Strategic realignment of medium-sized companies due to distributed ledger technologies in supply chain management

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More than 10 years after the invention of Bitcoin, the underlying blockchain technology is having an increasing effect on today's society. Although one of the most popular application areas of blockchain is still the field of cryptocurrencies, the technological concepts are crossing into further application domains such as international supply chains. Fast-changing markets, high costs of time and risk management as well as biased relationships between the actors pose big challenges to an appropriate supply chain management. Based on a case study about sensor tracking, this paper explores the potential impact of blockchain on small and medium enterprises within an international supply chain. We will show that blockchain technologies offers a high potential to reduce inequalities of power relations between involved actors within supply chains. To achieve this, the requirements for the use of blockchain in supply chain management will be analyzed by means of a conducted case study and an expert survey of the companies concerned.

1. Introduction

Nowadays, global competition, cheap production resources and the rapid availability of materials and products place high demands on an appropriate supply chain management (SCM) within companies. Within such a supply chain, a large number of different actors play a crucial role. Suppliers, manufacturers, customers and service providers all aim to improve its efficiency [1], usually resulting in a low manual effort, i.e., a process chain that is automated as much as possible [2]. To address the challenges of a low manual effort within the supply chain, there are plenty of different SCM systems and technical networks aimed at supporting (semi-)automated internal, but also external cross-company processes [3]. With the advent of inexpensive sensors and devices as well as new possibilities for data exchange, the Internet of Things (IoT) became an effective way to track and authenticate products and shipments using several kinds of data sensors such as GPS or RFID [4]. The IoT devices are further meant to measure environmental aspects and therefore to monitor conditions of products and their quality throughout the entire supply chain.

However, when focusing on small and medium enterprises (SMEs) within supply chains, they usually have large financial constraints, wherefore their high priority is more often placed on inventory management and control [5], instead of an effective SCM. Therefore, the data on the supply chain (including sensor values, environmental parameters, etc.) is held and maintained by the large companies. For this reason, SMEs are forced to trust the data of the large dominant companies within the supply chain, which lead to major differences in power relations and tensions.

Distributed ledger technologies (DLT), such as blockchain, promise a "trustless" transaction system including an unchangeable storage and transparent traceability of data [6]. The multitude of different actors within supply chain networks resulted in first use cases for the application of DLT within the SCM [7]. Distributed ledger technologies store the data transparently for all parties involved and thus create a basis of trust. These technologies thus enable process efficiencies and a uniform information basis to be created.

Such use cases usually consider new forms of sensor-supported hardware which automatically gathers data within the supply chain and stores it in a traceable manner within the distributed ledger. The DLT-based business relationships within the supply chain and the transparent traceability of sensor data are predestined to especially support SMEs to operate in collaborative value networks with shared power relations and grounded negotiations and to enhance the chances for a possible transformation from market imbalance to a rather transparent and fair business. Small and medium enterprises can develop competitive advantage through new implementation strategies [8]. However, in exactly which way SMEs are able to transform or strategically realign their traditional business with regard to their role in a supply chain and thus shifting into DLT-based supply chain management is not obvious. Within this paper, we therefore address the research question which requirements for the use of DLT technologies in SCM must be fulfilled and what are the impacts on power relations between their business partner?

The paper is structured as follows: within related work (section 2), we introduce into the fields of supply chain management and blockchain technologies and present current approaches that focus on applying blockchain technologies within SCM. We will then report on the findings of a product development about tracking IoT data within supply chains and its deployment within an actual

business case (section 3). Based on this product deployment meant as technology probe we were able to discuss with the involved actors blockchain technologies within SCM. Based on the following interview study with the involved actors (section 4), we present the findings about blockchain technologies in supply chain management from the SMEs perspective and its impact on power relations (section 5).

2. Background and state of the art

The research combines two areas of research. The first focuses on IoT-driven supply chain management, the second on blockchain and distributed ledger technologies.

