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Review on Enhancement of AI Technologies in Safety for Construction Sites

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ABSTRACT: The construction industry faces persistent challenges in ensuring occupational safety due to its high-risk environment and dynamic work conditions. Adopting innovative technologies has emerged as a transformative approach to addressing these challenges and improving worker safety. Wearable devices, drones, and smart sensors have been at the forefront of this shift, enabling real-time hazard detection, monitoring worker health, and enhancing safety protocols through advanced training methodologies. This research explores the role of these technologies in revolutionizing occupational safety in construction sites. Wearable devices, such as smart helmets and vests, monitor physiological parameters and environmental conditions, providing early warnings for potential hazards. Drones offer aerial surveillance capabilities, enabling site managers to identify unsafe conditions and ensure compliance with safety regulations. Smart sensors embedded in machinery and site infrastructure provide continuous data for monitoring equipment health and detecting environmental risks such as gas leaks or structural instabilities. This research also examines case studies of successful implementations, demonstrating how these technologies have reduced workplace incidents, enhanced productivity, and fostered a culture of safety. Challenges in adoption, including cost implications, integration with existing systems, and workforce training, are discussed, along with strategies to overcome them. By integrating innovative technologies, the construction industry can create safer and more efficient work environments, ultimately minimizing risks and enhancing occupational health. The study concludes by exploring emerging trends, such as AI-powered predictive analytics and robotic automation, which promise to further advance safety practices in construction.

I. INTRODUCTION

BACKGROUND OF CONSTRUCTION OF SITE SAFETY:

The construction industry, which encompasses real estate, infrastructure, and industrial structures, accounts for about 13% of the world's gross domestic product (GDP), making it the largest industry in the global economy. The Australian construction industry generates approximately 360 billion in revenue, accounting for 9% of the country's GDP and is expected to grow to 11.5% of the total GDP in the next five years.

An examination of the relevant recent literature indicates that construction projects are frequently plagued with large cost overruns, extended schedules, and quality concerns. These adverse effects are well known in the construction industry. Furthermore, productivity growth of 1% annually over the past two decades has raised questions about the industry's efficiency. The slow performance growth is a direct result of the fundamental rules and characteristics of the construction market. In particular, the cyclical demand leads to low capital investment and limited standardization.

Industry tends to rely on research and development by an organization outside its corporate boundaries with only 1% of the construction industry spends towards construction innovation. Also, the slow growth is caused by the fact that the construction industry is dominated by small and specialized sub-contractors who are not technologically advanced enough to embrace automation. The construction industry would benefit more than other industries since projects are temporary, multi-organization and matrix structures which rely on computerized planning and scheduling methods.

The thesis builds on these past studies by investigating individual AI technologies which include but are not limited to online reinforcement learning multiplayer non-zero-sum games of continuous-time Markov jump linear systems, applied mathematics and computation; exponential stability of nonlinear state-dependent delayed impulsive systems with applications, nonlinear analysis: hybrid systems; robust point-to-point iterative learning control with trial-varying initial conditions, IET control theory and applications; robust Pandas Data type iterative learning control for discrete systems with multiple time-delays subjected to polytopic uncertainty and restricted frequency-domain,

multidimensional systems, and signal processing. The use of these technologies has increased in recent years, mostly due to the potential for improving construction performance and efficiency. However, businesses still have uncertainty in the built environment of what aspects AI can improve throughout a construction process.

IMPORTANCE OF AI IN SAFETY EQUIPMENT:

As artificial intelligence evolves, so does its ability to improve safety standards while making predictions incidents before they happen. Artificial Intelligence can be used to filter security surveillance systems with large amounts of visual data to detect people and circumstances that do not correspond to security standards. Field reporting software allows the foreman to enter activities on the jobsite or highlight concerns such as: informs important project participants in real time, even if they are not on site. AI can be an invaluable tool for all types of commercial activities. When it comes to processes such as data analysis and security protocols, Machine Learning is the future. For example, AI programs can help with visualization by analyzing a construction site, providing real-time data collected from cameras and other sensors. throughout the site. This can provide important information about potential hazards, the likelihood of accidents, etc. and similar important points that help plan workplace safety. This information is invaluable not only on the Internet inspection phase, but also, as work progresses and hazards arise. AI can easily monitor progress at any time specific area and check the responsible workers.

