Applications of Artificial Intelligence in Construction Management

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Abstract: *Digital technology is changing the construction industry. Construction has strategic importance on the regional, national and global levels. It is largest business followed by Agriculture sector in India. Currently, the architecture, engineering and construction industry is facing enormous technological and industrial changes and challenges as well as proliferation of IT and appropriate applications of sustainable practices. The field of construction is well placed to benefit from advent of recent trends, tools, and technologies viz: IoT, ICT, Big data, Automation, Standardization, disruption, inflection, Block chain, and Supply chain. The advancement of Cloud Computing, Artificial Intelligence and Internet of Things offers great potential for the developing collaborative and integrated environment for construction Management. This paper presents in-depth literature review on adoption of artificial intelligence in construction management. Implementation of these emerging technologies provides tremendous benefits in improving the productivity in construction business. Moreover, this article is continuation of our earlier communication based on "recent aspects in digitalization of either construction management, construction project or construction industry along with construction business." As the development of this technology is still at an early stage, this research effort will provide a better understanding of the transformation and pave the way for further research in this area.*

Keywords: *Artificial intelligence, Cloud Computing, Machine Learning and Construction Management.*

I. INTRODUCTION

Engineering and Technology are two inseparable technologies with the present day's engineering to attain a better life. Rapid growth and increased need of multifaceted technical applications induces us to keep abreast regarding the power of various associated subjects in general and construction business in particular. The use of artificial intelligent (AI) has increased in the field of construction engineering and management in recent years, mostly due to the potential of the technology for improving construction performance and efficiency. In order to achieving a comprehensive understanding of the research of the research work on this subject, this paper include review of existing literature on AI focusing on the last decade.

The technology combinations of IoT and AI will change construction for long term with new business opportunities and revenue streams as well as new business models and structures that take advantages of IoT and AI capabilities. AI is expected to alter business models in the construction industry in areas including logistics, customer relationship management, support, workflow, automation and finance. Even more AI can help in realistic situations for training, reducing injuries and costly mistakes and making operations more efficiently. This can enable operators to better use existing labor resources, helping with the skill labor shortage. (Monroe, 2018). Thus, the digitalization in the construction industry provides opportunities to realize large construction projects within their time frame and budget limits. (Patil,2018). The prime objective of the paper is implementation of new emerging technology i.e Artificial intelligence in construction industries and management.

2) Background of the study and Rationale

Construction is the large industry which is of strategic importance on the regional, national and global levels. It is also an industry which has been suffering from a number of problems for many decades, including low productivity, low-profit margins, and waste and safety concerns. (Pistorius, 2017). Recent literature is gathered from the National and International reputed journals pertaining to Construction industry (CI), Construction project (CP), Construction Management (CM) and construction business. Secondary sources are books, reports, magazines, theses, conference papers, and book chapters. On referring to the literature in current decades led to the preparation of review paper, we have considered new emerging technology that is, Artificial Intelligence. Construction companies shift to digital stand to realize significant gains over the competition. Major areas impacted by digitalization include enterprise, knowledge, construction sites, project collaboration, and skilled labor networks. While studying digital transformation technology in concern to construction business, some questions arise in mind .These are: How AI is changing construction?, How can Architect adopt to AI in construction? How AI could link to Machine learning technique and Block chain? What are drawbacks and benefits of AI in construction? Innovative solutions in CI various tools, techniques and trends are being applied in construction business .This is the main theme of this article. Answers to these questions are presented considering as new age construction and architectural design in construction technology.

3) Literature review

Many references have been mentioned by various authors based on Construction Industry (CI), Construction Management (CM) and Construction Technology (CT) and CP regarding digital technologies viz: Big data, atomization, standardization, IoT, CC,AI and BIM,(Gerber & Kensek, 2009), Prefabrication & Disrupting along with applications and significance ,drawbacks and benefits.(Adwan & Soufi (2016) Benham (2017), Barbosa (2017), Brandt & Moyers (2013), Cearley (2017), Egbu (2004), Kapliński (2018), Buyer (2017) explained how Digitalization technology is useful in changing the CI. The construction business in India is growing at a fast pace and there's a major scope for improvement through adoption of rising new technologies like automation and artificial intelligence. The construction industry is that the second largest trade business in India followed by Agriculture sector. A lot of construction projects are incorporating systems of digital sensors, intelligent machines, mobile devices, and new software system application; progressively integrated with a central platform of BIM. Big data has the potential to produce solutions to construction problems and speedily rework each method of construction contracting.

Recent literature is gathered from the National and International reputed journals pertaining to CI, CP, CM and construction business. Secondary sources are books, reports, magazines, theses, conference papers, and book chapters. On referring to the literature in current decades led to the preparation of review paper on applications of Artificial Intelligence in construction industry.

