The Use of Blockchain Technology in the Supply Chain: A Case Study from Austria

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AFFIDAVIT

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ABSTRACT

As blockchain is praised being one of the upcoming game-changing technologies of our time, which leaves marks on various industries, actors of the supply chain are more and more occupied with its unique features, such as transparency, data immutability and data security. Likewise, various stakeholders along the supply chain were affected in different ways by the paradigm changes blockchain can bring to lower existing limitations and simultaneously strengthen trustworthiness within the supply chain. However, in order to be a reliable means of choice for supply chain business models, blockchain needs to improve on its maturity of technological development. This especially applies to limitations on its scalability and network capacity. This thesis follows the multiple case study approach based on the framework of Yin (2014). Two case studies deal with projects from Austria, but from different perspectives on blockchain utilization in the supply chain. While the case study of 'Blockchaininitiative Logistik' is about the digitalization of freight documents, the Rotharium case study focuses on a decentralized track and trace solution. Nonetheless, both cases mostly agree with the stated case propositions, which derived from literature-based theory. This thesis serves as a guide for practitioners interested in applying blockchain solution in their logistics environment and equips the reader with theoretical and practical recommendations.

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LIST OF ABBREVIATIONS

BIL	Blockchain Initiative Logistik
BVL	Bundesvereinigung Logistik Österreich
BPR	Business process re-engineering
CMR	Convention relative au Contract
COVID19	Coronavirus Disease 19
DSC	Digital Supply Chain
DLT	Distributed Ledger Technology
EDI	Electronic Data Interchange
ERP	Enterprise-Resource-Planning
GDPR	General Data Protection Regulation
P2P	Peer-to-peer
PoS	Proof-of-Stake
POW	Proof-of-Work
OECD	Organization for economic cooperation and development
QR-Code	Quick-Response Code
RBC	Responsible business conduct
RFID	Radio-frequency identification
SC	Supply Chain
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference Model
SHA	Security Hash Algorithm
USP	Unique selling proposition
VMI	Vendor Inventory Management

1 INTRODUCTION

"We have elected to put our money and faith in a mathematical framework that is free of politics and human error."

(Tyler Winklevoss)

From today's perspective, we cannot explicitly say if the quote above applies to be true. What we can say is that scholars, media and pioneers in particular attribute blockchain technology as a technology with a high level of potential. Still, besides the many possible ways and ideas of solving business-related issues, it is questionable how keen enterprises are to use this kind of technology and how a possible approach fits into regal regulatory of different governments around the world. While critics argue the technology for being in children's shoes with only having fraud-related currencies as a practical use case, this paper will reflect possible benefits in the area of the supply chain. The academic contribution shows in the first step by an analysis of state-of-the-art literature in the respective field of blockchain and the second step by qualitative research in the form of a case study reflecting a possible implementation of technology on a real-life case.

Below, the chapter continues with a further introduction to the master thesis. Through the next parts of the chapter, the topic gets illustrated and a context between research and central parts of the topic is built, identifies aims and objectives of the paper, induces to think about the research questions and raises understanding for the methodology answering them. Finally, a structured review of the thesis gives a guide to scholars and other readers.

1.1 Illustration of the issues

Kenton (2019) states that over the past tenths of centuries, the term supply chain (SC), which defines as a network between a company and its suppliers to produce and distribute a specific product to the final buyer, went through incremental changes. It is an emerging term, which emphasizes interactions among different corporations departments, like logistics, marketing and production. While in the beginning, transportation technology was necessary, production, consumption of most items were local, and the cost of moving goods easy to determine we nowadays speak about a highly complex process, which is evolving year by year, bringing up challenging opportunities to its stakeholders. According to Sanyal (2012), we today see worldwide shipping, including several means of transport and possibilities to communicate within seconds by mobile or the internet at little cost. Of course, in this context, Tang et al. 2011 point out that new challenging issues come up and significant concerns have emerged in supply chains. Overall having shorter product cycles and increasing demand among all companies react

with outsourcing strategies, which require an extended supply chain network with increased nodes in the system.

Moreover, Lyall et al., (2018) emphasize that today's supply chain management systems mostly use so-called legacy systems, which means outdated in a sense that they define a basis but could not hold with the future standards following it. The lack of end-to-end transparency paired with the situation that people in the supply chain do mostly repetitive and transactional tasks is an issue because it leads to overstaffing and a miss of efficiency and an undrawn of existing opportunities.

Ballou et al., (2000) identify more challenges in the interaction between several parts within a supply chain management system (SCM). First, the metrics like costs and other relevant numerical data within the inter-organizational accounting systems; focus on the individual firm, instead of looking broader to multi-enterprise channel cooperation. Then a shortage of information sharing among firms in the supply channel nurtures mistrust, which leads to a potential breakdown of coalitions and partnerships. Eventually, benefits do not distribute equitably between the members of the supply chain. However, there is a try to put in place some informal mechanisms. The result can be opportunist thinking among stakeholders while seeking equality in terms of economic management.

Furthermore, Asaad (2018) mentions that there is an example of traceability in the food or agricultural supply chain there is an apparent lack to track the food product through the different stages of the supply chain and is nowadays an evident demand among customers. Clients want to know when it comes to the question of where their consumed products or ingredients have been throughout the production and logistics process. The miss of authentic and truthful information about each supply chain step can weaken consumers' trust, brand integrity and decrease customer loyalty. With the customers' rising sophistication, there is on top of that, also a particular risk of legal issues, which can lead to considerable problems in product launches. Ultimately, Fernie et al. (2019) mark critical challenges for retailers coping with e-commerce businesses, which bring up very different processing of supply chain to the surface. In order to secure full convenient customer care, retailers started caring about home delivery with an emphasis on accurate and real-time stock management hand in hand with a shortened delivery period, especially in urban areas.

We see above a handful of issues, which come along within the area of the supply chain today. The demand amongst participating stakeholders is diverse and the supply chain needs to react appropriately to satisfy the different needs. From my perspective, it is worth investigating what can is doable to bring supply chain one or even more steps further towards a ready and steady department, which can cope with future challenges and use opportunities, especially in the digital world. On top of that, pairing the challenges in the supply chain with the potentials and opportunities of blockchain technology

could result in a value-added output for both supply chain stakeholders, the same as the blockchain ecosystem itself.

1.2 Previous research and general context

In general, there is plenty of research in the field of the supply chain. As businesses, since industrialization have to cope with changes and challenges within the supply chain of goods, scholars same as practitioners answer questions on the progress and possible optimization within the area of SC. Since the turn of the millennium, we can see almost a million scientific articles in the search database of google scholar[1] dealing with the supply chain. Lots of them are considering several concepts on how to bring up the supply chain to a higher level not only in terms of efficiency and effectiveness but also in light of the rising importance of digitalization in nowadays society. On the other hand, research in the area of blockchain is a relatively new one. Introduced with the bitcoin whitepaper more than a decade ago by Nakamoto (2008), blockchain technology slowly went from a geeky niche product into an at least knowledgeable keyword amongst internet users around the world, amounting in roughly over 40% of consumers in financial service having heard about it (Zhao, 2017). The novelty of the topic causes that research on blockchain covers mainly possible use cases in a full spectrum of industries together with state-of-the-art literature with a descriptive character on the technological aspects of it. Amongst many scholars such as Tapscott & Tapscott (2017) or Tötzer (2019), blockchain is characterized as a possible game-changer in several industrial areas, especially where digitalization plays a vital role in future developments. As soon as supply chain and blockchain were into a mutual context, it is essential to emphasize that there is a need for clarification and analysis if a possible digitalization in the area of supply chain brings benefits to the overall supply chain processes. If so, the circle closes with a definite need for some critical examination whether blockchain can play an essential role in SC, or its usage is more poorly suited and not a real solution, which can help out of existing issues.

