Rapport de veille n° 68

BIM

28/02/2025

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 for Safety: Applying Real-Time Monitoring Technologies to Prevent Falls from Height in Construction

F Pereira, MN González García, J Poças Martins - Applied Sciences, 2025, 15(4), 2218

DOI : https://doi.org/10.3390/app15042218

There are significant risks in the construction sector, with falls from height identified a greater hazard than in most other industries. Efforts to improve working conditions and reduce accident rates have driven research into real-time monitoring technologies to reduce the risk of falls. The main objective of this research is to review existing real-time monitoring technologies, identify the most relevant, and analyse their benefits and impact on reducing workplace accidents in the construction sector. A systematic review was conducted using PRISMA methodology to investigate the use of real-time monitoring technologies in the construction industry. Only studies specifically investigating real-time fall risk assessment were included. Of the initial 446 articles reviewed, 39 were considered highly relevant to the research objectives. Various wireless and computer vision technologies were identified for real-time worker monitoring, often integrated with BIM to improve workplace safety. The findings suggest that a combination of technologies may produce more effective results for worker monitoring. However, further research is needed to verify the applicability of these technologies on construction sites.

Automated fall risk classification for construction workers using wearable devices, BIM, and optimized hybrid deep learning

MY Cheng, DVN Soegiono, AFK Khitam - Automation in Construction, Volume 172, April 2025

DOI : https://doi.org/10.1016/j.autcon.2025.106072

With the highest rate of workplace fatalities, construction is one of the world's most hazardous industries. Current risk mitigation approaches, which still rely heavily on traditional methods, do not allow decision-makers to respond quickly and accurately to the dynamic changes that typify modern construction environments. To address this issue, this paper develops an automated worker fall risk monitoring system for dynamic construction sites, by integrating real-time data from wearable devices and BIM with optimized hybrid deep learning model. The model utilizes Neural Network (NN) for time-independent variables and Graph Neural Network (GNN) for time-dependent variables. Optimization is achieved through the Symbiotic Organisms Search (SOS), enhancing the model's architecture and output weights. The classification performance of SOS-NN-GNN consistently outperformed other models, which resulted in 90.98 % accuracy. This highlights the model's reliability in automatically detecting fall risk levels, significantly reducing fall-related accidents, and improving safety, efficiency, and project outcomes in construction engineering.

Construction schedule planning to incorporate social distancing regulations during pandemics–a BIM-based approach

P Perera, TC Dodanwala, N Van Engelen… - Innovative Infrastructure Solutions, 2025, 10, 72

DOI : https://doi.org/10.1007/s41062-025-01888-0

Integrating pandemic mandates into a project schedule can result in higher construction costs and unforeseeable construction delays. This issue was evident during the COVID-19 period. In order to mitigate the above challenges, this research proposes a Building Information Modeling (BIM) framework to integrate the social distancing mandates into a construction schedule. A rule-based decision-making method was incorporated into a visual programming platform to develop the BIM tool. The proposed planning approach can be utilized to optimize the schedule of construction projects that have more than one worker group. A case study was used to apply the proposed framework and compare it with actual delays. The results showed that the proposed

approach increased the planning and scheduling efficiencies while reducing the overall project delays compared to ad-hoc and manual planning. Therefore, the proposed framework and BIM tool can be used in construction projects to support project planners, schedulers, and project management teams in scheduling projects efficiently by integrating the needed rules.

Mixed Reality Simulator For Construction Workers'musculoskeletal Disorders Prevention [PDF]

M Hafsia, E Monacelli, O Rabreau, S Dong, H Martin – ResearchGate

Health and security is a critical issue in the construction industry which ranks amongst the worst industries regarding injury and fatality statistics. In this field, if not performed correctly, some tasks lead to musculoskeletal pains. Currently, qualitative tools are available to prevent health risks as MusculoSkeletal Disorders (MSD). Yet, these tools fail to address evaluation process as it depends on the trainers' perspective. Recently, virtual reality (VR) has started to be used as a training tool for construction workers and showed its relevance in the improvement of the training process. However, it is not used for posture analysis in construction field. Therefore, UVSQ and Bouygues Construction have developed "Virtual Compagnon", a Mixed Reality (MR) platform, in order to evaluate the physical efforts involved, depending on the worker posture, during the lifting of formwork panels. This platform is composed of a head mounted display (HMD) for visual and auditory immersions on virtual construction sites extracted from a BIM model, a robotic platform dedicated to "realistic" haptic feedbacks. This paper presents the functional specifications of the MR simulator and the first results on the lifting task done by students.

