Rapport de veille n° 81

BIM

31/03/2026

Objectif : *L'utilisation du BIM en phase de conception et de ses potentiels applications pour la prévention des risques*

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS.

Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

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1. Articles scientifiques

Automating health and safety regulation in construction by using BIM: a systematic review of capabilities and limitations

J Zhang, S Fadaie, T Kasim, Z Zhang, A Tezel… - Smart and Sustainable Built Environment, 2026, 1–30

DOI : https://doi.org/10.1108/SASBE-05-2025-0261

Construction sites inherently involve numerous hazards, and construction safety has consistently been a significant concern for the industry. Various countries have established health and safety frameworks for the construction industry, enforced by regulatory bodies such as OSHA (USA) and HSE (UK). Traditional manual and experience-based inspection methods are proved to be inefficient. Recent research has focused on automating compliance through building information modelling (BIM), which enables the simulation of hazardous scenarios, such as fall risk and fire outbreaks, and supports risk identification across project life-cycle phases. This research presents a systematic literature review of BIM-based automated health and safety compliance across multiple safety domains, including fall protection, scaffolding, fire safety, evacuation planning and excavation hazards.

Technology-Driven OHSM Frameworks for Sustainable Engineering

CD Ifeyinwa, JS Uzochukwu, PC Uchendu - Caritas Journal of Engineering Technology, 2026, Volume 5 Issue 1, 23 p.

his research explores the integration of emerging technologies—Artificial Intelligence, Internet of Things, Building Information Modeling, wearables, and blockchain—into Occupational Health and Safety Management (OHSM) to foster sustainable engineering practices in construction and manufacturing. Through a mixed-methods synthesis of recent studies, the research reveals that these technologies enable proactive safety management, reducing workplace incidents by 10–20% via real-time monitoring and predictive analytics, while enhancing sustainability by cutting construction waste by 10%. Despite these advances, high costs, technical expertise gaps, data privacy concerns, and regional disparities hinder adoption, particularly for small enterprises and developing nations. The study's novelty lies in its interdisciplinary approach, bridging OHSM, technology, and sustainability to propose scalable frameworks that address these barriers. It fills critical research gaps, including the lack of theoretical models and longitudinal data, by offering context-specific strategies and stakeholder collaboration models. Results underscore the transformative potential of technology-driven OHSM, providing actionable insights for practitioners and policymakers to institutionalize safer, sustainable workplaces globally.

Integrating CARVER Matrix with BIM for Security by Design in Critical Infrastructure Projects

AS Borkowski, G Buniewicz - Sustainability, 2026,18(5), 2492

DOI : https://doi.org/10.3390/su18052492

This paper presents the concept and implementation of the BIM–CARVER tool, which integrates the CARVER matrix (Criticality, Accessibility, Recuperability, Vulnerability, Effect, Recognizability) with an open BIM environment based on the IFC standard. Originally developed by the US military for target analysis, the CARVER matrix has evolved into a defensive tool for protecting critical infrastructure. Traditionally, physical security assessments of buildings are performed manually, separately from the digital model, contradicting the principles of Security by Design, which assume that security aspects should be taken into account at the early stages of design. As part of research conducted in accordance with the Design Science Research methodology,

a plugin for the Bonsai platform (BlenderBIM) was developed, enabling the assignment of vulnerability assessments to individual elements of the IFC model according to six CARVER criteria on a scale of 1–10, the visualization of results directly in the modeling environment, and the generation of security reports in HTML format. The tool was validated on a set of ten building models of varying purpose and complexity. The results confirmed the effectiveness of the tool in systematically identifying and classifying building elements into four risk categories: critical, important, significant, and insignificant. The developed semi-automated solution supports designers and security specialists in the proactive identification of threats and enables the comparison of design variants in terms of the aggregated risk level, contributing to the implementation of Security by Design principles in design practice. By reducing the need for costly security retrofits and enabling resource-efficient design decisions, the proposed approach also contributes to the sustainability objectives in the built environment.