1.3 Aims and objectives

There are several aims this thesis wants to cover, in order to make the complex topic of blockchain usage and implementation comprehensible for everyone who is reading it. First, there is not explicitly a goal but an intent to encourage the reader to understand blockchain, at least in outline, including a basic understanding, because in my eyes, it will be mandatory to have this knowledge similar to the extend people understand for

[1] Google Scholar database keyword search: ‘supply chain’ - retrieved on June 6th, 2019

example the internet at this stage. Based on that, there is hope to achieve a level where the reader can connect the dots from blockchain to the area of supply chain persists. From here, vigilant readers should be able to understand the possible deployment of blockchain technology to any other real-life application, which could make their life more comfortable at some point. They should also be able to select cases where blockchain may be helpful and deny ones where it is not the best applicable way to use. The aim is to have a clear distinction between the blockchain potential within the supply chain compared to other economics areas. Another aim of this thesis is to investigate the relationship between blockchain and governmental behavior, rules and legislation – which is crucial when it comes to the mass adoption of new technology. Overall, the paper should raise the level of understanding, go beyond the state-of-the-art of scientific research, and mark a starting point for further investigation, same as a red line for possible future implementations.

This thesis focuses on providing an in-depth analysis of the role blockchain play in a possible digitalized supply chain of the future. It will discuss the most pressing questions, same as common challenges in a possible implementation of blockchain technology in the SC. A research objective would be to get a clear picture of the status-quo of Blockchain usage within the supply chain part of the financial world and to find out which reasons prevent companies from using it at this particular stage of time. Another research objective is to find out if blockchain solves the problem of companies, or can these be solved without it too. After a thorough literature review, which will cover several aspects of blockchain getting used in real applications through the value chain, there will be a case study of an Austrian company on blockchain implementation in the supply chain. Therefor a whole implementation process and conceptual framework will be simulated and put into context with the papers' research questions. There will be a valuation of opinions and points of view that people who are involved possess and a review of best practices in order to assure smooth, progressive work. On the other hand, the problems and obstacles will be adequately addressed with a valid link to decision-making processes inside the project. The gathered data and information gets extracted in order to establish a scientific relationship between theory and practice.

1.4 Research questions and propositions

In this thesis, an investigation on theory is happening. This theory gets tested, verified and explained. In order to develop - as a result of this thesis - an effective action and implementation framework which can be of use in real-life supply chain applications particularly the research questions and statements of this paper can formulate as follows:

Research Questions:

1. *Which business issues can blockchain solve within the supply chain of companies?*
2. *Which limitations does blockchain technology have in the supply chain?*
3. *In which ways are legal regulations considered within possible blockchain implementation?*

I have chosen these research questions, as essential elements of scientific research by following characteristics assessed in the context of the used research design. According to Hulley et al. (2007), research questions should follow the mnemonic of FINER criteria, which include that they are feasible, interesting, novel, ethical and relevant.

Propositions:

- *The use of blockchain can identify and trace a flow of goods with a high level of detail.*
- *Blockchain ensures a fair distribution of available information amongst participants of the supply chain*
- *Blockchain technology is a perfect fit to meet the needs of stakeholders in the supply chain.*
- *Governments declare detailed legislative requirements during an implementation of blockchain technology.*

The relevance of these statements to the study works as validation of theory. The conclusions are generally untested and the logic works in a way that there is an attempt to generalize from the specific to general terms, which further is useful in other similar cases and occasions. The data is collected to explore this new technology, identify themes and patterns and create a conceptual framework

1.5 Methodology

Subsequently, there will be an explanation of what used methods in researching and developing the thesis. What follows is mainly a brief overview, as an explanation of details can stands in the methodology section of the thesis.

As a foundation and therefore starting point marks the use of secondary data for a literature review, which gives a picture of existing state-of-the-art. This structured literature review follows the guidelines of Siddaway (2018), which means that this paper will establish to what extent existing research has progressed towards clarifying the research questions. Moreover, the aim is to identify relations, gaps, inconsistencies in the literature or contradictions and explain the reasons for these. Out of that, general statements and a possible conceptualization is formulated, which provides implications for practice and policy.

Crucial here is how the identification of significant relationships or patterns is happening and if there is any conflicting evidence. Although in the world of digital, technologies change and progress happens very fast, the data collected does not characterize as being out of date, since the term blockchain is just slightly over ten years old.

The theoretical assumptions from the structured literature review will flow as challenging propositions into the case study resulting in a benefit for it. Figure 1 shows the components of a case study. I will operate mainly on level two, by comparing theory and rival theory propositions backed up with implications during the case study investigation. The case study findings will project the circumstances under which blockchain and supply chain meet each other and at that point, aim toward analytic generalization.

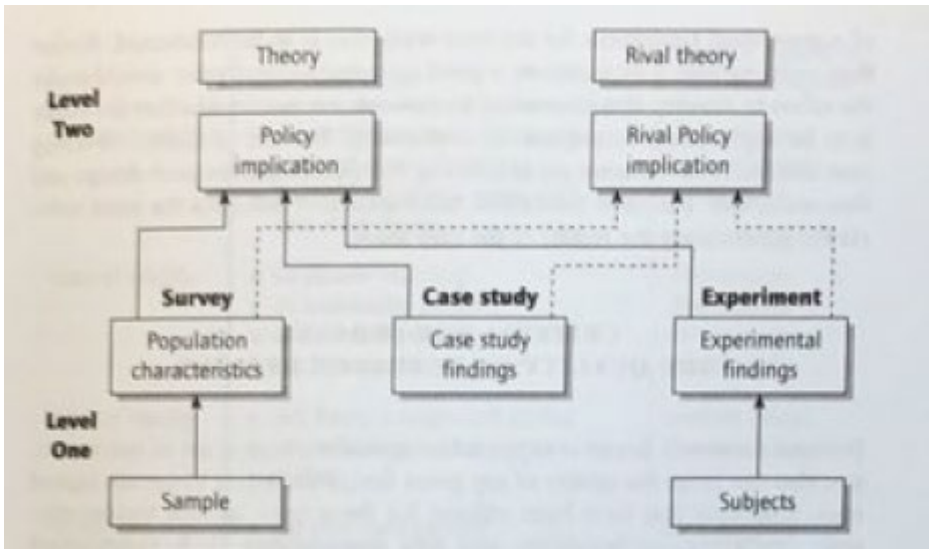

FIGURE 1 - ILLUSTRATION OF INFERENCES
(YIN, 2014, P. 39)

As the last step, the data analysis happens descriptively. There are logical descriptions of the outcomes and background information is revealed appropriately. The establishment of a problem-solution relation happens to stimulate discussions and recommendations on the research topic.

1.6 Thesis structure

After the introduction chapter, the literature review will consist of the following parts. The first sections will contain a brief definition and technical background of blockchain technology. Here readers get familiar with the underlying technological and cryptographical knowledge in order to be able to follow further paper content. The next part tackles the possible disruptive character of blockchain in the area of the supply chain. Here potential will be revealed to the reader by presenting ideas with clear distinction to what is possible to achieve with current technological progress and what may be achieved in the future when more and more people require the technology to mature. Based on that, the next

chapter points out problems and issues within the supply chain, which blockchain may solve when applied adequately. Finally, the role of politics and governments will get revealed when it comes to blockchain implementation and the question of what is permitted, what disallowed and are next steps to help the technology to break through mainstream usage. Based on this literature review, a first framework can be developed and put into comparison to real-life activities.

What follows is a detailed examination of the used methodology and the case study of blockchain implementation. I will accompany two firms, which are launching blockchain technology in their supply chain process. Moreover, the aim to spot as many contingencies as possible is essential, the same as the goal to describe the path of implementation in the best possible way. Possible best practices for further development are possible to extract and execute in future projects, the same as the avoidance of mistakes leading to issues in the project.

