From Linear to Circular: Implementing Digital Product Passports to Enable Data-Driven Circular Lifecycle Transitions in the Built Environment

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SUMMARY

The built environment remains a major contributor to global carbon emissions and construction and demolition (C&D) waste, largely due to the dominance of linear lifecycle models and static assessment methods such as cradle-to-grave Life Cycle Assessment (LCA). This paper proposes a comprehensive framework to support the transition toward a circular, cradle-to-cradle lifecycle in built environment projects, centred on the use of Digital Product Passports (DPPs). By analysing the full lifecycle, from raw material extraction to end-of-life and beyond, the study maps critical data flows, identifies purpose-driven data types, and classifies the digital tools required for data collection, processing, storage, and sharing. A novel contribution of this work is the integration of emerging technologies, including BIM, IoT, AI, digital twins, robotics, XR, and blockchain, linked to stakeholder roles and lifecycle stages. The resulting framework establishes a closed-loop information system that enables forward and backward feedback loops, enhancing decision-making, traceability, reuse, and circularity. This conceptual study lays the groundwork for implementing DPPs in practice and highlights their potential to engender sustainability outcomes across the built environment.
