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Prospect of Blockchain Technology for Construction Project Management in Malaysia

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Year 2017 is hailed as the year of the blockchain, a technology which has disrupted a wide array of sectors, particularly the financial and legal sectors. Blockchain is a technology derived from Bitcoin, the first cryptocurrency created by Satoshi Nakamoto in 2008. Since then, the Bitcoin concept has been innovated to create blockchain technology. Blockchain consists of de-centralized, tamper-proof digital ledgers of transactions, which are chronologically and securely recorded over complex networks. Proponents of this technology are looking into the adoption of blockchain in their operations, since it is safer and reduces operating costs. This paper provides an overview of the prospects of utilizing blockchain technology to solve issues existing in the construction industry, specifically in Malaysia. The scope of this study is confined to several aspects, which includes the fundamentals of blockchain technology, and the use of Building Information Modeling (BIM) for pre-construction and construction phases, within the purview of the project management field. Among the applications of this technology includes identity validation and notarization for construction personnel/industry players, project governance and smart contracts (BIM and Blockchain integration). As a result of this study, it was found that the application of blockchain technology in project management is still in its early adoption phase, with exciting developments in the near future. Despite being in its early stages of adoption, it can be seen that the blockchain technology adoption across the globe, particularly in the area of project management has a promising outlook. However, further research needs to be carried out to ascertain the feasibility of blockchain technology implementation in the local construction industry.

Keywords: Blockchain, Building Information Modeling, Smart Contracts, Project Management, Malaysia

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I. INTRODUCTION

In the construction industry, optimization of the construction project management process is always in demand, as it translates to the utilization of less resources i.e. time, cost and manpower to achieve project completion. However, optimized project management is possible, albeit difficult to achieve, since it involves smooth coordination between members of the design team, i.e. the client, contractor, architects, structural engineers and Mechanical, Electrical and Plumbing (MEP) engineers. Among the known issues that continue to plague various construction projects in Malaysia include delays in project completion (Hamzah *et al.* 2011) and inefficient claims management due to different reasons i.e. lack of proper documentation (Azman *et al.*, 2014, Bakhary *et al.*, 2015), which culminates in expensive cost overruns (Abdul Rahman *et al.*, 2013). Therefore, in recent years, Building Information Modeling (BIM) has been proclaimed as the solution to these above-mentioned issues.

BIM allows optimized construction project management to be carried out by the design team. More specifically, BIM is a modelling technology that allows all construction project data to be stored in a digital form, hence allowing the digital information to be used for communication and analysis by relevant members in the design team, for a given construction project (Abdullah *et al.*, 2014). The application of BIM is applicable throughout the entire life cycle of a given construction project, which starts from the project planning, design, pre-construction, construction and post-construction/ facilities management stages (Zainon *et al.*, 2016). However, for this study, the scope of BIM is narrowed down to the pre-construction and construction phase only.

More recently, blockchain technology has generated a lot of interest in the software development field. A technology derived from Bitcoin (Nakamoto, 2008), it consists of tamper-resistant, de-centralized digital ledgers containing records of peer-to-peer electronic transactions. The underlying concept behind Bitcoin eventually brought about the advent of Blockchain 2.0, the era in which we are currently in. With Blockchain 2.0, this allows computer scientists to create digital assets that cannot be copied, and can be transferred to another user without notarization of a trusted third party e.g. banking institutions (Geipel 2017). The combination of electronic transaction records with network timestamps and increased security measures (via tamper-proof ledgers) are indeed useful for tracking real-time project updates made to the BIM system, in the perspective of construction project management.

Despite the relatively low BIM adoption rate in Malaysia (Mamter *et al.*, 2017), the authors aim to delve into other avenues of improving the existing BIM technology using the Blockchain technology, which enables BIM to be future-proof and to address any shortcomings available in BIM. This has not gone unnoticed by other researchers within the construction management research community, where various studies are focused on optimized

integration between BIM and blockchain technology (Mathews *et al.* 2017, Turk & Klinc 2017). Furthermore, the current state of research in the field of blockchain technology mainly focuses on blockchain architecture, but has less emphasis on the application of blockchain in other fields e.g. education, health and finance (Zheng *et al.*, 2017). Therefore, this study aims to explore the integration of BIM and blockchain technology, in the Malaysian context.

I. BLOCKCHAIN TECHNOLOGY FUNDAMENTALS

In Satoshi Nakamoto's seminal work published in 2008, the first principles of Bitcoin (Nakamoto, 2008) were clearly relayed and explained in detail, as summarised by Mougayar (2016) : firstly, it is a peer-to-peer version of electronic cash, allowing online payments to be sent directly from one user to another, without the need of notarization from a financial institution. Secondly, a trusted third-party is not required to avoid double-spending made possible via a peer-to-peer network. Furthermore, network timestamps transactions are recorded in a digital ledger, forming a record that cannot be changed, therefore placing trust in the peer-to-peer network.