The last thesis section summarizes the findings from the literature and empirical study. It affirms or refuses the given statements and answers the relevant research questions. The proposition of recommendations adds to a well-established basis for discussion. The drawing of further conclusions from previous content analysis helps to provide perspectives for future research.

2 LITERATURE REVIEW

2.1 Introduction to Blockchain Technology

2.1.1 Definition and Terminology

As a topic of increasing relevance in the range of promising technologies, blockchain technology requires proper definition to ensure understanding amongst readers. While it is a trending topic, nowadays, there is no accepted standard definition, which includes all relevant factors of it. In a try to cover all notable aspects, Swan (2015) calls it the blueprint for a new economy, which is qualified by the existence of a transparent, open and decentralized database. Further definition from Bradley (2016) describes it as open-source technology, which works as an alternative to current centralized systems, because the intermediary, like a third party partner, is skipped in favor of a collective verification within the settled ecosystem. Another characterization by Drescher (2017) explains it as a peer-to-peer (P2P) system of journals, which uses an algorithm, based software components intending to exchange information in organized linked data blocks with the help of cryptographic security technologies. Other scholars like Klötzner & Iten (2019) see blockchain as an unalterable list of transactions in a distributed network where entries of participants are validated with a digital signature and put together sequentially following a consensus mechanism. Twesige (2015) compares it with the internet by calling blockchain a protocol that governs the rules and regulations for value exchange within a particular network, while the internet serves as a means for communication exchange. The value here is explained broadly as the measure of the benefit to an economic agent. A drill-down into three fundamental components marks Kuner et al., (2018), who formulates blockchain as a system for recording a series of data items that uses encryption to make it as difficult as possible to tamper entries and has a democratically agreed process for storing journal copies.

An opposite approach of defining blockchain comes from Pilkington (2017), who mentions Vitalik Buterin, the creator of the blockchain computing platform Ethereum. He states that a blockchain definition does not link to any technical features and attributes like above mentioned. He sees algorithms, consensus and cryptography rather as applications and properties than definitions. Blockchain here describes the visible consequences of the actions taken by users of a network. Therefore, as a transitional and evolutionary technology structured around a network.

Zheng et al. (2018) mention a significant distinction in defining blockchain is the subsumption in a public and private blockchain. Depending on the classification in either one of these two, possible usage fields can be determined. It depends on what kind of use case can be applied to which blockchain. The public blockchain is defined by the open-access of validation nodes for the consensus-building process, with all transactions being visible to the public. The large number of participants acting as a consortium in a

public network makes sure falsification is nearly impossible but at the cost of higher latency and efficiency issues.

On top of that, public blockchains identify as strongly decentralized networks. On the other hand, Lin & Liao, (2017) point out that private blockchains have strict authority management on data access, paired with a restriction in the decision who can participate in the network. This kind of authority management leads to the fact that these blockchains are in full control of an organization that could determine the mechanism of consensus, access permission or the possibility to alter or reverse ledger entries. Literature also provides mixed variants, like a consortium blockchain, which has attributes of both public and private databases. An overview of participating stakeholders in the blockchain economy comes from Lewrick & Di Giorgio (2018), who group according to several aspects dependent on the interest and aims of the parties involved. The starting point gets often formed by entrepreneurs or decision-makers in companies who have disruptive ideas, technological interest, the right feeling for potential or that a strategy of digitalization and optimization is mandatory for future success and competitiveness. The execution and final realization remain reserved for the labor, which is working operationally, namely IT developers or blockchain advisors. They sharpen, test and audit within the whole implementation process as specialists in their respective fields to satisfy not only leaders but also regulators, who build the next group of stakeholders. These regulators work on a structural framework, which represents current legislation in order to support upcoming decentralized systems. Finally, we see investors who aim to spot the inner value of a project and support it with a respective investment with the expectation of value gains.

Because of a ubiquitous tech hype all over the world, many scholars disproportionately use the term blockchain. However, there is a lot of wording and terminology, which goes hand in hand with it. Based on Dascano (2018), similar to an accounting journal, the term blockchain describes a spreadsheet. This spreadsheet contains all executed transactions between the users in a network. The process utilizes blocks and each of these blocks contains information on all happened transactions and connects to the previous block. The process of stringing together these blocks in a chain led to the term of blockchain.

Moreover, Back et al. (2014) mark that there is also a possibility to use so-called sidechains, which exist parallel to the main chain creating possibilities to lower latency of information exchange because of the number of confirmations to achieve consensus lowers while the trust principle is held constant. On top of that, with pegged sidechains, an asset transfer between multiple blockchains seems to get possible soon. Furthermore, Laurence (2017) mentions that size, period and triggering event for new blocks is different for every blockchain as not all blockchains see velocity, transparency, movement record or security as the same primary objectives. Dependent on the aim to create

value, particular attention shifts on either one of the targets. The act of chaining the different blocks together happens mathematically in a trust-building process.

The result of the above-mentioned trust-building process is called consensus. Scholars like Nguyen & Kyungbaek (2018) explain the term as an agreement, which governs whom of the network participants, is permitted to append the proposed blocks to the chain. In order to prevent the ledger holding procedure, the consensus algorithm requires nodes to show they are more eligible to do the work by giving certain rewards after appending a block to the chain in a proof-based consensus. A corresponding explanation comes from Frankenfield (2019), who states it as a fault-tolerant mechanism that is used in computer systems to achieve the necessary agreement on a value or state of the network. Hence, Baliga (2017) refers to several challenges when achieving consensus in a distributed system because it is of primary importance that consensus algorithms are resilient to failures of nodes, message delays or network portioning pointing security on top of the most crucial aspects when choosing a blockchain platform. With the statement of Bashir (2018), who exemplifies consensus as the backbone of a blockchain, which provides decentralization of control, we come to the next notion within blockchain technology.

In essence, Anderson (2019) states that blockchain facilitated social decentralization can potentially redistribute and democratize patterns of human participation and cooperation. Hence, blockchain is into a position of being censorship-resistant and fundamentally more elastic than other decision-making mechanisms for large amounts of people. A further literature review showed based on Morabito (2017) that the decentralized nature of blockchain reduces the need for centralized authorities remarkably and makes it more difficult for all participants to get attacked and data harmed simultaneously. Decentralized computing allocates resources, hardware, software and computing power to individual workstations, while the majority of functions splits between individual nodes with no need for everyone to access a single node to get a simple task done. In this regard, Tapscott & Tapscott (2016) point out that power distributes towards the system with no party being able to interfere all alone in the system. Even if there is an attempt to do so, the system is transparent enough to make sure everyone witnesses it. The functionality of a decentralized network works as the collaboration of many in their optimal form to enable collective force through distributed computing power.

When talking about blockchain as a technology, Ray (2018) sees the so-called distributed ledger technology (DLT) as the basis of it. DLT provides a database that divided into nodes or computing devices and each node replicates and saves an identical copy of the ledger, same as each node updated itself independently. There is a voting system on these updates to ensure that the majority agrees with the conclusion reached and the latest agreed version of the ledger is saved on each node separately. We see decentralization and consensus as core elements of DLT working together towards a possible new paradigm for how information is accumulated and communicated.

A very comprehensible illustration comes from Kuo et al. (2017), who provide a comparison of network topologies. Whereas today is well-known systems possess a single-point-of-failure, the next step marks the usage of DLT and eradication of this vulnerability. Blockchain eventually brings further development by verifying transactions mathematically and prohibiting double transmission of information, which are clear keys of trust in this context.

