



Rapport de veille n° 41

BIM

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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

[Advanced technologies for enhanced construction safety management: investigating Malaysian perspectives](#)

JBH Yap, M Skitmore, CGY Lam, WP Lee, YL Lew - International Journal of Construction Management, 2022

DOI : <https://doi.org/10.1080/15623599.2022.2135951>

The global construction industry continues to struggle with safety issues. Although the existing literature suggests that the application of innovative solutions can reduce workplace accidents and improve work safety, the adoption of safety technologies is still limited, particularly in the developing world. This paper aims to investigate the capacity of advanced technologies to enhance safety management and those suited to the Malaysian context. Following a synthesis of the literature, a questionnaire survey was developed comprising 9 potential applications and 15 types of safety technologies. The feedback from 150 local construction professionals was analysed. The leading benefits are related to advancing safety planning, building safety awareness, delivering effective safety training, improving safety inspections and optimising hazard identification. The most salient technologies for safety management are building information modelling (BIM), camera network systems, mobile devices on site, internet of things (IoT) and digital signage. The findings will provide industry practitioners with an increased understanding of the potential of integrating technological solutions into the various tasks associated with construction safety management. This study highlighted the capabilities of advanced technologies that will revolutionise the future of the construction safety landscape and the need for new technology-based policies, procedures, and practices.

[Safety in Off-Site Construction: Simulation of Crane-Lifting Operations Using VR and BIM](#)

A Shringi, M Arashpour, T Dwyer, A Prouzeau, H Li - Journal of Architectural Engineering, Volume 29, Issue 1, 2023

DOI : [https://doi.org/10.1061/\(ASCE\)AE.1943-5568.0000570](https://doi.org/10.1061/(ASCE)AE.1943-5568.0000570)

Tower cranes are frequently used for installation of prefabricated modules and are on-demand resources in off-site construction. Tower cranes, however, are associated with many site accidents and severe injuries. Proper safety training that builds upon hazard perception of tower crane operators will help to increase safety performance and reduce site accidents. Toward this aim, the current study develops a framework that facilitates the development of context-aware safety training for lifting processes. This framework is then evaluated for its applicability by creating safety training scenarios using building information models (BIM) and virtual reality (VR). The resultant outcome from employment of the framework developed in this study is enhanced situational awareness of tower crane operators that allows them to anticipate risks in a fast-paced construction environment, thereby reducing the number of safety incidents and (lost time injuries) LTIs. This framework allows inexperienced contractors to adopt newer construction methods, such as off-site prefabrication, by mitigating safety risks with context-aware training.

[Managing health and safety risks in restoration/renovation of historic buildings \[PDF\]](#)

GE Gürcanlı, İM Uzun, D Öztürk - Journal of Construction Engineering, Management & Innovation, 2022, 5(3), 13 p.

DOI : [10.31462/jcemi.2022.03181193](https://doi.org/10.31462/jcemi.2022.03181193)

Restoration and renovation of historic buildings aim to preserve and sustain those buildings with their original state. This fact is important to conserve historical values for a society as well as for sustainable city planning. Restoration projects have their own occupational health and safety risks and differ from ordinary construction

projects. Additionally, implementation of safety measures according to the current regulations are very difficult due to geometrical structure, type of material used and preservation consideration for the structural and architectural elements of the historic buildings. Since the risks as well as mitigation and abatement techniques differ from conventional buildings, restoration projects require paying attention to establish safety and health plan and risk management system to implement safety and health measures. In this paper, different health and safety risks of the restoration projects are discussed. Different safety and health practices are dealt with ordinary structures, risk assessment is made according to specific risks, findings are revealed in some certain restoration projects in Turkey and a new approach for health and safety management in restoration projects is introduced.