2.1. Supply Chain Management and IoT

A supply chain is a network of companies to supply, produce and distribute a specific product to a final buyer. Nowadays, a supply chain consists of several actors that including legally separated organizations for producing parts or components, providing logistic services and even the customer himself bound by material, information and financial flow [9]. Supply chain management (SCM) encompasses the integration of all core business processes within a supply chain which lead to an increase in value for consumers or actors across organizational boundaries through production data, services or information [10]. Advancing information and communication technologies (ICT) made it possible to process information at different locations within the supply chain, thus enabling advanced planning [9].

As supply chains become increasingly global and complex, companies try to outsource several supply chains services to specialized third-party logistic companies. Although on the one hand a multitude of tasks can be outsourced to specialized companies, on the other hand there are increased requirements for a comprehensive information management and mechanisms to share information within the supply chain. Borade and Bansod (2007) expect that in future all organizations need to adopt partnership information sharing initiatives with suppliers, which requires the establishment of mutual trust within the supply chain to share the vital information [11].

The concept of the Internet of Things (IoT) can be described as a network consisting of numerous “smart” objects, which form an overarching information network to exchange information between interconnected physical objects. The Internet of Things appeared for the first time within the supply chain area in 1990 [12]. Here, the devices are usually equipped with electronic sensors such as RFID making them uniquely addressable [13]. Applying IoT within the supply chain mainly contributes to an improved quality of information and new ways of enabling interactions between goods and machines, but also between humans and machines [14].

The basis for the advantages of applying IoT within the supply chain [15] lies primarily in electronic product coding technology coupled with internet technology [16]. Nowadays, RFID is especially widely used in SCM for efficient data acquisition. RFID tags contain information such as the volume of goods, weight, production date, batch numbers and much more. This technology is often the determining identification for the link from manufacturers, transportation, warehousing, distribution, to the assembler [17]. However, RFID typically requires a reader to query the data at certain stations in the supply chain, which means that there is no continuous tracking, for example on the high seas. To tackle this problem, first developments for tracking devices try to independently send data to relevant actors in the supply chain to get live status of goods and their conditions [18].

Some big ICT companies such as the Telekom AG are currently developing new solutions for IoT which will primarily benefit the manufacturing and logistics industries. The focus is usually on applications that cover the machine and sensor network Narrow-Band IoT (NB IoT). These novel technologies are characterized by the comparatively low costs and lower energy consumption. Using this technology, companies are able to integrate millions of objects and processes inexpensive, fast and integrate securely. Compared to the conventional technologies based on GPS the Low-Cost Tracker has the advantages of lower costs, worldwide 3GPP standard and longer battery life. In addition, these novel trackers also record – besides movement data – additional parameters like vibrations or temperatures. The built-in sensors record and transmit data about harsh environmental conditions or improper handling of the goods through the entire supply chain [19].

Such approaches foster transparency among the involved actors and may affect negotiating power. Transports can be continuing monitored, and due to the integrated movement alarm, theft prevention can be carried out successfully. The sum of these functionalities should pave the way for a large-scale cross-sector use. The Telekom AG reports that due to missing information 30 percent of all deliveries worldwide do not reach their destination in time, and freight theft costs companies billions. Intelligently networked load carriers bring more transparency into the supply chain and the transportation of goods by water, rail and road can be controlled more precisely.

2.2. Blockchain and Supply Chain Management

More than 10 years after the invention of Bitcoin in response to the 2008 global financial crisis [20], the underlying blockchain technology is having an increasing effect on today’s society. A blockchain consists of chronological blocks which represent digital information stored with time stamps in a public database. The individual blocks contain a hash value of the previous block so that verifiability is guaranteed and through referencing the previous block a chain of blocks (blockchain) is created

[21] Usually, the information sent and who sent it is encrypted and only visible to the sender. Each transaction made can be transparently viewed on the blockchain, where the users are usually represented by pseudonyms.

