2022 EC³
2022 European Conference on Computing in Construction
Ixia, Rhodes, Greece
July 24-26, 2022

CONCEPTUAL FRAMEWORK FOR THE ADOPTION OF STABLECOINS (USDT/BUSD) FOR CONSTRUCTION PAYMENTS

Musa Ayuba Musa[1], Temitope Akanbi[2]
[1]Department of Quantity Surveying, Ahmadu Bello University, Kaduna, Nigeria.
[2]Department of Construction Engineering Technology, University of Toledo, Toledo, OH. 43606, USA.

Abstract

The current global trend is digitalization; however, the architecture, engineering, and construction (AEC) industry has been reluctant in embracing this change.

Current strains in the supply chain caused by the on-going pandemic have heightened the need for all industries including the AEC industry to embrace digitalization, especially in the payment of goods and services. A major gap in the adoption of crypto coins / tokens is the high volatility associated with crypto coins as well as tokens which result to losses or gains in the worth of these coins. The proposed framework was developed qualitatively to aid in the adoption of stablecoins (USFT/BUSD) for construction payments.

Introduction

The current strain on supply chains caused by the pandemic is revolutionizing the way in which industries conduct their businesses. Practically all industries are embracing digitalization and that includes the architectural, engineering and construction (AEC) industry. Although, some of the key drivers for national economies is the employment of the citizens, the development of human resources and the return on investments (CBC, 2021); the structural and processual complexities of construction, especially pertaining to legal and financial aspects, makes return on investments, a challenge for the AEC industry (TRP, 2018). Digitalization technologies, specifically blockchain technology, creates an opportunity for industries to utilize digital equivalents to address the challenges created by the complexities of the legal and financial processes (Ciotta *et al*, 2021).

In the construction industry, disputes arise amongst several parties (owner vs general contractor, general contractor vs subcontractor, and etc.); these legal disputes cost money that were previously not budgeted which leads to delays in the completion of the project. Furthermore, such disputes cause disruptions in the cash flow, and it is therefore necessary for investors/stakeholders to be: (1) optimistic in the procurement frameworks; (2) contractual obligations; and (3) have access to relevant information; as these elements are decisive factors that can help avoid such disputes (Arcadis, 2021). According to Hamledari & Fischer (2021), lenders and developers agree that automating the financial process can expedite financial processing approvals, help in decision making processes and ultimately faster disbursement of funds.

In the AEC industry, progress payments dictate the cash flow on a project. Progress payments includes costs associated with direct/indirect costs for the general contractor, payments to subcontractors, payments to the suppliers, and payments for equipment used for the work performed during a billing period. The AEC industry is plagued with untimely payments and low productivity as a result of ineffective contracting practices (Chen & Chen, 2005; Xiang *et al*, 2015; Barbosa *et al*, 2017; Durdyev & Hosseini, 2019). Lack of timely periodic payments has been identified as a major cause of disputes among stakeholders in the industry (El-Sayegh, 2008); overtime, and lack of trust amongst these stakeholders (Manu, *et al*. 2015). Recently, researchers in the AEC industry have proposed systems that focus on automating construction payments using blockchain enabled smart contracts and robotic reality capture technologies (Ciotta *et al*, 2021). Tang *et al* (2010), Akinci (2015), Patraucean *et al* (2015) proposed the use of robotics, artificial intelligence, and building information modeling (BIM) for capturing, analyzing, and modeling the job site conditions. Cerovsek (2011), Volk *et al* (2014), Ham *et al* (2016), Omar & Nehdi (2016) proposed automated construction payment systems using reality capture technologies as basis for triggering construction payment. These proposed methods amongst others, have laid the foundation for utilizing BIM-based approaches to streamline payments and automate the transition from product flow to cash flow in the construction supply chain (Ciotta *et al*, 2021). However, despite the availability of such digitized progress data information, periodic progress payment is still being conducted using traditional methods (manually) (Hamledari & Fischer, 2021). Construction projects still heavily rely on traditional payment applications which are time consuming and dependent on manual information retrieval processes (Penzes *et al*,
2018). In recent years, digital payment management systems have been developed to help address these challenges posed by utilizing traditional payment applications (Hamledari & Fischer, 2021). Currently, there are existing commercial platforms that facilitates electronic payments amongst construction as opposed to traditional paper methods (Ciotta *et al*, 2021). According to Barron & Fischer (2001), these electronic payment systems reduces manual efforts involved in processing

construction payments by 84%. However, these current digital platforms are still limited in terms of full automation of construction payments. These limitations include: (1) robustness - the inability of the current systems to utilize reality capture technologies to trigger construction payment; and (2) manual methods – similar to the traditional methods, these digital platforms still depend heavily on manual operations. And as such, these digitalized platforms do not utilize centralized control mechanisms and lack guaranteed construction payment execution system (Hamledari & Fischer, 2021). To achieve this level of automation, there is a need for a seamless real-time transfer of job site observations to construction payment systems which triggers payment for work carried out on site real-time to construction stakeholders using blockchain technologies. (Ciotta *et al*, 2021; Hamledari & Fischer, 2021).