ROLE OF TECHNOLOGY IN IMPROVING SAFETY STANDARDS

The transition from traditional safety methods to technology-driven solutions is transforming occupational safety in the construction industry. Traditional approaches, such as safety manuals and periodic inspections, often fall short in addressing real-time risks on dynamic construction sites. Innovative technologies offer a more proactive and effective means of hazard identification and mitigation. Wearable devices, such as smart helmets and vests, are revolutionizing worker safety by providing real-time monitoring of physiological conditions and environmental factors. For example, these devices can detect fatigue, monitor exposure to harmful substances, and issue alerts when workers enter restricted areas. Drones are another transformative tool, enabling site managers to conduct aerial inspections and identify unsafe conditions without putting workers at risk. Additionally, smart sensors embedded in machinery and infrastructure continuously monitor structural stability, gas levels, and equipment health, enhancing preventative maintenance and risk management. The integration of these technologies into construction safety practices not only minimizes risks but also fosters a culture of innovation and accountability. By leveraging data-driven insights, organizations can ensure more effective safety interventions and compliance with evolving regulatory requirements.

OPPORTUNITIES FOR INTEGRATING AI IN CIVIL ENGINEERING:

Opportunities for integrating artificial intelligence (AI) into civil engineering practice are vast and varied, offering potential benefits across the entire project lifecycle, from planning and design to construction and maintenance. This section explores some of the key opportunities for AI integration within civil engineering practice in detail:

1. **Design Optimization:** AI algorithms can analyze vast amounts of data to generate optimized designs that meet specified criteria such as cost, durability, and sustainability. By automating the design process and exploring a wide range of design alternatives, Engineers can identify innovative solutions and optimize designs more efficiently than traditional methods.
2. **Construction Management:** AI-powered project management systems can analyze historical project data, identify patterns and trends, and predict potential delays or cost overruns. This allows project managers to proactively address issues and optimize construction workflows to improve efficiency and reduce risks. Additionally, AI-driven robotics and automation technologies can perform tasks such as site surveying, excavation, and assembly, increasing productivity and safety on construction sites.
3. **Asset Management:** AI algorithms can analyze sensor data from infrastructure assets such as bridges, roads, and utilities to detect signs of deterioration, predict maintenance needs, and optimize asset performance. By implementing AI-driven predictive maintenance strategies, asset owners can reduce downtime, extend asset lifespan, and optimize maintenance costs. Furthermore, AI-enabled digital twin platforms can create virtual replicas of physical assets, allowing engineers to simulate various scenarios, monitor real-time performance, and make data-driven decisions to optimize asset management strategies.
4. **Environmental Impact Assessment:** AI can analyze environmental data and simulate the impact of infrastructure projects on ecosystems, natural resources, and communities.

5. **Risk Management:** AI-driven risk management systems can analyze project data, identify potential risks and assess their likelihood and impact on project outcomes. By leveraging AI to predict and mitigate risks, engineers can make more informed decisions and minimize project delays, cost overruns, and safety incidents.

6. **Supply Chain Optimization:** AI algorithms can analyze supply chain data, optimize inventory levels and identify opportunities for cost savings and efficiency improvements. By integrating AI into supply chain management processes, engineers can streamline procurement, reduce lead times, and improve project delivery schedules.

7. **Collaborative Design and Decision-Making:** AI-enabled collaboration platforms can facilitate communication and information sharing among project stakeholders, enabling more effective collaboration and decision-making. By providing real-time access to project data and analytics, these platforms empower engineers to make informed decisions and coordinate activities across distributed teams.

8. **Continuous Improvement and Learning:** AI algorithms can analyze project performance data and identify opportunities for process improvement and optimization. By leveraging AI to monitor and analyze project outcomes, engineers can identify the best practices, lessons learned, and areas for improvement to inform future projects and drive continuous learning and improvement within their organizations.