Consensus algorithms are used to achieve agreement between distributed processes and systems within the peer-to-peer network. This peer-to-peer network is designed to achieve reliability in a network with unreliable nodes. Several different consensus mechanisms have already been established in the blockchain area. The most used are the proof-of-work (mining), proof-of-stake or byzantine fault tolerance algorithm [22]. Beside the field of cryptocurrencies, technologies such as Ethereum [23] or Hyperledger [24] allow the creation, administration, and execution of decentralized programs. These decentralized programs (called smart contracts) paved the way for the development of decentralized applications (dApps) that allow the distributed execution of an application within the peer-to-peer networks.

Decentralized applications offer great potentials in the area of trade finance, where a bank processes financing for goods traffic between exporter and importer. The involved actors often do not know each other or simply do not trust each other enough for paying in advance. The exporter wants to receive the payment for the goods before forwarding them to the importer. The importer on the other hand wants to receive the goods before paying the exporter. If blockchain technologies are used, it is possible that the manufacturer can be paid instantly [25].

Letters of credit are a conditional promise of payment by the credit institution, which notifies payment to the payee upon presentation of previously defined documents. The requested documents can be transport documents, such as bills of lading, waybills, unloading confirmations or take-over confirmations, certificates of origin, certificates of quality or insurance certificates. Within the supply chain, parties involved create the documents and pass them on to the other parties involved. Traditionally, most documents are still created and exchanged physically.

Blockchain technology aims to ease these process steps by storing data of IoT sensors transparently within a blockchain and linking those directly to the trade documents. This blockchain-based sensor data serves as evidence for later negotiation. A container, for example, can automatically link temperature and GPS data to the blockchain. Information is picked up by the sensors and saved in the blockchain. After receiving the data, the commands are interpreted, and the system can be executed automatically via the smart contract [25].

There are already several approaches that apply blockchain technologies to SCM. When focusing on rather technical studies, different blockchain frameworks get covered by Samaniego et al. [26] who elaborate on IoT devices which are being used within blockchains to manage device configuration, store sensor data or enable micro-payments. Augusto et al. [27] analyze smart contracts, that are used in the IoT environment of logistics where they highlight the benefits of applying blockchain technologies. However, these approaches mainly focus on rather technical evaluations and lack practical validation.

There is further work focusing on the impact of using blockchain technology in several branches and industries. Casino et al. [28] gives an overview with a systematic literature review about the current status of blockchain applications. Nagamalai et al. [29] deal with the perspective of smart contracts applied for security, privacy and performance issues. Saberi et al. [30] deal with blockchain applications in supply chain risk management, and Korpela et al. [31] perform research on strategic and operational information exchange within a supply chain network via blockchain. All these studies focus on large companies and do not take into account the specifics of SMEs and how blockchain technologies might impact the relationships with other actors within the supply chain.

Wong et al. [32] turned to SMEs and examined the adoption of blockchain in operations and supply chain management among Malaysian SMEs. They revealed the importance and potential of networked ledgers which share real time data to everyone who participate in the network. Within our study, we will extend these perspectives by examining German SMEs and providing substantiate views with an actual use case instead of merely remaining on a rather theoretical level about potential effects.

The literature study shows first investigation of blockchain technologies within supply chain management. However, current approaches focus either mainly on technical investigations or on large companies. Our paper therefore shows the explicitly turn to the role of SMEs and impacts of applying blockchain technologies on the current unequal power relations within supply chains as well as describing the necessary requirements for the implementation of the technology.

3. Case study on managing sensor data in supply chain management

As the literature review revealed, tracking the goods within a supply chain is a major concern for companies. Several problems can arise such as fraud, changes over illegal routes, stealing as well as wrong or unsafe storage under incorrect conditions. As soon as goods are on the way to their destination port, they can no longer be tracked and even if a data platform is used, the company must trust the data points and depends on the data of the shipping a company. This hampers a complete validity and there is no guarantee for the involved companies. Supply chain management is still mainly based on

physical paperwork such as the bill of landing, which secures the right to the goods. Tackling these challenges of modern SCM, the companies involved try to make use of modern ICT to digitalize the paperwork, foster automation, and track the supply chain with different kinds of parameters.

