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Enhancement of AI Technologies in Safety for Construction Sites

Mr. Naved Saqlain Ahmad[1], Prof. Pranav Lende[2]

Student M. Tech. Dept. of Civil Engineering, G.H. Raisoni University, Amaravati, India[1]

Assist. Prof., Civil Engineering Dept., G.H. Raisoni University, Amaravati, India[2]

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.

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

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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.

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.

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II. CASE STUDIES

AI IMPLEMENTATION IN LARGE CONSTRUCTION PROJECTS

Implementing Artificial Intelligence (AI) in large construction projects enhances efficiency, safety, cost management, and decision-making. AI technologies, such as machine learning, computer vision, and predictive analytics to help and manage complex project dynamics, reduce risks, and optimize resource allocation. Key Areas Where AI is Applied in Large Construction Projects is done with the Project Planning and Design AI Tools Generative design with an algorithms BIM (Building Information Modelling) with AI integration. Applications Automating design optimization for cost, energy efficiency, and material usage is done to Identifying potential design flaws early through simulations. Construction Site Monitoring AI Tools like Drones with computer vision, IoT sensors, real-time data analytics platforms. Applications for Monitoring site progress with aerial imagery and comparing it with project schedules. Equipment and Asset Management AI Tools Telematics, predictive maintenance software, equipment tracking systems.

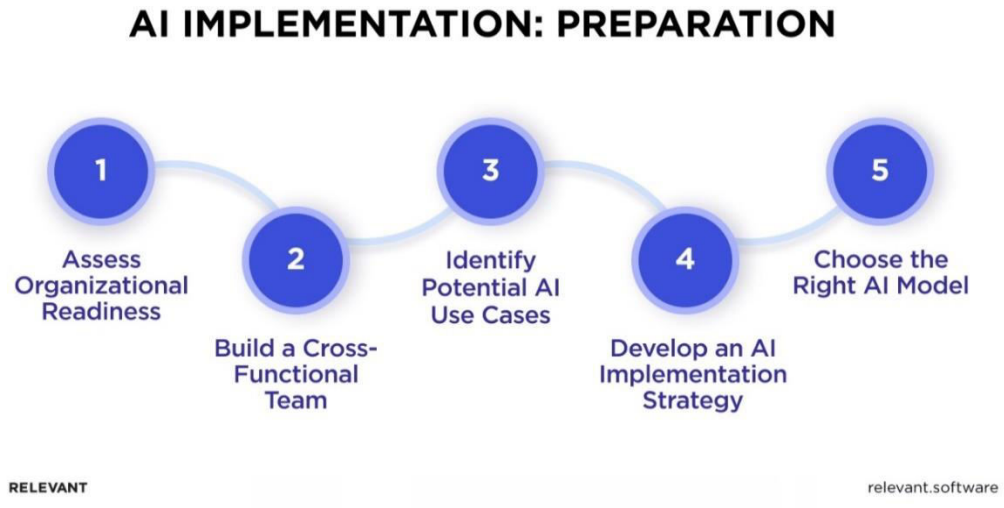

Fig. Preparation Process for AI Implementation.

Implementation Strategy for AI in Large Construction Projects are as follows: -

Step 1. Define Objectives Identify specific areas where AI can add value (e.g., safety, cost management, scheduling).

Step 2. Data Collection and Infrastructure Setup to Install IoT sensors, drones, and data collection devices on-site. Set up cloud or edge computing infrastructure for data processing.

Step 3. Select AI Tools and Platforms Choose AI software that integrates with existing construction management systems (e.g., BIM, ERP).

Step 4. Model Development and Training Train AI models using historical project data to improve accuracy. Continuously update models with new data for better performance.

Step 5. Integration and Testing Integrate AI tools into daily construction workflows. Conduct pilot tests to ensure reliability before full deployment.

Step 6. Monitor, Evaluate, and Optimize Regularly monitor AI performance. Adjust models and strategies based on feedback and Applications Monitoring equipment helps to predict failures and reduce downtime.

