Guest editorial

Application of design for excellence (DfX) in construction

Design plays a vital role in construction project success. Over the years, a large number of research studies have been carried out across the globe on improving design for the built environment. These studies investigated design optimisation from different angles, including design for sustainability, design for deconstruction, design for manufacturing and assembly, design for adaptability etc. However, design-related issues still arise and, at times, even damage the construction industry's image, whilst design optimisation is still far from reality. This has drawn the attention of industry practitioners and researchers to identify and investigate existing gaps in theory and practice that hinder design optimisation. In this context, the design for excellence (DfX) concept is currently used efficiently in the manufacturing industries. DfX is a new concept that refers to the use of a formal methodology to optimise a specific aspect of a design. The variable *X* represents the principal focus areas. The application of the DfX concept for construction is innovative and emerging.

This special issue aims to explore the overall concept and the application of DfX in construction. In achieving the above aim, the specific objectives of the special issue include:

(1) To identify, integrate, develop and disseminate knowledge on the DfX concept in opening up pathways to achieving design optimisation;

(2) To explore the barriers and opportunities in complete DfX optimisation for delivering optimal design solutions and

(3) To explore and analyse leading-edge examples of best practices and assess the impact of the adaptation and implementation of DfX in construction.

This special issue consists of seven research papers that synergised advances in theory and practice on DfX in construction. The papers focussed on what theoretical solutions are presently available, how to translate any new or improved propositions and theories to more effective and innovative practices and practices followed by various countries in transforming the construction industry to design upfront by exploring the challenges encountered and any corresponding mitigation practices.

Paper 1: Indicators bank for smart and resilient cities: design of excellence

The first paper in this special issue is from New Zealand and it aligns with the special issue's first objective above. Khatibi, Wilkinson, Dianat, Baghersad, Ghaedi and Javanmardi developed a comprehensive database of smart and resilient indicators using DfX to assist city administrators and authorities, and the like, to identify the level of smart and resilience determinants that will simultaneously provide ways to improve the city's infrastructure to meet smart and resilient objectives. The authors conducted an exploratory study using four frameworks, primarily focussing on New Zealand and Australia: New Zealand Resilience Index (NZRI); The Australian Natural Disaster Resilience Index (ANDRI); Code for Smart Communities (CSC) and International Telecommunication Union (ITU-T L.1603) Smart Cities'. A total of 236 indicators were filtered to remove similar and duplicated indicators, leaving 172 indicators in the Smart Resilience City Indicators Bank (SRCIB). However, the authors acknowledged that the proposed indicator bank needs to be tested in a real scenario to quantify or solve related urban issues in smart and resilient city concepts, as the urban systems are complex and interrelated.

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Paper 2: DfX-based approach for incorporating sustainability in infrastructure project planning

The second paper in this special issue is authored by Marinelli from the UK and it attempts to explore how the "Design for Sustainability" mindset of the manufacturing sector can be effectively transferred in the context of construction. This paper aligns with the first objective of the special issue, where the author synthesised the "Design for Sustainability (DfS)" concept in the manufacturing context and developed conceptually equivalent goals for construction. The paper primarily focussed on developing DfS goals for mega infrastructure projects because they frequently fail to achieve the planned sustainability benefits. Marinelli developed a DfS framework through a systematic literature review using well-known construction planning and management methods, techniques and strategies with a proven positive impact on project performance. These include cost-benefit analysis, sustainability-driven procurement criteria, contractors' involvement in design, value-based design, BIM and buildability review. The proposed framework expects to holistically promote the triple bottom line in feasibility, design and procurement of infrastructure projects.

Paper 3: Automation in New Zealand's off-site construction (OSC): a status update

Design for manufacturing and assembly is one application of DfX in construction that is known to have the potential in improving the design. Despite having many benefits, the uptake of off-site construction (OSC) is low in some countries. The next paper in our special issue aims to understand the current status of automation of OSC within the New Zealand construction industry and identify the barriers and enablers to its uptake. This is more related to the second objective of this special issue. Darlow, Rotimi and Shahzad conducted 15 semi-structured interviews using snowball sampling with New Zealand industry experts to achieve the above. The four main categories of barriers to the uptake of automated OSC include high capital cost, lack of knowledge, non-existence of regulations to support OSC and social constraints due to industry perceptions. The study proposed financial support to the OSC sub-sector in the form of subsidies, tax waivers and an enhanced leasing model to enhance the uptake of automation. It also suggests increasing industry awareness about the benefits of OSC to strengthen the confidence of business owners to invest in this area.