[Investigating the impact of emerging technologies on construction safety performance](#)

E Dobrucali, S Demirkesen, E Sadikoglu, C Zhang... - Engineering, Construction and Architectural Management, 2022

DOI : <https://doi.org/10.1108/ECAM-07-2022-0668>

Construction safety is heavily affected by using new technologies in this growing trend of technology adoption. Especially, safety performance is enhanced through the utilization of some effective technologies such as artificial intelligence, virtual reality, BIM and wearable devices. Therefore, the main purpose of this study is to investigate the influence of emerging technologies on construction safety performance and quantify the relationship between those. The proposed components of emerging technologies are BIM, GIS, VR, RFID, AI, ML, eye tracking and serious games and wearable devices, whereas the dimensions of construction safety performance are safety planning, safety training, safety inspection and monitoring, safety audits and reviews and safety leadership. A structural model was composed consisting of emerging technologies and safety performance indicators. Then, a questionnaire was designed and administered to construction professionals, and data from 167 projects were analyzed using structural equation modeling. The data were analyzed by using software, called SPSS AMOS. The analysis of the structural model proves that there is a positive and significant relationship between emerging technologies and construction safety performance. Moreover, the factor loadings for each factor were found to be high indicating a good representation of the construct by the components developed. Among the technologies, BIM, robotics and automation, AI and wearable devices were detected to be the most significant technologies in terms of impacting safety performance.

[BIM-based analysis of construction safety tracking using behavior-based safety in Bangladeshi construction industry \[PDF\]](#)

TI Meem, MM Hossain, J Akter - International Journal of Building Pathology and Adaptation, 2022, 22 p.

DOI : [10.1108/IJBPA-06-2022-0090](https://doi.org/10.1108/IJBPA-06-2022-0090)

In comparison to other industries, the construction industry is one of the most dangerous industries. Behavior-based safety (BBS) is a common and useful technique for risk indicator processing. Almost all studies are based on the BBS checklist, but very few of them focus on the increasing dangers faced by construction workers and the important factors that lead to accidents. This research represents a risk spatiotemporal analysis and visual tracking approach based on BBS and Building Information Modeling (BIM). After the literature review, a BBS checklist was developed. Then a survey was conducted based on the BBS checklist and the temporal evolution of risks has been completed. After that, managing the risk with the automatic rule checking (ARC) system using BIM was conducted simultaneously to develop a framework by conducting a case study. Based on the grey clustering analysis, this work provides a temporal evolution analysis approach for dynamic analyzing BBS risk. According to the grey relational analysis (GRA) data, the main key factor of risk was the missing guardrail/handrail system. After that, a case study was performed and the system automatically warn in the preconstruction phase that the barrier is missing as the system benefits.

1.2 Conférence / ouvrage / thèse

[BIM Capabilities towards Better Safety Climate in the Malaysian Construction Industry \[PDF\]](#)

NAA Ismail, BNB Baharun, H Adnan, M Maisham... - IOP Conf. Series: Earth and Environmental Science, 2022

DOI : 10.1088/1755-1315/1067/1/012070

The Malaysian construction industry are dealing with numerous cases of permanent injuries and death of workers in construction sites. This has caused lack of productivity and also losses of human resources. The urging working condition aiming for on time completion has led to unsafe working behaviour due to the top management pressure. This is where Building Information Modelling (BIM) came into view to increase the safety on site environment and through design phase by using technology to overcome human inconsistency behaviour. However, the lack of BIM implementation in Malaysia also causes even lesser implementation of BIM in safety of construction. Therefore, this study aims to investigate the BIM capabilities towards better safety climate in the Malaysian construction industry. A qualitative approach was used through semi-structured interviews and discussion with selected representatives from both private and government sectors. All the interviewed data were then analysed using content analysis technique which correlated the findings with the literature review to support the findings. Based on the findings, it can be concluded that (1) Visualisation for Safety, and (2) Simulation for Safety are the most potential BIM capabilities to be implemented in the construction industry for improving safety climate by using BIM technology. Significantly, the study provides insights towards outlining potential BIM capabilities on policy or Safety Rules and Procedure implementation by the government authority or organizations' top management.