The current workflows for construction payment in the AEC industry are manual and might be difficult to be integrated with reality capture technologies for automating construction payments. In an effort to address these limitations; (Hamledari & Fischer, 2021) proposed a blockchain (smart contract-based) method for autonomous transition of on-site job observations to progress payments. However, the method proposed by (Hamledari & Fischer, 2021) still had a limitation, in terms of an acceptable construction payment currency (crypto coins / tokens) for the blockchain. Crypto coin / token are subject to several challenges such as: (1) high volatility; (2) issues in the conversion of the coin / token to cash or vice versa; (3) public perception and knowledge of crypto coin / token; and (4) the willingness of AEC stakeholders to adopt and accept the coin / token as a form of payment tender (Ciotta *et al*, 2021; Hamledari & Fischer, 2021). Hence, this manuscript proposes a method that addresses these identified challenges by developing a framework to aid in the adoption of stablecoins for construction payments in the AEC industry. The authors conducted an extensive literature review to: (1) identify existing stablecoins, that can be adopted as payment of lien; (2) highlighted the current challenges associated with utilizing stablecoins as payments of liens in the AEC industry; and (3) proposes a framework that aid in the adoption of stablecoins for construction payment in the AEC industry.

Literature review

Why use blockchain for construction payment

Blockchain technology offers faster, low-cost, secured payment services along with a distributed ledger that can provide trust among the AEC stakeholders (WEF, 2021). Although blockchain started out as the initial support platform for digital currencies, it has now adopted by various industries for payments (WEF, 2021). Currently, the construction payment system is complex, challenging and can benefit from automating technologies (Hamledari & Fischer, 2021). In many cases, it can take days to process a transaction with extra fees and low security (Hamledari & Fischer, 2021). This is the one of the many reasons why stakeholders shy away from using payment methods to store or conduct transactions (Hamledari & Fischer, 2021).

A good portion of the AEC stakeholders do not have access to proper banking and payment channels (Hamledari & Fischer, 2021). Blockchain in this regard can help address the problem of accessibility to proper banking and payment channels (TCI, 2021). Blockchain can offer these stakeholders the opportunity they deserve and also reduce most payment issues to a significant extent (Hamledari & Fischer, 2021).

Challenges of crypto coins / token in relation to construction payment

Seven major challenges to the use of crypto coins / tokens as payment of liens in the AEC industry were identified by Hamledari & Fischer (2021). These challenges were: (1) non-stablecoins are subject to high levels of volatility, which might result in loss of value in money; (2) operational risks as a result of failures and disruptions preventing the use of services which might create some downtime resulting in loss; (3) cyber risks, that is hacking-related thefts of customer funds; (4) risks pertaining to the lack of transparency around issuance and distribution of crypto assets; (5) ease of converting crypto coins / tokens to cash and vice versa; (6) lack of greater public acceptance of crypto coins / tokens; and (7) stringent government polices discouraging the use of crypto coins / tokens.

Digital asset and stablecoin market

The adoption of digital assets has increased since bitcoin emerged in 2009. Currently, with a market capitalization of approximately $600 billion, bitcoin is the most highlyvalued digital asset (TCI, 2021). However, although it has been over a decade since bitcoin has been developed, it's adoption is still limited because of it's extremely high volatility (TCI, 2021). For exchange mediums, stability is a fundamental characteristic; however, with bitcoin's high volatility, stakeholders are concerned about the adoption and utilization of bitcoin as a means of payment exchange (TCI, 2021).