Optimizing the deployment of machinery across multiple sites. Supply Chain and Logistics Optimization AI Tools Machine learning algorithms, demand forecasting models. Applications Optimizing material procurement and reducing delays. Predicting supply chain disruptions and suggesting alternatives.

IMPACT OF AI ON REDUCING WORKPLACE ACCIDENTS

The implementation of Artificial Intelligence (AI) in workplace safety has significantly transformed how organizations manage risks, detect hazards, and prevent accidents. AI-driven technologies, such as predictive analytics, computer vision, and wearable devices, enable proactive safety measures rather than reactive responses. How AI Reduces Workplace Accidents Hazard Detection and Real-Time Monitoring AI Tools Computer vision, IoT sensors, smart cameras. Impact: Detects unsafe behaviour (e.g., workers without PPE, improper machine use). Identifies environmental hazards (e.g., gas leaks, structural instabilities) in real time.

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Triax Technologies (Manufacturing & Construction) Technology Wearable safety devices monitor worker vitals and location. Result Decreased fatigue-related incidents by 35% in heavy industries. ExxonMobil's Safety Program (Oil & Gas) Technology AI-driven predictive models for equipment failure risks. Result Reduced equipment-related accidents by 25% through proactive maintenance. Benefits of AI in Workplace Safety Proactive Risk Management Identifies risks before accidents occur.

III. COST-BENEFIT ANALYSIS OF AI IN SAFETY EQUIPMENT

A Cost-Benefit Analysis (CBA) for AI in safety equipment evaluates the financial and operational impacts of investing in advanced AI-driven safety technologies. This analysis helps determine whether the benefits, such as reduced accidents and improved efficiency, outweigh the costs of implementation. Costs of Implementing AI in Safety Equipment Initial Investment Costs AI Hardware Smart helmets, vests with sensors, exoskeletons, wearable devices Software & Platforms AI-driven safety management systems, analytics platforms.

Indirect Costs Downtime During Implementation: Temporary disruptions while integrating new systems. Regulatory Compliance Costs: Meeting industry-specific safety and data protection standards. Benefits of AI in Safety Equipment Direct Financial Benefits Reduced Accident Costs Lower insurance premiums, fewer legal liabilities, and reduced compensation claims. Decreased Downtime Less time lost due to injuries or equipment failures.

Assumptions for a Construction Company (Annual Data):

- Number of Workers: 200
- Accidents Without AI: 20 incidents/year
- Average Cost per Incident: $50,000 (medical, legal, downtime)
- AI Safety Equipment Cost: $150,000 (initial) + $30,000/year (maintenance)
- Reduction in Accidents Due to AI: 50% (10 fewer incidents)

Cost Calculation:

- Total AI Costs (Year 1): $150,000 + $30,000 = $180,000
- Accident Costs Without AI: 20 × $50,000 = $1,000,000
- Accident Costs With AI: 10 × $50,000 = $500,000
- Savings: $1,000,000 - $500,000 = $500,000

Net Benefit:

- Year 1: $500,000 (savings) - $180,000 (cost) = $320,000 (net benefit)
- ROI (Return on Investment): ($320,000 / $180,000) × 100 = 177.78%

Factors Affecting Cost-Benefit Analysis Industry Type High-risk sectors like construction, mining, or oil & gas see quicker ROI due to higher accident costs. Company Size Larger organizations benefit from economies of scale. Regulatory Environment Strict safety laws can increase the urgency and cost-effectiveness of AI implementation. Safety Culture Companies with proactive safety cultures may realize greater benefits. Real-World Case StudiesSmartvid.io (Construction Industry)

- Cost: $200,000 annually for AI safety platform
- Benefit: Reduced site accidents by 30%
- Result: Estimated annual savings of $600,000 in accident-related costs.

B. Triax Technologies (Manufacturing Sector)

- Cost: $150,000 for wearable safety devices and monitoring systems
- Benefit: Reduced workplace injuries by 40%
- Result: Saved over $400,000 annually in healthcare and insurance claims.

