Proceedings of the International Conference on Industrial Engineering and Operations Management
Washington DC, USA, September 27-29, 2018

Blockchain in Logistics: Mapping the Opportunities in Construction Industry

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Abstract

Blockchain is a promising emerging technology for wide range of industries. Blockchain provides a decentralized digital ledger system, which can be utilized effectively when parties does not trust each other's. The decentralized ledger system can be implemented in several ways as a part of logistics activities. However, many barriers exists, why blockchain cannot be used as a part of current logistical solutions. Aim of this paper is to research opportunities of blockchain technology as a digital ledger system in logistics in construction industry. The research shows that blockchain can be utilized, for example, to provide extended customer value, transparency and enhanced service network.

Keywords
Blockchain, logistics, opportunities, construction industry

1. Introduction

Today's digitalization in supply chain and logistics network is becoming dynamic due to increasing customer's demand. This digitalization offers easy access to customer needs through effectively shares the tracking information of the product/service deliveries. The tracking information is ensured through the integration of companies operating in supply chains process, whose role is to establish mapping among various systems. This data or information integration among various organizations typically caused high costs with slow diffusion (Korpela et al., 2017). This paper investigates the supply chain integration through blockchain technology. This technology works through Cloud integration, which offers a cost-effective business model for digital supply chains. In addition, this technology can help to achieve disruptive transformation in digital supply chain networks through extended visibility. Such visibility articulates continuous monitoring to ensure improved supply chain performance.

In addition, before implementing blockchain in logistics, it is recommended to analyze businesses to assess potential benefits and losses. It is also required to get the full cooperation from everyone involved in the supply chain to adopt blockchain (Earls, 2016). Although, blockchain has several strengths, such as access for anyone at any moment, however, it does still need to improve. This technology faces different ups and downs in the present days and peoples are interested in this technology and are skeptical too (Sadouskaya, 2017). In case of logistics and supply chain area, adaptation of this technology is slow due to the associated risks and some companies are skeptical about its implementation. However, it is hoped that blockchain will earn the necessary confidence and expands its acceptability through all industrial sectors.

The fundamental objective of this research was to identify the readiness of applying blockchain technology in the construction industry. A construction company in Finland was selected as the case to look for the possibility to apply blockchain technology there. From the study, it is noticed that there are huge potentials/opportunities to apply blockchain in construction business, especially in local and international logistics and sales. This technology also provides added benefit to the construction projects with respect to transparency and visibility of the total value chain.

2. Theoretical background

Blockchain is a new technological revolution has emerged with a decentralized database. It was first developed for Bitcoin, a cryptocurrency and first introduced in Satoshi Nakamoto's (pseudonym) whitepaper in 2008. It is considered as the combination of information block, marked with a timestamp and added as a new block to the existing one. Due to the combination of blocks of information with the time stamp, the information with respect to any activities performed in the past, are completely transparent and literally tamper-proof (Nguyen, 2016). All the necessary information in a block is stored in single database, which is then publicly distributed (Sadouskaya, 2017). If a database that does not claim any ownership then practically it is owned by everybody.

2.1. Blockchain technology

Blockchain technology is built from three technologies such as private key cryptography, P2P network and program (the blockchain's protocol). It maintains an open distributed ledger of transactions without revealing the identification of the transaction parties. This technology is capable to execute transactions and document exchange quickly and to provide security and flexibility of any transaction with lower cost than traditional way.

Blockchain database can be both write-controlled and read-controlled, which means that each of the participants within the blockchain can write and read into its database. Bitcoin is an example of a read and write-controlled database. Blockchain database offers more confidentially and trust than traditional database system. In order to maintain confidentiality in information, blockchain requires plenty of cryptography (Bauerle, 2018).

The difference between a blockchain a traditional database is mainly the architecture or the way of associated technologies are integrated with each other. A traditional database system is running mostly by using a client-server network architecture. With necessary permissions, a client (user) can change entries within a database, which are stored on a centralized server. Administrator controls such centralized database system and allows access right to the database is required permission. On the other hand, the blockchain database is a decentralized one, where each of the participant maintains, calculates and updates new entries into the database (Bauerle, 2018). It allows information sharing within the participants without requiring a central administrator.