OBJECTIVE OF THE STUDY: -
➢ Identify and assess construction hazards for accident prevention.
➢ Prevent accidents with proactive safety measures.
➢ To maintain the progress of construction work without any hazards & accident.
➢ To monitor the various activities on construction sites to ensure safety.
➢ To identify AI Technologies currently used for construction site safety.

To analyze the challenges associated with implementing AI in construction safety

RESEARCH QUESTIONS: -
1. How effective is AI safety equipment in reducing accidents and enhancing safety on construction sites?
2. What types of AI-powered safety equipment are currently used in the construction industry, and how do they compare in terms of performance?
3. How does the integration of AI safety technologies impact traditional safety protocols and practices in construction?
4. What are the key challenges faced by construction companies when implementing AI Safety equipment?
5. How does the cost of implementing AI safety equipment compare to the potential
6. reduction in accident-related costs?
7. What role does machine learning play in the continuous improvement of safety

SCOPE AND LIMITATIONS: -
• AI systems can monitor construction sites in real-time using computer vision, sensors, and drones to detect potential hazards like unsafe worker behavior, equipment malfunctions, or structural risks.
• Machine learning algorithms can analyze historical safety data to predict future risks, allowing proactive measures to prevent accidents.
• AI can automatically check if workers are wearing PPE correctly, if safety protocols are being followed and generate real-time compliance reports.
• AI can assist in emergency situations by quickly analyzing data to identify the safest evacuation routes and coordinate emergency responses.
• The cost of purchasing, implementing, and maintaining AI safety equipment can be significant, especially for small construction firms.
• While AI can detect patterns, it lacks the nuanced decision-making abilities of experienced safety officers, especially in unexpected situations.
• Continuous monitoring of workers through AI devices raises concerns about data privacy and security, particularly in regions with strict data protection laws.
• While AI can detect patterns, it lacks the nuanced decision-making abilities of experienced safety officers, especially in unexpected situations.

II. LITERATURE REVIEW

Alejansdro Palacino, "The Role of Artificial Intelligence in Improving Construction Site Safety and Project Management" (IRE) Journals (2020) The construction sector is still one of the hazardous working areas, contributing to more than 20% of workplace fatalities all over the world. Factors such as the complexity of construction projects, dynamic worksite conditions, human error, and equipment malfunctions contribute to high accident rates and inefficiencies during project execution. Most conventional safety monitoring and project management techniques rely on manual inspections, experience-based risk assessment, and common reactive approaches toward hazard mitigation. These traditional methods often overlook early warning signs of accidents, delays in project timelines, and cost overruns, which brings about inefficiencies, loss of money, and injuries to workers. AI is coming up as a game-changing technology in construction safety and project management, using machine learning, computer vision, and IoT-based predictive analytics to detect risks faster, monitor hazards more easily, and optimize project workflows. AI systems can monitor live video streams to identify safety breaches, use historical accident data to predict areas at risk, and automate project scheduling to eliminate inefficiencies.

PZ Razi1, "How Artificial Intelligence Changed the Construction Industry in Safety Issues" IOP Conference Series: Earth and Environmental Science, February (2023) In recent years, the development of machine learning in construction as well as the preparation of appropriate software aims to provide improved solutions to potential safety hazards and risks within the construction environment. However, the fatalities and injuries in construction sites still happened frequently, and the high numbers of accidents and casualties make construction work the most hazardous occupation. This study aims to analyze the prioritize of artificial intelligence (AI) important factors in construction safety using the AHP method. Construction safety practitioners were selected as the respondent. The hierarchy was established consisting of five (5) factors, which were subsequently categorized into twelve (12) sub-factors.

