Industrial Artificial Intelligence:

Important cases used in AI such as predictive maintenance, quality inspection & assurance, manufacturing process optimization, supply chain optimization, AI-driven cyber security & privacy, automated physical security, automated data management, smart assistants, AI-driven research & development, autonomous resource exploration [20, 21]. The Figure 2 shows the percentage wise important of these cases used in Industrial Artificial Intelligence [22].

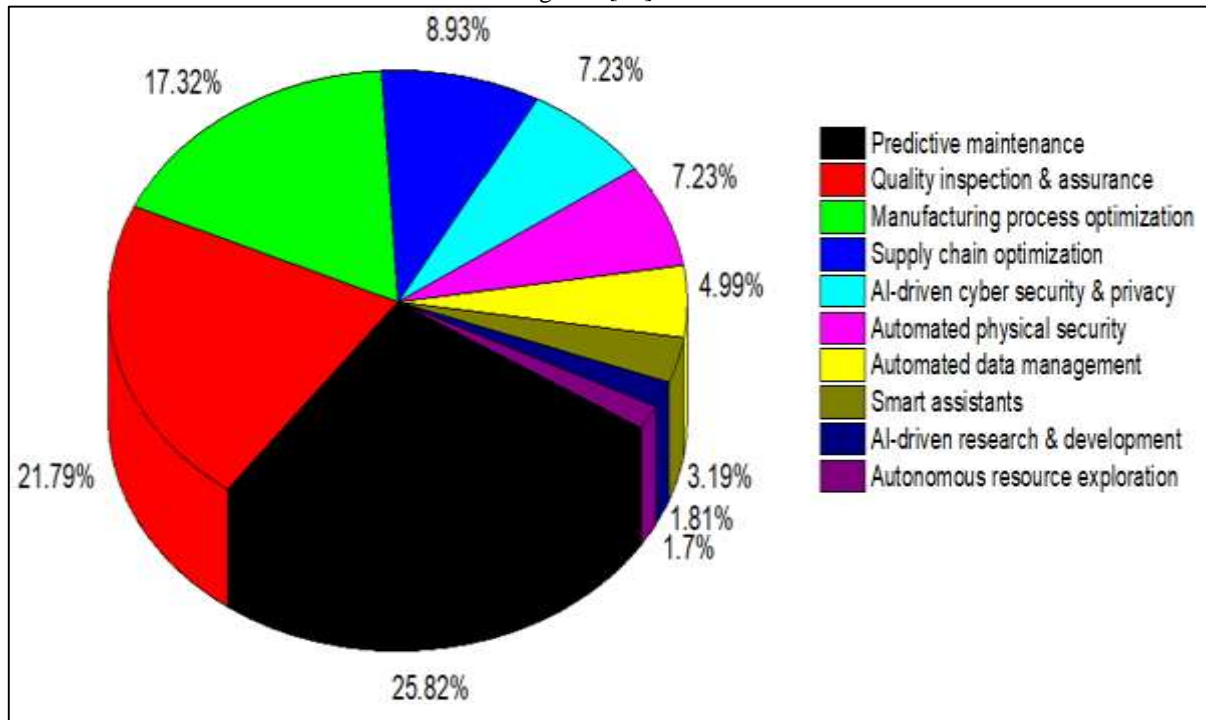


Figure 2: percentage wise important cases used in Industrial Artificial Intelligence

4. Literature survey:

This section discusses the key improvements made in the construction sector employing IoT and AI. AI in construction has the potential to benefit participants throughout the project lifecycle, including design, bidding, and budgeting; acquisition and construction; maintenance and asset management; and business model change. Construction as a whole benefits from AI's ability to help the sector address some of its most difficult problems, such as massive unemployment, safety issues, and price and time overrun [22, 23]. AI and Machine Learning (ML) are being adopted by construction companies as a smart strategy to digitize the sector. The construction sector benefits greatly from AI technologies since they facilitate accurate and efficient planning, designing, and construction processes. The way that businesses operate across the industry are being redefined by AI in construction. With the acceptance and promotion of automated systems like AI and ML, the construction sector is on the cusp of a digital revolution. The existing work procedures will be disrupted by this new business model, which will also open up a lot of chances for the sector. Workplace productivity will soar appreciations to AI. The overall value cycle of the construction sector will be impacted [23, 24]. Maru, R. et al [25] presented feasibility study of Internet of Things (IoT) in construction industry. Author reported the faster approach is to employ IoT technologies to accelerate building because developing nations like India currently require rapid infrastructure construction and expansion. Therefore, the purpose of this study is to examine the viability of IoT in the construction sector and to identify IoT applications that could aid in the rapid and high-quality development of the construction industry.

