**Blockchain-based supply chain coordination in modular construction**

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**ABSTRACT**

Modular construction is an industrialized process where building components (e.g., room, floors, and ceilings) are constructed offsite under controlled plant conditions before being transported and assembled at a final location (Lawson et al. 2014). There are many benefits of modular construction including speedy construction, increased productivity, enhanced quality, and decreased material waste (Generalova et al. 2016). To maximize benefits, supply chain coordination between different stakeholders such as manufacturers, transporters, and onsite assembly teams is particularly important (Wuni and Shen 2020). However, currently, a lack in reliable information sharing and coordinated decision-making processes often leads to discontinuities in project information (e.g., progress status) among them (Wang et al. 2020). For instance, if a module’s status (e.g., prefabrication status and location) is not shared among all participants, production or delivery schedules may be poorly coordinated with the final onsite assembly plan. This discontinuity of information may result in a failure to deliver modules on time, prolonged project durations, and even late payment issues between stakeholders.

Recently, several researchers have noted the potential value of blockchain technology for information management (Wang et al. 2020). Blockchain technology is a decentralized peer-to-peer distributed network ledger that can be a solution to reliable information sharing through providing an immutable digital footprint to all members of the network (Wan et al. 2020). Having an immutable digital footprint means every approved transaction that occurs throughout the supply chain is recorded in a tamper-proof ledger. Also, in the peer-to-peer network, members maintain their copies of the data, and all members authenticate any updates. Thus, any data can be shared in blockchain immutably and traceably without an intermediary (Dai et al. 2019). Further, blockchain enables smart contract, which is a computer protocol intended to automatically execute legally relevant events and actions according to the terms of a contract or agreement (Norta 2017). A smart contract can facilitate informed (i.e., data-driven) decision-making for effective supply chain coordination. Despite this potential, however, it is not well known how such information is created and how it ultimately leads to coordinated decision-making in modular construction.

To address this issue, the authors develop and test a blockchain framework for information sharing and informed decision-making in modular construction. Blockchain traceably records any information on the modular construction project and transparently share it among stakeholders. With such reliable information sharing, a pre-agreed smart contract can be initiated to trigger informed decision-making for supply chain coordination. The authors test the framework with a case modular construction project where modules with IoT sensors were manufactured offsite, transported, then assembled onsite. In the case study, the authors verify whether information generated from the IoT sensors can be shared traceably in the blockchain and whether such information can automatically trigger smart contracts for automated and prompt payment, one of the important decision-making issues in modular construction.

Results indicate that the IoT sensors automatically collect information and deliver them to blockchain for information sharing. After that process, such information sharing triggered a smart contract embedded in the blockchain within 7.2 seconds on average. The smart contract executed progress payment in the form of cryptocurrency according to a pre-agreed condition without an intermediary (e.g., bank). The main contribution of this paper is to show how the blockchain framework can help secure traceable information and facilitate informed decision-making in modular construction with realistic demonstration. Such an informed decision-making process can vastly speed up many decisions (e.g., progress payments, delivery ordering, scheduling changes, and change orders), which can ultimately facilitate better supply chain coordination among stakeholders in modular construction. In particular, progress payment can contribute to addressing late payment issues, which have previously disrupted cash flow to stakeholders and caused time-consuming and expensive disputes between them in modular construction.

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