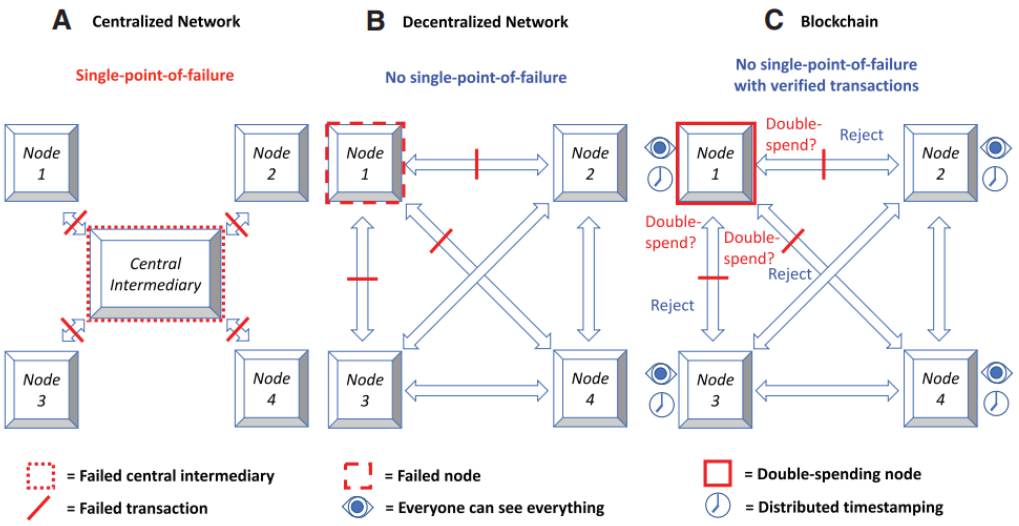

FIGURE 2 - COMPARISON OF NETWORKS (KUO, 2017, P. 1212)

The term double-spending, which illustrates in Figure 2, is numbered among the core content of a blockchain. Foroglou & Tsilidou (2015) argue that the network protocol implemented in blockchain technology disables the multiple transmission of the same data, because the network determines whether a transaction is legitimate, notices irregularities and collectively update the blockchain if the transaction is there only once and valid.

Overall, scholars related to blockchain, make use of keywords like transparency, irreversibility, traceability, security or trust. These attributes play a vital role when it comes to the questions of what kind of innovation to existing processes blockchain really can bring. This paper will catch up on these, the same as other important ones in context with the supply chain in the chapters, which follow.

2.1.2 Technical background and development

Casey & Vigna (2018) state that in the middle of the last financial crisis, caused by manipulation of financial entries and accounting books, at a point where the level of trust was alarming low, people started to put faith in a system, which offered transparency, speed, and security during information and data exchange. However, according to Burnett & Paine (2011), several puzzles, which draw up the picture of blockchain, where mentioned and made public sometime earlier. With the appearance of the cryptosystem

RSA in 1977, the usage of secure data transmission was facilitated by allocating random numerical and letter strings, which served as keys randomly created by an algorithm. Alam (2019) points out that in the early nineties of the last century, the scientists Haber and Stornetta brought up his first idea on the creation of a privacy driven document, which is timestamped and digital without the possibility of backdating. Unfortunately, the usage of the patent lapsed unused in 2004. Lastly, Nian & Chuen (2015) mark that the next step marks the introduction of a concept of so-called reusable proofs of work. This mechanism shows a scheme that permits the reuse and exchange of tokens, which represent some asset value.

Figure 3 shows the development of blockchain technology according to its fields of use. The newest progress aims to the area of applications, particularly tailored network solutions that are permissionless and explored amongst a brought number of industries. It means that markets get the chance to open up for the development and execution of a possible mainstream usage in the future, especially on mobile and portable devices.

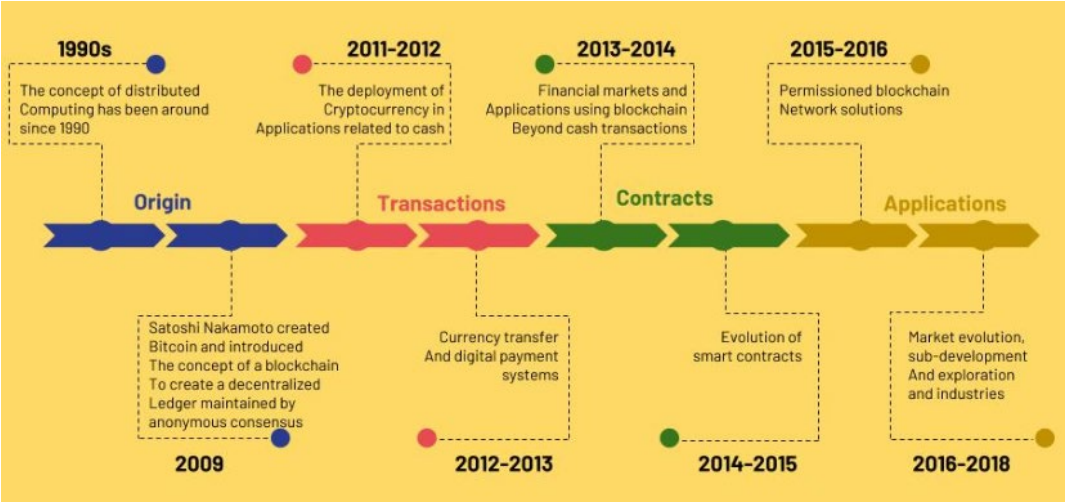

FIGURE 3 – DEVELOPMENT SINCE 2009
(SHAIKH, 2019, P. 3)

There are several methods to achieve consensus in a decentralized network. The most widespread is the proof-of-work (PoW) method. Here the technical basis is built on cryptography. Schneier (1996) describes cryptography as a science, which deals with securing messages, where input data encrypts to a so-called ciphertext, which represents encoded secret content. Decryption is necessary if the original information should be visible again. The whole ciphering process integrates into two mathematical functions, which represent a computing rule called a cryptographic algorithm. In order to make data transmission possible, Zheng et al. (2018) state that digital signatures are inevitable, meaning that each participant of the transaction owns a pair of keys, namely private key and public key. The public key defines as an address, which is visible to the network, whereas the private key represents the personal, unlock the possibility of the transaction receiver. While the receivers' public key is used first by the sender in the so-called signing phase to encrypt the value, we then see in the verification phase the receivers' private key used

by him to verify the transaction by comparing received and encrypted data. Mohanty (2018) argues in context with PoW that so-called miners, who provide computing power and solve mathematical problems, validate transactions inside the block. As soon as the miner finds the correct numeric solution, the network gets informed and distributed rewards to participating miners according to the blockchain protocol. Every block must include proof of work in order to get valid recognition.

The changes in the data structure in the process of decryption and encryption explain Paar & Pelzl (2010) by exhibiting the methodology of hash functions. The messages of the transaction are hashed, meaning transformed into a bit string. It makes the hash a representative of the transaction data and a unique fingerprint of the transaction content. The whole process of signing and verification only consists of hash values, which on the input length can be random while the output length is independent and with a fixed length of digits. This ensures fast processing of more significant data volumes avoiding latency times. The explanation that hashes are an integral part of blockchain architecture shows Nguyen & Kyungbaek (2018) by describing characteristics of a block in the chain. All information inside a block gets inputted to a hash function to get a value, which then assigns to a field called previous hash in the new block. This measure ensures that blocks are linked unmistakable with each other, including a timestamp showing the time when the block was found and completed. In this regard, it is valuable to say that not every blockchain is equally fast. A fitting explanation provides Antonopoulos (2016), who points out that the measure of how severe it is to find a hash is called difficulty. The network-wide setting that controls how much computer power is required to produce a PoW is necessary to avoid any extreme volatility and instability in the network. The setting is stored in the block as a difficulty bit metric, which is a dynamic parameter, and adjustable in a way that the block generating scheme remains constant on a long-term. Rosenberger (2018) calls the mining process a trial-and-error procedure and acknowledges various types of secure hash algorithms (SHA) in a bundle of so-called Merkle-trees, which put together hashes pairwise until the block size reaches. Whereas a reward-based system of PoW consensus seems beneficial for all involved stakeholders, it is questionable how energy sustainable it is to base decentralized on a high level of electric power consumption.