Artificial Intelligence Adoption in Construction Businesses: Strategic Impacts on Productivity and Risk Management [PDF]

AK Panabandani, H Pam, M Shafiabadi, M Fojlaley… - Journal of Scientific and Technology Research (TUBITTUM), Volume 5, Issue 1, 2026, pp. 175-189

URL : https://tubittumjournal.com/article/1135

The construction industry, despite its significant contribution to global economic development, continues to experience persistent productivity stagnation, cost overruns, schedule delays, and elevated operational risks. Traditional construction management approaches largely based on deterministic planning models and experience-driven decision-making have proven insufficient in addressing the increasing complexity and uncertainty of modern project environments. In this context, the integration of Artificial Intelligence (AI) represents a transformative opportunity to enhance strategic performance and risk governance in construction businesses. This study investigates the strategic impacts of AI adoption on productivity improvement and risk mitigation within construction enterprises. Drawing upon the Resource-Based View, digital transformation theory, and technology adoption frameworks, the research conceptualizes AI as a dynamic organizational capability rather than a standalone technological tool. The paper examines key AI applications, including predictive scheduling, cost forecasting, computer vision-based safety monitoring, supply chain optimization, and intelligent resource allocation.this research contributes to the literature by integrating engineering-focused AI applications with strategic management theory, offering a holistic framework for intelligent construction transformation. The study concludes that AI adoption is not merely a technological upgrade but a structural shift toward predictive, data-driven, and resilient construction business ecosystems.

A Systematic Literature Review of Internet of Things (IoT) Applications in Sustainable Construction Project Management

A Tighnavard Balasbaneh, W Sher - Sustainability, 2026, 18(5), 2614

DOI : https://doi.org/10.3390/su18052614

The construction industry is under mounting pressure to enhance its sustainability performance. Increasing project complexity and risk require real-time data collection, monitoring, and assistance in decision making via the Internet of Things (IoT). IoT has emerged as a critical enabling technology to overcome these hurdles. This study provides a bibliometric and thematic overview of IoT applications in sustainable construction project management to identify research trends, key themes, and practical implications for project managers. We used a structured screening process to analyze peer-reviewed journal papers, conference articles, and book chapters listed in the Scopus database. We identified 77 publications published between 2019 and 2025. Using VOSviewer_1.6.20_exe, we analyzed publication trends, source influences, geographical dispersion, and

keyword co-occurrence patterns. Since 2023, research output and citation impact have increased dramatically, with sustainability, project management, and IoT serving as the main conceptual foundations recorded. Real-time monitoring, wireless sensor networks, safety improvement, BIM and digital twin integration, and resource and energy optimization are the five main application domains recognized using thematic synthesis. This shows a marked transition from standalone sensing applications to integrated, intelligent, and predictive systems that enable data-driven decision making throughout the construction lifecycle. This review highlights the ongoing difficulties associated with data quality, sensor dependability, system interoperability, and energy limitations. IoT is progressing from a support technology to a core operational and managerial infrastructure for sustainable construction, with major consequences for project management and future research.

Modelling adoption of camera-based safety monitoring systems in construction: an extended technology acceptance model approach using PLS-SEM

N Manzoor, H Khan, MU Hassan, K Ahmed, MU Zubair - Innovative Infrastructure Solutions 11, 144 (2026)
DOI : https://doi.org/10.1007/s41062-026-02545-w

The construction industry represents one of the most hazardous sectors globally, with camera-based safety monitoring systems offering significant potential for accident reduction; however, their adoption remains limited due to inadequately understood barriers. Previous research has fragmented focus on individual adoption factors without comprehensive integration of technical, financial, human, and perceptual considerations necessary for effective real-world implementation. Unlike prior TAM extensions that examined isolated variables, this study presents the first integrated framework incorporating five construction-specific factors, financial constraints, human factors, technical issues, visible coverage, and safety and security concerns, within a unified Technology Acceptance Model. Data was collected from 130 construction professionals in Pakistan through a structured questionnaire and analyzed using Structural Equation Modeling in SmartPLS 4. The results revealed that Perceived Ease of Use is the most significant predictor of intention to use such systems ($\beta = 0.992$, $p < 0.001$), challenging the conventional assumption that perceived usefulness dominates technology acceptance. Financial Constraints emerged as the strongest barrier to Perceived Usefulness ($\beta = -{-}0.823$, $f2 = 2.542$), while Human Factors demonstrated complex dual relationships, positively influencing ease of use while negatively affecting usefulness perceptions. The extended framework achieved exceptional explanatory power ($R2 = 0.885$), with all eight hypotheses receiving empirical support. This study offers a validated, comprehensive framework for understanding technology acceptance in construction safety, providing practical recommendations for improving adoption through cost-effective, user-friendly, and secure system implementations.