A blockchain database allows transaction by a network of users to create the same-shared system of record simultaneously. Due to the decentralized control, blockchain database eliminates the risks of centralized system, where anyone can destroy or corrupt the data with necessary access right. In blockchain, current information can be stored in addition to as past information, while, in a centralized database system, any information is up-to-date at a particular moment. Blockchain database is comparably slower in speed than centralized database system.

There are various applications of blockchain in the financial market such as Bitcoin, Ethereum, and ICO (initial coin offering), which are nowadays being recognized as actual commodities that have function, value and scarcity (Mavadiya, 2018). All these cryptocurrencies are built on the blockchain technology.

Bitcoin is the most popular cryptocurrency and is accepted widely as a form of payment to buy any goods or services. Etherem is an instance of blockchain, which is also the first generic platform of blaockchain and allows users to easily create and deploy their decentralized and trustless applications (Mavadiya, 2018). It also allows user to pay micropayments (e.g. fraction of a cent). In comparison to traditional centralized system, both Bitcoin and Ethereum enable superior security. ICO is a new cryptocurrency used to raise capital for projects. This type of coins or tokens are usually specific to the project that can serve as serving value to the project.

2.2. Types of the blockchain

Two types of blockchain technology is commonly available namely public and private/federated. Both the types are decentralized peer-to-peer networks, where each participant maintains a replica of a shared append-only ledger of digitally signed transactions. The basic difference between public and private blockchain is related to permission of access right to the network, execute the consensus protocol and maintain the shared ledger (Sadouskaya, 2017). In general, a public blockchain network is completely open and anyone can join and participate in the network, whereas in the private network is close type and only approved participants can join the network. Bitcoin, Ethereum are the examples of public blockchain network.

A public blockchain is slower and requires substantial amount of computational power that is necessary to maintain a distributed ledger at a large scale. Due to the openness of the network, public blockchain is considered as a weak notion of security with little or no privacy for transactions. On the other hand, private blockchain is faster and less amount of computational power is required to maintain. It is comparatively more secured network due to the set of rules put by the network initiator. Such rules place restrictions on who can participate in the network or not. Required permission to join the network is set or licensed by the already existing participants or through a regulatory body or consortium within the participants. Enterprise-focus blockchains like Hyperledger and Corda are the examples of private blockchain.

2.3. Architecture of the blockchain

All blockchains share some common architecture but blocks in the chain variates based on its type and implementation. Thus, Hyperledger blockchain is fundamentally different than, for instance, Ethereum blockchain. Main idea of the blockchain architecture is to connect series of blocks together using previous block's hash which as well ensure the integrity of the blocks. Figure 1 is illustrating the architecture of the basic blockchain.

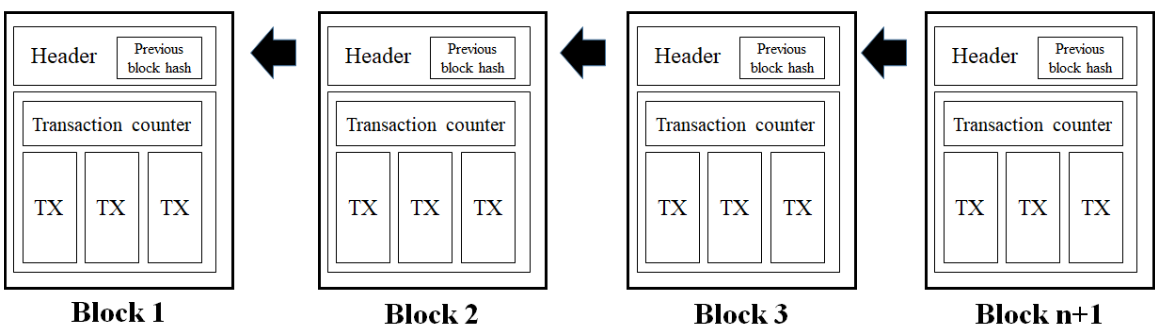

Figure 1. Basic architecture of the blockchain (adapted from Zheng et al., 2017)