To get insights into which requirements are necessary for the use of blockchain in SCM, we conducted a particular case study together with the companies described below. The aim was to examine the decisive parameters for the implementation of a blockchain solution based on an actual working product instead of rather a theoretical basis. Within the case study, we will report on the findings of an IT project together with a big bank (BANK), an Association for Technical Inspection (TÜV), a logistic enterprise (LOG) as well as a small, but global trading company (TRADE). Thus, beyond a pure literature review or test in a laboratory environment, a live test on the requirements for the use of blockchain in supply chain management was carried out. All names of the companies are anonymized for the review.

The small trading company has its headquarters in Germany and employs three managers, one of whom was responsible for working on the IT project. TRADE procure and sell non-food goods for customer needs, such as small electrical appliances, tools, gifts and decorative items. Their customers are well-known supply chains in Germany and Europe. TRADE offers an own logistics service for GPS data tracking of goods consignments.

The project was carried out by sending a tracker from LOG to the TÜV office in China. The TÜV inspector in turn attached the tracker to the goods and the container was sealed after the goods were loaded. This ensured that nothing could affect the tracker. The imported goods were able to be tracked and traced the entire distance through the tracker. The transport was followed from the production factory in China to the customer in Germany with geofencing. In the IoT tracking project the combination of an API interface with the geofencing contained all the relevant data, such as the time. In particular, at which time the goods arrived at a port on the route.

The implemented “Smart Visibility” service from LOG (Figure 1) made it possible to ensure real-time tracking along the process chain and as it was able to transmit the following environmental data: temperature, air pressure, humidity, vibration and door closing and opening. The IoT-based traceability system enables the company to monitor the quality from production process to delivery to the end customer. Moreover, trust in a cross-sectoral collaboration is enabled, as the data platform and the IoT-tracker share the correct information. This is however problematic, as the owner of the platform has all the power and data available.

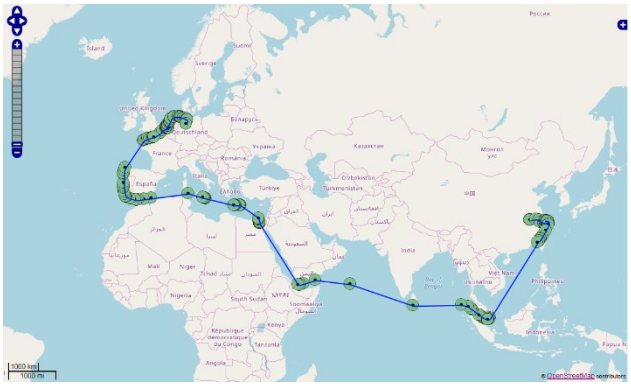

Figure 1 “Smart Visibility" service from LOG Platform

Through the development of procurement and sales activities, the SME wants to establish communication networks with partnership, equality and trust. Due to the pressure of small margins and innovations in SCM, new processes play an increasing role for the involved companies. For this reason, the goal is to process and digitalize the entire value chain so that competitiveness can be maintained.

Furthermore, if a product has left production, no specific information is available. The import companies like TRADE just get a status information, but has no chance of tracking their ordered goods through a reliable platform. To solve the problem, a distributed ledger technology like a blockchain was discussed to strengthen the partnership through trust in an unchangeable system.

In the corporate environment, primarily a consortium technology solution is going to be used to strengthen the negotiation power and equality between the partners. So, TRADE can have a more important role in the supply chain and have more security through the trustworthy data received. Moreover, the complete and reliable traceability in supply chain management can make it reliable and trustworthy, which enables process efficiencies and cost reductions for TRADE.