Praba et al [26] addressed the Internet of Things (IoT) is primarily concerned with departments of communication and information technology, but it can be applied to civil engineering structures to great advantage. In addition to developing Alternative Renewable energy Conversion Systems for self-sufficiency in electrical power generation for usage, researchers highlighted that there is a strong need to perform bridge monitoring utilizing IoT in practical applications. They discovered that the motion of automobiles has significant effects on bridges, and that by using the right technology, one may convert the impact energy into electrical energy. Mahmud, S. et al [27] used the questionnaire method to determine the classes of IoT applications deployed in Malaysia's construction sector. Utilizing nominal analysis, the questionnaire was analyzed. Government agencies, developers, builders, architects, quantity surveyors, and class G7 contractors were included in the research of participants in the construction sector, which was done throughout all states in Malaysia. By conducting this survey, it was determined that WhatsApp, Telegram, Facebook Messenger, email, and GPRS were the most commonly used IoT-based apps, whereas sensor technology, Scan-Marker, Smart Watch, and other IoT-based applications were less frequently utilized.

Kumar, A. et al [28] stated that the length, caliber, and expense of the project may all be significantly impacted by timely updates and deliveries of construction materials on a job site. The study's main objective was to evaluate the Internet of Things' (IoT) function of value addition into supply chain management and analyze the role of IoT in giving an actual update on transportation and data for handling of materials. Researchers came to the conclusion that the usage of IoT in conjunction with intelligent sensing devices could aid in communication and material monitoring with high precision and free of errors caused by human and other environmental variables. Therefore, it would aid the project manager in updating the timeline and increasing material efficiency.

Matharu, G. et al [29] the purpose of this study is to determine the level of awareness among construction practitioners on the application and relevance of IoT. It also analyzes the barriers to IoT adoption in projects and determines the most significant barriers in the construction sector.

Zhong, R. et al [30] reported because of the difficulty of construction project and the large chance of failure, which limits the applicability, it is challenging for the construction industry to accept and embrace new technologies. Faces major challenges, IoT has been implemented in the construction sector, with one of the most popular uses being the monitoring and control of planning and execution phases for a variety of projects, including bridges, trains, tunnels, and offshore infrastructure.

Xiao, C. et al [31] reviewed and undertook a bibliometric analysis of the last ten years' worth of AI publications. The articles were chosen by the authors based on several subcategories of AI technology. The authors examined the chosen publications from the angles of the publication date, journals, construction-related study domains, highly prolific researchers, and key AI methodologies. Additionally, this review has identified the next step of a thorough systematic analysis of the chosen literature from the perspective of its fields of research in the construction industry to come up with more effective data that could brighten the future usage of AI in construction-related studies. This review also indicated the recent trends of AI application in construction field.

Nagendra, S. et al [32] presented network applications of artificial intelligence and software used in relation to this domain along with practical has noted examples to compare with traditional methods of construction management. Based on this study, AI can be successfully incorporated into construction project management with the right infrastructure. AI implementation would give the organization a competitive advantage. Along with improving Quality Assurance, AI can help shorten project timelines and lower project costs. The survey found that the most likely effects of organizations deploying AI will be on quality assurance and time effectiveness. The implementation of AI has been shown to be most effective in the key areas: project cost and timeline prediction, integration with BIM, and supply chain.

5. Conclusion:

India has hug scope of growth in Global Construction Industry using AI and IoT. AI and IoT is impacting in positive way used and use for real-time tracking and communications of labours, equipment and things on the site. It can also enhancing the quality of design and planning, project management and scheduling and alert managers of potential safety concerns, construction faults, and output concerns. Artificial Intelligence (AI) and Internet of Things (IoT), two highly developed digital technologies having Vast Scope and Impact for making life easy, comfortable, hygienic and safe.

Lowering the risk of accidents, avoid of expensive mistakes, improved operations, intelligent tasks such as speech recognition, language understanding, language translation, self-learning, reasoning, problem solving, perception, user interface, jobsite image handling, knowledge representation, predictive ability to be carried out by AI and IoT assisted home automation with or without human intervention. Digital sensors, Smart machinery, Mobile platforms, Cloud-based apps and new software system applications empowers the IoT and AI Construction Industry and home automation capabilities in several folds.

The use of IoT in the construction industry has various benefits such as improved execution monitoring, efficient control, improved quality, lower costs, and time savings by using various sensors depending upon need. Due to the availability of actual data analytics, it has also been widened to be employed in making quick decisions. Many industries can greatly benefit from technology.

With the aid of new applications and technologies made possible the Global Construction Industry in particular is going through a new and strengthened period. Ai and IoT technologies are used by tech start-up companies to plan, design, and carry out their initiatives. The capacity of the cloud to enable greater freedom and convenience of access to information from satellite offices, job sites, or customer locations that extend across the globe positions construction industry in a unique position to profit from this feature. AI and IoT both are a brand-new technology that is on pace to transform the construction sector out of all the emerging technologies now available on the market.

6. Future Scope:

AI and IoT will be significant in the future for raising quality, profitability, and safety on the job site. AI and IoT can be used to monitor the on-site interactions between people, equipment, and items in real-time and notify managers of any potential safety hazards, design flaws, or productivity problems. Despite projections of significant job losses, AI and IoT is not likely to completely replace the labor force. Instead, it will change business strategies in the construction sector, lessen costly mistakes, lessen workplace accidents, and improve building operations. AI and IoT is being used by businesses to create workplace safety solutions. AI and IoT is being used to monitor the interactions between personnel, equipment, and items at the job site in real-time and notify managers of any potential safety hazards, design flaws, or productivity problems.

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