Rapport de veille n° 61

BIM

31/07/2024

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

Use of Knowledge Graphs for Construction Safety Management: A Systematic Literature Review
F Kong, S Ahn - Information 2024, 15(7), 390
DOI : https://doi.org/10.3390/info15070390
Effective safety management is crucial in the construction industry. The growing interest in employing Knowledge Graphs (KGs) for safety management in construction is driven by the need for efficient computing-aided safety practices. This paper systematically reviews the literature related to automating safety management processes through knowledge base systems, focusing on the creation and utilization of KGs for construction safety. It captures current methodologies for developing and using KGs in construction safety management, outlining the techniques for each phase of KG development, including scope identification, integration of external data, ontological modeling, data extraction, and KG completion. This provides structured guidance on building a KG for safety management. Moreover, this paper discusses the challenges and limitations that hinder the wider adoption of KGs in construction safety management, leading to the identification of goals and considerations for future research.

A systemic archetype for enhancing occupational safety in road construction projects through worker behavior
DK Das, AO Aiyetan, MMH Mostafa - Transportation Research Interdisciplinary Perspectives, Volume 26, July 2024, 101154
DOI : https://doi.org/10.1016/j.trip.2024.101154
Occupational health and safety (OHS) challenges persistently plague road construction endeavours. The pivotal role of worker behaviour in influencing these challenges is widely acknowledged. Nevertheless, a comprehensive exploration of how OHS issues manifest in road construction due to worker behaviour has been conspicuously absent. Within the context of India's National Highway expansion project, this study investigates the key factors associated with worker behaviour that contribute to accidents and presents a systemic archetype for ameliorating worker behaviour and, consequently, OHS. Data sourced from surveys and robust statistical analyses form the foundation of this research, with the System Dynamics modelling (SD) framework employed to construct the archetype. Furthermore, the Theory of Planned Behaviour (TPB) serves as the theoretical underpinning for this study. The findings underscore that accidents are often precipitated by a dearth of knowledge and inadequate training regarding safety codes and practices, which consequently leads to their violation. However, an investment in knowledge dissemination and comprehensive training to heighten awareness, encourage adherence, and facilitate implementation of safety standards and practices could markedly enhance OHS within road construction projects. This study posits that fostering appropriate worker behaviour rooted in knowledge and training, along with promoting the rigorous enforcement of safety codes and practices, stands as a crucial strategy for preventing accidents in road construction. Consequently, it is argued that knowledge acquisition and training should be recognized as pivotal leverage points for enhancing OHS through the prism of worker behaviour in road construction projects.

A new risk response strategy using association rule mining and BIM capabilities

M Yazdanian, M Mokhlespour Esfahani… - International Journal of Engineering, 2024

The dynamic and complex nature of the construction industry leads to increased project uncertainty, exposing construction projects to various risks and hazards. Poor risk management can hinder project objectives. Therefore, implementing effective risk management strategies can enhance project quality and safety and ensure on-time, under-budget completion. This is achievable when the construction industry adopts advanced methods and tools. Building Information Modeling (BIM) has been widely used to facilitate project risk management due to rapid technological advancements. Given the significance of risk management in construction projects, this study has proposed a novel BIM-based expert system for addressing project risk responses. Data were collected through a questionnaire, and hidden patterns were discovered using SPSS Modeler software (Clementine) through association rule mining. The Apriori algorithm extracted fifty-three top rules from the dataset based on rule evaluation indexes. Subsequently, an expert system was developed using the extracted rules to manage project risks. Finally, the expert system was evaluated by five unbiased experts through a questionnaire. This study can serve as a foundation for addressing project risks using BIM and data mining. Subsequent research can apply this method to other construction projects and compare the results with the present study.

Limitations for the Implementation of Artificial Intelligence in Construction Health and Safety in Ghana [PDF]

Z Mustapha, CK Tieru, BB Akomah, JE Yankah - Baltic Journal of Real Estate Economics and Construction Management, 2024, 12, 103–118

DOI : https://doi.org/10.2478/bjreecm-2024-0007

Building accidents and fatalities are prevalent, especially in rising nations like Ghana, despite rapid technical developments. Weak regulations, training, and change resistance typically undermine traditional safety measures. This study aimed to identify potential obstacles that prevent the implementation of artificial intelligence (AI) in construction health and safety in Ghana. A survey research approach was employed to get the study population, which consisted of 110 construction experts made up of project managers, site engineers, skilled workers, and safety officers complete the questionnaire. Data analysis included descriptive statistics, chi-square, and regression. According to varied demographic responses, AI increases design and engineering, safety and security, and human resources efficiency, decision-making, and safety. Lack of innovation culture, training, and regulation harms health and safety. Using AI promises to overcome these hurdles by minimising risks, improving worker well- being, and safe work environment. The Ghanaian industry study focus and small sample size may prejudice, as the limitations of the study. Samples must be larger and more diversified to generalise. The practical implication is that Ghanaian builders may use the study's findings. Understanding AI's potential and limitations helps them develop AI solutions and problem-solving methodologies. Safety, cost, and worker well-being can improve. The successful integration of AI in construction health and safety can affect society. AI can reduce workplace accidents and improve productivity, well-being, and healthcare costs. This work adds to the growing body of knowledge on AI's building safety applications in emerging economies like Ghana. It identifies environmental restrictions and enables governments, industry leaders, and researchers to develop and implement AI solutions.

