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Special Issue - Offsite Construction: Strategic Challenges and New Opportunities

This Special Issue of *Architectural Engineering and Design Management* invited critical debate and discourse on offsite construction with a particular focus on strategic challenges and opportunities. The offsite market is continuing to grow, with firm evidence suggesting that this trajectory is likely to continue to expand in line with increased demand. Production, manufacturing and assembly markets are now delivering conjoined synergies to support offsite. However, there is still a real need to evaluate a number of conjoined factors, including: the impact of process and business changes in design/construction/manufacturing; how new and emerging ICT solutions underpin processes to deliver integrated solutions; the impact of socio-economic drivers, including the delivery of evidence-based cost and value streams; and finally (and some might argue more importantly), the need to understand, develop and embed new skills and understanding into the offsite supply chain. These issues are certainly challenging, but are not insurmountable. This Special Issue presents additional knowledge and understanding on "Offsite Construction: Strategic Challenges and New Opportunities" through ten original and novel papers.

The first paper by Zakaria *et al* provides additional insight into contextual, structural and behavioural factors that influence the development and adoption of industrialised building systems (IBS). They note specific challenges and opportunities that have affected uptake, including such factors as policy approaches and technology developments, given that the decision making process are paramount from the outset. Findings identified that a number of interrelated issues had an impact on IBS, ranging from fiscal business case factors, through to attitudinal issues and tacit knowledge of stakeholders. These core influencers were categorised into three main areas: contextual, structural and behavioural. A conceptual framework that embodied this complexity was proffered as a potential solution. The second paper by Zakaria *et al*, also investigated the adoption of IBS, albeit from the specific context of Malaysia. This research used an inter-project approach with 27 domain experts to identify the main IBS spheres of influence. From this, interpretative content analysis was used to develop principal factors and relational aspects. Research findings noted that adoption and uptake was predominantly affected by cost, skills and customer 'attitude' issues. Potential solutions highlighted the need to make the IBS adoption decision more integrative, including project and socio-economic factors and the need to more fully embed human-related (behavioural) aspects.

Our third paper by Arashpour *et al* investigates the importance of process integration and cross training of multi-skilled personnel in offsite construction. The research methodical approach engaged three offsite manufacturers in Australia to identify optimal process integration architectures for offsite construction using a hybrid application of fuzzy and TOPSIS theories. Research findings present a fuzzy-TOPSIS model for discussion. This highlights the effectiveness of process integration and cross-training; including the need to transfer excess capacity from underutilised/overutilised resources to address capacity imbalances. The fourth paper by Hairstans and Smith identified the importance of establishing a collaborative regional framework for offsite knowledge exchange in the UK. It presents a critical debate on how a needs analysis process can be utilised to develop skills

training content for industry partners. It also identifies how industry-academia collaboration can be used to harness sector-level impact and knowledge exchange activities. Findings are espoused through a novel approach of utilising the 'Hoshin Planning' technique to form a larger regional Offsite HUB (Scotland) Community of Practice for wider international engagement.

The fifth paper by Montali *et al* evaluates the use of prefabricated façades to optimise a number of variables, including time, performance, cost, environmental service performance, and manufacturability. It examines a number of concatenated issues, from digital tools through to Knowledge Based Engineering (KBE) applications for evaluating the integration of design principles with manufacturing constraints. Research findings highlighted several similarities with the shipbuilding and aerospace industries in terms of tasks to be solved, noting that while the façade industry had not yet fully adopted KBE, it could be used as a vehicle for addressing gaps in façade design. The sixth paper by Bekdik *et al* evaluated the use of Off Site Production (OSP) through the application of modularity on design processes associated with façade design. This highlighted the complexity of construction design process integration, particularly with the differing disciplines and stakeholders. Design fixity and opportunities for optimising the design processes for OSP were evaluated through a façade design case study. Research findings presented a Design Structure Matrix (DSM) for discussion, emphasising the need to improve design management processes through greater specificity in planning and scheduling complex design processes. DSM was also advocated as a method for identifying dependencies and interfaces between cross-organisational design activities in façade design.

Our seventh paper by Al-Bazi and Dawood investigates the use of crew allocation for precast concrete. Manufacturing plants often engage multiple procedures and parallel repetitive processes, the corollary of which then results in inefficient manufacturing and ultimately higher costs. In order to address this a simulation-based multi-layered simulated annealing system was developed to solve crew allocation problems and repetitive manufacturing processes. This was tested through a case study with one of the largest manufacturers of precast concrete sleepers in the UK. Research findings highlighted that the advanced crew allocation system was successful in solving complex crew allocations – typically 4% per production cycle. Moreover, this approach could be applied to other production-related sectors. The eighth paper by Smith *et al* investigated the impact of mass timber construction (MTC) against traditional site built construction. This engaged three major stakeholders: architect, general contractor, and mass timber fabricator in order to fully appreciate performance drivers. Research findings highlighted significant advantages to MTC cases (4.2% cost reduction and a 20% schedule savings), albeit noting the need to make identical assessment to demonstrate the value of MTC beyond initial reductions to cost and schedule.

The ninth paper by Mostafa and Chileshe evaluated the application of discrete-event simulation on client order behaviour and offsite manufacturing performance in Australia. This evaluated the Australian housebuilding context through discrete-event simulation (DES) and supportive studies. Research findings present a conceptual model for discussion. This allows users to evaluate 'what-if' scenarios to seek improvement, especially on such areas such as client order information, and time (site preparation, manufacturing, and completions). The tenth and final paper by Ramaji and Memari examined the interrelationships of information and data management in construction, including the use of Information Delivery Manuals and Model View Definitions (MVD) to aid interoperability. The research methodological approach compared the differences in data structures for modular and non-modular building projects, as modular construction and information flow is often different from traditional site-built construction. Research findings highlighted the challenge of representing certain physical and non-physical objects specific to modular systems to current MVD standards. However, the development of extended MVD's could be used to address these issues in order to significantly improve design/construction/engineering designs and processes.