Guest editorial – Future construction: design solutions and approaches

With the ever-increasing pace of technological advancement, the AEC industry needs to either match the tempo or face the consequences of lagging behind. This needs to be applied to the entire lifecycle of built environment engineering projects from initial conception to eventual demolition, preferably recycling and deconstruction, to ensure circular sustainability both at the building and urban scale. Nevertheless, several construction industry segments lack the agility to depart conventional approaches and step into new paradigms. Our cities at a global scale are currently confronted with numerous challenges ranging from urban-scale impacts of climate change and harmful environmental influences to building-scale effects related to undesired indoor comfort conditions, low-rated building performance, and inefficient incorporation of industrial advancements in construction, design and beyond.

From a cultural resistance to changes to the infrastructural revolution necessary to facilitate the move forward, we are situated at a critical point in history where the emergence of novel design solutions and approaches is essential to support the required transition. Future-proofing the construction industry cannot solely rely on the induction of new technologies/platforms/norms; however, the change needs to be gradual, consistent and paired with a shift in thinking from high-level stakeholders to operators.

This special issue, as a continuation avenue building upon the 54th conference of the Architectural Science Association (ANZAScA), pulls together a diverse range of articles, focussing on *Adaptive Reuse, Artificial Intelligence and Deep Learning, Automated Construction, Green Roofs, Building Information Modelling (BIM), Building Life-Cycle Analysis (LCA), Daylighting, Future Smart Cities, Logistics and Transportation, Project Planning, Risk Management, Sustainable Urban Built Environments, and Thermal Comfort Assessment.* All these works, both individually and collectively, share the common objective of supporting the much-needed transition of our today's construction industry.

Aigwi *et al.* (2022) describe testing the applicability of the performance-based multi-criteria decision assessment (MCDA) framework developed by the authors to prioritise four underutilised historical building alternatives for adaptive reuse interventions in Auckland, New Zealand. Performance-based planning involves multiple stakeholder participation, defined via reference frames that can be easily adapted, transformed and connected with the inherent dynamics of contemporary urban systems. The focus group data collection method enabled testing the assumptions of the diverse adaptive reuse experts to achieve consensus on beliefs and opinions through deliberations. Random grouping of the participants was done to avoid bias. The findings provide a theoretical platform for urban planning researchers to advance performance-based planning for adaptive reuse in other locations and fields. There are also substantial implications for urban adaptive reuse stakeholders to improve their understanding of protecting intangible values of optimal historical buildings through adaptive reuse and the targeted needs of communities in the new functions of an optimal alternative from a representative group of historical buildings.

Melis *et al.* (2022) stress the need to explore biological systems as prominent design paradigms, to understand further the dynamic potentials of buildings for the design of future

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cities. Exaptation as a design strategy is analysed by exploring the evolutionary processes of biological systems, and thoughtful debates about the functionalistic design of our future cities are provided. On a similar note, from a lifecycle assessment viewpoint, creative and solid approaches for environmental load assessment of buildings are necessary for the AEC industry, particularly during construction phases. Kamari *et al.* (2022) explore the potential of Building Information Modelling (BIM) for drawing more in-depth attention to the lifecycle analysis of buildings during early design stages. Investigating a BIM-based prototype, the study demonstrates that the proposed tool allows cohesive decision-making as part of an integrated design process during the early phases based on the findings of case studies.

Arakawa Martins *et al.* (2022) concentrate on indoor spaces, where we spend over 90% of our time exploring thermal comfort conditions as one of the core components of Indoor Environmental Quality (IEQ). With attention to personalised thermal comfort models, the study explores older adults' thermal comfort preferences using deep learning approaches. Their findings present the high accuracy of the developed individualised models compared to recent studies and the Converted Predicted Mean Vote (PMVc) model. On the other hand, for the more efficient design of buildings, particularly concerning their vertical skins, daylight illuminance data are vital. In this line, Aghimien and Li (2022), with a view to the crucial role of daylight for energy-saving and visual comfort as another critical component of IEQ, attempt to create luminous efficacy models under fifteen CIE standard skies. The findings can be utilised for the future design of vertical buildings while enhancing the energy efficiency of building envelopes and visual comfort.

Purushothaman and Kumar (2022) examine dynamic scheduling (DS) and its component factors as an evolved methodology for the execution of road construction projects. It identifies factors in addition to cost, time, resources, cash flow, and whether they impact DS. It classifies parameters such as critical factors, critical time, and critical resources, pioneering the classification of factors into the environment, resources, and surrounding categories to better understand in-control and out-of-control. It links these for purposes of road project scheduling. Based on Kapiti Expressway Repair Project and Transmission Gully Project failures, the semi-structured interview (SSI) and systematic literature review (SLR) methodologies were used to determine the impact of weather, pandemic, material, geotechnical, disaster, equipment shortage, breakdown, design error, labour and event on DS in the New Zealand road construction industry. The study adds pandemic and disaster to existing literature.

