Rapport de veille n° 60

BIM

30/06/2024

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. Références anglophones

1.1 Articles scientifiques

Integrating BIM with 3D web design for enhanced 3D building visualization and safety planning in construction projects

IMS Kumara, IKAW Raharja, H Chan - Journal of Infrastructure Planning and Engineering (JIPE), Volume 3, Issue 1, April 2024, pp 18 - 23

DOI: https://doi.org/10.22225/jipe.3.1.2024.18-23

The construction industry is renowned for its hazardous nature, with a significant number of accidents occurring annually. These accidents result in serious consequences, including costs for disability benefits, decreased worker productivity, and idle equipment, hindering development. To address these challenges, safety must be a priority during the construction planning stage. Occupational Health and Safety (OSH) programs play a crucial role in ensuring worker safety and health. Building Information Modeling (BIM) has emerged as a technology that can significantly improve safety in construction projects. BIM provides detailed information and visualizations that help identify potential hazards and develop effective mitigation strategies. However, its implementation in Indonesia is still limited to level 1 BIM, primarily involving 2D and 3D CAD drafting. To enhance 3D building visualization and safety planning, this paper proposes integrating BIM with three.js and ReactJS. Three.js is a JavaScript library that enables the creation of 3D visualizations in web browsers, while ReactJS is used to build user interfaces in web applications. By combining these technologies, interactive web applications can be developed to display 3D buildings in real-time. This allows users to easily view building designs, identify potential hazards, and make informed decisions regarding safety measures. Furthermore, the Industry Foundation Classes (IFC) file format is utilized for data exchange in the BIM environment. IFC contains building geometry information, material properties, and other relevant data, enabling collaboration among project teams using different software. This integration enhances collaboration and facilitates more informed decision-making in construction projects. The results demonstrate efficient 3D rendering of BIM models with an average response time of 0.8 seconds, as well as real-time visualization of worker positions within buildings based on sensor data.

Exploration of Smart Construction Site Management Applications Based on BIM [PDF]

Z Yidan, S Quan, Z Chengli, W Chaohui, L Yuhang… - International Journal of Advances in Engineering and Management (IJAEM), Volume 5, Issue 8, Aug 2023, pp: 481-488

DOI: 10.35629/5252-0508481488

This article takes a particular library project as an example, analyzing and exploring the application of BIM technology during the construction phase and investigating methods for intelligent management during this phase. By integrating BIM technology into construction site layout, the construction of smart construction site platforms, and construction management, it achieves efficient, intelligent, and visual construction. Through the combined application of BIM technology and smart construction sites, cloud platform information technology is used to effectively manage the construction phase. By integrating various intelligent technologies and methods such as BIM and GIS, the focus is on intelligent management of the construction site, establishing a comprehensive and efficient digital system platform for the construction site, and realizing intelligent management of the construction site.

A State-of-the-art Analysis of Virtual Reality Applications in Construction Health and Safety

N Akindele, R Taiwo, H Sarvari, B Oluleye, IA Awodele… - Results in Engineering, Volume 23, September 2024

DOI : https://doi.org/10.1016/j.rineng.2024.102382

The construction industry contends with high injury rates, emphasizing the need for innovative preventive measures in construction health and safety (CHS). While previous studies have investigated the potential applications of virtual reality (VR) in the construction industry for different purposes, an in-depth study on VR in the CHS context is lacking. Hence, this study provides a state-of-the-art analysis of VR applications in CHS, employing a dual scientometric and systematic review approach. A scientometric analysis is conducted to examine annual publication trends, keyword co-occurrences, and science mapping of publication outlets, alongside mapping the contributions of leading countries in this domain. This analysis reveals a marked increase in research interest and identifies central thematic connections within the body of literature. The systematic review assesses VR technologies, including immersive, desktop-based, BIM-based, 3D game-based, and augmented reality, addressing their roles in hazard identification and safety training. The study also underscores challenges like infrastructure, content modeling, and interoperability and proposes directions for future research. Recommendations include probing into VR's role in cognitive safety risks and the impact of users' prior safety knowledge on learning outcomes. This study suggests that developing tailored VR experiences for specific user groups could significantly advance safety practices in the construction industry.

