

Analysis of Blockchain-based Approaches for Future Supply Chain Management

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1. Introduction

The issue of blockchains has attracted attention during the past few years, particularly through the application of the bitcoin payment system. With the introduction of the digital currency of bitcoin in 2008, the fundamental mechanisms of the financial industry were questioned (Nakamoto, 2008). The disruptive force is due to the underlying technology of blockchains. This decentralised database makes it possible to carry out transactions in the digital space in a tamper-proof manner (Petersen et al., 2016, p. 626). In recent years, both current research activities and numerous start-ups are addressing further application possibilities of blockchain technology. One of these applications is the use of blockchains in supply chain management.

Supply chains are becoming more complex, more advanced and more global. Through globalisation, billions of products are produced every day in the world and distributed throughout the world through complex supply chains. However, the information about how, when and where these products were produced and transported was very limited. Even before reaching the end user, goods travel through an often extensive network of retailers, distributors, transporters, warehouses and suppliers, who participate in design, production, delivery and distribution, but these processes run invisibly in the background without informing the end consumer (Abeyratne & Monfared, 2016, p. 1). The end user is just one reason why it is necessary to provide more transparency and security in the supply chain. Other reasons, involving other stakeholders in the supply chain, are issues such as environmental damage, end-of-life waste, unethical work and counterfeit products. The Nike child labour scandal in 1996, the Foxconn suicide scandal in 2010, the VW emissions scandal in 2015 and Nissan scandal in 2016, or the spread of the EHEC virus in 2011 are only a few examples of the demand for more transparency and traceability within the supply chain (Abeyratne & Monfared, 2016, p. 2; Connor, 2001; Moore, 2012; Cremer & Taylor, 2016; Bundesinstitut für Risikobewertung, 2011). Supply chain visibility is thus a major challenge for companies. Blockchain technology provides a distributed ledger that is updated and validated in real time with each network user. Thus, the blockchain allows for the same visibility of activities and can show where an asset value is at a given time, who owns it and in which state it is. This results in new possibilities for the traceability and control of goods (IBM, 2017).

Another challenge of supply chain management is the large number of people involved and their interactions, so the transport of a single container is linked with 200 interactions and more than 30 involved persons (Churchill, 2017). Having a large number of intermediaries in supply chains has several disadvantages: high transaction costs and a slowdown within the supply chain, as well as the possibility of human errors and malicious manipulation (Nakamoto, 2008, p. 1). The blockchain creates trust because it allows people who do not

know one another (and therefore do not have a basis of trust) to work together without an intermediary of confidence, thus saving both transaction costs and delivery times (Christidis & Devetsikiotis, 2016, p. 2292; Schwab, 2016, pp. 33-37; Crosby et al., 2016, pp. 9-13; Nakamoto, 2008, p. 1)

At the same time, the use of blockchain technology in supply chain management is also associated with challenges, and because this is a new technology, numerous questions remain. To date, very few studies deal with the use of blockchain technology in supply chain management. These studies are based almost exclusively on theoretical considerations of the possibilities of utilisation and on the opportunities and challenges associated with the technology for today's supply chain management. For this reason, the goal of this study was to examine the practical implementation of the use of the blockchain in supply chain management. Based on this, it was considered how the blockchain can be utilised in the future in supply chain management. The aim of this thesis is to answer the following research question by analysing the status quo in theory and practice and analysing the trends in future supply chain management taking into account the chances and challenge of using this technology in supply chain management:

***How and Why can Blockchain Technology revolutionise
the Future Supply Chain Management?***

To answer the research question, this study is divided into the following sections. Following the introduction, Chapter 2 of this thesis is first used to carry out a literature analysis to show the status quo of the theory. For this reason, the literature on the topics of blockchain and supply chain management is reviewed to analyse the intersections. Following the current status quo of the relevant literature, Chapter 3 presents all of the necessary theoretical foundations for explaining both the blockchain and its functioning, as well as smart contracts and supply chain management. At this point, the fictional case 'dry aged beef' of this thesis is also presented, which is a preface to a typical supply chain and its stakeholders. In the following chapter, Chapter 4, the trends in future supply chain management will be introduced. Subsequently, a case study analysis according to Yin (2014) was conducted and is described in Chapter 5, with nine case studies analysed regarding how blockchain technology is currently used in supply chain management, which stakeholders are currently involved in these applications and the purpose of using the blockchain. Due to the novelty of the topic, and because many start-ups and white papers dealing with the subject exist, the case study research also used some internet sources. However, the scientific background is not neglected in the literature analysis and the theoretical foundations.

The results of the literature analysis and the case study research are critically discussed in Chapter 6, and recommendations are made based on the findings. In addition, the opportunities and challenges as well as the potential applications of future supply chain management are discussed. The discussion ends with the adaptation of the case 'dry aged beef' through the findings of the study and the answer to the research question. It remains questionable to what extent this study can lead to more detailed recommendations for supply chain management, but this thesis is expected to provide insight into the opportunities and challenges of using blockchain technology in supply chain management. In addition, the goal is to provide an outlook regarding the possibilities of using the blockchain in future supply chain management. Finally, the limitations of this thesis are explained in Chapter 7, and in Chapter 8, a conclusion is drawn and an outlook provided.

