# *Rapport de veille n° 38*

## BIM

**31/08/2022**

**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

### Virtual design and construction for occupational safety and health purposes–A review on current gaps and directions for research and practice

Virtual design and construction (VDC) is an umbrella term for technologies altering communication, visualization and organizational design in construction projects. There are high expectations to the potentials that VDC offer in terms of integrating technological possibilities with occupational safety and health (OSH). Research in this area has however been limited and little is known about use and characteristics of the concept as a potential for improving OSH in construction. The aim of this review is to 1) map out research trends, 2) currently concerned OSH topics addressed by and 3) the status of this research, as well as to 4) identify and discuss particular knowledge gaps in order to provide a point of departure for future research and practice. In the study, we performed a scoping review conducting a search on Pubmed, Web of Science and Google Scholar databases with no time limit. 4282 papers were identified and screened for addressing VDC for OSH purposes. 74 studies was found eligible for full review. The summary of studies display five current research trends displaying vast potentials for integrating VDC technologies and OSH by addressing a number of topics. The status on most research is however at proof-of-concept levels which leaves a number of gaps in research and practice. Of central significance, the review identifies and discuss ten particular gaps to be addressed for improving OSH through VDC technologies. Thereby the study provides directions for future research and for stakeholders aiming improve OSH through engagement with VDC technologies in the construction industry.

### Integrating knowledge management and BIM for safety risk identification of deep foundation pit construction

The outbreak of COVID-19 pandemic has posed severe challenges to infrastructure construction in China. Particularly, the complex technology and high process uncertainty of deep foundation pit construction make its safety risk identification a challenging issue of general concern. To address these challenges, Building Information Modeling (BIM) can be used as an important tool to enhance communication and decision-making among stakeholders during the pandemic. The purpose of this study is to propose a knowledge management and BIM-integrated safety risk identification method for deep foundation pit construction to improve the management efficiency of project participants. This paper proposes a risk identification method that integrates BIM and knowledge management for deep foundation pit construction. In the framework of knowledge management, the topological relationships between objects in BIM are extracted and visualized in the form of knowledge mapping. After that, formal expressions of codes are established to realize the structured processing of specification provisions and special construction requirements. A comprehensive plug-in for deep foundation pit construction is designed based on the BIM software. The proposed method was verified by taking a sub-project in deep foundation pit project construction as an example. The result showed the new method can make full use of the existing specification and special engineering requirements knowledge. In addition, the developed visual BIM plug-in proves the feasibility and applicability of the proposed method, which can help to increase the risk identification efficiency and refinement.

## 1.2 Conférence / ouvrage / thèse

### BIM Digital twins environment to enhance construction process

Nowadays, the quality of life is mostly related to the quality of construction. Poor performance of construction project could be related to the poor quality of used construction materials but also to the unsuitable construction processes. BIM methodology adopted an innovative and more effective workflow in construction process. Benefits of BIM are widely recognized and documented including enhanced communication and collaboration between stakeholders, effective decision-making and monitoring, reduced construction cost and duration, etc. However, there is a lot of construction process related information outside of BIM methodology like ERP and building automation system. Digital Twins (DTs) contribute to smart construction through the integration of artificial intelligence, machine learning and data analytics. As construction projects are getting more complex and need more advanced and integrated tools to achieve economic and sustainability objectives, this work proposes a new construction system using the power of digital twins (DTs) and BIM to improve construction process. Genetic algorithm is used to optimize repetitive floor construction cycle. it is reasonable to expect a reduction of 25% of unused resources, which greatly improves site productivity and obtain better economic efficiency. In addition, the working and safety conditions of workers are improved since daily rates of working hours are balanced.