This project was a first step in using an IoT data tracking platform as a technology probe for discussing SCM platforms using blockchain. To be able to make demands on a functioning blockchain system it is necessary to conduct a live use case and to share these experiences with the participating companies. The case study evaluated to what extent and with which conditions a blockchain-based solution can be used. Furthermore, the imported goods were real goods, where a mistake would be costly and therefore a comparison was made from the results, which requirements had to be fulfilled step by step, so that the blockchain could be connected. Therefore, a classical data platform was taken from the provider LOG and the collected data was evaluated afterwards.

The result of the project was that the different parameters, such as the fact that the IoT tracker does not have access to the network on the world's oceans and cannot retransmit the data packets. It was also revealed that these data that had not been transmitted could be for-

warded afterwards. This is important to adapt the automatic pre-defined contracts to this special feature. Such requirements must be considered, as well as the fact that the sending of the data packets for the different contractual partners may arrive with delays and that there must therefore be no breaches of contract or penalties. The letters of credits to be redefined must also be adapted as well as that the decisions are no longer based on pure trust in the contractual partners rather than the new implemented system.

During the case study and the actual live tracking of the product, a trade finance blockchain solution was announced by the companies as an alternative product to the existing solution. The IoT tracking project therefore served as a helpful component for further development for new solutions in SCM. In addition, BANK has entered a cooperation with 12 other enterprise partners to develop the supply chains of the future. Exactly this endeavor can now be developed with the data collected from the TRADE project.

During the study, the involved actors discussed that the information obtained, such as a trusting structure across the entire delivery network, as well as the transparency and real-time of the delivery information is of crucial importance. Based on the measurement data collected, smart contracts can be attached to a blockchain solution, which can automatically make a payment for predefined events. The manual and paper-based checks of the documents can thus be omitted. However, a transition from the current IT infrastructure to a company-owned blockchain database would require a substantial shift. Indeed, the shift to a blockchain based technology with an IoT traceability system could, through the data immutability, prevent fraud, reduce costs, gain trust and leads to more negotiation power between the participants.

Blockchain technology now enables all banks to store the information on a node and make it accessible to everyone involved. The confirmations are validated by the contractual partners and posted synchronously. Since all data is stored on the permissioned blockchain and cannot be changed, protection against forgery is guaranteed. Interest and principal payments can still be automated via smart contracts. The bank that provides the platform can charge everyone an extra fee, but the platform can make it more transparent, faster and cheaper for everyone. Smart contracts offer the opportunity to agree contracts between business partners without programming via a central office. Breach of contract or legal disputes are thus imposed [33].

In addition to trade finance, the decentralization of the standard credit business also causes many distortions on the financial markets. Through peer-to-peer transactions, the intermediary is no longer involved in the customer's value chain. Blockchain could become a valuable tool for negotiation power, in which SMEs join through a consortium and receive the chance to develop the supply chain process. These processes are usually complex and need a lot of manual execution. The exchange between the enterprises is time-consuming and expensive due to the different IT structure and the exchange of paperwork.

4. Evaluation of the applicability of blockchain-based SCM

To further evaluate the case study findings and first ideas, this section introduces an interview study. The interviews were conducted after the actual product deployment to obtain practical information from the participating companies. Based on the analysis of the companies' feedback, we derive requirements for the use of blockchain in supply chain management.

4.1. Methodology

The interview study was meant to validate, prioritize and enrich the prior case study outcomes with further practice-oriented experiences. We chose semi-structure interviews with multiple experts involved in the same case. We selected five participants according to their position and project involvement within the different companies BANK, TRADE, and LOG [34]. The employees of the companies were also involved in the use case, so that a subsequent evaluation of the results could be carried out. All participants are employed in the trade finance area and would like to see changes in the process in the future In this paper, the importance of having experts give insights into their personal view of the analyzed problem was also considered [20].