Meanwhile, Swan (2015) categorized Bitcoin as Blockchain 1.0, which refers to Bitcoin as the first and largest of all cryptocurrencies, the technology that makes decentralization of money and payments possible. Subsequently, rapid technological developments of Blockchain 1.0 has made the emergence of Blockchain 2.0 possible. Blockchain 2.0 refers to the decentralization of markets, and involves the transfer of many types of assets besides digital currency using the blockchain, in the form of contracts (Buterin, 2014). Value is created each time these digital assets are transferred or transacted through the peer-to-peer network. Table 1 shows the partial list compiled by Ledra Capital, which shows the different types of property and contracts that can be converted into digital assets, with blockchain technology:

Table 1. Blockchain applications for non-currency assets (Ledra Capital Mega Master Blockchain List from Swan (2015))

Category	Examples
Public Records	Identity cards, Land titles, Business license and ownership records
Private Records	Contracts, Escrows, Wills
Semi-Public Records	Degree, Certifications, Medical records

Although the use of blockchain applications as non-currency assets is rather new, it has been embraced by future-oriented institutions and governments. For example, the government of Dubai will issue digital health records, and will enable digital title transfers backed by blockchain technology (Buck, 2017). In short, blockchain technology can be defined in three types of definitions, namely in the technical, business and legal aspects (Mougayar, 2016). In technical terms, blockchain is a

database that maintains a distributed ledger that is accessible to all network users; in legal terms, it constitutes as a transaction validation mechanism that can be carried out without an intermediary. Lastly, in terms of business, blockchain is a network to transfer value or assets between peers, which does not require intermediaries.

II. BLOCKCHAIN TECHNOLOGY APPLICATION IN CONSTRUCTION PROJECT MANAGEMENT IDENTITY VALIDATION AND NOTARIZATION

In general, the successful completion of construction projects involves the seamless synergy between a wide range of stakeholders to oversee the works, over the course of the project duration. It is important that the right workers, with the suitable amount of experience and expertise are a right fit for a given project. For example, undertaking a complex project with inexperienced personnel, or staff members lacking the required skills to complete the project works will inevitably cause costly project delays.

In order to optimize the workflow for a given construction project, it is important to hire workers with the correct skill set, and also to determine reliable suppliers for materials on-site. To address this need, Hughes (2017) has proposed that with blockchain technology, workers with suitable skills and qualifications can be identified via a Digital Identity Card (ID), which can be shared with the relevant authorizing body. For example, in Malaysia, a chartered engineer involved in a project would have to undergo a screening process, made possible by blockchain technology since their Digital ID will have to be authorized by the Board of Engineers Malaysia.

In addition, with the Digital ID embedded in the blockchain, the reputation of a worker or a materials supplier can be tracked over time. Hughes (2017) describes this as having proof of membership to relevant professional bodies, or proof of reliability in providing services and goods. With the Digital ID and reputation readily available in the blockchain network, parties interested to engage the services of a worker or a supplier within the construction industry can do business.

In the Malaysian context, it is proposed that the current BIM initiative espoused by the government to be integrated with blockchain containing Digital IDs of construction industry stakeholders. More specifically, the authors would like to propose the digitization of paper-based certificates (i.e. identity cards, contractor operating licenses) and ownership documents (i.e. land titles, house ownership titles) by the relevant authorities. The next step would be to create a centralized blockchain network to keep records of completed construction activities, whereby a database of competent members of the construction industry stakeholders, e.g. chartered engineers, architects and machinery suppliers will be created. In return, these members with excellent reputation may be considered to participate in high-profile, flagship projects. Furthermore, to start this initiative,

perhaps these proposed changes could be implemented on a small-scale pilot project, to assess its viability and practicality in the Malaysian construction environment.

III. PROJECT GOVERNANCE AND SMART CONTRACTS WITH BIM

Presently, paperwork is still the main method of keeping contract documentations and tracking completed on-site works (Geipel, 2017). In Malaysia, most contract documentation and work completion tracking are also done using paperwork. Nowadays, with the advent of BIM, cloud-based, real-time updates of works on site can be uploaded to the cloud by the contractor. However, these BIM-based work progress tracking can be further enhanced by integrating BIM with blockchain technology. This is done by authenticating the real-time updates on the BIM cloud using blockchain (Mathews *et al.*, 2017). Having the electronic records on the blockchain network ensures that the work progress records remain tamper-resistant and are safely distributed within the BIM cloud users. This way, proof in the form of digital documentation is available and can be used for claims after certain milestones have been reached in a project. Consequently, this directly addresses the claims management problem that was underscored by Bakhary *et al.* (2015), whereby their findings highlighted a need for good documentation by a competent site worker for claims payment to be released by the client.

Another application of the blockchain is in the form of smart contracts. Swan (2015) states that for a smart contract, it features the agreement between two (or more) parties to fulfil their obligation, as stipulated in the contract. It is defined by lines of code, which are executed once certain criteria (as described in the contract) has been fulfilled. A smart contract can be written to release a payment when a given work package has been completed. For instance, if a work package is completed and it passes the inspection process, the funds transferred by the client will be released to the worker who completed the works. This transaction is recorded on the digital ledger and is almost instantaneously distributed across network nodes. Accordingly, this concept has been developed by ETCH (Evans 2017), which proposed to offer daily remittance for construction workers via blockchain-powered payment systems.

The blockchain integration with BIM and smart contracts can indeed be a proper solution to the delays in project completion as raised by Hamzah *et al.* (2011), since any work or payment delays caused by the design team members can be traced back to the digital ledger system. It is able to pinpoint whether the delays are caused by the supplier, contractor or client– and the costs incurred due to the project work delay has to be borne by the responsible party. In return, this could avoid cost overruns as described by Abdul Rahman *et al.* (2013) as well.

IV. SUMMARY

This paper provides an overview of the prospects of utilizing blockchain technology to

solve issues existing in the Malaysian construction industry. Among the applications of this technology includes identity validation and notarization for construction personnel/industry players, and project governance and smart contracts (BIM and Blockchain integration). More specific examples involve drawing up smart contracts directly between client and service providers, i.e. daily remittance for construction workers based on completed works. Another example is the integration of Blockchain with the existing BIM system for real-time and optimized construction project management. The application of blockchain technology in construction project management is still in its early adoption phase, but it has a promising outlook. However, further research needs to be carried out to ascertain the feasibility of blockchain technology implementation in the local construction industry.

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