We have collected relevant information from year 2000 onwards based on digital transformation in CI. Ilter & Dikbas (2018) reviewed applications of AI in construction dispute resolution. Steven (2017) stated various implications of AI in construction. Its rise in construction sector is precisely noted by Guinn (2017). Waldeck-Consulting (2017) linked AI in transforming the CI. Bhardwaj (2018) discussed many AI applications in construction –current use-cases .Further he also explained its applications in additive manufacturing (3D printing). Blanco et al.(2017) outlined AI is next frontier in construction business. Chaturvedi (2018) and Chengu (2018) explained immense and massive potential of AI in the construction management. Recently, Marvin (2018) described 10 steps to adopt AI in construction business. Wadlow (2018) quoted feature: “How AI supports the CI?” And conversely, Debney (2018) emphasized importance and

supporting the CI with AI.

Very recently, (Patil, 2018) reviewed in depth various "recent aspects on digitalization in construction industry/construction management". She described various tools, techniques and technologies in the CM and construction business. This paper is the extension of previous data on digital technologies transformation implied in construction business.

Out of all emerging technology hitting the market today, AI is a new technology that is on track to revolutionize the construction industry. One of the overall goals of Artificial Intelligence is to develop computer algorithms that can improve automatically through experience in construction. We can use these algorithms to improve processes in a much faster way than a human brain could ever imagine doing Autodesk's product line on generative design opens a new world of design possibilities for Architects & Engineers.

3. Artificial intelligence (AI)

AI is a rapidly advancing technology made possible by internet that may soon have significant impacts on our daily lives, AI traditionally refer `to an artificial creation of human –like intelligence that can learn, reason, plan, perceive or process natural language. These traits allow AI to bring immense socioeconomic opportunities while also posing ethical and socioeconomic challenge. AI is beginning to make its way into construction. In the future of construction, AI will play a larger role in terms of improving productivity, quality, and safely on the jobsite (Clavero, 2018). AI captures large amounts patterns and trends. In essence, AI uses the power of machines to model natural intelligence of human. It uses the machine learning (ML) to store problems and execute tasks with greater speed & recovery. (Tan, 2016; Rajgopal, 2017). Hence, we can say AI in construction happening now. Some of the strategies on application of AI in CI are summarized here. These are:

3.1 How can we leverage AI in Construction?

The adoption of Technology in the construction job-site is happening sure, it's happening slowly. However the good news is that the adoption is casting on. Thanks to cloud-based applications and mobile devices the amount of data i.e. captured (Jobsite photos, material used, labor hours, equipment utilization etc) on a job-site has grown exponentially ever the past 10 years. The value of this information is to do deeper analysis, trending, and what-if scenarios to make projects and companies more profitable. Activities that hamper construction can now use AI to make improvements in productivity, safety, quality, and scheduling. (Goubau, 2018). The immense potential of AI in construction industry is well explained by Chaturvedi (2018) and he stated that the further digitalization and automation of the construction industry would involve synchronization of AI & BIM. A new ecosystem has to be developed which faster ingenuity and helps in increasing an arenas about the prospects of AI. It has the potential to be a decisive game-changer would be helpful in its evolution as mass adoption of it in construction becomes a reality. In the same year, Cheung has broadly explained the massive potential of AI in the C.I.

3.2. Emerging Trends of AI in Construction safety sensors

The IoT has automated our home to be more energy efficient. Similarly, the IoT is automating our job-site to make them safer; we have able sensors such as spot identify the location of workers & provide any alerts if a worker slip or falls. Field reporting software allows foreman to enter job-site activity or alerts issues like keeping important project stake holders informed in real time even if they are not on job-site. Drones, Autonomous vehicles, and Robots are some emerging trends of AI (Clavero, 2018). Wu et al(2017), in their project on supply chain resilience assessment with structure dynamics consideration, analyzed AI in engineering risk analytics. Risk exit in every aspects of our lives, and

can mean different things to different people.

3.3. How AI is changing construction?

In year, 2010, Wang described importance of parallel control management for intelligent Transportation Systems, concept, Architectures and applications.

AI is changing the way the construction industry does business. After years of hype, the technology is finally here and can boost productivity, safety, and other critical aspects of business success.(Monroe,2017). Kranz makes the analogy that AI is the brain and IoT is the body, with IoT providing both input (Data) and output (action) for the smart computing and analytics function of a centralized AI system. For the construction industry, AI has come long in leaps and bounds, both a solid tooling option and a management support. (Debney, 2018). By using combination of Virtual Assistants (VA) and AI in place of manpower, the CI can save money and time.