Moreover, another scope of cryptography, which possibly is of value for blockchain applications, is the utilization of zero-knowledge proofs described by Schneier (1996). Especially when the company for its departments wants to use private blockchains, e.g., for the usage in the supply chain, the topic of privacy comes into view. As a one-way function, this method ensures that one party can prove to another one that they know value without delivering any information apart from the fact of knowing it. Hence, scholars like Beutelspacher (2015) emphasize the factor of anonymity as a core achievement of cryptography-based technologies, because there is an avoidance of problems with the

general data protection regulation (GDPR) or other global privacy laws through the deployment of cryptographical solutions by rendering anonymous the broadcasting process or using pseudonyms.

Besides the content of cryptography, Ploom (2016) describes the possibility to implement and save scripts into the blockchain. An example is given by the so-called smart contracts, which are self-executable protocols, meaning digital, and credible in a way that legal obligation gets valid for participants of an asset transaction.

2.2 Disruption in supply chain

2.2.1 Changes and paradigm shift in the supply chain

Concerning manufacturing and supply chain processes since the industrialization, there were many steps forward in terms of process optimization and information exchange. Nowadays, new technology introduces to change the production process of a good significantly. These upheavals require not only technological expertise but also strong leadership a precise strategic planning and influential groups amongst the participating stakeholders. Hence, Gray (2017) outlines significant shifts in paradigms caused by blockchain, namely the advancing of digital transformation. That means global stakeholders are connected and benefit from emerging trends as the design of value networks, multiple data forms, for example, open-source data, intelligent response and autonomous and localized processes.

2.2.1.1 Technical development and digitalization

Several European Associations, according to Van Wassenhove et al. (2007), speak about supply chain collaboration in the sense that supply chains are in a connected status and communicate with each other regularly. Plants and clusters, which are producing, can benefit from interconnection with the existence of aggregate information available. Hence, Korpela et al. (2017) envision several benefits of the so-called digital supply chain (DSC). It includes cost-effectiveness of services and value-creating activities that are advantageous to many actors in the supply chain ecosystem. It is characterized by the strategic and operative exchange of information between suppliers to enhance communication and in general, inter-organizational coordination is achieved through electronic links between information systems.

Moreover, Mirando et al. (2019) add that technological advances have to get impacted how humans participate in a supply production process. Therefore three types of interactions could be implemented in new products, namely human-human collaboration, which has less technology content and human-machine and machine-machine collaboration. The wider variety of technologies and devices included in the process would result in a more autonomous system backed by ledger solutions like blockchain. Further, Treiblmaier (2018) exhibits that with the advent of new technologies, the way supply

chain structures are managed, obviously changes. From a resource-based view (RBV), which describes the way to competitive advantage by the optimal use of resources and capabilities, a possible blockchain transformation would result in a shift of existing boundaries on either the increase or decrease of the respective source. It implies that blockchain induced transformations afford opportunities which go beyond existing ones. An interesting aspect of how a possible supply chain of the future could look like give Gromovs & Kammi, 2017 who include in a smart map structure three behavioral steps forward in the supply chain processes. Based on the research of the IBM company, these supply chains are intelligent, which means include analytics, simulation models, carbon footprints, predictive and business intelligence analysis, amongst others. Furthermore, the connection with real-time visibility, on-demand network, interactive KPI's and collaboration platforms is factual. Eventually, machine-generated information will replace people's creations in the form of radio-frequency identification (RFID) tags, sensors, actuators, self-counting inventory and container content self-detection.

Overall, Tholen et al. (2019) write about a highly developing digitalization of assets in the financial world. Non-digital assets are commodities and raw material gets so-called digital twins in the process of tokenization. Still, the created token is only as reliable as the party that first created it, so fraudulent action still is possible without proper governmental rules and regulations.

2.2.1.2 Insufficiencies within supply chains

Scholars like Zhao et al. (2019) argue on the topic of food supply four distinctive themes, which show insufficiencies in the supply chain. These are traceability, manufacturing, sustainable resource management and information security. The lack of clarity within the above stated deficitial topics results in less agile value chains. According to Barner (2019), visibility is needed from end to end, especially in the food supply chain, both to make sure companies can label their products with confidence and to prevent some possible spread of illnesses because of contaminations. Several challenges in a supply chain due diligence are explained by Tholen et al. (2019), who emphasize the fact that modern supply chains are fragmented, complex and rely on a large number of suppliers and intermediaries from all around the world. Hence, this leads to deficits in the information on the flow of goods, which prevents companies from carrying out due diligence by identifying risks, prioritizing activities or track goods and report figures more efficiently. Although there are standardized systems as nomenclatures and norms, which share information in a similar digital language, there is still much room for improvement and facilitation.

Furthermore, because of the fragmentation of supply chains in highly complex vehicles with many participating actors, an understanding and categorization of severity and likelihood of risks is tough to achieve. This inaccuracy of risk information puts pressure on the company's value chains, because of information on risks in order to be leveraged right needs be at some point reliable and credible, but also comparable and accessible

by stakeholders. Examples here are bribery risks, tax evasions, labor conditions, human rights abuses and many more. Moreover, many supply chain actors tend to be transparent because gathering information on suppliers and sub-suppliers at crucial points in the chain because local governments in some countries simply do not require proper governance in relationship information amongst the supply chain. Abeyratne & Monfared (2016) mark that it is challenging to have an overall picture of all transactions within the chains, especially in an extensive supply chain system. The information, for example, contracts, financial transactions, goods transactions or resources and the respective system entries in today's supply chain systems, are typically stored in multiple locations and are accessible only to certain system entities.

Additionally, Casado-Vara et al. (2018) attest to the supply chain sector the problem that its scale may lead to delays and defaults in the delivery of goods as well as other issues within the supplying process. In an attempt to solve the problem, process automatization was the result, hand in hand with a significant increase in the number of distributors in the supply chain. However, that means that the risk of attacks on the databases is high and the intentions of hackers may be to modify, delete or steal valuable data. It is resulting in better visibility of performance management, optimized inventory controls, event-driven alerts and automated data feeds from logistic partners.

2.2.1.3 Expectations of supply chain stakeholders

Different stakeholders in the overall supply chain world have, of course, different, sometimes diverging interests and needs. From a customer's perspective, for example, there are plenty of reasons why the supply chain of the product is essential. Montecchi et al. (2019) see a high level of perceived risk by customers if their information hides in a product's supply chain. This so-called perceived risk can influence customers to purchase decisions and attitudes because the information asymmetry can lead to undesired consequences or outcomes for the customer. Halder & Pati (2011) point out the example of the Indian population that due to demographic growth, the demand and consumption patterns change tremendously and therefore, these people simply seek enough supply of the products they need. According to Mattila, 2016 firms themselves expect to keep track of the legitimacy within their supplier networks, which can be very sophisticated nowadays, but currently are not able to do it properly. Besides that, customers are currently very limited in their ability to evaluate the origins of the materials used or the ethical aspects of how the manufacturing of products happens. More than that, customers seek for more democratization of the supply chain. Now, where a reconfiguration of the balance of power in supply chain networks can be the result of customers aspirations to arrange each step in the supply chain to their liking, by using specified raw materials and suppliers for a product which gets produced precisely as the customer wants it, can mean a massive paradigm shift. Similar other customer motives are described by Westerkamp et al. (2019), who emphasize the increasingly important factor of goods compliance with specific ecological and ethical standards. Customers expect to know where the goods

are from and how they came into their property. Similar comes from Abeyratne & Monfared (2016), who added that currently, there is a development of overall demand for improved access to information in order to regain consumer trust in products. The expectation is a higher level of awareness of the various potential events happening in the supply chain. Consumers are more than ever encouraged not to accept any information without being able to verify and thoroughly understand the meaning behind it. Recent examples of abuse of trust in reputable companies are the emissions scandals of Volkswagen in 2011 and Nissan in 2016.