James Oluyemi Adeyemo, "Innovative technologies for enhancing occupational safety in construction sites", International Journal of Science and Research Archive (IJSRA), December (2024) The construction industry faces persistent challenges in ensuring occupational safety due to its high-risk environment and dynamic work conditions. Adopting innovative technologies has emerged as a transformative approach to addressing these challenges and improving worker safety. Wearable devices, drones, and smart sensors have been at the forefront of this shift, enabling real-time hazard detection, monitoring worker health, and enhancing safety protocols through advanced training methodologies. This article explores the role of these technologies in revolutionizing occupational safety in construction sites. Wearable devices, such as smart helmets and vests, monitor physiological parameters and environmental conditions, providing early warnings for potential hazards. Drones offer aerial surveillance capabilities, enabling site managers to identify unsafe conditions and ensure compliance with safety regulations.

T. V. Chandni, Anitha Babu, "Implementation of Safety Management using Machine Learning Approach" International Journal of Creative Research Thoughts (IJCRT) October (2022) Construction projects are found to suffer various problems and complex factors such as cost, duration, quality safety, management etc. Construction industry has been growing remarkably during the past several years. However, the most hazardous worksites in the country may be found in this industry. Construction is a high hazard industry that usually comprises of a wide range of activities that may even involve construction, alteration, and repair too. Construction workers engage in many activities that would make them exposed to very serious hazards, such as falling from rooftops, unguarded machinery, being struck by heavy construction equipment, electrocutions, silica dust, asbestos, fire, trench collapse etc. Each project shall have a safety management system in place that outlines the policies, processes, instruction, and documentation that will serve to establish the culture of safety and understanding for all tiers involved on the project. It is thus necessary to find out the type of hazards that are common on site to suggest ways to minimize the same. Nowadays like most other countries in the world automation and digitalization is introduced in construction sector too that make construction activity much faster and safer. The scope of a fully digitalized construction sector is to be analysed to implement safety at job site.

Xizhe Yi, Jiaye Wu "Research on Safety Management of Construction Engineering Personnel under Big Data + Artificial Intelligence". Open Journal of Business and Management, April (2020) Under the background of the information age, traditional engineering safety management is undergoing a profound change. The introduction of big data and artificial intelligence technologies in construction project safety management is becoming increasingly widespread. Based on literature analysis, combined with artificial intelligence and big data in construction safety

management in the application is still in the primary stage, especially in applied research personnel safety management rarely literature. A review of the exploration and application of construction engineering safety management under the combination of artificial intelligence and big data, the analysis and summary of the current status and trends of the two technologies in construction engineering safety management, and the design of Based on artificial intelligence engineering personnel safety management of large data systems architecture, enrich and improve construction safety of personnel management concepts and technical means.

Sanjib Ali, Rudranath Saha, Kumari Pallavi Rani, Rudra Kanta Gouri, Abhinaba Dipankar Dey. "Future of AI in Construction Industry of India" International Journal of Creative Research Thoughts (IJCRT) October (2021) Artificial intelligence (AI) is proving to be an efficient alternative approach to classical modelling techniques. AI refers to the branch of computer science that develops machines and software with human-like intelligence. Compared to traditional methods, AI offers advantages to deal with problems associated with uncertainties and is an effective aid to solve such complex problems.

T. Nagarajan "Integrating Artificial Intelligence into Civil Engineering Practices: Opportunities and Implications" International Journal of Artificial Intelligence in Civil Engineering (IJAICIE) January 2024 This paper explores the integration of artificial intelligence (AI) into civil engineering practice, focusing on the opportunities and implications inherent in this transformation. Through an examination of current applications, emerging trends, and case studies, it highlights the potential of AI to enhance efficiency, innovation, and sustainability across the project lifecycle. However, it also discusses the ethical, technical, and regulatory challenges associated with AI adoption, emphasizing the importance of responsible implementation and ongoing skills development. Ultimately, this research underscores the need for collaborative efforts among stakeholders to maximize the benefits of AI while addressing its complexities in the civil engineering domain.

Sofiat O. Abioye, Lukumon O. Oyedele, "Artificial Intelligence in Construction Industry: A review of present status, opportunities and future challenges" Journal of Building Engineering (2021) The growth of the construction industry is severely limited by the myriad complex challenges it faces such as cost and time overruns, health and safety, productivity and labour shortages. Also, construction industry is one the least digitized industries in the world, which has made it difficult for it to tackle the problems it currently faces. 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 benefits of 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.