Figure 1 is a simple example of the blockchain architecture. Every block includes a header which includes previous block's has which ensures the connectivity. Moreover, every block includes a body which includes a transaction counter and series of transactions. Number of transactions and transactions sizes are depending on the block size and the size of each transaction (Zheng et al., 2017). Moreover, a block may include code which is executed by the nodes in blockchain (e.g. Ethereum smart contracts) network (Ethereum, 2018).

2.4. Challenges of the blockchain in logistics

Logistics and supply chain involve various points in producing and delivering goods. It can be consisted of different stages and locations. There are several challenges in the global logistics and supply chain network such as visibility or transparency, performance monitoring, transportation protocol, etc., which cause misunderstanding between parties involved in the supply chain layer. (Willams et al., 2015). Due to such challenges of transparency or monitoring, buyers and customers are not be able to track their products with respect to quality and condition monitoring (Dickson, 2016).

Information sharing through transparency between supply chain parties can enhance the relationship and trust between them and contributes improved efficiency within the supply chain. The application of blockchain can be a good solution for transparency and security for fixing logistics and supply chain. Even the simplest application of the blockchain technology could provide better traceability of transported goods/items in the logistics and supply chain and ensure the fulfillment of transport contracts. It provides the opportunity to track products from the place of origin to the final destination (end customer). Due to nature of decentralized structure, blockchain gives the ability for participation for all parties in the supply chain. In addition, blockchain technology offers assurance of security in the supply chain due to its cryptography-based and immutable nature.

Blockchain technology enables to provide customers to monitor and to evaluate the products, services, suppliers, carriers, etc., before making a decision (Baker and Steiner, 2015). It supports to reduce risk with respect to fraud or counterfeit goods and simplifies exchange of goods and payment systems (Nakamoto, 2008; Hancock and Vaizey, 2016). In addition, blockchain was recognized to be implemented to bring visibility, optimization and forecasting in various logistics and supply chains (Lieber, 2017). There are many example applications or efforts have endeavored to streamline the leverage of blockchain for improving supply chain (e.g. IBM, Walmart, Maersk, Provenance, etc).

3. Methodology

This research was based on a single case study of a company which is acting at construction industry. The name of the case company is CLT Finland Ltd. (http://www.hoisko.fi/en/your-clt-building-partner/). The company was established in 2015 by five companies and six private persons in Hoisko, Alajärvi, Finland (Hoisko, 2018). The Hoisko village has a strong tradition of wood processing and Hoisko shareholders represent the Finnish top knowledge in their own fields and create a value chain that enables cost-efficiency and quality (Hoisko, 2018).

The company is not currently utilizing the blockchain technology on its activities. In order to identify the possibility to implement blockchain technology in the company, this research was carried out with a semi-structured interview where the director of research and development and international sales were interviewed. The interview questionnaires were mainly focused to measure the motivation of the company towards blockchain, which can be stated as attitude towards the blockchain technology, added benefits from it in the logistics chain and sales, transparency to the customer, usability of cryptocurrency, etc.

4. Results

Blockchain is a complex technology which provides several opportunities for logistics to develop new business models and improve existing ones in the construction industry. This research is providing several possible directions and opportunities how to utilize blockchain in logistics as well in wider scale. Figure 2 summarizes the opportunities of the blockchain technology based on the single case study.