Analyzing Research Trends in Smart Construction Safety: A Topic Modeling Approach

HJ Seo, YG Yoon - Buildings, 202, 15(4), 520

DOI : https://doi.org/10.3390/buildings15040520

The construction industry is increasingly embracing smart technologies to enhance safety, efficiency, and sustainability. Despite their potential, the practical integration of technologies such as digital twins, the Internet of Things (IoT), and big data into construction safety management systems remains insufficiently explored. This study investigates how these technologies can be effectively implemented to improve safety outcomes. A systematic review of the literature is conducted, culminating in the development of a conceptual framework for integrating smart technologies into safety systems. The study highlights the application of digital twins, the IoT, and big data for real-time monitoring, predictive risk management, and resource optimization. The findings reveal that these technologies significantly enhance construction site safety by proactively identifying hazards, reducing accidents, and improving resource allocation. Moreover, smart technologies contribute to environmental sustainability by optimizing energy use and lowering carbon emissions. This research underscores the dual benefits of technological integration, advancing both safety and sustainability objectives. While the study provides theoretical insights and practical implications, further empirical research across diverse construction environments is necessary to validate and refine the proposed framework.

Study on the measurement of the level of construction occupational health and safety management in prefabricated building: a case study of a practical training building

W Liu, Z Feng, Y Hu, X Luo - Engineering, Construction and Architectural Management, 2025

DOI : https://doi.org/10.1108/ECAM-10-2024-1412

Prefabricated building (PB) has high technical requirements and is susceptible to safety accidents, and its construction occupational health and safety (OHS) problems should not be ignored. To promote the better development of PB, this study aims to measure their construction safety management level and propose corresponding countermeasures. By systematically combing the relevant literature, this study extracts the influencing factors that appear frequently in several studies and categorizes them according to six dimensions: people, materials and components, technology, mechanical equipment, environment and system. Combining

expert opinions, the measurement index system, including 6 primary indexes and 24 secondary indexes, is constructed. The structural entropy weight (SEW) method is applied to calculate the index weights. The cloud matter element (CME) model based on the weights is constructed to determine the level of construction occupational health and safety management (COHSM). A project case of a training building is used to verify it. The results obtained from the model are compared with those from other measurement models to verify the feasibility of the model in measuring the level of COHSM for PB. The calculated weights show that technology is the most important for the COHSM of PB. The management level of the project in terms of people, materials and components, technology, machinery and equipment, environment and system is Level II good. The overall safety management level is also Level II, which is good. The model of this study is consistent with other model measurements. The methodology of this study yields reasonable and realistic results.

Integration of human well-being in digital construction processes and digital twins: a systematic review of stress detection parameters and tools to support human-centric construction processes

V Getuli, E D'Ascenzi, I Fiesoli - Journal of Information Technology in Construction (ITcon), 29, 2024, pp. 1257-1274