The construction industry is rife with issues contributing to adverse sustainability impacts, precisely fragmentation, precedence-based operations, and adversarialism. New Zealand's construction sector, in addition, is geographically isolated, conservative, and slow in responding to contemporary business and management philosophies. It faces various challenges: skill shortages, poor productivity, uptake of current construction methods, insufficient knowledge sharing and collaboration, fragmentation, and limited Research and Development. The Construction Sector Accord (2019) and Construction Sector Transformation Plan (2020) aim to transform the New Zealand's construction industry. A NZ$2.4bn decade-long Watercare (Auckland) programme of delivering water infrastructure adopts program alliancing (based on UK Project 13 precedence) as a strategic solution and a Construction Consolidation Centre (CCC) as an operational vehicle. Dhawan *et al.* (2022) suggest a research framework and examine an appropriate research design to exploit this unique contextual research opportunity arising from the specific geography of Auckland and associated logistical planning constraints.

Premier *et al.* (2022) focus on solar-powered (smart) urban furniture and aim to provide classification, understand the main problems related to their adoption, and future focus areas of design-led research. A selection of international case studies in critical urban contexts was selected as the research instrument to focus on three main aspects of urban furniture *viz* architectural integration, context-sensitivity, and system visibility of photovoltaic (PV) technologies. The case studies pertained to objects dedicated to sheltering (canopies and pergolas); mobility and transport (carports, bus stops); energy harvesting and artificial lighting (solar trees and streetlights); and other experimental prototypes, mainly focused on energy harvesting, located in USA, Europe and the Middle East. The paper classifies the studied objects in terms of functions (energy, IT, physical), stakeholders (industry, end-users) and user interfaces. It discusses theft, visual impact, annual variations in solar radiation, overshadowing, glare and the effect of heat islands. The possible applications in Auckland are also discussed. Similarly, with the growing popularity of green roofs and walls, primarily given their environmental benefits both at building and city scales, Zaina *et al.* (2022) review the issue of water security for the integration of such sustainable design solutions in hot climates. Accordingly, considering intelligent irrigation systems, the study recommends utilising the Internet of things (IoT) and morphological thinking (MT) for smarter automated platforms for irrigation systems.

Guaranteed maximum price (GMP) contracts are becoming an increasingly popular contract solution; however, many projects experience higher levels of risk and exceed predetermined GMPs, failing to accomplish the main motive behind the concept. Palihakkara and Perera (2022) identify a risk management process for GMP projects. It adopts a quantitative approach consisting of three Delphi rounds. The collected data were analysed using statistical data analysis tools. In total, 17 critical risk factors in GMP projects and their levels of severity are identified and ranked, along with risk allocation amongst the client, contractor, and consultant, and strategies to handle the most significant risk factors. Poorly defined scope and design changes are identified as the most critical risks in GMP projects. Clear definition of project scope, preparing precise documentation, early involvement of the contractor and using a partnering approach is discovered as the most effective risk mitigation strategies. Risk handling strategies have also been addressed in their order of magnitude for each significant risk factor and allocation amongst the client, contractor and consultant. Findings can form a basis for further research on the GMP mechanism.

Sloping topographies in urban areas are often underutilised due to complex designs and difficult access, resulting in low construction productivity and high cost. Automated construction techniques are usually limited to flat sites or lab spaces. Tong and Wilhelm (2022) combine automated and prefabricated construction concepts with hillside dwelling design, proposing a strategy to integrate both aspects while informing the design process and output. The aims are to generate design from hillside access and construction automation, improve productivity and use more affordable hillside sites. The paper examines hillside typologies (e.g. elevated, stepped, etc.) and automated construction strategies (e.g. factory setting, exo-structural, etc.) and overlays them to develop three initial concepts *viz* Stepped Assembly, Funicular Assembly, and Access Spine assembly for automated hillside construction, and compares them. It further develops a scripted process for integrating topography with criteria from hillside dwelling design and automated construction techniques. This generates innovative, site-specific design outcomes suited for a process that adapts contemporary construction automation techniques and allows for more efficient use of hillside sites, demonstrating how robotics and generative tools can inform early design stages.

In conclusion, any multi-faceted issue needs to be reviewed from diverse lenses. The status quo of the design/construction industry is not an exception, with several paradoxes, namely simultaneous achievement of sustainability and affordability, successful induction of technology while preserving conventional values, etc., present it as a highly complex matter requiring creative philosophers to step up and offer out-of-the-box ideas.

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