Rapport de veille n° 77

BIM

30/11/2025

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

BIM-IoT methodology for the assessment and management of occupational noise risk in wastewater treatment plants

M Núñez-Fernández, JPC Pérez… - Results in Engineering, Volume 28, December 2025

DOI : https://doi.org/10.1016/j.rineng.2025.108114

Noise risk is a relevant factor in the operation of wastewater treatment plants. However, high accident rates highlight the ineffectiveness of its current management. Technologies such as IoT and BIM have been shown to bring significant benefits in occupational risk prevention. In this context, this research proposes a methodology to improve noise risk management through its integration in BIM, structured in two phases: design of preventive measures and operation of the asset. In the first phase, the standardisation of information by means of structured sets of parameters is proposed, which makes it possible to automate risk assessment from BIM and generate a single database. In the operation phase, an innovative advance is introduced: the occupational risk map associated with noise, which combines information on acoustic conditions and workers' routes obtained through IoT with the risk assessment, thus overcoming the limitations of noise maps, which only show the distribution of sound pressures. The proposed methodological framework, validated at the Coria WWTP (Spain), allows speeding up the risk assessment, optimising the duration and planning of the operation works, defining the appropriate preventive measures and guaranteeing the traceability of the risk throughout the life cycle of the infrastructure. Furthermore, the safety information can be managed in the open IFC format, which favours interoperability with other technologies and the replicability of the methodology in other infrastructures.

Occupational Hazards and Safety Measures in Large-Scale Construction Projects

R. Ogunobo ; I.U. Onyenanu - Bushwealth Academic Journals, Vol. 2, 2025

URL : https://www.bwjournal.org/index.php/bsjournal/article/view/3433

Large-scale construction projects play a pivotal role in global economic growth, yet they expose workers to significant occupational hazards due to complex operations, heavy machinery, and evolving site conditions. This study examines the main dangers that together cause the bulk of industry fatalities: electrocution, falls from heights, struck-by and caught-in-between events, and ergonomic and chemical hazards. Drawing on global statistics, empirical studies, and case analyses, the paper evaluates the effectiveness of safety interventions, including regulatory frameworks, technological solutions (BIM, wearable sensors, drones, AI-based monitoring), and behavioral measures (training and integrated safety management systems). Findings reveal that while regulations reduce incident rates by 20–30% and technologies enhance hazard detection by up to 50%, inconsistent enforcement, high costs, and resource limitations remain barriers, particularly in developing countries. The study concludes that integrated, adaptive safety ecosystems are essential for reducing risks, protecting workers, and enhancing efficiency in large-scale construction projects.

Digital Technology Integration in Risk Management of Human–Robot Collaboration Within Intelligent Construction—A Systematic Review and Future Research Directions

X Ding, Y Xu, M Zheng, W Kang, X Xiahou - Systems, 2025, 13(11), 974

DOI : https://doi.org/10.3390/systems13110974

With the digital transformation of the construction industry toward intelligent construction, advanced digital technologies—including Artificial Intelligence (AI), Digital Twins (DTs), and Internet of Things (IoT)—increasingly support Human–Robot Collaboration (HRC), offering productivity gains while introducing new safety risks. This study presents a systematic review of digital technology applications and risk management

practices in HRC scenarios within intelligent construction environments. Following the PRISMA protocol, this study retrieved 7640 publications from the Web of Science database. After screening, 70 high-quality studies were selected for in-depth analysis. This review identifies four core digital technologies central to current HRC research: multi-modal acquisition technology, artificial intelligence learning technology (AI learning technology), Digital Twins (DTs), and Augmented Reality (AR). Based on the findings, this study constructed a systematic framework for digital technology in HRC, consisting of data acquisition and perception, data transmission and storage, intelligent analysis and decision support, human–machine interaction and collaboration, and intelligent equipment and automation. The study highlights core challenges across risk management stages, including difficulties in multi-modal fusion (risk identification), lack of quantitative systems (risk assessment), real-time performance issues (risk response), and weak feedback loops in risk monitoring and continuous improvement. Moreover, future research directions are proposed, including trust in HRC, privacy and ethics, and closed-loop optimization. This research provides theoretical insights and practical recommendations for advancing digital safety systems and supporting the safe digital transformation of the construction industry. These research findings hold significant important implications for advancing the digital transformation of the construction industry and enabling efficient risk management.