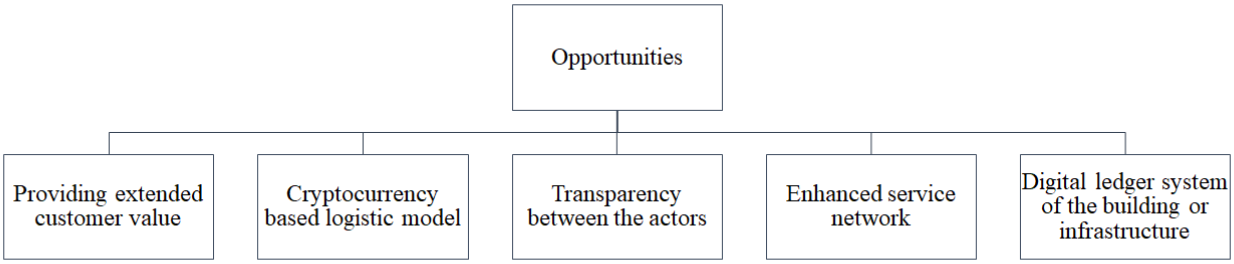

Figure 2. Opportunities of the blockchain technologies in logistics in construction industry

Providing extended customer value. The blockchain technology provides extended customer value as the buildings and infrastructures becomes more complex. The digital ledger system can record most important parts of the supply chain and as well provide valuable information and services for the end user. This can be, for example, following the process of construction from very beginning, reporting the actual status and costs of the construction items in the supply chain and record the process of construction. Moreover, this same information can be used as well between the actors in logistics network and supply chain. Privacy should be in high-level and restrictions should be clear in this case (cybersecurity).

Cryptocurrency based logistic model. Integration of cryptocurrency to supply chain or logistic model provides value for entire logistic network. Cryptocurrencies, like Bitcoin, provides a possibility to transfer currency between actors without bank involvement the payment process. This could mean, for instance, that every phase in the logistic chain is charged with cryptocurrency after the process step has been successfully implemented. This would provide value especially in international sales and logistics because the currency transfer is direct and does not require multiple banks in the process. This leads to decrease the requirement of different warranties between the actors. Moreover, this type of model could have its own cryptocurrency.

Transparency between the actors. Transparency is a crucial as the supply chain includes multiple actors which is as well one of the main points in blockchain technology. Transparency of blockchain in the logistics connects the actors together providing the new possibilities for end user or customer to manage the supply chain. Transparency does not, however, mean that all parties in the chain should have full insight to all the data in the blockchain. Therefore, privacy is one of the main concerns in this case.

Enhanced service network. Buildings and infrastructures always requires maintenance and multiple actors during the construction process. The blockchain technologies may provide enhanced service network of multiple firms during the construction process and even after that. The data in the blockchain should be accessed only by the customer request or approval. This could mean, for example, the case where customer need to renovate the building. The customer could open the blockchain for multiple firms to give the information for better understanding of the case. This same applies as well to construction phase where multiple actors are involved.

Digital ledger system of the building or infrastructure. Buildings and infrastructures requires a large amount of different types of plans, contracts, and reports and so on. All of this data could be connected in the blockchain with external systems. Currently most of this information is available in multiple actors but it can be hard to get all the information from the one source. The blockchain might record all the transactions during the logistic chain and more. The development of the blockchain as a solution for logistics should be holistic. Thus, blockchain should include more detailed information about the actual construction.

The blockchains and its type needs to be selected based on the need and the level of privacy. Based on our case study, private blockchains would provide most of the value in construction industry because most of the data is private and should provide decent level of security. Moreover, blockchain can be concluded as a positive development of new kind of technology based on our single case study and level of readiness in the construction industry is good. However, piloting and testing are required to cover the biggest threats which are mainly concerning about security and as well the cryptocurrency and its utilization in large scale construction projects.

5. Conclusions

Blockchain technology is becoming more and more an attractive tool to solve existing problems in various sectors in logistics and supply chain. Logistics companies are considering to implement it to achieve competitive advantage. Logistics and supply chains are usually very hard to change and adapt. In general, companies put lots of effort and spend years to put supply chain in place and refining them (Mougayar, 2016). It is therefore, not an easy task to insert a new technology in it due to the integration challenges. According to Venegas and Krabec (2017), it is necessary to count financial risks of handling a large portfolio of suppliers before implementing block technology. They also stated that there is another challenge to implement block chain in logistics due to not having enough specialists with particular experience in cryptocurrency with broader knowledge of other types of crypto assets.