Construction safety analysis of urban steel structure buildings based on cloud-building information modeling

Z Zhang, Y Qiu - Environment, Development and Sustainability, 2024

DOI : https://doi.org/10.1007/s10668-024-05176-2

Construction safety accidents often occur in urban steel structure buildings due to construction complexity and safety managing difficulty. Therefore, this study constructs an evaluation index system of construction safety collaborative management in the context of Building information modeling, and introduces cloud model to evaluate its safety. At the same time, it carries out experimental verification. The weight results determined by Network Analytic Hierarchy Process and Entropy Weight Method are mostly consistent, but some single indicators have significant deviations. For the Statistical dispersion, network analytic hierarchy process is about 0.389, entropy weight method is about 0.389, and the comprehensive weighting method is about 0.156, which is far lower than both. In addition, the scores of ten experts on 40 indicators remain between 70 and 90. And remains between 77 and 89, remains between 0.1 and 4.9, and remains between 0.1 and 2.3. Meanwhile, in the cloud model security evaluation, the evaluation score of indicator A is between 70 and 90, indicator B is between 75 and 95, indicator C is between 78 and 92, indicator D is between 78 and 94, indicator E is between 75 and 97, and indicator F is between 78 and 91. Overall, the proposed comprehensive weighting method has practicality and reliability, while the cloud model used in the BIM context for the safety evaluation and analysis of steel structure construction in cities has high effectiveness and accuracy. The model constructed by the building information management system fully considers the randomness and fuzziness of the evaluation set, achieving a qualitative and quantitative conversion. The actual empirical analysis results are consistent with the actual project, it has reference value for strengthening the safety management of steel structure construction in cities.

Exploring Data for Construction Digital Twins: Building Health and Safety and Progress Monitoring Twins Using the Unreal Gaming Engine

C Ellul, N Hamilton, A Pieri, G Floros - Buildings, 2024, 14(7), 2216

DOI : https://doi.org/10.3390/buildings14072216

Although digital twins have been established in manufacturing for a long time, they are only more recently making their way into the urban environment and present a relatively new concept for the construction industry. The concept of a digital twin—a model of the physical environment that has a real-time two-way link between the physical and the digital, with the virtual model changing over time to reflect changes in the real world—lends itself well to the continually changing environment of a construction project. Predictive capabilities built into a twin also have great potential for construction planning—including in supply chain management and waste disposal as well as in the construction process itself. Underpinning this opportunity is location data, which model where something is happening and when and can be used to solve a wide range of problems. In particular, location (the power of where) can integrate diverse data sources and types into a single system, overcoming interoperability challenges that are known to be a barrier to twin implementation. This paper demonstrates the power of location-enabled digital twins in the context of a highway construction project, documenting and addressing data engineering tasks and functionality development to explore the potential of digital twins in the context of two case studies—health and safety and construction monitoring. We develop two demonstrators using data from an existing construction project (building on data and requirements from industry partner Skanska) to build twins that make use of the powers of 4D data presentation offered by the Unreal Gaming Engine and CesiumJS mapping, while software development expertise is sometimes available to construction firms, we specifically explore to what extent the no-code approach available within Unreal can be deployed in this context. Our findings provide evidence to construction companies as to the benefits of digital twins, as well as an understanding of the data engineering and technical skills required to achieve these benefits. The overall results demonstrate the potential for digital twins to unlock and democratise construction data, taking them beyond the niche use of experts and into the boardroom.

1.2Conférence / ouvrage / thèse

Perspectives on Implementation of Digital Tools and Technologies within Construction Safety Management: An Interview Study [PDF]

M Matti, MSE Zahid - TRITA – ABE-MBT-24565, Stockholm, Sweden, Master of Science Thesis, 2024, 52 p.

