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Smart and Sustainable Built Environment

Enabling circularity in Turkish construction: a case of BIM-based material management utilizing material passports

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Abstract

Purpose – The Turkish construction sector, facing mounting environmental pressures, needs to rapidly adopt circular economy (CE) principles. However, a critical barrier is the lack of accessible and comprehensive material information. This paper investigates how building information modeling (BIM) can facilitate the adoption of material passports (MPs) to overcome this challenge and helps enabling circularity in Turkish construction.

Design/methodology/approach – A case study approach is adopted, focusing on the New Istanbul Esenler Arena, a major sports facility designed with BIM. An in-depth analysis of the project's BIM model and material data was conducted to develop a practical framework for integrating MPs into BIM workflows. The framework outlines a comprehensive MP data structure, addresses technical integration strategies and highlights the importance of stakeholder collaboration.

Findings – The research demonstrates that integrating MPs with BIM has the potential to significantly enhance material tracking throughout the building lifecycle, leading to more informed decision-making regarding material selection, reuse and recycling. This approach can improve material recovery rates, reduce construction waste and minimize the environmental impact of construction projects. The study also identifies key challenges to MP implementation, such as ensuring data accuracy and interoperability, and proposes strategies to overcome these hurdles.

Originality/value – This paper contributes to the limited but growing body of knowledge on the practical implementation of BIM and MPs for circular construction, particularly in the Turkish context. The proposed framework, informed by a real-world case study, provides valuable guidance for construction professionals, policymakers and researchers seeking to accelerate the transition to a circular economy in the built environment.

Keywords Circular economy, Building information modeling (BIM), Material passports, Sustainable construction, Construction waste, Turkey

Paper type Research paper

1. Introduction

The global construction industry, recognized as a major driver of economic growth and urbanization, is facing increasing pressure to mitigate its substantial environmental footprint. The sector's traditional linear "take-make-dispose" model, heavily reliant on resource extraction and generating vast amounts of construction and demolition waste (CDW), poses significant challenges to sustainability. CDW constitutes a significant portion of global waste streams, raising concerns about resource depletion, landfill capacity, and the environmental damage associated with material extraction and disposal (Akinade *et al.*, 2020; Coelho and de Brito, 2012; Ortiz *et al.*, 2009). This situation necessitates a fundamental shift in how the industry approaches design, construction, and material management throughout the building lifecycle.

The Circular Economy (CE) model, rapidly gaining traction as a framework for sustainable development, presents a compelling alternative to the linear model, emphasizing closed-loop systems that keep resources in use for as long as possible (Ghisellini *et al.*, 2016). CE principles, applied to construction, advocate for designing buildings for adaptability, disassembly, and material recovery, transforming structures into "material banks" for future use (Akinade *et al.*, 2020; Hansen *et al.*, 2018; Kibert, 2008). This approach promotes resource efficiency, minimizes waste generation, and aligns with the broader goals of environmental sustainability.

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