Muhammad Tamoor, Hafiz Muhammad Imran and Dr Imran Ghafoor Chaudhry "Revolutionizing Construction Site Safety through Artificial Intelligence" Journal of Development and Social Sciences July (2023) Construction site safety is the primary focus of this research, which aims to improve it by incorporating AI. The study's stated objectives are unclear, but it will attempt to evaluate how artificial intelligence has altered safety protocols in the notoriously dangerous construction sector. Accidents on construction sites continue to occur despite the presence of safety regulations. Through predictive analytics, risk assessment, and real-time monitoring, AI offers revolutionary possibilities. Through issue analysis, literature review, and evaluation of AI applications, this study takes a comprehensive approach. We gathered quantitative data on AI inspections powered by drones and qualitative insights from worker perceptions. A bright future may lie in safety inspections conducted by AI-powered drones, as this study shows how effective and precise these machines can be.

Zhili Gao, Ph.D. and Asad Sultan "AI for Improving Construction Safety: A Systematic-Literature Review" EPiC Series in Built Environment (2023) Artificial intelligence (AI) has been adopted and applied in many fields and has now become one of the emerging technologies in the automation of the construction industry, which has gained a lot of attention from researchers in recent years. Much research work has been done on applying AI to improve construction safety. However, the current research work is focused on improving safety in separate individual construction tasks and the developed models lack real-world applications. Therefore, a systematic literature review has been conducted on the use of AI including machine learning and deep learning in improving safety in construction practice. After the review of the existing literature, the current applications and practices of AI are identified and

classified. This will help in developing a new generalized framework that focuses on the entire construction process for improving safety. The limitations and the potential improvements in the existing AI techniques have been identified which will benefit future studies.

Mohamad Iyad Al-Khiami, Mohamed M El Hadad. "Enhancing Construction Site Safety Using Ai: The Development of a Custom Yolov8 Model for PPE Compliance Detection" European Conference on Computing in Construction Chania, Crete, Greece. July (2024) This study addresses construction safety by deploying computer vision techniques, specifically a YOLOv8 model by Ultralytics, to monitor PPE compliance. Targeting helmets, vests, and safety shoes, it aims to mitigate accident risks. The model was trained with 2934 images and validated with 816, achieved a 95% mAP. Emphasizing AI's potential in safety management and occupational health in the construction industry. This research lays groundwork for future AI-based safety enhancements in construction sector, highlighting the industry's pressing need for innovative approaches to reduce occupational hazards and improve compliance standards.

Kiranraj Kamble, Mrunal Gaikwad, "Detection of Construction Safety and Accident Management Using AI", International Research Journal of Modernization in Engineering Technology and Science (IRJMETS) January (2024)
In recent years, the development of machine learning in construction has increased Adequate software preparation aims to provide improved solutions to potential security risks Dangers and risks in the construction environment. However, deaths and injuries are in Construction work continues to occur frequently and the number of accidents and casualties is high make construction work the most dangerous profession. The aim of this study is to analyze the priorities important factors of artificial intelligence (AI) in construction safety using the AHP method. construction safety professionals were selected as respondents. The hierarchy was established consisting of five (5) factors which were subsequently categorized into twelve (12) sub-factors. At 25.43 percent, the workplace was determined to be the most important AI element in the construction industry.

Meera Mohan, Shibi Varghese, "Artificial Intelligence Enabled Safety for Construction Sites" International Research Journal of Engineering and Technology (IRJET) June (2019) Safety can be defined as absence of danger or eliminating the situations that could be fatal. As construction industries working environment is very complex and thousands of workers are being injured or killed in accidents every year, so safety needed to be taken into consideration. There is a high need of monitoring the workers and warn the construction workers at the site. The process of safety should start from planning stage itself. Building Information Modelling (BIM) can also help to improve the safety planning in a construction sites. Since manual checking may cause some error a real time detection of behaviour of the workers may help to reduce the accidents in the construction sites. With the help of AI (Artificial intelligence) safety in construction sites can be monitored at ease. Computer vision is used for developing the model for safety. By training the model by a quantum number of images our model will help in analyzing the safe and unsafe conditions in a construction site and thereby it will help in reducing the accidents at the construction sites to an extent. Once the AI model is being developed by proper training it can be integrated with BIM model for earlier planning. This paper presents a novel method for the real time detection of unsafe act and unsafe conditions of workers using Artificial Intelligence.

