

Rapport de veille n° 87

BIM

31/10/2026

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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Safety in the Construction Industry: A Literature Review

SS Quadri - Journal of Industrial Safety Engineering, 2026, Volume 13, Issue 2, pp. 28-35

URL : https://journals.stmjournals.com/joise/article=2026/view=254958

The construction industry remains one of the most hazardous sectors of the global economy, consistently reporting disproportionate rates of fatal and non-fatal injuries relative to its share of employment. Over the past two decades, research on construction safety has expanded from traditional accident statistics and compliance-based approaches toward a more holistic understanding of safety performance, safety culture and climate, safety leadership, and the growing role of digital technologies such as Building Information Modeling (BIM), wearable sensors, virtual reality (VR), and computer vision. This paper presents a literature review of twenty peer-reviewed studies published in leading construction, safety, and engineering management journals, including Safety Science, Automation in Construction, the Journal of Construction Engineering and Management, Construction Management and Economics, the Journal of Applied Psychology, and other well-regarded outlets. The review synthesizes findings across seven thematic areas: safety performance conceptualization and measurement, safety culture and climate, safety management systems and leading indicators, safety leadership, BIM-enabled safety risk management, wearable and IoT-based monitoring, and immersive and AI-based training and detection technologies. The review finds that while measurement and management frameworks have matured considerably, persistent gaps remain in standardizing definitions, integrating human and technological factors, and translating digital innovations into consistent field-level safety outcomes, particularly in developing- country contexts. The paper concludes by outlining directions for future research aimed at closingthese gaps.

Dynamic Occupational Risk Assessment as a Basis for Proactive Safety Management in Construction [PDF]

L Aktayeva, A Bekmagambetov, A Rakhmetova… - International Journal of Safety and Security Engineering

Vol. 16, No. 8, August, 2026, pp. 1847-1860

DOI : https://doi.org/10.18280/ijsse.160814

Construction remains one of the most hazardous industrial sectors due to the combined effects of technical, organizational, environmental, and climatic risk factors. This study aimed to develop and test a dynamic approach to occupational risk assessment in the construction industry, taking into account hazardous occupational factors and extreme climatic conditions, and to analyze associations between occupational environmental indicators and recorded morbidity among workers. The methodology combined occupational hygiene assessment, analysis of recorded morbidity, and correlation, regression, and epidemiological risk analyses. Dynamic occupational risk assessment (DORA) tools, including safety checklists for work at height and outdoor work, were developed and tested to support timely hazard identification under changing working conditions. The results revealed distinct occupational risk profiles at the two pilot enterprises. At Enterprise 1, the most pronounced associations were related to physical workload and microclimatic conditions, including associations of work intensity and air temperature with upper respiratory tract diseases ($r = 0.816$ and $r = 0.818$, respectively; $p < 0.001$). At Enterprise 2, chemical aerosols and dust were predominant, with the strongest association observed between quartz-containing inorganic dust and respiratory diseases ($r = 0.970$; $p < 0.001$). The findings support differentiated occupational risk management according to site-specific technological, exposure, and climatic conditions. Integration of occupational exposure monitoring with dynamic risk assessment may provide a practical basis for proactive occupational safety management in construction.

Smart Infrastructure Systems: Integrating AI, Building Information Modeling, and Sustainable Materials for Enhanced Construction Safety

SL Lativia - Pacific Journal of Advanced Engineering Innovations, October 2026, 3(2):127-135
DOI : 10.70818/pjaei.v03i02.0279

The swift evolution of the infrastructure development has made the demand for construction systems that are able to predictively respond to safety issues and enhance environmental and operational performance even greater. Traditional safety management methods are still very reactive and mostly rely on manual checks, past history, and reactive measures to deal with hazardous situations. Smart infrastructure systems provide an integrated approach with the use of Artificial Intelligence (AI), Building Information Modeling (BIM), Internet of Things (IoT) technologies, sustainable materials, digital twins, robotics and automation throughout the infrastructure lifecycle. The review compares and contrasts the technologies and their potential to bolster construction safety by providing continuous monitoring, predictive risk assessment, better design coordination, and automated intervention. With AI, the patterns of accidents, unsafe behaviors, equipment failures, and structural anomalies can be identified, whereas computer vision can automatically detect violations of personal protective equipment, falls, entry into restricted areas, and unsafe proximity. BIM supports the safety focused design, construction sequencing, spatial coordination, and lifecycle information management. Digital twins link dynamic digital representations of physical infrastructure to real time data from IoT devices and environmental sensors, which relay worker movement, equipment condition and hazardous exposure data. Sustainable materials can also play a role in safety, impacting structural performance, material handling, durability and construction practices. The review points out that an integrated smart infrastructure system can transform construction safety from being a reactive process of control to being a predictive process of continuous and lifecycle risk management.

