Digital Twins in the Built Environment: A Systematic Literature Review

Authors : Bagireanu Astrid, Bros-Williamson Julio, Duncheva Mila, Currie John

Abstract : Digital Twins (DT) are an innovative concept of cyber-physical integration of data between an asset and its virtual replica. They have originated in established industries such as manufacturing and aviation and have garnered increasing attention as a potentially transformative technology within the built environment. With the potential to support decision-making, real-time simulations, forecasting abilities and managing operations, DT do not fall under a singular scope. This makes defining and leveraging the potential uses of DT a potential missed opportunity. Despite its recognised potential in established industries, literature on DT in the built environment remains limited. Inadequate attention has been given to the implementation of DT in construction projects, as opposed to its operational stage applications. Additionally, the absence of a standardised definition has resulted in inconsistent interpretations of DT in both industry and academia. There is a need to consolidate research to foster a unified understanding of the DT. Such consolidation is indispensable to ensure that future research is undertaken with a solid foundation. This paper aims to present a comprehensive systematic literature review on the role of DT in the built environment. To accomplish this objective, a review and thematic analysis was conducted, encompassing relevant papers from the last five years. The identified papers are categorised based on their specific areas of focus, and the content of these papers was translated into a through classification of DT. In characterising DT and the associated data processes identified, this systematic literature review has identified 6 DT opportunities specifically relevant to the built environment: Facilitating collaborative procurement methods, Supporting net-zero and decarbonization goals, Supporting Modern Methods of Construction (MMC) and off-site manufacturing (OSM), Providing increased transparency and stakeholders collaboration, Supporting complex decision making (real-time simulations and forecasting abilities) and Seamless integration with Internet of Things (IoT), data analytics and other DT. Finally, a discussion of each area of research is provided. A table of definitions of DT across the reviewed literature is provided, seeking to delineate the current state of DT implementation in the built environment context. Gaps in knowledge are identified, as well as research challenges and opportunities for further advancements in the implementation of DT within the built environment. This paper critically assesses the existing literature to identify the potential of DT applications, aiming to harness the transformative capabilities of data in the built environment. By fostering a unified comprehension of DT, this paper contributes to advancing the effective adoption and utilisation of this technology, accelerating progress towards the realisation of smart cities, decarbonisation, and other envisioned roles for DT in the construction domain.

Keywords : built environment, design, digital twins, literature review