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The application of blockchain-enabled material passports for circular supply chains

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Extended abstract

Since the industrial revolution, the linear economy of 'take, make, dispose' has been widely implemented in the vast majority of industries. The circular economy (CE) strives to enhance product design through strategies (5R) such as reuse, remanufacture, redesign, reduce and recycle. Given climate change concerns, it is essential for the transition away from the linear business models toward circular business models, to reduce negative impacts of CO_2 on the climate (Boons and Leudke-Freund 2013; Pollard et al., 2021; Rosa et al., 2019; Ranta et al. 2021). One of the well-known thought leaders on the CE, the Ellen MacArthur Foundation, considers the potential of 38% decrease in emissions from building materials by 2050 in a CE. To encourage “5R” strategies in construction supply chains and for stakeholders to work cooperatively toward CE (Cigolini et al., 2022), we investigate a digital platform that supports connectivity, transparency, and innovative economic models.

The extensively used business model canvas (BMC) (Joyce and Paquin, 2016) offers us a foundation for designing a blockchain canvas for the construction supply chains. We argue that blockchain technology, in conjunction with other technologies like cloud computing and building information modelling (BIM), is essential to enable a circular supply chain, especially to support the emerging idea of a material passport (MP) (BAMB, 2017; Honic, et al., 2019; Li and Wang, 2022; Wang, Chen and Zghari-Sales, 2021). Based on design science research methodology (DSRM) (van Aken, Chandrasekaran, and Halman 2016; Peffers, Tuunanen, and Niehaves 2018), we use qualitative data from expert workshops to design and evaluate the application of blockchain-enabled MP in the built environment. We re-designed the building blocks of the BMC based on three main components to fit the focus on a stakeholder value creation perspective: value opportunities, value challenges and value transformation (Bocken, Rana & Short, 2015; Ranta, et al 2021; Sjodin et al. 2020; Al-Debei and Avison 2010).

We find that a blockchain-enabled material passport presents a technical system value opportunity for all actors and stakeholders by providing verified data and information flow to support circular strategies such as reuse, recycling, and redesign. However, the most significant system value opportunities relate to the potential of the blockchain-enabled material passport to support organizational strategy, processes, procedures, and protocols for the circular built environment.

During the investment stage of a building project, a blockchain-enabled material passport can provide investors with secure and high-quality shared information, allowing for effective data capture and use. This real-time information can support decision-making for operational and strategic planning, particularly for circular strategies and approaches. Long-term investors, such as pension funds, can benefit from understanding the value of materials at the end of their life cycle, which can drive interest in circular practices and strategies in the built environment. Additionally, the ability for investors to know the value of materials at the end of their life cycle can promote urban mining strategies to reclaim materials from landfills. A blockchain-enabled material passport can enhance the verification system to support compliance with environmental, social, and governance (ESG) initiatives, thereby promoting circular practices in the built environment.

A blockchain-enabled material passport can provide asset holders with a better understanding of the intrinsic value of materials in their building projects, which can promote circular strategies to sustain it. Additionally, asset managers and developers, such as public clients and commercial real estate owners with portfolios of projects across the entire building life cycle, can benefit from the transparent data and information provided by a blockchain-enabled material passport. This information can support effective decision-making for implementing circular economy practices, such as green procurement and the reuse of materials in new buildings. The security and safeguard against data manipulation provided by new technologies, such as multi-chain blockchain in digital material passport, can help asset holders effectively manage risks related to building. Furthermore, it can provide an enhanced audit trail to support better administration of materials by asset managers.

These value opportunities include the potential for high quality shared information among all stakeholders which can enhance supply chain visibility and transparency, enable real-time decision making, and ultimately enable the possibility to innovate the present business model. However, systemic value challenges such as ensuring standardisation of material metrics, lack of collaboration, lack of skill capabilities and stakeholders in the supply chain who pays for digitally enabled MP are critical concerns. Therefore, the value transformation perspective shared by the workshop participants includes the need for skill and capacity building across the various stakeholders in the supply chain and the need for investors to play an enabling role by their demand for material in circularity.

Keywords

Blockchain, material passports, business model canvas, value creation

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