A multifaceted approach to enhance safety performance of a commercial construction company

S Aliakbarlou, Z Liu, R Masood, J Bakshi - International Journal of Construction Management, 2026
DOI : https://doi.org/10.1080/15623599.2026.2642892

The construction industry remains one of the most hazardous work environments globally, marked by high injury and fatality rates despite evolving regulatory frameworks and safety interventions. In New Zealand, the sector accounted for over 400 notifiable incidents in the first eight months of 2023 alone. This study examines the implementation and effectiveness of strategies for enhancing safety performance at a commercial construction company in Auckland, which has over three decades of operational experience. Using a qualitative case study methodology, data were collected through semi-structured interviews with senior professionals and through the analysis of internal safety documentation. Findings suggest that proactive safety management, leadership engagement, and ongoing training are crucial to enhancing safety outcomes. The company's emphasis on near-miss reporting and compliance monitoring has resulted in a measurable reduction in incidents

and a rise in safety compliance. Key challenges include human error, documentation overload, and the need for culturally inclusive communication strategies. The study underscores the importance of integrating behavioural safety, inclusive training, and leadership-driven safety culture in construction environments. Insights contribute to the broader literature on construction safety, offering actionable guidance for industry practitioners and policymakers seeking to enhance safety performance.

Enhancing Sustainability and Construction Safety Research in the Era of Artificial Intelligence

A Gupta, S Singh, V Asari, TV Nguyen - ASME Journal of Engineering for Sustainable Buildings and Cities, 2026, 53 p.

DOI : https://doi.org/10.1115/1.4071434

Construction remains one of the most hazardous global industries, with worker fatalities occurring approximately every 99 minutes. In response, a growing body of research has explored the use of advanced technologies, such as machine learning, robotics, wearable, and immersive visualization, to synergies safety improvements with sustainable building practices. In this paper, we systematically review 165 peer-reviewed articles in the era of artificial intelligence (AI) that capture how technologies have evolved to address the dual imperatives of safety and sustainability in response to technology driven transformation. To analyze this inflection, the paper develops a four domain taxonomy spanning AI, Visualization, Surveillance, Robotics & Navigation, and Wearable Technology each mapped against earlier and recent research studies. Crucially, we highlight emerging dual-utility applications, such as the use of 'Green Digital Twins' for real-time lighting optimization and UAVs for building envelope energy auditing. By mapping this transition, the article provides a grounded perspective on current capabilities, identifies research practice gaps, and supports informed decision making for the implementation of future integrated safety and sustainability technologies. Our review identifies recurring themes in the recent studies, including the integration of real time sensing, multimodal data fusion, and user centered system design. By offering this structured analysis, the review aims to contribute a domain wise benchmark of progress, capturing the recent technological inflection in construction safety and sustainability, and outlining future opportunities to support researchers, technology developers, and industry professionals.

Digitalizing workplace safety regulations for rule-based validation of escape routes and movement areas in BIM

D Napps, A Aziz, M König - Automation in Construction, Volume 186, June 2026, 106883

DOI : https://doi.org/10.1016/j.autcon.2026.106883

Ensuring compliance with safety regulations is essential in building design and construction. This paper presents a methodology for automating workplace safety compliance through rule-based validation of escape routes and movement areas in as-designed Building Information Modeling (BIM) models. The study digitizes workplace safety regulations and transforms them into machine-readable rule sets to improve the efficiency of compliance checks. Although the Industry Foundation Classes (IFC) schema does not explicitly define escape routes, they can be derived by constructing a navigable graph from spatial and door elements, enabling algorithmic identification of evacuation paths. The rule sets are applied to real-world BIM models to demonstrate practical applicability. Results show potential for reducing planning errors, improving regulatory compliance, and enhancing safety during construction and renovation. The methodology advances the digitalization of regulatory processes by providing an automated and scalable approach for verifying workplace safety requirements within BIM environments. It supports safer planning outcomes overall.

AI safety management for hazard mitigation and worker protection in green construction

F Al-Anazi, M Al-Zu'bi, M Rabi, MJ Al-Kheetan - Proceedings of the Institution of Civil Engineers - Engineering Sustainability, 2026, 13 p.

DOI : https://doi.org/10.1680/jensu.25.00177

Recent growth in green construction projects in Saudi Arabia has increased the use of advanced construction systems, necessitating more proactive and intelligent approaches to safety management. This study examines the role of artificial intelligence (AI) in improving hazard mitigation and worker safety in green construction projects. Five AI-enabled components were assessed: hazard detection, risk prediction, wearable smart devices, AI-based training systems, and AI-supported compliance tools. A quantitative descriptive–analytical approach was adopted using a structured questionnaire distributed to 350 employees working on green construction sites. Simple random sampling was applied, and reliability and validity were confirmed through expert review and Cronbach's alpha testing. Data were analysed using SPSS and AMOS to examine relationships within the proposed model. The findings indicate that all AI components significantly enhance safety performance. AI-based training systems showed the strongest influence (R2 = 0.509), followed by wearable devices (R2 = 0.334), hazard detection (R2 = 0.216), risk prediction (R2 = 0.124), and compliance tools (R2 = 0.060). The results confirm the robustness of the model and demonstrate that AI integration supports predictive safety management, improved compliance, and reduced incidents, aligning with Saudi Arabia's Vision 2030 sustainability objectives.

