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SPECIAL ISSUE EDITORIAL: THE FUTURE OF CONSTRUCTION IN THE CONTEXT OF DIGITAL TRANSFORMATION (CONVR 2022)

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Despite its notable impact on industrial employment (i.e. over 6.6% contribution) and representation of 9.8% of the UK's Gross Domestic Product (Rhodes, 2019), the Architecture, Engineering, and Construction (AEC) sector has been continuously criticised due to its fragmentation spanning a period of more than five decades. This persistent disconnect, often attributed to the gap between the design and construction phases, has garnered significant attention in numerous studies (Abrishami et al., 2014; Fruchter et al., 2016; Goulding and Pour Rahimian, 2019; Goulding et al., 2015; Pour Rahimian et al., 2019; Pour Rahimian et al., 2008; Rahimian et al., 2011).

Meanwhile, the rapid proliferation of various industry 4.0 technologies such as artificial intelligence, virtual reality, augmented reality, robotics and internet of things is heralding unprecedented opportunities for digital transformation in the construction industry. The potential benefits of digital innovation in connecting design and construction, boosting productivity, improving safety and reducing costs across the construction lifecycle are well established. However, the integration of state-of-the-art technologies into the construction workplace is still faced with significant challenges including interoperability issues, high cost of entry, inadequate training and safety concerns.

In the context of the built environment sector, industry 4.0 can be said to be underpinned by BIM, a widely acknowledged tool of choice to address key issues as industry fragmentation, value-driven solutions, decision making, client engagement, and design/process flow to name but a few. Exemplars from other industries such as automotive, aerospace and oil and gas already demonstrate the power and application of similar technologies. However, the built environment has only just started to recognise terms such as "golden key" and "golden thread" as part of BIM processes and workflows. Construction 4.0 offers a portfolio of potential solutions to bridge the knowledge and information gaps between design, construction and operations (Gomez-Trujillo and Gonzalez-Perez, 2021; Newman et al., 2020; Sawhney et al., 2020).

This has led to the emergence of a series of cutting edge technologies in the AEC realm, including but not limited to virtual reality-based collaboration technologies (Pour Rahimian et al., 2019), artificial intelligence-based optimisation (Pilechiha et al., 2020), data-driven decision support (Seyedzadeh et al., 2019), smart data modelling (Seyedzadeh et al., 2020), blockchain and distributed ledger technologies (Alizadehsalehi and Yitmen, 2021; Brandín and Abrishami, 2021; Elghaish et al., 2020; Wong et al., 2020), and computer vision and graphics (Moshtaghian et al., 2020; Pour Rahimian et al., 2020; Park et al., 2023). Where for example, these advancements are now able to assist decision-making in predicting the cost and performance of optimal design proposals (Elghaish and Abrishami, 2020).

As a reflection on the issues discussed above, this special issue of ITCON brought together seven papers on digitalization and Construction 4.0 related topics. These articles are drawn from papers presented at the 22nd International Conference on Construction Applications of Virtual Reality (CONVR 2022) held at Chung-Ang University in Seoul, South Korea. CONVR is one of the world-leading conferences in the areas of Virtual Reality, augmented reality and building information modelling. Each year, more than 100 participants from all around the globe meet to discuss and exchange the latest developments and applications of virtual technologies in the architectural, engineering, construction and operation industry (AECO). The conference is also known for having a unique blend of participants from both academia and industry. The overarching theme for CONVR2022 was "The future of construction in the context of digital transformation and decarbonization."

Disney et al. (2023) explored the influence of Total BIM, a dynamic model-based approach, on construction site practices. In Nordic regions, Total BIM replaces static 2D drawings with BIM models accessed through mobile devices for contractual documentation. Through case studies, interviews, and site visits, the study revealed that Total BIM could transform construction processes, with mobile BIM-viewer software serving as a central communication platform. Site workers employed digital Total BIM features like visualization, measuring, and checklists, demonstrating how jobsite processes could be digitally transformed .

Anifowose et al. (2023) proposed a multi-user VR-based system named EnergySIM to address the challenges in teaching the complex thermal behavior of buildings. The authors presented a case study which demonstrated how menu-driven interactions, virtual exploration, and model manipulation in EnergySIM could facilitate immersive learning of building energy concepts. Girgin et al. (2023) conducted a case study investigating the impact of mixed reality (MR) on field-detected MEP (mechanical, electrical, and plumbing) issues in construction. Interviews and observations revealed that MR-based inspection improves MEP installation quality by swiftly identifying and resolving errors. The study compared current and MR-integrated MEP workflows, showcasing a potential 75% coordination overhead reduction and at least 50% faster issue resolution.

Yogeeswaran et al. (2023) explored the challenges and benefits of prefabricated construction, proposing upskilling of local workers for efficient adoption. The study introduced two Augmented Reality (AR) workflows with QR codes for panel location and construction sequence, and predefined markers for assembly guidance. The AR workflows were found to present a promising avenue for integrating design for disassembly concepts. The proposed approach demonstrated potential to aid panel assembly and upskill the local workforce, facilitating the transition to prefabrication in construction projects.

Dossick et al. (2023) presented an ethnographic study exploring how time orientations lead to tensions in owners' selection of IOT devices and systems, in the integration of new technologies into existing systems, and in the operations of keeping existing systems up and running for the longer time scales. Nagatoishi and Fruchter (2023) addressed the ambitious challenge of designing and constructing space habitats for multi-planetary life, particularly focusing on Mars missions. The study introduced a prototype Virtual Space Construction Decision Framework (SCDF) to guide decision making regarding the use of advanced construction methods and technologies from the terrestrial AEC industry. The SCDF was built upon six departure points, including General Contractor Workflow, BIM, Generative Scheduling, Construction Robotics, 3D Printing, and Virtual Reality (VR) Visualization.

Sari et al. (2023) devised a framework to enhance building energy efficiency by merging smart building traits and machine learning. The study identified pertinent smart building features contributing to energy efficiency and developed a predictive model using the K-Nearest Neighbor algorithm. The proposed model was trained and tested on building energy management system data, achieving a 17.76% average relative error in energy use prediction and energy efficiency levels of 34.5% to 45.3% for different floors based on the identified features.

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