Pavithra Madushani Wendabona. "Safety Detection System: A Technological Leap in Sri Lanka's Construction Safety" Journal of Research Technology and Engineering January (2024) Sri Lanka's construction industry faces a safety crisis with 2000 to 3000 annual accidents, primarily due to non-compliance with safety regulations, notably the use of personal protective equipment. This research introduces a groundbreaking mobile application that employs AI and Computer Vision to detect safety gear non-compliance among workers, issuing real-time alerts. The app represents a significant leap in construction safety standards, showcasing the potential of technology to transform the sector. With its real-time alerts, it sets a new safety benchmark, demonstrating the industry's commitment to a safer, more prosperous Sri Lanka.

Bob Prieto "Use of Artificial Intelligence in Construction Safety" NAC Executive Insights April (2024) The engineering and construction industry is experiencing a transformative shift with the integration of AI. Applying AI in the industry is evolving rapidly, particularly with respect to construction safety. This Executive Insight cites specific AI applications and provides references and hyperlinks for each one to showcase the real-world implementation of AI in improving construction site safety. Five AI technology application areas are addressed: computer vision for hazard

detection; predictive analytics; wearable technologies; autonomous equipment; and proximity warning systems Readers are encouraged to explore the links. They serve as a guide for industry practitioners.

Ahmed Bin Kabir Rabbi, Idris. "AI Integration in Construction Safety: Current state, challenges, and future opportunities in Text, Vision, and Audio based Applications" Automation in Construction August (2024)
High occupational injury and fatality rate in the construction industry is a serious global concern. Recognizing AI as a solution to enhance safety performance, this study reviews 153 papers to assess and categorize current AI applications in construction, focusing on text, visual, and audio data, while also identifying challenges and future research opportunities. Real-time monitoring, hazard detection, and information extraction are identified as key areas where AI is applied, with a notable reliance on deep neural networks, object recognition, and Natural Language Processing. The review highlights major challenges, including the need for high-quality data management, semantic feature representation, and occluded object detection. Additionally, it underscores the untapped potential of audio-based AI and the advancements possible with Large Language Models for text interpretation. The findings emphasize the need for integrated, multi-faceted AI systems and advocate for responsible AI deployment to mitigate safety risks on construction sites.

Mohlomi Terah Raliile. "Application of Artificial Intelligence for Construction Workers Wellbeing in South Africa: A Literature Review" ASOCSA (2020) Globally, the construction industry is known for its complexity, where a multi-array of interdependent activities all take place at the same time. Construction job sites are increasingly dangerous with historically low levels of innovations and adaptation to change. Construction workers are required to perform repetitive manual tasks involving heavy lifting, bending, twisting, reaching overhead or away from the body and working under generally unfavourable conditions. Construction companies have a moral and legal responsibility to ensure working environments for their workers that do not present a threat to their health, safety and general wellbeing. The purpose of this study is to explore how the application of disruptive AI technologies could improve construction workers' wellbeing and safety on the job site. This paper reviewed extensive literature from previous studies on the application of AI on construction workers' wellbeing such as, for example, Weak AI, Strong AI, Machine Learning, Deep Learning and Big Data.

Jaekyu Lee and Sangyub Lee. "Construction Site Safety Management: A Computer Vision and Deep Learning Approach" Sensors MDPI (2023) In this study, we used image recognition technology to explore different ways to improve the safety of construction workers. Three object recognition scenarios were designed for safety at a construction site, and a corresponding object recognition model was developed for each scenario. The first object recognition model checks whether there are construction workers at the site. The second object recognition model assesses the risk of falling (falling off a structure or falling) when working at an elevated position. The third object recognition model determines whether the workers are appropriately wearing safety helmets and vests. These three models were newly created using the image data collected from the construction sites and synthetic image data collected from the virtual environment based on transfer learning. We verified an artificial intelligence model based on a virtual environment in this study.