More standpoints from the position of strategic and operational decision-makers within supply chain-operating companies bring Chang et al. (2019), who refers to the term of business tracking process (BPR) as a re-engineering procedure within the SC. It is described as a pathway to rethink and radically redesign business processes to achieve improvements in contemporary critical measures of performance, such as service, quality, cost and speed. A valid point here is the fact that implementing new technology requires changes and different approaches compared to the way organizations execute routine operations. Moreover, Tholen et al. (2019) argue about the importance of satisfying voluntary principles for example, the sectoral supply chain due to diligence guidance within the OECD guidelines. These include an embedment of responsible business conduct (RBC) into supply chain policies and management systems, followed by a correct execution of communication, identification, assessment and tracking of adverse impacts. In implementing this framework, enterprises may face obstacles that directly affect their ability to conduct a meaningful supply chain due diligence. In general, a snowballing trend towards transparency and more reliable expectations of consumers, regulators and investors in terms of responsible business conduct is global in scope and cuts across different economic sectors.

2.2.2 Potentials of blockchain in context with supply chain

Amongst the various number of potential, blockchain technology can bring, Table 1 shows some of them with relevance to a possible enhancement of supply chain processes. Likewise, there is a list of limitations in order to classify if the technology with its characteristics is the right choice to meet the requirements of being beneficial to supply chain processes.

Feature	Benefit	Limitation
General	• The early development stage of technology offers room for improvement towards holistic SCM add-on • Opportunity to reduce control structures of centralized databases	• Still, no accepted and understood the single underlying standard • High level of computerization prevents usage in developing countries

	• Process enhancement through decentralization by information sharing with a change of competencies • Automated data transfer under one umbrella	• Scalability prevents from handling of vast amounts of data, e.g., big data in real-time • Regulatory uncertainty • Incompatibility of data formats
Trust Level	• Decision-based on a democratic majority • Smart contracts as a self-execution procedure • Technical feasibility aspects easy to implement • Technical configuration assures objectivity and is adaptable with technology matureness • Trust evaluation model possible because of sufficient blockchain features • 'Trust factories' as the end product of decentralization • Self-generating audit trails • All SC participants are known, tracked and certified properly	• The public still not convinced on the safeness of storage and transmission, e.g., new technology acceptance low • Composition of trustworthy consortia challenging • History of fraud & hacking incidents reduces confidence • The right choice of participants based on principal-agent theory • The authenticity of observation questionable • Interorganizational trust from still uncoupled from blockchain • Self-generating audit trails lack recognition of regulators
Transparency	• Visible tracking activities • End-to-end visibility according to permission levels • Reduction of waste for perishable food • Mitigation of friction and self-execution on information, goods and capital flows • Customers gain loyalty and knowledge with product transparency • Regulators' opportunity to monitor properly • Purposeful targeting of customer consumption enabled • Reduction of the bullwhip effect • Zero-knowledge proofs for data sensitivity improvement	• Risk of exposing confidential information • Decrease of the level of transparency sometimes needed but contradicts BC core competences • Blockchain transparency contradicts with privacy resulting in neutralization of BC benefits • Either more restricted or more open blockchain to choose • Missing of proper data checks before pulling them into the ledger causes information asymmetries
Data security	• Digital certificates instead of paper ones mitigate the risk of physical loss	• Superordinate authority giving permissions limits decentralized character

	• Uniquely identification of data enhances its security level • Data correctness improves the comprehensiveness of SC • Data integrity at low cost through a guarantee of participants identities • Permissioned system • Storage of hash data only enhances anonymization	• Security gap due to latency of transactions and scalability • On-chain storage blow up BC capacities • Off-chain storage lowers traceability
Traceability	• Optimization of time schedules • Real-time information for customers on origin and product life cycle • Identification of grey market activities • Comprehensible data flows generate customers' willingness to pay premiums • Higher responsiveness to global trends and movements enabled	• Compatibility problems through inconsistencies in captured datasets • Latency in the confirmation and verification process • Deployment and maintenance costs still questionable compared to legacy systems
Irreversibility	• All participants with the same information • Reduction of communication and data transfer errors • History of network activities improves trust issues within manufacturers • Immutability of data boosts the legitimacy of complex supplier networks and favors products on blockchain-based solutions	• Illegitimate data entries not changeable anymore • Participants not used to a high level of consensus • Human involvement allows erroneous data input

TABLE 1: POTENTIALS OF BC IN SC

Source: Adapted from Kamble et al., 2018; Abeyratne & Monfared, 2016; Laaper et al., 2017; Ganeriwalla et al., 2018; Treiblmaier, 2018; Malik et al., 2019; Kshetri, 2018; Behnke & Janssen, 2020; Francisco & Swanson, 2018; Blechschmidt & Stöcker, 2016; Sanjeev, 2019; Chang et al., 2019; Hackius & Petersen, 2017; Tribis et al., 2018; Steiner & Baker, 2015; Saberi et al., 2019; Lyons & Courcelas, 2019; Blossey et al. 2019; Kang et al., 2019; Kritikos, 2018; Tholen et al, 2019; Fisher et al., 2018; Sarkis et al., 2011; Tijan et al. 2019; Hepp et al., 2018; Mirchandani, 2019; Aung & Chang, 2014; Casino et al., 2019; Westerkamp et al., 2019; Sodhi, 2019; Apte & Petrovsky; 2016; Mattila, 2016; Korpela et al., 2017; Perboli et al., 2018;

Kamble et al. (2018) describe the possibility of gaining trust in a supply chain environment with a reduction of possible payment gaps between the actual delivery of a product and the final payment settlement. The risk reduction of losing funds results in a high level of trust achievable through self-execution of agreed contract components based on smart contracts acting as a rulebook towards the financial sustainability of the supply chain. According to Abeyratne & Monfared (2016), a sufficient level of trust nowadays is only achievable with trust reliance on the foundation of a democratic majority, instead of relying on individual organizations or people. The flow of trusted information between

parties requires accurate data collection and secure data storage, which are key elements of blockchain technology. Having examples of various fraud, corruption or hacking incidents happening in the past decades, which reduced the trust level amongst stakeholders, shows that trust level enhancement leads to a potential reducing risk of losing consumption of goods and services, which represents the backbone of supply and demand in economics. Moreover, Laaper et al. (2017) reveal concerns about proper cybersecurity paired with blockchain technology. For them, it is highly questionable if the public will entrust sensitive data to a blockchain solution without labeling it as a hundred percent safe way of data storage and transmission. A potential mitigation effect here can be the right choice of the blockchain implementation partner with the satisfaction of privacy and security needs, tested carefully beforehand.

Further, Ganeriwalla et al. (2018) show that trust is an integral part of any functioning supply chain and that it usually develops over time as companies and suppliers work successfully together, sharing various types of information. In today's complex manufacturing ecosystems, participants often do not know each other and thus, they lack visibility and trust, therefore, must be built elsewhere. A solution provides the self-execution procedure of smart contracts, which is simultaneously a bypass of conventional ways of establishing trust by using blockchain for a wide range of supply chain transactions, such as materials and food delivery information, payments, insurance payouts or copyright transfers. Still, the overcome of the trust barrier is linked to the formation of a trustworthy consortium to run the blockchain. It can be challenging to choose and coordinate, because the principles of a democratic majority, whose decisions are binding for participants, should be appropriately met.