8. Conclusion and Future Outlook

The aim of this thesis research was to examine the chances and challenges of the use of blockchain technology in future supply chain management and to investigate whether the blockchain can revolutionise future supply chain management. For this purpose, a literature analysis was carried out as the first step to collect the current state of research. Nine selected studies were investigated and the contents compared. Furthermore, a case study research according to Yin (2014) was carried out to analyse the current state of the practice. Nine case studies were investigated to examine how and to what extent they use blockchain technology in today's supply chains and which stakeholders are involved in their applications. In addition, various trends in future supply chain management were presented both from the social and business area as well as from the technological area and were discussed critically in the discussion. Furthermore, possible applications regarding blockchain technology were identified. In the discussion, the results of the literature analysis, as well as the case study research were analysed critically, and the opportunities and challenges of the use of blockchain technology in future supply chain management were highlighted. To solve these challenges, various recommendations were made, such as the use of certain trends in future supply chain management.

Both the literature analysis and the case study research showed that current supply chains have some weaknesses. On the one hand, a lack of transparency exists in today's supply chain, which is necessary, for example, for checking working standards, fair-trade directives or environmental guidelines and for creating security against counterfeiting, fraud and theft. On the other hand, supply chains are linked to a significant number of people and interactions, which slow down the processes. An example of this is that a container from China travels to Europe for 40 days, but it is moved only 24 days; during the remainder of the days, nothing happens, which shows that enormous potential exists for increasing efficiency along the entire supply chain.

The case study analysis demonstrated that blockchain technology can solve these problems. Thus, the analysis of the Skuchain and Provenance case studies showed that the blockchain makes the supply chain more transparent. As explained in the theoretical foundations, transparency is one of the fundamental characteristics of blockchain technology and therefore offers the solution to this problem. In addition, the analysis of the Blockverify and Everledger case studies showed that the blockchain can also make the supply chains more secure and thus protect against counterfeiting, fraud and theft. On the one hand, the assets in the blockchain can be registered, managed and traded to prevent fraud, counterfeits and theft. Blockchain technology offers the advantage of almost being impossible to hack. Integrity is also one of the essential features of the blockchain, protecting data from tampering.

On the other hand, trade in counterfeit goods is considerably harder due to the new transparency. The IBM and Walmart, IBM and Maersk and Port of Rotterdam case studies have shown that by digitising and automating the supply chain, the processes can be accelerated with the help of the blockchain and smart contracts.

Thus, blockchain technology is capable of solving the problems of supply chains, but some challenges also exist. Thus, the new transparency has a different side due to too much transparency; the free market economy can be impaired, as every supplier would know what offer his or her competitors made, or some stakeholders of supply chains could simply be left out. In addition, for small IoT devices, too much information could lead to the loss of efficiency. The solution to this challenge lies in the original idea of the blockchain, which is not the storage of data decentrally but only the concatenation of hash values for verifying transactions. However, due to modifications in many current blockchain-use cases, data sets are also stored in the blockchain. If the blockchain is used only for verifying transactions, it can be publicly accessible without too much transparency. The storage of the actual data, such as offers, invoices, customs papers and so on, could then take place in another data layer, where access to the data could be restricted. Moreover, for the integration of IoT devices, it would be critical not to store too much information in the blockchain that would not be necessary for executing their processes, as this would only make them inefficient.

Probably the biggest challenge with the use of blockchain technology in supply chain management is, however, that the blockchain cannot guarantee that physical products have not been altered without this being stated in the blockchain. The problem exists because physical products are transferred to a digital world, and in most cases, people are the interfaces. However, the physical state and its digital state may not match due to human errors or malicious manipulation. Although it is possible that the physical and the digital state do not match, the blockchain actually does not bring any great added value because, again, intermediaries, such as external auditors, are needed to create trust. It is therefore important to note that blockchain technology can improve today's supply chain but cannot revolutionise it due to the problems that cannot be solved today. However, the topic of this thesis research was the analysis of blockchain technology for future supply chain management. The various technological trends in future supply chain management lead to the automation of the supply chain, making machines the interface between physical assets and digital technology, which does not result in human failure or malicious manipulation because machines are now used instead of humans. According to this, blockchain technology can also offer great added value for future supply chain management and revolutionise it.

It should be noted that both the theory and the practice of using the blockchain in supply chain management is still in its initial stages, and new developments as well as adaptations over time could have an influence on the use of the blockchain in future supply chain man-

agement. In this thesis, only ideas for the use of future supply chain management have been proposed and discussed. It is necessary to examine these more closely and to integrate these successively into supply chains. However, solutions must also be found for situations where, for example, a machine in the supply chain fails. Furthermore, it was possible to investigate the case studies only with today's known information, which is still very small and will certainly be available in the future in more detail. It is also questionable how future legal regulations will be designed and how they will influence the use of the blockchain as well as trends in future supply chain management.

Recommendations can already be made in this thesis, but deeper investigations, such as observations or experiments, should be carried out in the future regarding the successful use of blockchain technology in supply chain management.