Guest editorial

Advances in digital engineering, computing and simulation for the AEC industry

The rapid development of new technologies and approaches in the architecture, engineering and construction (AEC) industry opens an opportunity to develop highly integrated and situationally aware management systems for effective decision-making. These technologies and approaches, such as sensing and tracking technologies, Internet of things, building information modelling (BIM) and geospatial methods, have made the acquisition and processing of project data much easier and more accessible in recent years. In addition, the complexity of construction and engineering problems has increased significantly over the past few years. Due to the rapid recognition of construction automation, future workforces and researchers need to understand how construction and engineering assets can be managed intelligently by integrating advanced equipment, computing and simulation platforms for asset monitoring, real-time planning, collaborative supply chain and automated site execution.

The aim of this special issue is to investigate recent advances in the development of digital engineering, computing and simulation for the AEC industry so that the traditional experience-based decision-making process can be usefully improved to a data-driven one.

In this special issue, we have a total of 18 papers, covering various developments in this area, including BIM, computer vision, deep learning, virtual reality (VR) and augmented reality (AR) and simulation methods.

Six articles collected in this special issue focus on BIM development and implementation. Meng *et al.* summarise a total of 24 typical BIM implementations in a project life cycle through a critical review of 153 journal papers. They also point out six research gaps that need to be further explored, such as BIM incentive mechanisms and collaborative BIM implementation. Li *et al.* and Ji *et al.* explore the potential of using BIM to improve building environmental performance. Specifically, Li *et al.* propose a technical framework to automate building information exchange between Autodesk Revit and EnergyPlus. This framework is then implemented in a single-family house to validate its efficiency and effectiveness through a comparison with traditional simulation tools. Ji *et al.* utilise BIM technique to analyse and compare the environmental performance of conventional and prefabricated buildings. The results show that prefabricated buildings have better environmental performance but with some exceptions in acidification and mineral resource consumption.

Yuan *et al.* and Xu *et al.* focus on using BIM technique to assist the evaluation of public–private partnership (PPP) project performance. Specifically, Yuan *et al.* develop a BIM-based PPP performance management system and test this system in a real case study. Xu *et al.* develop an IFC-based PPP project performance evaluation model which extends existing IFC schema to express all of their established evaluation indicators.

Stride *et al.* discuss the potential benefits and challenges of using BIM by quantity surveyors in facility management (FM) roles. Findings from this study will be useful to develop strategies for adopting BIM in FM and supporting quantity surveyors' roles in FM.

Five articles in this special issue focus on other innovative technologies, including VR and AR, computer vision and natural language processing (NLP). Xu and Wang concentrate on developing a safety pre-warning mechanism by combing a risk assessment model and a safety pre-warning system, which can help evaluate integrated human-machine-environment risks and provide prompt instructions. Computer vision technology is used for providing early alerts with five warning levels.

Xie *et al.* focus on the development of an AR-supported automated environmental anomaly detection and fault isolation method to assist facility managers in dealing with

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problems that affect building occupants' thermal comfort. Jeelani *et al.* integrate VR with the stereo-panoramic scenes to help improve hazard identification and improve hazard management performance.

Tang *et al.* use social media platform data to conduct a comparative study of the construction industries in China and the US on construction companies, construction workers, construction media and construction unions.

Wu *et al.* address the issues that patents of information and communication technology in construction cannot be easily retrieved. In their study, NLP techniques and a supervised deep learning model are developed to help search and screen a corpus of information and communication technology patents for the use in the construction process.

Seven articles in this special issue focus on the use of other simulation and optimization methods to assist decision-making. Specifically, Xu, Mei, Luo and Tan have reviewed the optimization approaches used in construction site layout planning with an aim to assist the selection of suitable optimization approaches in this area.

As occupant's behaviours and actions may contribution to 50% of the overall energy consumption of buildings, Almeida *et al.* use simulation approach to simulate interactions between occupants and the energy performance of buildings.

Lu *et al.* aim to develop a multi-agent-based safety computation experiment system in order to simulate the complex relationship amongst human, shield machine and underground environment in shield tunnelling projects. Li, Li, Zhang, Gao and Zhang propose a simplified method to determine the viscous damper parameters for double-tower cable-stayed bridges. Li, Sun, Tao and Gao have used bi-objective non-linear integer programming models to combine project scheduling with multi-skill personnel assignment with an aim to develop multi-skill workforces for project management.

Zhang *et al.* use structural equation modelling and system dynamics to investigate the cultural differences between employees of different nationalities and the factors causing joint venture employees to accept or reject joint management practices.

Hu *et al.* use a mixed-integer programming model and a two-phase optimization schema for effective planning of a hub-and-spoke underground logistics network in urban regions.

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