Paper 4: Empirical investigation of the applicability of constructability methods to prevent design errors

The fourth paper aligns with the first and the third objectives of the special issue. It explores the application of design for constructability with the aim of preventing constructability failures in construction projects. Raviv, Shapira and Sacks used a two-step approach to achieve the above. The authors first reviewed the cutting-edge scholarly contributions in literature to identify constructability methods and implementation practices. Subsequently, 4 comparative case studies were conducted in four major building construction projects and identified nearly 400 constructability problems. Using empirical data, a relationship matrix (RMTX) was developed as a context-independent tool to provide preferred constructability methods in general and specific to the project contexts.

Paper 5: Design for maintainability tool for nano-façade-coating applications on high-rise facades in the tropics

Like the fourth paper, the fifth paper authored by Conejos, Ubando and Chew focussed on DfX from a "design for maintainability" angle. This study in Singapore aims to develop a tool to evaluate the maintainability potential of nano-facade-coating applications on high-rise façades with concrete and stonemasonry finishes and curtain walls. The study aligns with the first and third objectives of this special issue. The authors used quantitative methods such as expert and practitioner surveys to develop the multi-criteria design decision score sheet that evaluates the maintainability potential of nano-facade coating application. Analytic hierarchy process (AHP) and sensitivity analysis were also used to develop this robust design for maintainability tool. Key findings show that safety, performance, risk, environmental impact and energy consumption are the top priorities in the maintenance decision-making criteria. The design for maintainability tool is expected to guide the designers on potential maintenance issues on nano-facade-coating application maintenance requirements at the design stage.

Paper 6: Allocating scarce financial resources effectively through function analysis in social housing projects

The sixth paper is from Brazil and is closely related to the special issue's first and third objectives. Design for value is the primary focus of this paper. Through this study, Paiva Melo, Ferreira de Oliveira and Sampaio de Melo addressed a prevalent issue of poor value delivery to the end-users in the social housing projects (SHPs) in Brazil. The authors identified the lack of significance given to the function analysis (FA) step in the value management (VM) study in SHPs as the main reason for poor value delivery in the SHPs in Brazil. The authors used design science research (DSR) in a single case study context to address the above. The findings suggest that scarce financial resources in SHP do not necessarily lead to low-value delivery and low-design quality. Instead, the study proposed a systematic FA method with 11 steps to improve cost reallocations to enhance values in SHPs.

Paper 7: Designing for construction procurement: an integrated decision support system for building information modelling

The last paper in the special issue is a New Zealand-based study that explored the concept of designing for procurement in construction. This aligns with objectives one and three in the special issue. Jelodar, Wilkinson, Kalatehjari and Zou developed a decision support system (DSS) for construction procurement by applying existing informatics infrastructure and building information modelling (BIM). Authors expect the DSS to help the construction industry suffer from poor decision-making in the early project stages due to insufficient information. Literature review, expert interviews and case studies with complex procurement considerations were used to identify and validate attributes and criteria for procurement decision making. Multi-attribute utility theory (MAUT) methodology and mathematical models were used as the foundation for a DSS. Time, cost, relationship quality, sustainability and quality of work were identified as the major criteria for complex construction procurement decision-making.

The seven papers presented in this special issue incorporate scholarly contributions on the application of DfX in construction and fulfil the three explicit objectives of the special issue. We hope that the readers enjoy reading the above selected papers from diverse geographical backgrounds on DfX application in construction. It is hoped that this special issue serves as a platform for future researchers to further develop the innovative and emerging concept of DfX in construction. The guest editors would like to thank all the authors who submitted manuscripts to this special issue and the reviewers who contributed to improving the papers' quality by providing insightful comments on the submissions. Also, the guest editors would like to acknowledge the immense support given by the Editor-in-Chief Professor Mohan Kumaraswamy for his valued advice and for providing an excellent opportunity to run this special issue in such a prestigious journal. Last but not least, the guest editors would also like to acknowledge the unreserved support and technical assistance given by the Emerald Publishing team.

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