The actors were asked about the company's status quo in dealing with supply chain management, assessments of the requirements for blockchain technology and the influence of blockchain technology on SCM in their respective companies Hence, a standardized way to approach the interviewees in three categories to ask general questions, case related questions and questions dealing with a future outlook were used. The interview outcomes then were analyzed according to Mayring's qualitative content analysis [35].

4.2. Interview Results

Our results revealed, that the participants see high potentials in blockchain technology for reducing the administration (costs) of paperwork, and replace the current silo systems by new technology possibilities: "Customers try to digitize and work with us to get off the big paperwork" (interviewee 1). However, there are some major challenges in the current supply chain process. Currently the within the entire process and the forwarder is dependent on the decisions and specifications of the other partners. For instance, the supplier is between the two big power relations of the producer and the retailer. On the one hand, the producer has all the power if the producer has not started the production or acquired the material at his own expense. On the other hand, the retailer can reject the goods as any time: The

retailer can also look at the goods so closely at any time and reject them for no reason (interviewee 2). There is no objective process, if there are contractual defects concerning the goods. Also, the retailer acts as a translator and as a kind of insurance agent between the two parties and becomes the risk taker in the procedure.

Due to the above-mentioned aspects, it is especially interesting for the surveyed companies to test out new technology-based use cases. Basically, there are a handful of companies with which we can work in partnership and further develop projects (interviewee 3). The area of blockchain could be one of the most promising. However, there is just curiosity in blockchain, a real adoption and implementation shall not affect the current supply chain process until advantages are visible. The implemented use case of IoT data tracking was also valuable for the development of the blockchain-based supply chains, because problems arose which could not have been thought of before. The IoT device transmits via the mobile data network and if there is no access to the data network, then no information can be stored in the blockchain-based. In this specific case, the tracker in the Indian ocean was too far away from land and could not transmit the ship's position and other predefined data. In this case, such challenges must be considered for the implementation of trigger events via smart contracts. “Smart Contracts are useful in that an action can be triggered as soon as a shipment arrives in the geofence. The triggering of an automatic payment process would be sufficient, too” (interviewee 3).

According to the interviewees, the following points can be seen as advantageous for the current challenges: no down payments and automatic payments, less paperwork because of the credibility of a distributed ledger, smart contracts in specific defined trigger events, more transparency, less fraud, security data quality IT standards, networks and equality in the drafting of the contract. The challenges must be solved before the new technology revolution can be applied in practice. This also requires the creation of product solutions and easy implementation interfaces. “There is no real product available yet [...] We are not faced with the choice of using either blockchain products or classic products. At the moment it is only interesting, but not practicable. (Interviewee 2)

Finally, the respondents praised that supply chain-based technology solutions are more attractive to them: “We also have a great interest in knowing that our data is stored securely and that we do not fall into the hands of individual large companies, and therefore we would tend to use blockchain solutions” (interviewee 2). Here, the integration of different business networks can help with collaboration of different companies. “It will become decentralized and many business networks will emerge, like Marco Polo [a trade finance initiative]. Many business networks with specific degrees of decentralization will emerge and networks will be established between the entire platforms” (interviewee 1).

After analysis of the survey the decision for distributed ledger networks plays a decisive role in improving cooperation between supply chain partners. Furthermore, analysis showed that the use of objective clearly defined rules, which are observed equally by all contractual partners, leads to a fair and sustainable business relationship.

5. Discussion

The case study has shown the usability of an IoT application in SCM and what requirements or potentials lays in DLT technology, which can create an equilibrium of forces for German SMEs in supply chain management. With the collected data from the use case and the insights gained from the interviews, a blockchain based solution can be developed. By interviewing experts following the use case, the insights could be shared and analyzed to answer the research question about requirements for the use of DLT technologies in supply chain management and its impact on power relations between involved business partners.