The promise of digital assets has missed expectations, with visions of a frictionless and highly liquid monetary system falling short of its initial intentions (TCI, 2021). A solution that might address this challenge to the digital asset markets is the concept of a stable store of value that is pegged one-to-one to fiat currencies (for example; USD, GBP etc.) or other hard assets (for example; precious metals); which are often called a stablecoins (TCI, 2021). The demand for stablecoins has been proven to be sustainable by blockchain consumers, stablecoin vendors such as Gemini, Circle, and Paxos, which offer USD-pegged stablecoins (WEF, 2021). There are few stablecoin

vendors that issue tokens, backed by other fiat currencies that have a reasonable market presence (TCI, 2021). An immediate need for a digital medium of exchange is not limited to USD (TCI, 2021). In the future, there will be more issuers of stablecoins, broadening the assets that back a stablecoin, such as foreign currencies, gold, other precious metals, and oil or other commodities (TCI, 2021).

Stablecoins in monetary systems

In the last decade, the adoption of stablecoins has been growing rapidly, with stablecoins being accepted as valid method of payment in various financial services (TCI, 2021). With various industries and financial organizations adopting stablecoins as their valid payment method, regulatory agencies are beginning to engage and pay closer attention to the regulations surrounding stablecoins in terms of transparency, solvency, trust, and etc. (TCI, 2021). And according to TCI (2021), from a regulatory perspective, the global markets needs a globally accepted and trusted fiat – currency, secured utilizing blockchain technology. There are a number of stablecoins currently in use as methods of payments (WEF, 2021); however, the three major stablecoins in terms of market capitalization are: (1) Tether [USDT]; (2) Binance USD [BUSD]; and (3) Gemini dollar [GUSD] (Ingolf *et al*, 2019; TCI, 2021; WEF, 2021).

Tether (USDT)

USDT is among the first Bitcoin-based USD fiat pegged crypto token and it is still currently in use (WEF, 2021). USDT is hosted on the Ethereum blockchain, one of the most secured and tested public ledger blockchain in existence (WEF, 2021). USDTs are fully reserved at a one-to-one ratio against the United States (US) dollar, and they are completely independent of market forces, pricing, or liquidity constraints. USDTs constantly undergoes regular professional audits and have reliable Proof of Reserves (PoR), that is, cash deposited in a bank as cash backing to asset deployed digitally online (WEF, 2021). Furthermore, the underlying banking relationships, compliance, and legal structures of USTDs provide a secure stablecoin (Ingolf *et al*, 2019).

Binance USD (BUSD)

BUSD is a USD-denominated stablecoin approved by the New York State Department of Financial Services (NYDFS) in partnership with Paxos and Binance (WEF, 2021). Similar to USDT, BUSD are regulated at a one-toone ratio against the US dollar. BUSDs can be currently purchased and redeemed without incurring additional transactional fees from the digital trust space. BUSDs can be transferred globally, quickly (in minutes) and at a relatively low-cost (WEF, 2021).

Gemini dollar (GUSD)

GUSD is a stablecoin that is also hosted on the Ethereum blockchain and establishes POR through cryptographic regulatory oversight (WEF, 2021). GUSD utilizes an offline approval mechanism for high-risk actions, and a hybrid online-offline approval mechanism for token issuance. These features provide the required level of security and flexibility for end-users (WEF, 2021). The GUSD operates under the regulatory authority of the New York State Department of Financial Services and is subject to the New York Banking Laws and other applicable U.S. laws and regulations (WEF, 2021).

Crypto token network

These are token standards, smart contract-compatible specific protocol for creating, transferring, or returning a balance (Houben, 2018). There are a number of cryptocurrencies currently in use as methods of payments (Ingolf *et al*, 2019); however, the major cryptocurrencies networks in terms of transaction volume are: (1) BEP-20, (2) ERC-20 (WEF, 2021).

ERC-20

ERC-20 is one of the most significant Ethereum tokens (WEF, 2021). ERC-20 has been considered the technical standard used for creating smart contracts on the Ethereum blockchain (Houben, 2018). ERC-20 is similar, to bitcoin, Litecoin, and any other cryptocurrency; ERC20 tokens are blockchain-based assets that have value and can be sent and received (WEF, 2021). The primary difference is that instead of running on their own blockchain, ERC-20 tokens are issued on the Ethereum network (Houben, 2018).

BEP-20

BEP-20 is the Binance Smart Chain token (BSC) standard, which is similar to Ethereum's smart contractcompatible specific protocol ERC-20 (Houben, 2018). BEP20 is a user-friendly token standard that provides features enabling users to create tokens (Houben, 2018). With current rate increases, there is a demand for affordable smart contract-compatible DeFi-platforms (WEF, 2021). BEP-20 is interoperable with ERC-20 and BEP-2 with ease of token management (Ingolf *et al*, 2019; TCI, 2021; WEF, 2021).

