Cooperative Business Models for Data Sharing in Construction Industry

Data cooperatives: data-sharing ecosystems and federated learning

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Extended abstract

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The transition from a linear to a more circular economy calls for several novel factors to be in place and for innovation related to processes, business models and products yielding more circular resource use. Innovative paths can be challenging due to a variety of reasons, including cross-organizational cooperation for innovation.

Technological innovations often dominate the field of circular economy (Zott et al., 2011; Grin et al. 2010). While some technological innovations and digital solutions facilitate inter-organizational collaboration and cooperation, they also come with their own limitations and challenges. The challenges and future directions of business applications of digital technologies, such as collaborative use of data and federated learning have been extensively discussed (Li 2019).

Sustainable business models often rely on technological (digital) advancements (Bocken et al., 2014; Chesbrough, 2010; Teece, 2010) enabling shared ownership and value creation. The cooperative model turns out to be highly flexible and promising in meeting new challenges of inclusive sustainability transition as well as developments towards trust-based governance, knowledge sharing and boosting innovation. It has been shown to increase the mutual benefit of data-sharing ecosystems, such as data spaces, by allowing companies to collaborate without sharing sensitive data (Krasteva, 2023). Data-sharing ecosystems are crucial for unlocking and realizing the maximum potential of data. The potential of data cooperatives and the barriers they face have also been explored by Kirsanova (2020).

The use of cloud systems and blockchain technology, as proposed by Udokwu (2021), can further enhance transparency and trust by providing secure and traceable data exchange (Pattini, 2021). Data spaces are an emergent concept

that helps to overcome some of the challenges related to data sharing and supports the creation of innovative solutions in a trustful and mutually beneficial manner. Also federated learning, as an emerging privacy-preserving AI technique, offers the possibility to train models locally and formulate a global model based on the local model updates without transferring local data externally (Yang, 2019). Also, the potential for federated learning to address data isolation and privacy concerns has been highlighted by Yang (2019).

However, in some cases federated learning systems struggle to achieve trustworthiness and embody responsible AI principles. Federated learning systems face accountability and fairness challenges due to multistakeholder involvement and heterogeneity in client data distribution. To enhance the accountability and fairness of federated learning systems, a blockchain-based trustworthy federated learning architecture can be introduced. Furthermore, the concept of agnostic federated learning, which aims to reduce bias and enhance fairness has been proposed (Mohri, 2019). Specifically, the construction industry faces challenges with data sovereignty and governance. As a traditional sector, it is at crossroads in terms of digital development and technological stewardship (for responsible innovation) that can be addressed by data governance based on shared ownership (Norouzi et al. 2021; Yu et al., 2019).

Therefore, this paper will explore how companies in the building sector can collaborate toward data partnership by transmitting transversal knowledge among interested parties, and innovate using AI models for quality checks, anomaly detection, predictive maintenance, forecasting and simulations. The aim of this research is to provide a conceptual framework for cooperative business models. By synthesizing the relevant theories of business models, cooperatives, and management paradigms, a new business model framework for data cooperatives in construction industry will be developed.

This paper proposes a framework for designing sustainable cooperative regimes to govern innovation. By integrating principles from cooperative governance, sustainability, and technology ethics, we explore how cooperative models can effectively manage the rapid advancement of AI while ensuring privacy, ethical standards, legal compliance, and equitable benefit distribution. We draw upon existing academic literature to highlight the importance of democratic decision-making, trust, transparency, community-centric approaches, and adaptability in the governance of AI innovations. This paper will impart the comprehension of cooperative specific characteristics with regard to design and implementation of business models and develop a theory-based conceptual framework based on the examples of federated learning (AI at Mondragon, Wageningen data cooperative, etc.). Subsequently, an inductive

qualitative study (innovation in the construction industry in the Netherlands) will be conducted. The authors plan to establish a sustainable data cooperative and data sharing blockchain-based platform with a federated digital architecture and a robust governance structure, ensuring a high level of trust among all participants. In addition, the authors plan to investigate the potential of collaborative business models for inclusive transition in construction industry of the future and to propose new innovative paths.

Cooperatives, as autonomous associations, are a powerful economic and social force that can also benefit the environment. Cooperative organizations can benefit from digital technologies, and their transition to a digital society can be facilitated through digital innovations (Sobolev, 2020). They offer inspiring models of collective organization with an additional community approach. Federated learning and data cooperative governance can significantly enhance transparency and trust, also in the construction industry (Loorbach 2010). Bühler (2023) and Ahmed (2020) also highlight the potential of these technologies in fostering collaboration, data sharing, and trust.

Lo (2023) and Li (2021) propose specific solutions, such as a blockchain-based architecture for federated learning systems and the use of AI, blockchain, and BIM technology in project management in the building sector. These solutions can improve accountability, fairness, and the management of construction projects, ultimately enhancing transparency and trust. Federated learning (collaborative learning), which is mainly motivated by data privacy, transparency and shared ownership, ensures that the data remains decentralized.

Successful systems are constituted from networks of artefacts, actors, and institutions and gain stability and path-dependence as particular 'socio-technical regimes' (Grin et al. 2010), (e.g. the regime of centralized decision-making and inclusion). As such, data cooperatives have been identified as a key driver of digital transformation, particularly in small communities and SMEs. They can facilitate secure, trusted, and sovereign data exchange, and promote digital entrepreneurship and community well-being. In the construction industry, data cooperatives can enhance collaboration and the digital transformation of the value chain. There are many challenges in regard to data exchange in this sector, which can be addressed through a data cooperative model. An effective, successful data cooperative business model require that actors should not be understood in isolation from their environment, what might be referred to as a system-level approach (Wolters et al. 2023). At this system level the focus should not be just on the business

environment (Mahdad et al., 2022), but also on the technological environment, and the interplay between the two.

Many emerging business models draw on co-op idea. Designing sustainable data cooperatives and developing strategic partnerships with key stakeholders can be a major enabler of creating valuable cooperative business models. The evolution of digital technology has currently arrived at a level that involves complex systems integration and sustainable digital innovation ecosystems, in which many stakeholders in different roles are involved (Loorbach, 2010; Jacobsson, 2011). At the core of this work is a framework that facilitates a deeper understanding of a lean multi-actor approach to sustainability transitions. Such a systemic perspective can influence traditional industries to promote the use of technological innovations as well as the adoption of data sharing cooperative design and trust-based governance.

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