The design of the use of such a blockchain-based platform must consider the fact that international transport routes can lead to tracker failures, as it is not always possible to establish a network on the world's oceans. Smart contracts must meet these requirements. Furthermore, the live use case showed that a platform has to meet the requirement that the objectivity of the data can be given to all participating persons at any time and that decisions are no longer based on pure trust in the contractual partners. As the empirical survey revealed, the participating companies are concerned about the data security, applicability, evaluability of the shared information. Furthermore, the evaluation of the existing frameworks should be advanced as well as standardization for rapid adaptation to the market.

Intermediary-free structures enable objective and fair corporate relationships to be established for supply chain management. The inherent transparency of blockchain also means that information is shared equally between all parties and can no longer be manipulated. Equal rights in the supply chain management also means that the SME is no longer subject to uncertainty, but rather to trust. The experts involved also agreed that a distributed database infrastructure like blockchain will come on the market anyway and that early testing has the decisive added value for future implementations. They also list some potential advantages like no down payments and automatic payments, less paperwork because of the credibility of a distributed ledger, smart contracts in specific defined trigger events, more transparency, less fraud, security data quality IT standards, networks and equality in the drafting of the contract

Furthermore, this research indicates that it is essential to conduct live use cases, as this is where the real problems and challenges can be identified. Some points cannot be considered in a theoretical considerations and

tests, such as the issue that the IoT-tracker had no connection to the country and could no longer send data live but had to retransmit it. These uncertainties could be found out with the research approach of accompanying the use case. Currently, most approaches do not focus on already existing (and well-established) ICT which is already used in SCM. This paper could thus provide decisive assistance for future studies that focus on the equality of bargaining power for SMEs in supply chain management under consideration of IoT devices based on blockchain.

6. Conclusion

Since Blockchain is increasingly crossing into various application fields, we provided not only an overview of the current literature in supply chain management with IoT and blockchain, but also a case study with an actual working product together with a German SME. Our case study was conducted to examine the potential impact of blockchain on small and medium enterprises within an international supply chain.

With the help of an empirical study, our case study was able to show that blockchain has the opportunity to reduce inequalities of power relations between the large enterprises and SMEs within supply chains. With the requirements now established for the use of blockchain in SCM a valuable input on the current state of research could be identified. The change of increasing negotiation power in supply chain management for SMEs is based on the new technology blockchain in combination with consortia with other companies. Future studies may be focused on DLT-Use-Cases using IoT-Devises to do automated payments or implementations for a transfer of risk for insurance. There is also a possibility of a more quantified perspective for the blockchain technology.

Moreover, the inherent blockchain characteristics like interoperability, transaction speed, costs, rights and remedies needed to be assessed. Blockchain or distributed ledger technologies could be one of the game changers in future supply chains. However, in order for a fundamental change, cooperation between all participants is required and problems like the limited transaction speed must be solved. Also, the frameworks need an evolution in form of satisfactory IT security, objective standards and equality in the process. The case study of the German SME was presented to uncover necessary requirements for using blockchain in SCM tracing systems as well as current open research areas. Also, the implemented IoT tracking case will be implemented in a subsequent step by the participating companies in a permissioned blockchain solution and the gained insights will be included.

However, further studies are needed to examine the impact of the use of blockchain technologies in SCM in terms of profitability particularly for SME's [36, 37, 38]. The results of this study should therefore not be considered as part of a series of examinations. Only a few studies were focused on the use of blockchain in SCM and no study on the effects of reducing inequalities within power relations has been conducted so far [32]. The small number of studies in this new specific makes it difficult to comparisons our work with other existing and actual tested technologies and use cases. Also, hardly any small and medium sized enterprises have adapted their existing business models in such a way that blockchain can be integrated into SCM [36, 39], which leaves an field of research that can be focused on in future. Following studies can therefore build on our initial work and examine the process chains in the SCM that will change significantly in the future due to distributed ledger systems [32]. Although our work only presents the first steps of applying blockchain technologies in international supply chains, we hope to inspire other designers and developers trying to engage with the issues that may arise from the intersection of SCM, IoT and blockchain.

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