Assessing The Use of AI for Improving Safety and Performance for Building Construction Workers [PDF]

I Umar, TO Iyendo, A Adejumo – Nile Journal Of Engineering and Aplied Science, Volume 2, Issue 1, 2024

DOI: https://doi.org/10.5455/NJEAS.189076

The study "Assessing the Use of AI for Improving Safety and Performance for Building Construction Workers" delves into the potential applications of artificial intelligence (AI) in enhancing project management within the construction sector, focusing on safety and performance for construction workers. Through a mixed-method research approach utilizing structured online survey questionnaires, the findings shed light on the feasibility of employing AI in construction project planning and management. Major conclusions suggest that while AI presents opportunities to boost worker safety and performance, challenges such as high implementation costs and the need for data preparation hinder widespread adoption. The implications of the findings underscore the importance of integrating AI technologies in construction practices to enhance project efficiency and worker well-being. Recommendations include developing tailored AI solutions for construction professionals and organizations to optimize project outcomes and mitigate risks.

BIM-based Security Management of Underground Buildings [PDF]

W Zhou - International Journal of Engineering Technology and Construction, 2024, Vol. 5, Issue 1: 42-50

DOi : https://doi.org/10.38007/IJETC.2024.0501

The security management of underground buildings has become increasingly important. This study aims to explore an underground building security management method based on Building Information Modeling (BIM), and propose an innovative security management strategy by integrating BIM technology with security management practices. The methods section described the process of collecting security accident data, including the organization and analysis of historical accident data, as well as the construction of a BIM security management model. By collecting historical data on construction security accidents in underground buildings, statistical methods were used to classify and trend analyze the accident data, in order to identify high-risk construction stages and common types of accidents. In addition, this study also investigated the application

cases of BIM technology in underground building security management, and collected practical application data of BIM technology in risk assessment, security planning, construction monitoring, and accident prevention. The research results indicated that BIM technology exhibited significant advantages in risk assessment and monitoring.Through BIM technology, the accuracy of risk identification has significantly improved, reaching a maximum of 98.2%. In addition, as the application of BIM deepened, the emergency response time continued to decrease, with a minimum of 27 minutes. These results validate the potential of BIM technology in improving the efficiency of underground building security management.

Decentralized adaptive work package learning for personalized and privacy-preserving occupational health and safety monitoring in construction

X Li, J Zeng, C Chen, T Li, J Ma - Automation in Construction, Volume 165, September 2024

DOI : https://doi.org/10.1016/j.autcon.2024.105556

Precision construction occupational health and safety (COHS) is a prerequisite for project success. Work package-based distributed monitoring shows a high capability for this purpose. However, a theoretical dilemma exists between larger work packages with greater technical efficiency and smaller ones with greater data privacy. This paper develops a decentralized adaptive work package (DAWP) learning model and blockchain for personalized COHS monitoring. The DAWP learning model is first formulated to form adaptive topologies to concatenate and share model parameters of work packages with their neighbors. DAWP learning can compute graphs using mixing weights and similarity to improve personalization. Then, studying blockchain can transform DAWP into a decentralized collaboration. Lastly, blockchain-DAWP (BC-DAWP) is evaluated by controlled experiments of multiple monitoring tasks. The results indicated that the BC-DAWP with lightweight models outperforms the proposed baselines in a personalized and privacy-preserving manner, which paves the way for the next-generation decentralized COHS monitoring.

Analysis of the impact of building shape on safety accidents

S Son, T Kim, K Son - Safety Science, Volume 177, September 2024

DOI : https://doi.org/10.1016/j.ssci.2024.106595

Preventing various types of safety accidents on construction sites with safety control efforts centered around site engineers has limitations. To resolve this issue, efforts have been made for the last decade to identify safety risk elements that arise during construction and have them reflected in the Design for Safety (DfS). Taking two buildings with the same total floor area for example, the building with a more complex shape or higher floors is expected to have a higher probability of safety accidents in DfS terms. However, little research is available that has used safety accident data from real construction to analyze the impact of building shape on safety accidents. One of the reasons is that many construction companies do not disclose safety accident data. The purpose of this study is to analyze the impact of building shape on safety accidents. For this research, actual project data collection including safety accidents and analysis on their correlation with each risk element were performed in series. As a result, it was demonstrated that R2 was 0.947 for the correlation between shape factor and safety accidents and R2 was 0.881 for the correlation between the number of building floors and safety accidents, showing that safety accidents are closely related to both elements. It is recommended according to the research findings that designers should take into account of building shape in order to perform more effective DfS and developers and constructors should add more safety facilities and manpower depending on building shape for the same total floor area.