3.4 New business Models in Construction

AI is expected to alter business Models in the CI in way including logistics, customer relationship management, support, workflow mistakes making operations more efficient. The construction industry is currently facing an increasing skill shortage and as a result many businesses are feeling the pressure. This statement is made by Ghinn (2017). In his article more detail is given on the rise of AI in the construction sector. AI is transforming the automation, and finance. Even more AI can help in recreating realistic situations, training, reducing injuries, and costly construction industry. AI is no longer a thing of the future, it is not a far-fetched notion resigned to our imagination, it is a reality, and something we are experiencing and benefiting from each and every day, without even realizing. The use of AI is growing across many industries. It has taken off in post-construction (Hodge, 2018) and the smart home has become highly developed as a result of this the construction industry has started to take heed. Kingspan group (2017) mentioned four things about AI in construction: (i) Friend or fee? (ii) Saving time on surveying (iii) making innovative technology even more cutting edge & AI & BIM. Kingspan is a leading innovator in the building industry, constantly working to make building better. AI clouds help the construction industry work faster and keep its workforce accident free (Woyke, 2018). In her article she tagged important key words viz: Big data, wearable technology, data science, analytics, future work, jobs. Bharadwaj (2018) classified the major applications for AI in construction & building. These are; (i) Planning & Design (ii) Safety (iii) Autonomous equipment, & (iv) Monitoring & maintenance. He dealt in depth how AI applied in the construction & building sector today real life use-cases for AI in construction & the challenges and also limiting the adoption of AI & ML in CI. In the next five years, he expects to see many AI vendors working on improving efficiency of the construction processes from planning to monitor during actual construction or in other words, Bharadwaj predicted great future potential for AI in construction. In the same year, Wadlow (2018) explained importance of planning stages, construction underway, after construction, & BIM & VA (a virtual assistant) as key categories of AI in the CI. (Debney, 2018). Ilter and Dikbas (2018) reviewed application of the AI in construction, dispute resolution. In his paper, he analyzed and categorized in to three groups as settlement oriented system method, selected oriented system & dispute evaluative oriented systems.

3.5. The rise of AI in Construction

Rajagopal (2017) exhaustively described various processes those are making changes across various areas, including risk management, Schedule management, Subcontractor management, Construction site environmental monitoring, and Safety. As part of the BIM 360 project IQ team at Autodesk, he had the privilege to participate in Autodesk's foray in to ML for construction. Clavero (2018) mentioned AI utilizes computer processing to complete tasks that normally require human intelligence. However, it performs action with a greater level of accuracy & much quickly. Because of this

capability, AI in CM is another tool in a contractor's digital tool box.

3.6 How does AI works?

According to father of AI, McCarthy, it is the science and engineering of making intelligent machines, especially intelligent computer programs. AI is a way of making computer a computer controlled robot, or a software think intelligently. In the similar manner the intelligent human think. AI is a complied by sliding how human brain thinks, and how human learns decide, and work while trying to solve a problems of this study as a basis of developing intelligent software systems. What is exact role of AI in next 20 years?

Table 1: Summary of applications of AI in CM

	Users	Tool/technique	Activity
1	Designers	Autodesk's Generative Design.	i) To generate option ii) To select iii) To edit
2	Estimators	Combine AI with BIM	Estimates with greater accuracy within a short time.
3	Safety Managers	Smart…….	Visual processing algorithms are risk monitoring & prevention tools
4	Project Manager	Drones sensors cameras Doxel	Jobsite activity To measure quantity of material To keep the project on schedule
5	Foremen	The 3D Model	To detect the defect, if any error or inconsistencies.

3.7. How can architect adopt to the coming age of AI?

Bernstein (2017) focuses on the evolving role of an architect of the intersection of design & constructions, including subject such as alternative delivery systems & value generations.

3.8 The future of AI in Construction

Robotics, AI, and the Internet of Things can reduce building costs by up to 20 percent. 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 the real-time interactions of workers, machinery, and objects on the site and alert supervisors of potential safety issues, construction errors, and productivity issues.

Leaders at construction companies should prioritize investment based on areas where AI can have the most impact on their company's unique needs. Early movers will set the direction of the industry and benefit in the short and long term.

II. CONCLUSION

Technology is a great enabler in any industry. In particular, the construction industry is experiencing a new & revitalized era with the help of technology through new application & tools. These applications from tech start-up companies are designing, Planning, and executing their projects.

Construction companies are uniquely positioned to benefit from the clouds ability to provide greater freedom and ease to access information anytime from satellite offices, job sites or customer location that span cross the globe. Given the wide adoption workers for personal use today's construction software solutions need to leverage this employee interest and work to serve up the project information and capabilities in this format to propel construction productivity in to the future.

Out of all emerging technology hitting the market today, AI is a new technology that is on track to revolutionize the construction in industry. One of the overall goals of Artificial Intelligence is to develop computer algorithms that can improve automatically through experience in construction.

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