Treiblmaier (2018) brings up the so-called agency theory in connection with trust creation using blockchain in the area of the supply chain. The information consistency and its complete distribution achieved with the use of blockchain enlarges trust levels between principal and agent, but still, the major challenge lies not on the technical configuration of BC, but instead in the right choice of the principal to select an agent. The formal guarantee to both parties, that agency issues are addressed considerably is provided by the blockchain in a comprehensible way, given its specifications. On the contrary, Malik et al. (2019) argue that although data related to supply chain events are not changeable once recorded on the ledger, blockchain technology cannot ascertain the authenticity of observations provided by supply chain entities. The limitation gets very clear if participants generate false data. Therefore, a possible proposal for a solution is the integration of accountability and reward mechanisms to penalize dishonest on the one hand and incentivize trustworthiness, on the other hand, correctly. However, the prerequisite of a trust management system added into today's existing blockchain systems speaks against the blockchain as a fully integrated base technology of a supply chain management system of the future. Kshetri (2018) affirms the statements of Malik. He speaks about the importance of data quality in order to achieve a system, which is characterized by trustworthiness. From a technical standpoint, blockchain can assure objectivity and a

low level of bias of data. Still, trust builds outside the technological boundaries of blockchain. An example from the food supply chain brings Behnke & Janssen (2020), who criticize that actors in the SC still use individual quality standards instead of exchanging information with each other on a detailed level. This encountered lack of trust cannot be solved with blockchain, although the technology is heralded of being the choice number one when it comes to the need of trust creation, in this example, the initiatives blockchain bring forward are mainly technology-driven, focusing on technical feasibility aspects.

Francisco & Swanson (2018) distinguish between two types of trust, namely the trust of technology and inter-organizational trust. This construct to frame trust concerning technological innovation shows that blockchain has the potential to be trustworthy in terms of technological aspects, although the credibility of new technology rises with its mainstream adoption and here it is still some way to achieve that. Inter-organizational trust refers to the trust between institutions and is the same as critical for technology acceptance and information sharing as the technology basis beyond. This type of trust is more difficult to achieve with technological solutions, as the so-called behavioral intention cannot be verified that easy. Opposing standpoints come from Jiang & Yongjun (2017), who put in place a model to evaluate trust among supply chain enterprises. Here, trust in the supply chain is not determined by any specific definition, but as a conglomerate of sufficient features, such as transparency, irreversibility or undeniableness. Therefore, a blockchain in connection with the supply chain is always trustworthy, given its technical cornerstones.

Blechschmidt & Stöcker (2016) bring up the creation of so-called ‘trust factories,’ which are end products of blockchain-based technology progress. These factories or decentralized institutions and organizations provide trust at a far lower cost than traditional providers do. That means that even intellectual property and knowledge overall were excessively expensive until the occurrence of DLT because third parties were collecting high margins on it. Even though blockchain also poses challenges, because organizations move their trust from the known to for many unknown mathematical algorithms, which only a few people understand. A negative aspect blockchain faces nowadays can be eradicated, the more people are keen to gain at least a basic understanding of the subject matter. Similar views come from Behnke & Janssen (2020), who point out that acceptance of new technology, especially in the early stages of adoption, is a huge obstacle to overcome. Particularly blockchain, with its present day’s characteristics, has limitations in the ability to gain and maintain trust for the majority of supply chain stakeholders.

Saberi et al. (2019) report intra-organizational barriers and propose the usage of so-called Technology Acceptance Models in order to reduce resistance and hesitation from individuals and organizations during the adaption to the blockchain as a new technology in the SC. This framework model evaluates the blockchain in a sense that statements formulate why people use particular technology and why not. Another trust-related use

case comes from Sanjeev (2019), who points out that as a trust-building activity, self-generating audit trails can be established and put in place amongst supply chain participants. That means a highly detailed level of granularity formed by the nature of the blockchain gives insights on every transaction that happened in the ledger. Of course, this is a solid foundation for auditors to rely on, but still lacks recognition of governments and financial institutions, who first need to put a framework in place, which remains authorized and valid for further usage. Furthermore, Steiner & Baker (2015) emphasize the clear benefits of having all participants of a supply chain blockchain certified by authorities or independent audit firms to maintain the system trust.

As one of the key benefits of using blockchains in a supply chain environment, Chang et al. (2019) refer to several consulting reports and studies focusing on the advantages of enhancing the transparency and visibility of tracking activities in business operations. A conceptual framework of a blockchain-based information tracking process includes a transparent view of information within the shared ledger, then a self-execution of information flows through smart contracts amongst suppliers, buyers and logistics within the supply chain. Integrated blockchain solutions have the potential to mitigate friction in business in not only the flow of goods but also on the flow of capital and flow of information. The more transparent and cross-fitting information in a supply chain is, the more cost savings and economic incentives through the optimization of time schedules participants can collect. Hackius & Petersen (2017) add that sustainability improvements through blockchains' ability to facilitate origin tracking are another benefit because the waste of perishable goods, for example, food, can be reduced heavily if the newly available data on shelf life is used argument for the optimization within the SC.

Further, Tribis et al. (2018) envision that a blockchain approach in the SC increases the transparency of physical distribution processes and therefore eliminates the ability to cheat, providing each participant amongst the stakeholders' end-to-end visibility based on the several permission levels on the chain. For governments, for example, blockchains bring the potential to track, monitor and audit the supply chain and to serve manufacturers to record transactions with a high level of authenticity. For customers, there is the possibility to enhance their product knowledge and loyalty through transparent, freely viewable information on the products and their goods flow. Additionally, Steiner & Baker (2015) argue that with blockchain and its ability to enlarge the level of transparency, the supply chain can widen its field of vision by stopping the limits stakeholders have. Where usually stakeholders work in supply chains, which are held secret, now there is the chance to prevent environmental, social, health and safety issues. Nowadays, where differentiation and conscientious consumption are required to be mandatory for success, a sustainable and transparent supply chain benefits strongly from the definite impact blockchain brings. Lyons & Courcelas (2019) agree on data transparency being a great effort of blockchain usage in the supply chain, because of easements in terms of managing and securing supply chains, but bear the risk of exposing confidential information

to competitors and unwanted counterparts. Hence, transparency through blockchain creates new opportunities and ways of cooperation along with the SC but only can prepare the path if new mindsets establish amongst stakeholders. Moreover, Abeyratne & Monfared (2016) mark that a controlled level of transparency amongst related parties is only possible if there is a chronological list of all previous owners of data in a network is available. Using blockchain each time exchange of product information or data is happening, the newly created entry with the details of the transacting parties is stored openly to people with authorized access.

Blossey et al. (2019) identify the transparency feature of the blockchain as the right measure to eradicate supply chain inefficiencies caused by the so-called bullwhip effect. This concept refers to increasing swings in stock in response to shifts in customers' demand. Blockchain enables the sharing of real-time information about the status and location of a particular good between multiple SC members. With the addition of IoT and sensor technology data, which lies and is verified on the blockchain, any measurable condition or availability figure can be identified without errors. An example poses a product temperature measurement used at Modum, a Swiss blockchain startup, which creates trusted digital ecosystems for sensitive goods in areas of pharmacology and logistics. The combination of transparency and smart contract automation means that supply chain parties cannot revert the contractual commitments and therefore head towards the fulfillment of a new paradigm, called smart factory.

Kang et al. (2019), who argue that in the starting phase of blockchain adoption in the SC organizations, are hesitant to be more transparent under a distributed ledger system, bring up a negative aspect of high transparency within blockchain. The reason is that, mainly because the level of transparency cannot downregulate that easy, as BC's core competencies require the maintenance of the best possible standards the technology can offer. Besides, Kritikos (2018) points out that although blockchain adds a degree of accountability that has not existed to date, at the same time, it contradicts with another appealing aspect, namely privacy. Therefore, blockchain benefits neutralize and limit each other in a very different way resulting in a significant reduction of innovation potential.