C. BAE Systems (Shipbuilding Industry)

- Cost: $500,000 for AI-driven exoskeletons and smart helmets
- Benefit: Improved worker safety and reduced musculoskeletal injuries by 50%
- Result: Lowered long-term healthcare costs and increased productivity.

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IV. CHALLENGES IN AI ADOPTION

Adopting Artificial Intelligence (AI) in industries like construction, manufacturing, healthcare, and more can revolutionize operations, but it also comes with significant challenges. These challenges can hinder successful implementation if not addressed properly. Technical Challenges Data Quality and Availability Issue: AI relies heavily on large volumes of high-quality data. Impact Inconsistent, incomplete, or biased data can lead to inaccurate predictions and poor decision-making. Integration with Existing Systems Issue AI solutions often require integration with legacy systems.

Sr. No.	Project	Location/ Type	Timeline	Budget (₹cr)	AI Tech / Vendors	Applications	Outcomes (Key Benefits)
1	Ganga Expressway (UP)	594 km highway (Meerut–Prayagraj)	2021–25 (ongoing)	37,350	AI-driven roadway QA (ETH Zurich/ RTDT): sensor-equipped inspection vehicles	Construction QA: detect pavement defects	Fewer reworks and maintenance; real-time road quality checks
2	Delhi– Meerut Expressway	96 km highway (Delhi–UP)96 km highway (Delhi–UP)	2017–2021	8,000	Edge-based ALPR (Samajh AI), IoT cameras, FASTag integration	Traffic monitoring, toll automation, surveillance	Travel time to cut 45 min is approved safety/flow
3	Delhi Metro Phase-IV	103 km metro (Delhi–NCR)	2019–26 (phased openings)	50,000	DMRC i-ATS, ML predictive maintenance ("Trinetra"), AI drones, CCTV vision	Train maintenance, crowd/safety management	Faults predicted (e.g. motor bearing fix) 17 ; improved safety surveillance
4	Mumbai Trans-Harbour Link	22 km sea-bridge highway (MH)	2018–25	18,000	AI video analytics, ANPR cameras (ITS)	Traffic monitoring, future violation enforcement	Travel time/ CO_2 savings groundwork for AI-based enforcement
5	Namo Bharat RRTS	82 km semihigh-speed rail (Delhi–Meerut)	2019–25 (Priority oper. 2023	30,274	AI security cameras (36/ train), AI X- ray scanners, facial analytics	Passenger security/ screening	Faster security checks, threat alerts; high punctuality

LESSONS LEARNED FROM AI CASE STUDIES

Examining real-world case studies reveals valuable insights into the successes, challenges, and best practices of AI adoption in workplace safety. These lessons can guide organizations looking to implement AI-driven safety solutions effectively. Case Study: Smartvid.io (Construction Industry) Overview Problem High rates of construction site accidents due to unsafe practices and environmental hazards. Solution AI-powered platform that analyzes site images and videos to detect safety risks (e.g., workers without PPE, unsafe equipment) Lessons Learned Data is Key High-quality, real-time images significantly improved hazard detection accuracy.

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Lessons Learned Real-Time Monitoring Works Continuous health monitoring enabled early intervention, reducing injury rates. Privacy Concerns Addressing employee concerns about data privacy was critical to gaining trust. Predictive Analytics Leveraging AI to predict potential health risks helped prevent accidents before they occurred. Outcome Reduced injuries by 40% and saved over $400,000 annually in healthcare costs. Case Study: BAE Systems (Shipbuilding Industry) Overview Problem: High rates of musculoskeletal injuries among shipyard workers due to repetitive tasks and heavy lifting.