Critical Barriers to Immersive Technology Adoption for Construction Health and Safety Management: Evidence from a Developing Country

H Pittri - International Journal of Construction Education and Research, 2026, 1-33
DOI : https://doi.org/10.1080/15578771.2026.2742192

The construction industry continues to experience high rates of occupational accidents, particularly in developing countries where regulatory, institutional, and technological capacities remain constrained. Immersive technologies (ImTs) offer significant potential to enhance hazard recognition, safety training, and proactive risk management. However, their adoption in construction health and safety (H&S) management remains limited, and empirical evidence on the underlying barriers in developing contexts is scarce. This study investigated the critical barriers to immersive technology (ImT) adoption for construction H&S management using data from a questionnaire survey of 204 construction professionals in Ghana. Data was analyzed using mean score ranking, exploratory factor analysis, and fuzzy synthetic evaluation. The results reveal six major barrier dimensions, with technical expertise and data quality emerging as the most critical, followed by financial and market, organizational and data security, institutional and awareness, cultural and technical complexity, and adoption and feasibility barriers. The findings demonstrate that socio-institutional and capability-related constraints, rather than purely technological or financial factors, constitute the primary impediments to adoption. This study advances socio-technical perspectives on digital safety transformation in construction and provides actionable insights for policymakers, industry practitioners, and technology developers seeking to accelerate the integration of immersive solutions in high-risk construction environments.

Engineering strategies to improving health and safety practices in the Ethiopian construction engineering projects

MD Sellato, K Ramdass, T Seadira - Discover Civil Engineering, 2026, Volume 3

DOI : https://doi.org/10.1007/s44290-026-00640-6

Despite the construction sector's high hazard profile in developing nations, limited empirical evidence exists on how engineering-led interventions interact with governance structures and sociocultural dynamics to influence occupational health and safety (OHS) outcomes. This study addresses that gap by investigating the mechanisms through which engineering solutions, grounded in sociotechnical systems and resilience engineering theory, can enhance construction safety practices in Ethiopia. The research employed a mixed methods design. Quantitative data were collected from construction project stakeholders via a structured questionnaire using a 5-point Likert scale and analyzed through descriptive and inferential statistical techniques, including regression analysis. Qualitative responses were examined using thematic analysis to contextualize and deepen the quantitative findings. The study focused on engineering solutions targeting high-risk activities such as excavation, scaffolding, falseworks, concrete operations, edge protection, worker movements, and temporary protective measures. The results demonstrate that engineering solutions constitute the strongest predictor of improved OHS outcomes ($\beta = 0.82$, $p < 0.001$). However, their effectiveness is significantly mediated by contextual factors. Engineering interventions including modular guardrail systems, digital monitoring, and design-integrated safety measures proved substantially more effective in complex projects than in standardized settings, confirming that technical efficacy is context-dependent. Three primary barriers were identified: financial constraints (68% of firms), skills gaps (57%), and organizational resistance to change (42%). Notably, training in isolation showed weak statistical significance ($p = 0.11$), while thematic and NLP-based analyses revealed pervasive workforce exclusion from safety decision-making, underscoring that technological solutions underperform without genuine worker participation. The study concludes that resilient OHS frameworks require the coordinated integration of engineering strategies, robust institutional governance including centralized enforcement, safety-integrated, and tax incentives and participatory, human-centered practices that embed safety as a shared value rather than a regulatory burden.