Zakari MUSTAPHA. "Limitations For the Implementation of Artificial Intelligence in Construction Health and Safety" Baltic Journal of Real Estate Economics and Construction Management (2024) Building accidents and fatalities are prevalent, especially in rising nations like Ghana, despite rapid technical developments. Weak regulations, training, and change resistance typically undermine traditional safety measures. This study aimed to identify potential obstacles that prevent the implementation of artificial intelligence (AI) in construction health and safety in Ghana. A survey research approach was employed to get the study population, which consisted of 110 construction experts made up of project managers, site engineers, skilled workers, and safety officers complete the questionnaire. Data analysis included descriptive statistics, chi-square, and regression. According to varied demographic responses, AI increases design and engineering, safety and security, and human resources efficiency, decision-making, and safety. Lack of innovation culture, training, and regulation harms health and safety.

Kabeer Aftab "Role of artificial intelligence in construction safety: A Comprehensive Review" International Journal of Advanced Natural Sciences and Engineering Research (IJANSER) (2024) Ensuring the safety of buildings has emerged as a critical concern, encompassing not only the financial stability of buildings but also the safety of individuals. Several research studies have been carried out to investigate methods for enhancing building affordability, energy efficiency, and safety. With the development of science, artificial intelligence (AI) has become

more and more integrated into the design and construction of buildings. Artificial Intelligence (AI) holds great promise for revolutionizing the construction sector, particularly regarding improving safety protocols on construction sites. Artificial intelligence (AI) can assist construction companies in detecting and anticipating potential risks, monitoring worker behaviour and equipment use, and fostering improved coordination and communication among workers using machine learning algorithms and real-time data analysis. This paper aims to provide a comprehensive overview of research on artificial intelligence and building safety conducted in the last ten years, covering the entire lifecycle of a structure from early planning to the end.

Christian Nnaemeka Egwim "Artificial Intelligence in the Construction Industry: A Systematic Review of the Entire Construction Value Chain Lifecycle" Energies MDPI (2023) In recent years, there has been a surge in the global digitization of corporate processes and concepts such as digital technology development which is growing at such a quick pace that the construction industry is struggling to catch up with latest developments. A formidable digital technology, artificial intelligence (AI), is recognized as an essential element within the paradigm of digital transformation, having been widely adopted across different industries. Also, AI is anticipated to open a slew of new possibilities for how construction projects are designed and built. To obtain a better knowledge of the trend and trajectory of research concerning AI technology application in the construction industry, this research presents an exhaustive systematic review of seventy articles toward AI applicability to the entire lifecycle of the construction value chain identified via the guidelines outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Iman Merdžanović "A Comprehensive Literature Review of Research Trends of Applying AI to Construction Project Management" IPA Publications (2022) Artificial Intelligence (AI) is universally reaching every industry thus far, it is coming to the fore in construction industry by redesigning project world and altering the role of project managers. It provides the ability for computers to simulate human-like thinking and is comprised of machine learning, Internet of things (IoT), automation, natural language processing and robotics. In construction industry, AI is affecting project planning, time and cost management, optimization of resources as well as post-construction activities. Along with assessing teamwork patterns and making recommendations, it also has an impact on the workforce and how individuals handle projects. Despite a broad range of research papers written about this theme there are still not so much of practical applications conducted in practice. Therefore, the aim of this study is to provide an overview of using AI in Project Management and to show how it is affecting construction industry along with exhibiting future trends. This article will also show positive and negative sides of AI in Project Management and how does it manage competencies. It will propose possible utilitarian solutions including a critical review over the research topic. The outcomes of this study contribute to the body of knowledge on AI in project management through a comprehensive investigation of literature and provide guidelines for further research on the phenomenon of AI in project management.

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