2. Références francophones

2.1 Conférence / ouvrage / thèse

Maquettes numériques comme outil de prévention et d'aide à la décision en santé et en sécurité du travail

C Tiaya Tedonchio - Mémoire de maîtrise électronique, Montréal, École de technologie supérieure, 2022

Les maquettes numériques favorisent l'observation des situations de travail futures grâce à la représentation géométrique des produits/ouvrages. En phase de conception, elles présentent la possibilité d'être couplées à des technologies de gestion des connaissances pour l'identification des risques de sécurité du travail. Ces risques sont des risques majeurs lors des travaux d'exploitation et de maintenance des ouvrages industriels. Dès lors, le couplage des maquettes numériques aux technologies de gestion des connaissances est une approche qui sied aux besoins de prévention à la source des risques des travaux d'exploitation et de maintenance des ouvrages industriels. Par ailleurs, ces approches permettent de combiner le potentiel de visualisation offert par les maquettes numériques à la rigueur des méthodes formelles et structurées d'identification des risques. Parmi ces méthodes structurées, on peut noter les méthodes des arbres de causes, d'analyse des tâches, HAZOP et les listes de vérifications. Ces dernières permettent de garantir la conformité des produits/ouvrages aux règlements de Santé et de Sécurité du Travail (SST) en vigueur. Au cours de cette étude, nous avons réalisé une analyse comparative des approches de gestion des risques de SST à l'aide des maquettes numériques BIM et PLM. Cette dernière a permis de relever que les outils de vérification automatique des modèles, disponibles à la fois dans les environnements de modélisation BIM et PLM, conviennent à la vérification automatique de la conformité des produits/ouvrages aux règlements de SST. Catia V5 étant le logiciel de modélisation utilisé par les équipes de conception du partenaire industriel, la mise en œuvre des principes de la méthodologie de recherche dite de recherche en conception, nous a permis de tester les outils de vérification automatique disponibles sous Catia V5. Cela nous a permis de proposer une approche d'identification des risques qui consiste à utiliser les codes macro sous Catia V5 pour enregistrer les règles de SST auxquelles les produits/ouvrages doivent se conformer. Cependant ces règles de SST doivent préalablement être : 1) extraites des Guides des Exigences de Maintenabilité et d'Exploitabilité (GEME) < des Ouvrages, 2) convenablement reformulées de manière à être compatibles avec la méthode d'interprétation de textes à l'aide de quatre opérateurs logiques : Requirements, Applicability, Selection et Exception (méthode RASE), 3) l'interprétation en langage machine par la méthode RASE. L'analyse de la faisabilité de l'approche proposée s'est faite sur le cas d'étude d'un évacuateur de crues du partenaire industriel. Les risques liés aux sources d'énergie apparaissant comme le risque prioritaire du partenaire industriel pour la phase d'exploitation et de maintenance de ses ouvrages, l'étude de cas a consisté à tenter d'utiliser la démarche proposée pour l'identification automatique des sources d'énergie sur la maquette numérique. Cette étude de cas a par ailleurs permis d'identifier deux principales difficultés d'opérationnalisation de la démarche proposée. Celles-ci sont liées au besoin : 1) de standardisation de la nomenclature des objets numériques et des procédures de conception et 2) de réserver des couleurs à affecter aux objets numériques en fonction du niveau de risque que ceux-ci présentent pour la sécurité et la santé des travailleurs. Cependant, l'étude de cas a permis de valider la faisabilité de l'approche proposée et, ainsi, la possibilité d'utiliser les maquettes numériques pour éliminer à la source les risques règlementés liés aux travaux d'exploitation et de maintenance des ouvrages industriels. Au demeurant, les limites de l'approche proposée sont triples : 1) la non prise en compte des effets des interactions et des liens de renforcement entre les risques, 2) l'impossibilité d'anticiper les situations accidentelles non prévues dans les GEME et 3) la non-intégration des interactions entre les humains et les produits/ouvrages à

entretenir. A cet effet, nous proposons d'étudier, dans de futurs projets, la possibilité de coupler les maquettes numériques aux méthodes émergentes d'identification des risques telles que la Méthode d'analyse de résonance fonctionnelle (méthode FRAM) ou le Modèle théorique et systémique d'accidents et de processus (méthode STAMP/STPA) pour être en mesure d'identifier les risques liés à des situations accidentelles non prévues dans les GEME et ceux liés aux effets de renforcement entre les risques. Nous proposons, enfin, d'étudier la possibilité d'utiliser le module d'analyse ergonomique de Catia V5 pour intégrer le génie des facteurs humains/ergonomie à la conception des ouvrages et ainsi contribuer à la réduction de la fréquence d'occurrence des risques ergonomiques, susceptibles de générer notamment des troubles musculosquelettiques chez les travailleurs de la phase d'exploitation des ouvrages industriels.