### Application of Artificial Intelligence in Mechanized Construction of Power Grid Engineering

Artificial intelligence is one of the most disruptive science and technologies at present, with strong processing capabilities in computational intelligence, perceptual intelligence and cognitive intelligence. This paper expounds two applications of artificial intelligence in the mechanized construction of power grid engineering, namely the application of BIM building model and BP neural network in emergency rescue of mechanized construction, and the application of artificial intelligence in the positioning and sway prevention of tower cranes. The application of artificial intelligence in the mechanized construction of power grid projects improves the rescue work of rescuers, ensures the personal safety of construction workers, and enables tower cranes to quickly locate and eliminate swings. The corresponding links of its application are described in detail in this paper.

### Construction workspace management using 4D BIM

Workspaces are important resources when executing construction tasks. Workers, equipment, materials and facilities need different workspaces and compete with each other to execute different tasks within the same workspace. Locations and volumes of workspaces change in three dimensions and across time during the construction process. Without proper workspace management, productivity loss, poor quality and safety hazards could be occurred. Many research efforts have been exerted in this field, however, the approach which facilitates the interaction between tasks, workspaces, and spatial–temporal conflict resolution is still missing. In this regard, this research proposes a flexible 4D BIM that could facilitate such interaction. The objectives of this study are firstly to generate and allocate the required workspaces, then to simulate and visualize them, and finally to detect and resolve the conflicts. Workspaces are classified into labors, equipment, auxiliary and safety groups. 3D shape of the workspace is created using a bounding box. BIM plugin is developed to facilitate the proposed model. The developed model has been validated using a commercial building project. Empirical results showed that the proposed model is able to assist construction workspace management where workspace

conflicts can be detected and resolved prior to construction to avoid schedule delays.

## Research high fall safety management of building based on BIM technology

In this paper, it is concluded that the falling accidents about buildings is the highest through data analysis. In order to promote the steady and healthy development of the construction industry, a comprehensive information model based on BIM technology combined with REVIT, RFID, VR and so on. Effective control of high fall safety management and provides a new way to prevent safety accidents from falling from high buildings.

## Harnessing BIM-Based Technology with Risk Assessment to Identify Hazards and Generate Automated Safety Schedule

In India, 24.20% of the accidents are construction related, causing nearly 38 deaths every day. Since every construction activity has some level of associated hazards, it often leads to either loss of lives, compensation loss, work delays, or various levels of ergonomic and Musculo-Skeletal Disorders (MSDs). Poor safety management at sites often leads to accidents and reduced worker's morale and productivity which ultimately increases indirect cost (4 times the direct cost). Safety planning also becomes necessary in Indian construction sector as it employs 51 million people but has only 4% formally skilled labours. Hence, safety planning is one of the aspects that should be paid much attention to in project management. The current study harnesses risk assessment using Failure Mode and Effect Analysis (FMEA) method to identify and rank major hazards and associated risks. A safety database was prepared from applicable safety codes. Risk assessment data and safety database were integrated using Visual Scripting in Dynamo v.2.10 and exported to BIM environment of Autodesk Revit to generate a 'Safety Schedule' along with safety measures, which is a state-of-the-art approach in the domain of safety planning. A case study demonstrates the applicability and effectiveness of the proposed method. The proposed approach can be used by designers, site project managers, safety engineers, and other participants as a tool to foresee and predict hazards. As a result, accidents can be avoided by making timely decisions and proactive actions.

## A Proposal of a BIM and AR Integrated Application Against Fall Risks in Construction Projects [PDF]

M Aksu, S Ofluoğlu

The construction sector carries many risk factors in terms of occupational safety. Many studies reveal that the use of Information and Communication Technologies (ICT) is effective in reducing losses in the construction sector. Lately, BIM (Building Information Modeling) has been deployed as one of the working methodologies to tackle and automate safety measures in the construction industry. Apart from other methodologies, safety information and risk factors are often identified during the project design phases in BIM. Fostered with Augmented Reality (AR) and Virtual Reality (VR) technologies, BIM can also efficiently visualize such risks to prevent them. This study proposes a mobile application called AG-IGU that incorporates a BIM-supported AR environment against the risk of falling, which is the most common accident in construction projects.