ABSTRACT

With the economy and businesses worldwide increasingly driven by automation and digitization, there is an enormous amount of digital information and data flooding in projects. The increasing exchange of digital information and assets without much regard to contractual requirements has resulted in various data corruption, privacy, and security issues escalating to claims and disputes. The need for a well-structured legal and contractual framework is seen as a necessary pre-condition for successful collaboration in projects. Hence, there is a need to institute reforms in the existing contracting system to achieve a more efficient, collaborative, and transparent system. However, little research has been done on the digitalization of the contracting process, which continues to be traditional. An efficient legal and contractual system requires an environment that supports trust and sophistication in data from multiple stakeholders. If the contracts are executed in a transparent and decentralized environment, with due consensus of stakeholders, then trust is in-built into the system by design.

Blockchain technology is increasingly gaining traction across different aspects of the business world due to its intrinsic qualities of transparency and security. Consequently, this research is driven by the motivation to explore how blockchain technology can be integrated into the current contracting processes. The present study is one of the first to develop a digital and automated contract management system leveraging blockchain technology and smart contracts. The research pursues a twofold goal: 1) automation of

the construction contract clauses using blockchain-based smart contracts and 2) decentralization and automation of the contract implementation system. The computable contract clauses would enhance certainty and reduce the scope for misinterpretation and ambiguity for different parties, thereby mitigating many afterthought claims. Simultaneously, the blockchain-based decentralized and secured environment would improve collaboration between the stakeholders, incorporating transparency and accountability.

The research endeavors to develop a decentralized and automated contract management system encompassing the following - (1) a decentralized permissioned network of stakeholders with well-defined roles and approval workflow, (2) automated contract execution based on pre-defined conditions using smart contract clauses, and (3) preservation of transaction history integrity with time stamps through a secured blockchain-based data structure. Design science research methodology is adopted to achieve the goal. Based on systematic literature review, the problem statement of the research is defined. Subsequently, the rationale for integration of blockchain technology into the contracting system is established. Following this, a conceptual model for the proposed decentralized contract management system is developed comprising three key features: 1) Automated smart legal contracts, 2) Decentralized blockchain network, and 3) Digital blockchain platform. The entire system involves multiple layers of digital and communication technologies which are represented in the

form of an architecture stack. Next, an integrated framework for blockchain-based contract execution is presented, outlining the process of information exchange and contract administration throughout all project phases, including tendering, design, execution, and maintenance.

The practicality, limitations, and advantages of the suggested contracting system are examined through its application in a real-life construction megaproject case. A conceptual blockchain network is established, comprising the key project stakeholders, using a permissioned blockchain architecture. The roles, responsibilities, and access controls of the stakeholders within the network are defined using the RACI (Responsible Accountable Consulted and Informed) matrix. Computable and automated smart legal contract clauses are formulated for the industry and academia, focusing on the 'extension of time, delay compensation, and variation' that can be applied to all projects worldwide, regardless of the complexity or scale.

Further, a prototype of the proposed contracting system is developed, showing its applicability, feasibility, and ease of use. This prototype is then presented to a group of experts in contract management for megaprojects. Their feedback was sought through a follow-up questionnaire post-demonstration based on two criteria: user-based requirements and system attributes. The validation of the prototype by industry experts confirms the proposed system as a workable solution to enhance cooperation and improve traceability and accountability. The case study of a legal construction dispute

is used to triangulate the findings and demonstrate the application of the system in early dispute identification and avoidance.

This study offers researchers, lawyers, and practitioners an insight into the interdisciplinary confluence of engineering, law, and technology. It offers a novel approach for future research across a diverse array of sectors and domains. Some of the perceived benefits of the research are:

- Reduced transaction time and costs by digitization;
- Enhanced security and authenticity;
- Trust distributed equally across the contracting parties;
- Computable and flexible contract conditions;
- Self-executing and transparent payments based on performance;
- Standardized risk allocation; and
- The ability to trace information and determine accountability in the event of claims and disputes.

Keywords: automation; blockchain; collaboration; computable contracts; contract management; digitalization; dispute cause; dispute avoidance; megaprojects; smart contract; stakeholder management.