DOI : 10.36680/j.itcon.2024.056

The increasing digitalization of the construction industry, driven by Building Information Modeling (BIM) and the rise of digital twins, necessitates a holistic approach to worker well-being. Understanding how digital tools and processes, including BIM-based workflows and digital twin applications, impact the psychological and physiological states of construction workers is crucial for improving safety, productivity, and overall job satisfaction. This study integrates construction practices and neuroscience by systematically reviewing quantitative parameters and tools for assessing worker well-being within various digital construction workflows, with a specific focus on BIM and digital twin applications. We identify key stress detection parameters (e.g., EDA, HRV) and tools from medical research applicable to construction management for enhancing worker well-being and mitigating risks. A comprehensive literature review synthesizes findings from multiple disciplines, focusing on stress detection techniques and their application in optimizing digital construction processes, specifically within BIM-driven projects and the development and utilization of digital twins. Results highlight stress detection parameters and tools offering valuable insights into worker experience, emphasizing the need for both qualitative and quantitative measures in project management, particularly within the context of BIM and digital twin technologies. A holistic, interdisciplinary approach merging ergonomics, neuroscience, and construction methodologies is crucial for enhancing worker experience in increasingly digitalized construction environments. Integrating stress detection technologies into construction management processes, especially those leveraging BIM and digital twins, is essential for promoting worker well-being and safety, while acknowledging limitations in current systematic research. Future exploration includes developing human-centered digital tools within BIM and digital twin workflows and applying medical findings to improve construction workflows. This research aims to inspire construction professionals to prioritize worker well-being and adapt their methodologies to address the unique challenges of digital transformation in the industry, leveraging the potential of BIM and digital twins to create safer and more productive work environments.

Effects Of Emerging Technologies On Computer-Based Project Management [PDF]

GC Enyinna, JOC Oguzie, UU Moneke, CC Ekennia… - Journal of Management Information and Decision Sciences, Volume 27, Issue 6, 2024, 18 p.

The main challenge for organizations to meet client requirements is finding ways to enhance computer-based project performance and make management knowledge more efficient. The solution is to apply key emerging technologies that have recently entered the market, including artificial intelligence (AI), 3D printing (3DP), augmented reality (AR) and mixed reality (MR), building information modeling (BIM), drones, and mobile technology (VP). The study used a well-structured questionnaire to collect data from the four randomly chosen

construction companies, from which a sample size of 100 was acquired. This study used a descriptive survey research design. The study employed simple percentages, mean, standard deviation, Rank, and tables for a better interpretation. At the same time, the multiple rationalization analysis was used to determine the link between the study's variables and derive conclusions and suggestions from them. Findings reveal that the 7 identified Ets significantly influenced computer-based project management, having ascertained that the participants possess sufficient knowledge regarding emerging technologies and their impact on computer-based project management. Therefore, the study recommended adopting and implementing emerging technologies for managing computer-based projects, speedy automation, swift project delivery, and customer satisfaction.

SMART technologies that influence construction health and safety factors risk reduction in the current digital era

MB Purushothaman, FE Rotimi, S Samarasekara… - Smart and Sustainable Built Environment, 2025

DOI : https://doi.org/10.1108/SASBE-09-2024-0400

This paper aims to highlight the factors affecting health and safety (H&S) and the SMART Technologies (ST) used to mitigate them in the construction industry through a range of selected papers to encourage readers and potential audiences to consider the need for intelligent technologies to minimize the risks of injuries, illnesses and severe harm in the construction industry. This paper adopts a double systematic literature review (SLR) to analyse studies investigating the factors affecting H&S and the ST in the construction industry using databases such as Google Scholar, Scopus, Science Direct and Emerald Insight publication. The SLR identified “fatal or focus five factors” that include objects Fall from heights (FFH) and trapped between objects; Falls, Trips and slips (FTS); Machinery/Equipment Malfunction and Moving Equipment; Pollutants: Chemicals, Airborne Dust, Asbestos; and Electrocution. The ST includes Safety Boots/SMART Glasses/SMART Helmet/SMART Vests/SMART PPE/SMART Watch, Mobile Apps, Building Information Modelling (BIM), Virtual Reality/Augmented Reality (VR/AR), Drones/Unmanned Aerial Vehicles and Wearable Technology/Mobile Sensors help mitigate the risk posed by “Fatal five”. However, other factors within the scope of ST, such as Weather Conditions, Vibrations, Violence, Disease and illness, Fire and Explosion and Over Exertion, are yet to be adopted in the field.