AI-Augmented Safety Management in Construction [PDF]

AF Mohammed, S Mohammed, A Raheman - International Journal of Computer Science and Information Technology, October 2025, 17(5), 18 p.

DOI:10.5121/ijcsit.2025.17507

The construction sector continues to be one of the world's most hazardous, with high rates of accidents fuelled by multicomponent site dynamics, extensive use of heavy equipment, and unstable human behaviour. Conventional safety management methods, although essential, are generally reactive and fall short in offering real-time hazard perception or forecasting risk assessment. Recent advancements in Artificial Intelligence (AI) provide revolutionary opportunities to enhance safety performance through anticipatory, automated, and evidence-based decision-making. This article explains how AI techniques—ranging from computer vision for PPE detection and unsafe behaviour recognition, to wearable sensor analysis for fatigue and stress monitoring, to predictive machine learning models for incident prediction—can significantly enhance construction safety management. Furthermore, the combination of AI with Building Information Modelling (BIM) and digital twin technology allows for real-time hazard mapping, safety scenarios through simulation, and end-to-end synchronization between the virtual and physical worlds. This paper proposes a complete AI-based safety paradigm that harmonizes multimodal data sources, edge analytics, and interpretable predictive models to close the risk mitigation gap with worker privacy and trust. Data quality anomalies, model generalization, alert fatigue, and surveillance implications in terms ofethics are also addressed with responsible deployment practices. AI will eventually be able to shift construction safety from reactive compliance to preventive intervention, reducing incidents and safer conditions.

Architectural perspectives on the prevention through design concept: navigating worldview of barriers, opportunities and implementation strategies

MZ Mohammad, NS Samsudin, N Khalil… - Engineering, Construction and Architectural Management, 2025, 1–25

DOI : https://doi.org/10.1108/ECAM-01-2025-0002

Architects must ensure safety and health in the built environment. This review seeks to emphasise the importance of Prevention through Design (PtD) in the context of occupational safety and health (OSH) concerns from the architectural perspective. The study employs a systematic review of 29 peer-reviewed journal articles. The selected articles were analysed using qualitative software, ATLAS.ti 8, to conduct a thematic analysis. The findings present the benefits of PtD, such as the viability of the approach, barriers,

opportunities and implementation strategies in the future. Findings reveal that architectural design has the potential to mitigate accidents by examining opportunities and implementing design strategies.

Application of Building Information Modelling (BIM) for Enhancing Safety and Environmental Performance on Construction Sites in Nigeria [PDF]

I Okwose, O Okpan, OG Uwadileke… - World Journal of Civil Engineering and Architecture, 2025, 3, 16 p.

DOI : https://doi.org/10.31586/wjcea.2025.6205

Background: Building Information Modelling (BIM) improves safety planning in construction by enabling visualization and simulation to identify and reduce risks. However, its adoption in Nigeria is limited. This study examines the application of BIM in enhancing safety and environmental performance on construction sites in Nigeria. Methodology: A quantitative cross-sectional survey was conducted using a structured online questionnaire distributed to professionals in Nigeria's construction industry. A purposive sampling method was employed to target respondents with relevant BIM experience. Data were analysed using SPSS version 28, applying descriptive statistics, chi-square tests, and logistic regression at a 5% significance level. Result: Findings show that BIM was fully adopted by 7.0% of organizations, with only 19.8% of respondents using it to identify safety hazards during planning. While 76.8% reported no notable safety benefit, 19.5% identified improved risk management as the key benefit. Most respondents (80.2%) reported no noticeable environmental benefits. Among those who did, improved energy efficiency was the most cited benefit (16.4%). Respondents with 10 or more years of experience were significantly more likely to report enhanced safety and environmental outcomes (AOR = 4.555; p = 0.003) and adequate BIM utilization (AOR = 3.255; p = 0.023). Those with intermediate BIM experience were also more likely to report high enhancement (AOR = 2.857; p = 0.039) and effective tool use (AOR = 2.881; p = 0.050). Conclusion: This study revealed that BIM has the potential to improve construction outcomes in Nigeria if supported by training, experience, and structured implementation.