Occupational risk prevention in the European Union construction sector: 30 Years since the publication of the Directive

M López-Alonso, ML de la Hoz-Torres… - Safety Science, Volume 177, September 2024

DOI : https://doi.org/10.1016/j.ssci.2024.106593

The construction sector is a key industry in the economy of the European Union (EU), with a significant impact on the Gross Domestic Product and employs approximately 30 % of the industrial workforce. Despite this positive economic impact, the construction sector suffers from high accident rates which result in significant economic costs. In 1992, the EU introduced the Directive 92/57/EEC, which aimed to establish minimum Safety and Health (S&H) requirements for construction sites. The Directive lists a number of premises that justify the need to incorporate risk prevention from the design stage of a project and to strengthen coordination throughout the project's life. For these reasons, the Directive created the role of the Coordinators for S&H matters during the project preparation stage and execution stage, as well as the definition of a S&H Plan. The current paper analyses the state of the accident rate in the construction sector 30 years after publication of the Directive, the changes that have been made to the original text, as well as the identification of the difficulties that have been detected, both in terms of lack of definition and problems in implementation. It is possible to conclude that the management of prevention in the early stages of a project remains a persistent challenge for the industry. Additionally, it is essential to address the sector's adaptation to the new working methods required for its transition to Construction 4.0. This discussion can serve as a valuable tool for future decision-making aimed at improving the regulatory framework.

1.2Conférence / ouvrage / thèse

Using virtual reality for occupational safety & health in a tunnelling megaproject

M Tender, JP Couto, P Fuller, P Demian, V Chow… - Emerald Publishing, 2024

DOI : https://doi.org/10.1680/jmapl.23.00109

Recent advancements into Key Technological Developments (KTD) are leading to a paradigm shift in the way Occupational Safety and Health (OSH) is managed in the Architecture, Engineering, Construction, and Operations sector. This paper reports on a pilot case study where BIM and Virtual Reality were used for OSH training purposes related to the operation of a Tunnel Boring Machine. The aim of the research was to identify the benefits, barriers and challenges associated with the implementation of these KTD's in a Joint Venture organisation delivering part of a complex megaproject in Central London, The Tideway Thames Tunnelling Project (thereafter, "Tideway"). The reported benefits included better safety in design and improved hazard perception. Tideway estimates that the project could potentially see a 20% reduction in training time and a 10% reduction in accidents. The key lessons learned include the need to keep costs down, the necessity of system portability, and ease of access. The results of the study will assist organisations that are interested in the adoption of these KTD's and provide valuable insights to the wider construction industry. This will in turn enable companies to improve how OSH is managed and promote the uptake of KTD for OSH purposes.

Current Safety Practices in the Construction Industry: A Case Study Approach [PDF]

P Tripathi, YK Mittal - IOP Conference Series: Earth and Environmental Sciences, 2024, 10 p.

DOI :10.1088/1755-1315/1326/1/012156

Construction is a hazardous occupation due to the unique and complex nature of the work involved and the repetition of certain field behaviors. Hazardous nature of the construction environment can lead to delays, cost overruns and severe injuries to the workers. Injuries and fatalities in the construction sector are higher than in any other industry. Unsuitable working environments and workers' behaviors are the two significant reasons for

accidental risk on the construction sites. Proper workplace safety management practices are essential while performing hazardous work activities. The conventional safety management practices in construction projects primarily focus on reacting to risks rather than preventing them. Therefore, a proactive approach emphasizing early risk identification and mitigation is crucial for enhancing project success. Risk mitigation and proactive approach like safety planning, monitoring and evaluation through inspection and technology adoption are some factors identified in the literature. This study comprises of a case study approach to understand the current safety practices adopted on building construction project in India. The study aims to highlight the findings by recognizing different types of hazards, occupational injuries, proactive strategies in mitigating accidents on the construction sites and identification of barriers to the limited adoption of safety measures on the construction site. In the process of detailed comparison with the OSHA's guideline, the findings of the current study indicate that chosen construction site exhibits both positive and negative aspects of safety precautionary measures. Positive and well-organized safety practices are helpful in making strategies for maintaining safety standards on any construction project. Future recommendations include digital technology-oriented safety measures for improving site monitoring and safety management scenarios.