2. Conférence / ouvrage / thèse

AI for the Built Environment: An Opportunity to Improve Safety, Efficiency, and Sustainability

G Scagliotti, A Agrawal, MA Fischer - In: Marseglia, G.R., Previtali, P., Reali, A. (eds) Socio-economic Impact of Artificial Intelligence. Progress in IS. Springer, Cham, 2025, pp. 119-134

DOI : https://doi.org/10.1007/978-3-031-73514-1_9

The Architecture, Engineering, Construction and Operation (AECO) industry suffers from problems such as lack of safety and sustainability, inefficiency, and labor shortage, which can be mitigated by the adoption of solutions based on artificial intelligence (AI) that automate tasks traditionally performed by humans. However, while planning the adoption of AI-driven solutions, AECO professionals often lack knowledge of what can be automated and encounter difficulties in setting goals and defining a digital strategy that integrates automation with manual work. To assist professionals, we propose a two-dimensional conceptual framework for determining the roles played by AI-driven solutions, their level of automation, and the roles that suit humans best. We analyze potential AI applications in AECO to explain how to use the framework and show the variety of AI development opportunities in this industry. The aim of the framework is to facilitate structured discussion and communication between professionals to plan the development of AI applications that have more chance to succeed and can help overcome AECO industry's long-standing challenges.

Construction Accident Factors That Can Be Addressed During the Design Phase

AR Farooq – Thesis for the Degree of Doctor of Philosophy, Manchester Metropolitan University, 2024, 282 p.

The construction industry experiences accidents at alarmingly high rates, recording the highest fatality rate and the second-highest injury rate among all UK industries as of 2023. Substantial efforts have been directed towards reducing accidents and improving safety. A critical focus is the design phase of construction projects, which holds significant potential to reduce accidents in subsequent phases. This study aimed to identify factors leading to construction accidents that can be moderated during the design phase and the extent of designer influence over these causes. A quantitative survey and qualitative interviews were conducted with construction industry participants worldwide. A total of 298 participants from 46 countries responded to the survey, and six engaged in qualitative interviews. The findings identified five causal variables of accidents that designers can influence during the design phase: the permanent structure, temporary structure, building equipment, building materials, and site environment. However, Qualitative findings further reveal that designers do not exert equal influence over these areas. They have the strongest influence on the permanent structure and building materials, moderate influence on the temporary structure and site environment, and the least influence on building equipment. Content analysis revealed weaknesses in Construction Hazard Prevention through Design (CHPtD) methods and identified eleven challenges faced by designers. These include insufficient consideration of the project's full life cycle, limited involvement of other stakeholders in design decisions, and inadequate site experience and safety knowledge among designers -all of which hinder effective CHPtD implementation-. The findings underscore the critical role of designers in mitigating construction hazards and highlight the need for targeted interventions to enhance their impact on accident prevention. This study contributes to the field by identifying five key variables and illustrating the degree of influence designers have on each. These insights could improve training for designers on site-specific safety considerations and promote collaboration among stakeholders, making CHPtD more effective, ultimately reducing construction-related accidents and improving overall industry safety.

Smart and Sustainable Construction: Enablers and Inhibitors to Utilising Technologies for Health and Safety Management [PDF]

SC Yap, JBH Yap, YL Lew, WP Lee - 5th International Symposium on Civil and Environmental Engineering, IOP Conference Series: Earth and Environmental Science 1453 (2025) 012017
DOI : 10.1088/1755-1315/1453/1/012017

Construction is one of the most dangerous sectors of the economy. Worldwide, construction workers are three times more likely to be killed and twice as likely to be injured than workers in other occupations. It is therefore imperative to improve construction safety science and management with the use of smart technologies for better safety performance. This paper provides a thorough overview of smart safety technologies in the construction industry. The enablers and inhibitors to utilising technologies for sustainable health and safety management (HSM) are examined using a questionnaire survey involving industry practitioners from G7 contractors in Malaysia. The significance of the enablers and inhibitors are prioritised using mean scores. Employing Spearman's correlation test, the association between the enablers and inhibitors are established. The findings explained the important inhibitors such as the lack of consistent standards, interoperability issues, and the need for strong managerial support and staff training. To improve the adoption rate of utilising smart technologies for HSM, deliberate steps must be taken to standardise technologies, improve technology literacy, and win over senior management.