Technologies for Safety and Health Management in Malaysia's Construction Industry: Adoption and Benefits [PDF]

CC Yuan, NH Abas, M Hassan - Journal of Academic Research in Business and Social Sciences, 15(11), 213–230

DOI : http://dx.doi.org/10.6007/IJARBSS/v15-i11/26901

The construction industry significantly contributes to Malaysia's economic growth and employment; however, it remains one of the most hazardous sectors globally, necessitating effective Occupational Safety and Health (OSH) management. This study aims to identify available technologies for OSH management, examine key barriers to their adoption, and propose solutions to enhance their implementation in the Malaysian construction industry. A quantitative research approach was employed, beginning with a comprehensive literature review to identify relevant technologies. The findings informed the development of a structured questionnaire, which was distributed to construction professionals, including site engineers, site supervisors, safety officers and project managers in Kuala Lumpur. Data collected from the survey was analyzed to determine prevalent technologies and adoption challenges. The results indicate that Radio Frequency Identification (RFID), Exoskeletons/Exosuits and Wearable Sensing Devices are the top three technologies utilized for OSH management; however, their adoption faces significant challenges, including limited technical support, high initial investment costs and restricted functionality. These barriers hinder widespread implementation despite the potential benefits in reducing workplace accidents and enhancing safety culture. The findings provide valuable insights for contractors, policymakers and industry stakeholders to develop strategies for overcoming these barriers. Addressing these challenges through improved technical support, cost-effective solutions and enhanced functionality could facilitate greater adoption of safety technologies, ultimately fostering a safer construction environment in Malaysia.

A systematic review on safety practices in high-rise building construction: benefits, barriers, and strategic improvements

WR Lei, MA Khoiry, AA Mutalib - Journal of Civil Engineering and Management, 2025, Vol. 31, N°8
DOI : https://doi.org/10.3846/jcem.2025.24790

High-rise building construction has long been considered one of the most dangerous jobs globally. However, there is currently a lack of comprehensive systematic reviews that approach the implementation of safety practices in high-rise construction. This study aims to fill the following research gaps: first, to understand the significance and identify the barriers faced to implementing safety practices in high-rise construction; second, to propose a framework to improve safety performance. A total of 109 articles from databases were thoroughly reviewed in this study. The research identified six categories of benefits, five types of safety barriers, and 15 strategies proposed to overcome these barriers. In terms of the number of sources, “reduced accident rates” and “improved organizational reputation” were identified as the top benefits in terms of the significance of safety practices. “Lack of health and safety training” was deemed the largest barrier. To address these challenges, this paper explores the strategies and risk mitigation measures from the perspectives of six stakeholders: regulatory agencies, government, owners, contractors, consultants, and workers. The findings suggest that establishing strict market entry mechanisms are fundamental while strengthening worker safety training and conducting regular safety inspections and real-time site monitoring are the most effective methods.

Integrating posture-hour constraints into construction scheduling to enhance workforce wellbeing [PDF]

K Qi, M Lu - Computer-Aided Civil and Infrastructure Engineering, 2025, pp. 1-20
DOI : https://doi.org/10.1111/mice.70140

This study introduces a new posture-hour-based scheduling framework that integrates ergonomic constraints into construction planning. It shifts the traditional focus from “labor-hours” to “posture-hours” as a primary resource unit. The novelty lies in (1) defining and formulating this new problem in practical construction settings and (2) developing algorithms that treat posture capacity as an allocatable resource. This approach proactively manages musculoskeletal disorder risks by accounting for each activity's posture-specific demands and workers' posture-holding capacities as scheduling limits. Validated via a benchmark case and a real-world concrete pouring project, applying the framework significantly reduces cumulative exposure to high-risk postures, compared to traditional methods. While it may slightly increase project duration, this trade-off better balances physical workload, prevents posture-induced health issues, and enhances long-term workforce wellbeing and sustainability. This interdisciplinary research provides a foundational framework for integrating occupational health considerations, labor productivity metrics, and construction planning methodologies.

2. Conférence / ouvrage / thèse

Design-build: How to manage construction safety risks on building projects?