V. CONCLUSION

SUMMARY OF FINDINGS

- The integration of Artificial Intelligence (AI) in construction safety has demonstrated significant potential to enhance risk management, reduce accidents, and improve overall site safety. Here's a consolidated summary of key findings from recent studies and industry applications Enhanced Hazard Detection and Risk Assessment Real-Time Monitoring AI-powered sensors and computer vision systems effectively detect hazards such as structural weaknesses, unsafe worker behaviors, and environmental risks.
- Predictive Analytics Machine learning algorithms analyze historical data to predict potential safety incidents, enabling proactive risk mitigation strategies. Automated Site Inspections Drones and AI-driven cameras provide continuous, real-time site surveillance, identifying hazards that might be missed during manual inspections. Improved Incident Prevention and Emergency Response.
- Early Warning Systems AI systems can send instant alerts to supervisors when unsafe conditions are detected, reducing response times during emergencies. Real-Time Communication Integration with IoT and 5G technologies ensures seamless communication of safety alerts, improving coordination during critical situations.
- Worker Safety and Health Monitoring Wearable Technology AI-enabled wearables monitor workers' vital signs (heart rate, temperature, fatigue levels) and environmental conditions (air quality, noise levels), sending alerts for health risks. Behavioral Analysis AI models analyze worker behavior patterns to identify signs of stress, fatigue, or non-compliance with safety protocols.
- Mental Health Support: Emerging AI tools are being developed to monitor and support workers' mental well-being, addressing stress-related safety risks. Data-Driven Safety Management Centralized Safety Dashboards AI systems aggregate data from various sources (sensors, wearables, cameras) into centralized dashboards for real-time safety monitoring and decision-making.
- Incident Analysis Post-incident analysis using AI helps identify root causes, improving future safety protocols and training programs. Continuous Learning AI models continuously learn from new data, enhancing their accuracy in predicting and preventing incidents over time.
- Resource Optimization: AI optimizes resource allocation, ensuring safety equipment and personnel are deployed effectively where needed most. Return on Investment (ROI): Studies show that while initial AI implementation costs can be high, the long-term savings from reduced accidents, insurance costs, and legal liabilities outweigh the investment.
- Challenges and Limitations High Implementation Costs The initial cost of AI technologies, including hardware, software, and training, can be a barrier for small and medium-sized contractors. Data Privacy Concerns Collecting and analyzing large amounts of worker and site data raises privacy and ethical concerns, particularly regarding surveillance.
- Technology Reliability Dependence on AI systems requires robust fail-safes, as technical glitches can lead to

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missed hazard detections. Resistance to Change Some workers and managers may resist adopting AI due to fears of job displacement or unfamiliarity with the technology

- Global Standards Development There's increasing collaboration across industries to develop global standards and best practices for AI-driven construction safety. Focus on Ethical AI Research is expanding on ethical AI practices, ensuring AI systems are unbiased, transparent, and respectful of worker rights. Conclusion