Crypto coin / token exchanges

Cryptocurrency exchanges allow users to sell their tokens for fiat currencies or buy new cryptocurrencies with fiat currencies. Furthermore, this cryptocurrency exchanges allow for swapping of one crypto token to another crypto token (Houben, 2018).

Wallet

Wallets are entities that provide services to safeguard private cryptographic keys on behalf of their customers, to hold, store and transfer virtual currencies (Houben, 2018). Hardware wallet provide cryptocurrency users with specific hardware solutions to privately store their cryptographic keys (Houben, 2018). Software wallets provide cryptocurrency users with software applications allowing them to access the network, send, receive cryptocurrencies, and locally save their cryptographic

keys. Examples are Trust Wallet, Safepal Wallet, and etc. (Houben, 2018). Custodian wallets take (online) custody of a cryptocurrency user's cryptographic keys. Examples are Binance wallet, Pooswap wallet (Houben, 2018).

Off-chain flow of products

According to Hamledari & Fischer (2021), accurate and timely understanding of changes in the physical reality (i.e., product flow) is the first step towards the successful automation of payments. Construction progress is measured using reality capture solutions operated manually (e.g., laser scans) or mounted on robotic platforms (e.g., camera-equipped unmanned aerial vehicles) (Ingolf *et al*, 2019). The captured data is analyzed using machine intelligence to arrive at the percentage completion data for various scopes of work (Hamledari & Fischer, 2021). This was achieved by identifying the components (e.g., columns, studs, insulation panels) or the state of progress for building elements (e.g., painted partition) (Hamledari & Fischer, 2021). Depending on the choice of machine intelligence algorithm, the progress results can vary in terms of their granularity, available per globally unique identifiers (GUID) or per a larger scope of work such as one or few building floors (Hamledari & Fischer, 2021). The resulting progress data is then automatically incorporated into an as-built 3D/4D BIM (Hamledari & Fischer, 2021). This creates an integrated data-driven approach that makes it possible to directly value the work completed using the captured physical reality (Hamledari & Fischer, 2021). After the progress of the work is captured and analyzed, it is categorized and valued using the project's corresponding cost codes, making the product flow structured for use by smart contract (Hamledari & Fischer, 2021).

On-chain flow of cash

The on-chain management of cash flow needs to accomplish two objectives: (1) settle payments between project participants in accordance to off-chain flow of products; and (2) and transfer lien rights alongside payments [the mechanics lien is a contractor's claim on the property, and it can be filed for work that is not compensated] (Hamledari & Fischer, 2021).

Research method

The study adopted a qualitative research approach - convenient sampling with a known population size Furthermore, semi - structured interviews were also carried out, 14 respondents in the AEC industry conversant with cash flow and payment were interviewed; they were selected from a sample size of 20. Descriptive method was used for analysis, the result was transcribed and summarized into: (1) level of awareness of stablecoins; (2) stakeholder knowledge on converting stablecoins to fiat currencies; (3) stakeholder willingness to accept stablecoins as payment of lien; (4) economic implication of adoption stablecoins; (5) government policies; and (6) possible drawbacks to the adoption of stablecoins. Based on these results, a conceptual framework was then proposed on the adoption of stablecoins for construction payments.

This study adopted combining multiple chain-link oracle service to propose the stablecoin conceptual framework; that is, the combination of an on-chain blockchain infrastructure and an off-chain oracle service. This forms the foundation of a powerful new hybrid smart contract framework, where applications can retain the noncustodial and censorship-resistant properties of blockchains while becoming substantially more featurerich via oracle (Chainlink, 2021). Though many hybrid smart contracts began by using a single oracle service, this is quickly changing as applications are becoming more sophisticated (Chainlink, 2021). Developers are now combining multiple chain-link oracle services together within a single application to unlock more utility and simplify user experience (Chainlink, 2021).

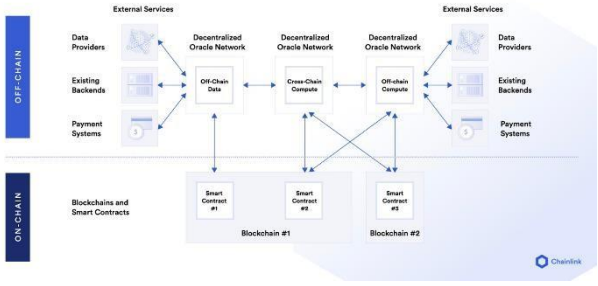

Figure 1: Combining multiple chain-link oracle service.