The construction sector is considered one of the most hazardous industries in the world. The reason for this is due to several factors. Earlier literature shows that a construction site can be dynamic as different types of objects or people are in constant motion. Difficulties arise when trying to predict safety hazards on-site. Collisions between objects or falling from a height are examples of hazardous situations that can occur on construction sites. In a construction environment, there are also static risks related to, for instance, dust, unsafe substances, and chemicals from paints, fuels, and solvents. Simultaneously, society is in an era of digitalization and innovation with, among other things, artificial intelligence (AI), drones, building information modeling (BIM), virtual reality (VR), augmented reality (AR), digital twins, internet of things (IoT), automation, robotics and sensor-technologies on the topic. These tools have the potential to improve current safety management methods. At the same time, the attitudes towards the construction industry are associated with traditional working methods where digitalization and new technology are perceived to be moving at a slow pace. Technologies and digital methods for securing construction sites have mainly been investigated in controlled research settings and test projects. The research gap lies in the fact that there is not enough knowledge regarding the implementation of technologies and digital methods in more authentic construction site environments. The study aims to identify different technologies and digital tools within construction safety management in the Swedish context. The purpose of this thesis is to provide a general understanding of the topic and to broaden the perspective on existing attitudes and behaviors toward digital tools and technologies within construction safety management. In this thesis, the focus is on construction sites during the production phase with their respective personnel. Other parts of the construction project process, such as the planning and design stages, are taken into account by exploring how these stages can contribute to safer construction sites. To obtain empirical material, methods based on qualitative research have been suitable where semi-structured interviews and fieldwork have been conducted. The Technology Acceptance Model (TAM) has been used as a theoretical framework for the results and a thematic analysis has been used as a data analysis approach. The thesis has examined how construction sites can become safer with the help of digitalization and new technology. Attitudes and behaviors towards the implementation of digital tools and technology have also been investigated. The results indicate that there are different attitudes towards the implementation of digital tools and technologies concerning safety management in both the design and planning phase and the production phase. To summarize the results, many of the interview participants were positive towards using digital tools and technologies for safety purposes. However, they were also skeptical about the success of implementation due to factors such as cost, risks, traditional methods, and attitudes and behaviors. The attitudes and behaviors, in turn, affect the actual usage of construction safety management implementations. In this thesis, we hope to broaden the perspective on how digital tools and technology could contribute to safer construction sites and the attitudes and behaviors towards the matter.

Uses And Risks Of Augmented Reality In Occupational Settings [PDF]

S Grassini, L Amdal, SK Meling, S Pettersen – In Advances in Reliability, Safety and Security, Part 5 – Kolowrocki, Kosmowski (eds), Polish Safety and Reliability Association, Gdynia, 10 p.

ISBN 978-83-68136-17-3

The rapid advancement of extended reality (XR) technologies like augmented reality (AR) is transforming digital interactions, particularly in occupational settings. This paper aims to enhance the scholarly discussion on AR's occupational applications and its associated risks, an area generally less examined than for other similar technologies. Our investigation examines various risks linked to AR use in work environments, encompassing health concerns, environmental perception challenges, ergonomic limitations, cognitive impacts, privacy issues,

and socio-psychological effects. This study highlightsthe multifaceted implications of AR in professional settings and emphasizes the necessity of balancing technological advancements with user health and safety. The reported findings suggest that while AR offers significant benefits for work efficiency, safety, and modernization, its deployment must be carefully managed to mitigate potential negative effects on users and their environment. Within Occupational Safety and Health (OSH), these findings underline the importance of a user-centred technological implementation, that should aim at developing guidelines and best practices for AR implementation in the workplaces, focusing on minimizing health risks, ensuring ergonomic compatibility, and saf eguarding mental well-being, thereby promoting safer and healthier workplaces.

Applications of UAV, BIM, and Game Engine Technologies for Enhanced Construction Safety

AAU Zaman - University of Wyoming, ProQuest Dissertations & Theses, 2024. 31293169

Unmanned aerial vehicles (UAVs), building information modeling (BIM), and game engines are evolving technologies that are rapidly being adopted to enhance construction safety management and create safety training platforms. For construction safety improvements, utilizing game engines plays a crucial role where a 3D model is required. 3D models of a real construction site can be produced using UAV photogrammetry. High-quality UAV photogrammetry-derived 3D models have the potential to be integrated with game engines and support construction safety. However, the qualities of the 3D models from the photogrammetry techniques vary due to several factors, such as flight altitude, image overlapping percentages, and structure from motion (SfM) algorithms of post-processing tools. Hence, this study aims to evaluate the qualities of photogrammetric products (point cloud and 3D models) by employing several novel methods for more efficient integration with game engines. Furthermore, the study's goal is to ascertain whether construction safety improvement can benefit from integrating game engines with 3D models generated from UAV photogrammetry. A game is developed to provide virtual instructions to workers and safety associates based on OSHA regulations through the integration of a UAV-derived 3D model and game engine. On the other hand, BIM is another source of 3D models, and in this study, the potentialities and limitations of BIM technology in improving safety management are discussed. In addition, a comprehensive framework is developed to integrate BIM data and a game engine. Finally, two case studies are conducted on real-life scaffolding accident simulation and emergency evacuation modeling following the framework.