REFERENCES

1. Alejansdro Palacino, "The Role of Artificial Intelligence in Improving Construction Site Safety and Project Management" (IRE) Journals (2020).
2. PZ Razi1, "How Artificial Intelligence Changed the Construction Industry in Safety Issues" IOP Conference Series: Earth and Environmental Science, February (2023).
3. James Oluyemi Adeyemo, "Innovative technologies for enhancing occupational safety in construction sites", International Journal of Science and Research Archive (IJSRA), December (2024).
4. T. V. Chandni, Anitha Babu, "Implementation of Safety Management using Machine Learning Approach" International Journal of Creative Research Thoughts (IJCRT) October (2022).
5. T. Nagarajan "Integrating Artificial Intelligence into Civil Engineering Practices: Opportunities and Implications" International Journal of Artificial Intelligence in Civil Engineering (IJAICIE) January 2024.
6. 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).
7. 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).
8. Zhili Gao, Ph.D. and Asad Sultan "AI for Improving Construction Safety: A Systematic-Literature Review" EPiC Series in Built Environment (2023).
9. 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).
10. Meera Mohan, Shibi Varghese, "Artificial Intelligence Enabled Safety for Construction Sites" International Research Journal of Engineering and Technology (IRJET) June (2019).
11. "Safety Detection System: A Technological Leap in Sri Lanka's Construction Safety" Journal of Research Technology and Engineering January (2024).
12. 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).
13. Mohlomi Terah Raliile. "Application of Artificial Intelligence for Construction Workers Wellbeing in South Africa: A Literature Review" ASOCSA (2020).
14. Jaekyu Lee and Sangyub Lee. "Construction Site Safety Management: A Computer Vision and Deep Learning Approach" Sensors MDPI (2023).
15. Christian Nnaemeka Egwim "Artificial Intelligence in the Construction Industry: A Systematic Review of the Entire Construction Value Chain Lifecycle" Energies MDPI (2023).
16. Davcik, Nebojsa S. "The use and misuse of structural equation modeling in management research: A review and critique."Journal of Advances in Management Research (2014).
17. Deng, Langni, et al. "Research on safety management application of dangerous sources in engineering construction based on BIM technology." Advances in Civil Engineering (2019).
18. Hazen, Benjamin T., Robert E. Overstreet, and Christopher A. Boone. "Suggested reporting guidelines for structural equation modeling in supply chain management research." The International Journal of Logistics Management (2015).
19. Hou, Lei, et al. "Deep Learning-Based Applications for Safety Management in the AEC Industry: A Review." Applied Sciences 11.2 (2021): 821.
20. Jazayeri, Elyas, and Gabriel B. Dadi. "Construction safety management systems and methods of safety performance measurement: A review." Journal of Safety Engineering 6.2 (2017): 15-28.
21. Jeelani, Idris, et al. "Real-time vision-based worker localization & hazard detection for construction." Automation in Construction 121 (2021): 103448.
22. Keng, Tan Chin, and Nadeera Abdul Razak. "Case studies on the safety management at construction site." (2014).

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|| Volume 12, Issue 3, May-June 2025 ||

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23. Lin, Zi-Hao, Albert Y. Chen, and Shang-Hsien Hsieh. "Temporal image analytics for abnormal construction activity identification." Automation in Construction 124 (2021): 103572.
24. Perry, Melissa J., Amanda McQueen, and S. Kim. "Evaluating Fall Safety Compliance Among Skilled Trades in Construction." Small Study Final Report (2015).
25. Tam, C. M., et al. "Non-structural fuzzy decision system for evaluation of construction safety management system. "International Journal of Project Management 20.4 (2002): 303-313
26. Tixier, Antoine J-P., et al. "Application of machine learning to construction injury prediction." Automation in construction 69 (2016): 102-114.
27. Wang, Mingzhu, et al. "Predicting safety hazards among construction workers and equipment using computer vision and deep learning techniques." ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction. Vol. 36. IAARC Publications, 2019.www.ijcrt.org © 2022 IJCRT | Volume 10, Issue 10 October 2022 | ISSN: 2320-2882 IJCRT2210019 International Journal of Creative Research Thoughts (IJCRT) www.ijcrt.org a139
28. Wang, Ting-Kwei, and Chang Qin. "Integration of BIM, Bayesian Belief network, and ant colony algorithm for assessing fall risk and route planning." Construction Research Congress 2018. 2018.
29. Wu, Haitao, et al. "Combining computer vision with semantic reasoning for on-site safety management in construction. "Journal of Building Engineering 42 (2021): 103036.
30. Xie, Zaipeng, et al. "A convolutional neural network-based approach towards real-time hard hat detection." 2018 IEEE International Conference on Progress in Informatics and Computing (PIC). IEEE, 2018.
31. Xiong, Bo, Martin Skitmore, and Bo Xia. "A critical review of structural equation modeling applications in construction research." Automation in construction 49 (2015): 59-70.
32. Xu,Yayin, et al. "Machine learning in construction: From shallow to deep learning." Developments in the Built Environment (2021): 100045.
33. Yiu, Nicole SN, et al. "Implementation of safety management system for improving construction safety performance: a structural equation modelling approach." Buildings 9.4 (2019).

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