Discussion

Level of awareness of stablecoins

Stakeholder awareness level seems to be on the basic level, respondent where questioned on their general knowledge on crypto currency especially stablecoins. 12 out of the 14 interviewed had basic level awareness while 2 respondents demonstrated an advanced level of awareness. However, the respondents with the basic level of awareness were curious to have a deeper understanding of stablecoins. This shows that stakeholder's awareness of stablecoins can be further explored.

Stakeholder's knowledge on converting stablecoins to fiat currencies

Stakeholder's knowledge of converting stablecoins to fiat currencies were on the basic level, respondent where questioned on their knowledge on the stablecoins' exchange platforms, networks and wallets. 13 out of the 14 interviewed had basic knowledge, while 1 respondents had advanced knowledge. However, the respondents with the basic level of knowledge were curious to have a deeper understanding of stablecoins' exchanges, networks and wallet.

Stakeholder willingness to accept stablecoins as payment of lien

The respondents are willing to accept stablecoins as payment of lien provided, they would be able to get liquidity whenever the need arise and with ease.

Economic implication of adoption stablecoins

The respondents agree that the adoption of stablecoins will go a long way in reducing project failure, due to late payment resulting from manual processes; however, with the full implementation of stablecoins smart contract payment, such risk will be mitigated. This will increase the turnaround time for project delivery there by ensuring rapid growth of the Gross Domestic Product.

Government policies

The respondents agree that the adoption of stablecoins might hit a roadblock because some government policies do not support stablecoins because the central banks are not able to regulate its circulation. Furthermore, there are claims that stablecoins can aid criminal activities, such as fraud, tax evasion, financing terrorism and more. However, according to the respondents, the major reason for stringent government policies on stablecoins is hinge on government's inability to generate revenue from the billions of transactions being carried yearly.

Possible drawbacks to the adoption of stablecoins

Some of the possible drawback to the adoption of stablecoins according to the respondents are: (1) stringent government policies against stablecoins; (2) difficulty getting liquidity; (3) lack of awareness of stablecoins; (4) bad public perception of stablecoins to defraud AEC stakeholders; and (5) lack of proper enablers for stablecoins adoption.

Based on these responses from the respondents, a conceptual framework was developed to serve as a guide to aid the adoption of stablecoin as a means of payment.

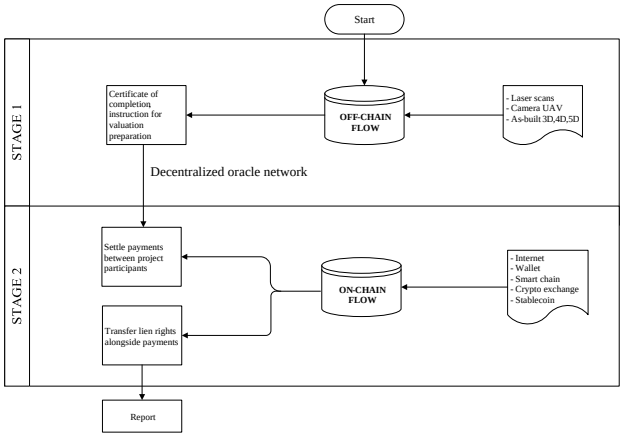

Figure 2: Conceptual framework for stablecoins adoption for transfer of lien rights alongside payment.

Figure 2 comprises of two major stages; Stage 1: off chain flow, where the certificate of completion is generated automatically after site observation. This is carried out using laser scan, camera UAV to check the work done against the as-built model. If everything meets the requirements for payment, a command instruction triggers Stage 2, the oracle system architecture service was adopted.

Stage 2: This is executed within the smart contract, when an instruction is received, from the sender (financer) the smart contract checks to ensure that both the sender and the receiver (contractor) agrees to the payment terms, after which transfer of the exact lien right is executed automatically. It is important that both parties have separate wallets, the sender shall have stablecoins to pay the receiver, both must use the same crypto smart chain network to avoid loss of payment.

Note: A smart contract will be created to support the above process (stage 2) across all standards that support stablecoin.

Conclusion

Despite the potential advantage of blockchain technology to automate the payment system in AEC industry by linking off-chain product flow and on-chain cash flow, its adoption in payment systems faces a major barrier, that is, high volatility of the crypto currencies / tokens, hence, a conceptual framework for the adoption of stablecoins (USDT/BUSD) for construction payment was proposed to address the issue of volatility of cryptocurrencies.