Our empirical research indicates that there is a lot of opportunities to develop new types of blockchain applications and processes in construction industry to provide more value for the customer or end user of the building or other infrastructure. This could mean, for example, to give more information for customer and as well record the information in the blockchain and use it later on. However, our research is a single case study and, therefore, it should be acknowledged that more qualitative and quantitative empirical evidence is required to raise validity of the research. Moreover, more testing and piloting a blockchain applications in the construction industry would provide more valuable information practical use blockchain applications as well in multinational and wider scale projects.

References

Nguyen, Q.K. (2016), "Blockchain – a financial technology for future sustainable development", 3rd International Conference on Green Technology and Sustainable Development

Davidson, S., De Filippi, P. and Potts, J. (2018), "Blockchains and the economic institutions of capitalism", Journal of Institutional Economics, Vol. 14, No. 4, pp. 639-658.

Korpela, K., Hallikas, J. and Dahlberg, T. (2017), "Digital supply chain transformation toward Blockchain integration", Proceedings of the 50th Hawaii International Conference on System Sciences.

Bauerle, N. (2018), https://www.coindesk.com/information/what-is-the-difference-blockchain-and-database/ , accessed on 21.08.2018.

Mavadiya, M. (2018),"Blockchain, Bitcoin and Ehereum explained", https://www.forbes.com/sites/madhvimavadiya/2017/08/22/blockchain-bitcoin-ethereum/#67b9db906df9, accessed on 22.08.2018

Dickson, B. (2016), "Blockchain has the potential to revolutionize the supply chain", Techcrunch, Available at: https://techcrunch.com/2016/11/24/, accessed 23.08.2018.

Williams, R. (2015). "How Bitcoin's Technology Could Make Supply Chains More Transparent", Coindesk. Available at: http://www.coindesk.com/how-bitcoins-technology-could-make-supply-chains-more-transparent/, accessed 23.08.2018.

Baker, J. and Steiner, J. (2015), "Provenance | Blockchain: the solution for transparency in product", Provenance, available at: https://www.provenance.org/whitepaper, accessed 23.08.2018.

Hancock, M. and Vaizey, E. (2016), "Distributed ledger technology: beyond block chain", 1st ed. [ebook] London: Government Office for Science. Available at: https://www.gov.uk/government/, accessed 23.08.2018.

Sadouskaya, K. (2017), "Adoption of blockchain technology in supply chain and logistics", Bachelor's Thesis, Business Logistics, Kaakkois-Suomen Ammattikorkeakoulu Oy, Finland.

Zheng, Z., Xie, S., Dai, H., Chen, X. and Wang, H. (2017). "An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends". 2017 IEEE 6th International Congress on Big Data, pp. 557-467.

Ethereum. (2018). "Building a smart contract using the command line". Available at: https://www.ethereum.org/greeter, accessed 2.9.2018.

Mougayar, W. and Buterin, V. (2016). The Business Blockchain: promise, practice, and application of the next Internet technology. 1st ed. New Jersey, USA: John Wiley & Sons, Inc.

Earls, A. R. (2016), "Blockchain not a panacea for supply chain traceability, transparency", Searchmanufacturingerp. Available at: http://searchmanufacturingerp.techtarget.com/, accessed 21.08.2018.

Venegas, P. and Krabec, T. (2017). Trust the Name: Demonstrating Material Value Added by Management Using Intangible Flows Maps – A Case from the Blockchain Smart Contracts Industries. Available at: https://papers.ssrn.com/sol3/, accessed 21.08.2018.

Nakamoto, S. (2008). "Bitcoin: A peer-to-peer Electronic Cash System". 1st ed. [pdf]. Available at:
http://www.cryptovest.co.uk/resources/, accessed 23.08.2018.

Hoisko. (2018). "Hoisko: Your CLT building partner". Available at: http://www.hoisko.fi/en/hoisko-4/, accessed 29.8.2018.

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