The benefits and challenges associated with technologies in managing workplace health and safety. An explorative study through the lens of construction health and safety stakeholders in two countries

K Leifels, J Zeller-Lanzl, A Rahman, P Knöpfle… - Construction Economics and Building, 2026, Vol. 26, n° 1

DOI : https://doi.org/10.5130/70gext45

Digital technologies can enhance health and safety on construction sites. However, despite their benefits, only few of these technologies have been implemented. This study explores how construction health and safety stakeholders perceive the benefits and challenges associated with digital technologies to enhance health and safety on construction sites. Based on a literature review, digital technologies in the construction industry were categorised into nine distinct types, namely, Personal Communication Technologies, GPS-based Technologies, Planning & Simulation Tools, Visualisation Technologies, Training Programs, Wearables & Smart Tools, Additive Manufacturing, Robotics & Exoskeletons, and Vision-based Surveillance. Utilising semi-structured interviews, this research gathers insights into perceived benefits and challenges associated with these technologies from construction health and safety stakeholders, health and safety professionals, and construction specialised academic industry experts in Germany and Australia. Each type of technology was further analysed to understand its perceived benefits and obstacles. The findings indicate that some technologies offer significant benefits, notably in automating construction processes and pre-emptively identifying potential incidents. However, the study also uncovers critical obstacles, particularly concerns about data protection and the financial burdens of development and implementation. This study provides unique insights into the perceptions of construction health and safety stakeholders regarding digital technologies. It highlights the dual nature of technology as a tool for advancement and a source of new challenges, specifically in terms of health and safety efficiency in the construction industry. The identification of specific benefits and obstacles offers a foundational understanding for further research and practical application in enhancing health and safety practices through digitalisation in construction.

Technology-Driven OHSM Frameworks for Sustainable Engineering

CD Ifeyinwa, JS Uzochukwu, PC Uchendu - Caritas Journal of Engineering Technology, 2026, Volume5, Issue 1

This research explores the integration of emerging technologies—Artificial Intelligence, Internet of Things, Building Information Modeling, wearables, and blockchain—into Occupational Health and Safety Management (OHSM) to foster sustainable engineering practices in construction and manufacturing. Through a mixed-methods synthesis of recent studies, the research reveals that these technologies enable proactive safety management, reducing workplace incidents by 10–20% via real-time monitoring and predictive analytics, while enhancing sustainability by cutting construction waste by 10%. Despite these advances, high costs, technical expertise gaps, data privacy concerns, and regional disparities hinder adoption, particularly for small enterprises and developing nations. The study's novelty lies in its interdisciplinary approach, bridging OHSM, technology, and sustainability to propose scalable frameworks that address these barriers. It fills critical research gaps, including the lack of theoretical models and longitudinal data, by offering context-specific strategies and stakeholder collaboration models. Results underscore the transformative potential of technology-driven OHSM, providing actionable insights for practitioners and policymakers to institutionalize safer, sustainable workplaces globally.

2. Conférence / ouvrage / thèse

Video object detection-based intelligent early warning method using BIM technology and YOLOv5

K Xu - Proceedings Volume 14121, International Conference on Computer Vision, Pattern Recognition, and Detection (ICVPRD 2025) ; 141210R (2026)
DOI : https://doi.org/10.1117/12.3106489

With the rapid development of artificial intelligence technology, intelligent algorithms have been widely applied in the field of engineering site monitoring. To enhance the real-time and intelligent risk identification of construction sites, a civil engineering safety management risk intelligent warning system is proposed by integrating building information modeling technology with you only look once version 5 (YOLOv5) object detection model. The system identifies personnel, safety equipment and hazardous areas in real time through video streaming, and synchronizes the results to the building information model for spatial localization and risk assessment, realizing the closed-loop management of intelligent safety warning. In the experimental test, the system shows excellent performance in four types of typical risk scenarios. The target recognition accuracy reaches 97.5%, 95.7%, 97.2%, and 97.8% in the four scenarios, the recall rate is 97.6%, 97.5%, 97.9%, and 98.2%, and the average response time is controlled within 6.4s, which is significantly better than the comparison method. In addition, in terms of the warning trigger rate index, the system exceeds 91% in all scenarios, with a maximum of 95.8%. The experimental results show that the proposed system of the study has the ability to perceive engineering risks with high accuracy, high time efficiency and strong robustness, and still realizes stable early warning in complex dynamic environments, which has significant practical application value.