The study proposed a framework for the adoption of stablecoin as means of payment in the AEC industry customizing it to the peculiarities in the construction industry.

References

Akinci, B. (2015) Situational awareness in construction and facility management. Front. Eng. Manage, 1, p.pp.283–289.

Arcadis. (2021) Global construction disputes report 2018 does the construction industry learn from its mistakes. New York, United States.

Barbosa, F., Woetzel, J. & Mischke, J. (2017) Reinventing construction: a route to higher productivity. New York, United States.

Barron, A. & Fischer, M. (2001) Potential benefits of internet-based project control systems–a study on change order processing, center for integrated facility engineering. Center for Integrated Facility Engineering. London, United Kingdom.

CBC. (2021) Blockchain & construction cash flow (whitepaper). London, United Kingdom.

Cerovsek, T. (2011) A review and outlook for a 'building information model'(BIM): A multi-stand-point framework for technological development. Adv. Eng. Inform., 25, p.pp.224–244.

Chainlink. (2021) Combining multiple chainlink oracle services to build advanced smart contracts. New York, United States.

Chen, H.I. & Chen, W. (2005) Clarifying the behavioral patterns of contractor chain payment conditions. Int. J. Proj. Manag, 23, p.pp.463–473.

Ciotta, V., Mariniello, G., Asprone, D., Botta, A. & Manfredi, G. (2021) Integration of blockchains and smart contracts into construction information flows: Proof-of-concept. Automation in Construction, 132, p.pp.1–12.

Durdyev, S. & Hosseini, M. (2019) Causes of delays on construction projects: a comprehensive list. Int. J. Manag. Proj. Bus.

El-Sayegh, S. M. (2008) Risk assessment and allocation in the UAE construction industry. Int. J. Proj. Manag, 26, p.pp.431–438.

Ham, Y., Han, K.K., Lin, J.J. & Golparvar-Fard, M. (2016) Visual monitoring of civil infrastructure systems via camera-equipped unmanned aerial vehicles (UAVs): a review of related works. Visualiz. Eng., 4, p.pp.1-14.

Hamledari, H. & Fischer, M. (2021) Construction payment automation using blockchain enabled smart contracts and robotic reality capture technologies. Automation in Construction, 132, p.pp.1–14.

Houben, R. (2018) Cryptocurrencies and blockchain: Legal context and implications for financial crime, money laundering and tax evasion. New York, United States.

Ingolf, G.A.P., Sebastian, H., Roman, P., Martin, F., Hermann, E. & Bjorn, S. (2019) Monetary stabilization in cryptocurrencies design approaches and open questions. Weizenbaum Institute for the Networked Society, p.pp.1–13.

Manu, E., Ankrah, N., Chinyio, E. & Proverbs, D. (2015) Trust influencing factors in main contractor and subcontractor relationships during projects. Int. J. Proj. Manag, 33, p.pp.1495–1508.

Omar, T & Nehdi, M.L. (2016) Data acquisition technologies for construction progress tracking. Automation in Construction, 70, p.pp.143–155.

Patraucean, V., Armeni, I., Nahangi, M., Yeung, J., Brilakis, I. & Haas, C. (2015) State of research in automatic as-built modelling. Adv. Eng. Inform., 29, p.pp.162–171.

Penzes, B., KirNup, A., Gage, C., Dravai, T. & Colmer, M. (2018) Blockchain technology in the construction industry: digital transformation for high productivity. Inst. Civil Eng., p.pp.1–53.

Tang, P., Huber, D., Akinci, B., Lipman, R. & Lytle, A. (2010) Automatic reconstruction of as-built building information models from laser-scanned point clouds: a review of related techniques. Automation in Construction, 19, p.pp.1-16.

TCI. (2021) Trust company whitepaper. New York, United States.

TRP. (2018) Blockchain for construction/real estate. New York, United States.

Volk, R., Stengel, J. & Schultmann, F. (2014) Building information modeling (BIM) for existing buildings—literature review and future needs. Automation in Construction, 38, p.pp.109–127.

WEF. (2021) Digital currency governance consortium white paper series. New York, United States.

Xiang, P., Huo, X. & Shen, L. (2015) Research on the phenomenon of asymmetric information in construction projects the case of China. Int. J. Proj. Manag, 33, p.pp.589–598.