An Integrated Bibliometric Analysis and Systematic Review of Three Decades of Research in Advancing Construction Safety Through Virtual Reality

I Abubakar, Z Adamu, D Fong, A Nazif - Journal of Safety and Sustainability, 2026

DOI : 10.1016/j.jsasus.2026.10.001

Over the past three decades (1996–2025), virtual reality (VR) has evolved from an experimental technology into a widely used tool for construction safety training. However, the literature remains fragmented across engineering, computer science, and occupational health domains, making it difficult to assess overall effectiveness. This study employed an integrated bibliometric analysis and systematic literature review (SLR) design, utilizing a novel Artificial Intelligence/Machine Learning (AI/ML) enhanced screening workflow to process a large multidisciplinary corpus. A comprehensive search of seven bibliographic databases retrieved 1,247 records, of which 760 duplicates were removed, yielding a deduplicated bibliometric corpus of 487 unique publications. An ensemble classifier: Support Vector Machine (SVM), Random Forest (RF), Bidirectional Encoder Representations from Transformers (BERT), i.e. (SVM+RF+BERT) achieved an F1-score of 0.92, supporting the screening of 487 total papers for bibliometric mapping and 138 empirical studies for systematic effectiveness synthesis. Findings reveal that publication volume grew in three distinct phases, with 80.85% of all research published in Phase 3 (2016–2025). Four thematic clusters emerged: hazard-recognition training (41.3%), equipment operation (15.2%), worker wellbeing (17.4%), and Building Information Modelling (BIM) integration (8.0%). Effectiveness synthesis indicates that VR-trained workers identify 40–50% more hazards than control groups and show improved retention 30–60 days post-intervention, though evidence for long-term behavioural transfer remains limited (89% of studies measured only immediate

outcomes). Wellbeing-focused research is growing 4.2 times faster than hazard training. Results indicate that the field is expanding beyond physical hazard mitigation to increasingly include psychological safety and worker wellbeing. The increase in wellbeing-based publications is seemingly due to a broader occupational-health trend towards fatigue, stress, mental burden, and human-centred safety management. However, significant structural gaps remain, including a complete absence of African institutions in the dataset and zero collaboration between European Augmented Reality (AR)/BIM clusters and Oceanic wellbeing researchers. Future work should address these geographic inequities and prioritize longitudinal studies to validate behavioural transfer to real-world construction sites.

Predicting Construction Safety Violation Recurrence Using Longitudinal Occupational Safety and Health Administration Enforcement Data

H Li, F Liu, L Tang - Buildings, 2026, 16(21)

DOI : https://doi.org/10.3390/buildings16214200

Construction safety prediction commonly addresses accidents or current hazards, whereas the timing of repeated violations after case resolution is less clearly characterized. This retrospective longitudinal cohort prediction study used public U.S. Occupational Safety and Health Administration enforcement records to construct 741,436 employer–standard observations from 2012 to 2025, including 16,002 observed same-standard recurrences. Follow-up began at a resolution-based anchor and was right-censored at five years or the administrative study end. CatBoost-Cox, XGBoost-Cox, and XGBoost-AFT combined inspection context, resolution information, pre-index history, and regulatory hierarchy. Models were trained on 2012–2018 anchors, validated in 2019, and compared in a 2020 benchmark that informed model selection. The selected 63-predictor XGBoost-Cox model achieved a 2020 C-index of 0.8062 (95% CI 0.7908–0.8200) and 3-year AUC of 0.8128 (0.7953–0.8290); recent AUC was 0.7988 (0.7884–0.8091). A separate highway holdout yielded AUC 0.7281 (0.6463–0.8080) among calendar-complete observations. A sensitivity analysis censoring development outcomes at 31 December 2019 retained AUCs of 0.8105 and 0.7948 in the two later cohorts. Section-level encoding provided a consistent predictive increment. The highest-risk decile contained 42.61% and 36.45% of recorded 3-year events, although absolute-risk calibration deteriorated. The contribution is a resolution-anchored framework linking standard-specific recurrence, unequal follow-up, and construction hazard history. A predictor-level audit could not confirm historical availability of the extracted inputs, leaving temporal leakage unresolved. The framework supports retrospective assessment; prospective use requires verified inputs, recalibration, and independent validation. The endpoint remains inspection-detected recurrence rather than unobserved hazards or a demonstrated preventive effect.