R Arifuddin, A Basri, MR Fadlillah - AIP Conference Proceedings, 2025

DOI : https://doi.org/10.1063/5.0301121

The design and build method is one of the delivery system innovations developed in Indonesian construction projects in the last decade. Unfortunately, the construction sector in Indonesia is still listed as a sector that contributes to work accidents compared to other sectors. The objectives of this research include: (i) identifying work breakdown structure-based construction safety risks, analyzing risk levels, and developing risk management in building projects with integrated design-build contracts. The method used was a literature study, which experts in risk identification then validated. A questionnaire design related to risk data was used to obtain respondents' perceptions, which were processed using the fuzzy method to determine the risk level analysis obtained, and several experts validated the results. Furthermore, based on the risk level analysis, risk control was developed by brainstorming with several experts. The results of the literature study and expert validation obtained 205 variables out of 257 that affect construction safety risks, divided into six main variables. Thirty-five risk variables with moderate categories and 170 small risks were obtained using the descriptive analysis method to determine the mean and level of risk. Then, from the results of the fuzzy method analysis, 207 variables with moderate risk were obtained. Risk handling/control is based on the Minister of Public Works and Public Housing Regulation Number 10 of 2021, namely from the stages of elimination, substitution, technical engineering, and administration of personal protective equipment. The use of Pareto theory was 20% of the total 205 variables, resulting in 41 potential variables in handling/control, which were then validated again by experts. The dominant control was found to be administrative control of the 41 variables given handling.

Sustainable Innovations in Construction Projects: A Case Study

Pandey, A., Kumar, A.- In: Bajaj, D. (eds) Handbook of Construction Project Management. Springer, Singapore, pp. 1571-1603

DOI : https://doi.org/10.1007/978-981-96-7631-6_52

The construction industry is under increasing pressure to adopt sustainable practices in response to a range of environmental, economic, and social challenges. This paper highlights the importance of sustainability in construction, focusing on key innovations that are transforming the industry. It examines the role of sustainable materials, energy-efficient designs, and smart technologies, which are reshaping construction projects and improving overall performance. These innovations are shown to have a significant impact on cost, quality, and environmental outcomes, contributing to reduced energy consumption, lower emissions, and enhanced resource efficiency. Through a series of case studies, this chapter demonstrates real-world examples of sustainable innovations in construction, addressing challenges faced, solutions implemented, and measurable results achieved. Additionally, this chapter explores the unique challenges encountered by emerging economies and unorganized sectors in adopting sustainable practices, highlighting barriers such as lack of resources, policy constraints, and insufficient knowledge. The economic, environmental, and social impacts of these innovations are further examined, illustrating their potential to drive cost savings, emission reduction, and improved community engagement. Looking ahead, this chapter explores future trends, including emerging technologies, policy developments, and the growing need for collaboration across the construction industry. Ultimately, this chapter stresses the necessity of continuous innovation in achieving sustainable construction practices and offers recommendations for professionals seeking to integrate these innovations into their projects.

Technology Trends and Digital Transformation in Construction

S Halder - In: Bajaj, D. (eds) Handbook of Construction Project Management. Springer, Singapore, 2025, pp. 789-811
DOI : https://doi.org/10.1007/978-981-96-7631-6_25

This chapter provides an in-depth exploration of technology trends and the ongoing digital transformation within the construction industry. It examines the latest advancements in construction technology, including building information modeling (BIM), Internet of Things (IoT), artificial intelligence (AI), virtual and augmented reality (VR/AR), robotics, and blockchain. Through theoretical frameworks and practical examples, readers gain insights into the impact of these technologies on various aspects of construction project management, such as design, planning, execution, quality control, and facility management. The chapter explores the benefits of digital transformation, including improved productivity, enhanced safety, better quality control, and increased sustainability, as well as the challenges associated with adopting digital tools and technologies, such as resistance to change, workforce skill gaps, and data security concerns. Additionally, it discusses strategies for successful implementation, including best practices for integrating digital tools into workflows, change management approaches, collaboration with technology providers, and human-centered design principles. By understanding the evolving landscape of technology in construction, professionals can harness innovative solutions to address industry challenges and drive positive change in project delivery processes. The chapter concludes with a look at future trends, emphasizing the need for continuous adaptation and innovation in an increasingly digitalized construction sector.