Tholen et al. (2019) add here that commercial regulatory or the satisfaction of GDPR legislations prevents using an open blockchain platform. If there is some restricted version of the blockchain, the principle of maximum transparency does not hold anymore. Possible solutions like the implementation of so-called zero-knowledge proofs, which improve the sensitivity of data in a public ledger, still need to be fully understood and in a next step formally approved by authorities. Still, organizations have to choose which fundamental design of a blockchain-based supply chain tool is their preferred one, based on the focus, which lies on either transparency or privacy. This fact speaks against blockchain as an integrated supply chain management solution. The aspect of proper data

management reflect Fisher et al. (2018), as they point out that data entering and adequate care of this data are essential for reaching potential full transparency on the one hand, but on the other hand also reducing costs of subsequent amendments in data structure and security. Here blockchain needs to find solutions to proper data checks before transforming them into the ledger. The problem of information asymmetry address Sarkis et al. (2011), who speak about issues supply chain organizations have expressing information underlying a product to their respective customer base. The aim is to put customers in the position of believing in the more excellent value of a particular product and it is essential to mention that in order to reduce information asymmetries, more significant interaction, in the form of decentralized data sharing, can be the right choice. Here the information sharing process becomes less critical because it tends to be easier to achieve with internal system coordination than necessarily by closer customer relationships.

In terms of data security, Hackius & Petersen (2017) argue that especially for supply chain products of high value, such as diamonds, paper certificates expose to high risk of data insecurity, through physical loss or manipulation. The possibility to collect and record as many data points as possible, stored on the blockchain, can uniquely identify the product's origin and historical data structure, which makes it much more difficult for tampering information. Similar assertions come from Tijan et al. (2019), who points out that up to ten percent of every logistics document, for example, a bill of lading, contains incorrect data, leading to possible litigation or controversies. The mitigation of that kind of issue and, in the next step, the improvement of underlying business processes puts blockchain into importance within a comprehensive supply chain management. According to Abeyratne & Monfared (2016), data security goes hand in hand with a proper guarantee of a participant’s identity. Blockchain technology could provide the infrastructure to scale digital identity at little cost and therefore improves digital security and integrity profoundly. For the supply chain, this means that verified participants on the chain can, with integrated smart contracts, improve the security of transactions as the buyer who has signed a relevant contract with the seller can only receive each item. The nature of blockchain allows here the system to identify fraudulent transactions or misplaced items in a short timeframe.

Moreover, Kshetri (2018), reports that supply chain companies who implement blockchain, such as the logistic giant Maersk were less worried about data security issues because they prefer a permission system over a permissionless solution. Here a closed group of participants that are known depends on access issuance from some superordinate authority. However, this limits the decentralized character blockchain has in its outline and diminishes innovation in the sense that dependence on individual actors rises. Nevertheless, Tribis et al. (2018) identify a gap of security and data integrity because the latency of transactions, as the result of poor scalability, opens a window for cyber-attacks. The vulnerability here gets visible if actors decide to build a more centralized supply chain setup.

Furthermore, Hepp et al. (2018) distinguish between on- and off-chain storage affecting, to some extent, the appraisal if data security within supply chain processes is efficient or not. Full blockchain integration into SC does not necessarily mean an on-chain storage approach only. The ability to store various amounts of data on the blockchain itself would be more secure but not sufficient in terms of scalability. For example, the possibility to store the hash information only on the chain is intriguing if the information needs to be verified but not immediately made available in full detail. Additionally, vast amounts of data would blow up blockchains capacity in an often not necessary way. This tends to be also the preferred way of approach for supply chain participants because the new technology could be declared as innovative but not too disruptive and changing for the actual state of the supply chain processes. Similarly, Mirchandani (2019) argues that having only hashes stored on a blockchain would likely fit into GDPR and be classified as anonymized in terms of data security. On the other hand, this would result in very low traceability of hashed personal data to a data subject, which then weights against other benefits of BC.

From a perspective of traceability, according to Aung & Chang (2014), characteristics like unique identification of units, transfer information and an adequate link of unit and movement are defining and end-to-end traceability system. Although the benefits of blockchain, such as transparency, immutability and data encryption, can address the above requirements appropriately, there are also challenging parts, namely a lack of standardized data and inconsistencies in captured datasets. The result is the creation of compatibility problems as actors use several different traceability methods. In order to eradicate these barriers, which limit blockchain usage in the area of traceability, the establishment of global standards is unavoidable. Abeyratne & Monfared (2016) note that especially end customers can enlarge their knowledge about origin, manufacturing and usage through the product life cycle by profiting on the implementation of blockchain technology in supply chains. This level of transparency, which allows auditing and inspecting of datasets in real-time, makes network activities and operations highly visible and thereby reduces the additional need of trust significantly. As an example here, the implementation of certifications and standards, such as Fairtrade or Forest Stewardship Council (FSC), on the blockchain brings a maximum of transparency. Here inspections and verifications of facilities and factories, same as the identity verification, are digitally managed and stored on a distributed ledger.

Fisher et al. (2018) emphasize the beneficial character of blockchain for regulators to trace source and treatments of products the same as for suppliers and manufacturers to identify precisely possible defective, inadequately or even grey market counterfeit components along the supply chain. Furthermore, Laaper et al. (2017) envision that through transparent and accurate end-to-end tracking, not only costs can be reduced significantly, but also consumers stated that they would pay a premium for services or products from companies promoting social responsibility through comprehensible data flows. An analysis of the complex food supply chain comes from Casino et al. (2019), who identify

on the one hand blockchain as a tool to overcome certain obstacles of traditional traceability mechanisms, like lack of information sharing and system integration difficulties. On the other hand, blockchain faces constraints in the ability to project traceability solutions properly, because of performance issues, either because of vast amounts of processed data or latency in the confirmation and verification process. Also, Westerkamp et al. (2019) point out that the input information available at tracking systems embodies in batches and dependent on the product as a batch can have hundreds of logs too. This fine-grained approach can be handled by blockchain from a technical perspective by, for instance, tokenizing the information with its unique features. Still, the question comes up at which deployment and maintenance costs and which speed blockchain can perform in order to represent a better option than existing supply chain legacy systems. Sodhi (2019) argues that blockchains potential to make supply chains more responsive to trends and movements and more stable against market disruptions shows the best in a way that it connects participants and companies can fetch the intelligence quickly and securely. This competitive advantage of having an information advantage within the area of tracking and tracing forces whole industries to react in order to set new standards of innovation within their supply chain processes.

Laaper et al. (2017) discuss the subject of data irreversibility by blockchains' ability to provide all parties within a respective supply chain with access to the same information, resulting in a reduction of communication and data transfer errors. Therefore less time is spent with the validation of data. Instead of that, more can be spent on delivering better goods or services while improving quality and cutting costs, respectively. Furthermore, Abeyratne & Monfared (2016) point out that blockchains immutable record of data with controlled user access helps a lot in building trusted foundation, whenever information is typically stored and accessible in different locations, or participants have only partial access to the overall data. The irreversibility of data with a history of all network activities is a catalyst for improvements in transparency and traceability issues within manufacturers.

Moreover, Apte & Petrovsky (2016) question the data consistency in private blockchains. After all, the need for substantial PoW processing across multiple supply chain information channels does not envision in a sense that participants can live with a lower level of consensus because they are used to it in their previous centralized legacy systems. This enlarges the probability of external attacks from actors with the majority of the networks hashing power, resulting in changes towards Illegimate data entries, which are not changeable anymore. Additionally, Saberi et al. (2019) argue that blockchains prevention to falsify and tamper data cannot entirely prevent any possibility of having erroneous data because humans are still involved in applying and running the technology. If key owners edit data and update it with additional information before it is displayed on the chain the first time, participants are not fully covered from damage done by the existence of invalid information. Mattila (2016), argues that the massive improvements of companies' and customers' access into detailed and irreversible supply chain records, even on

the detailed level of individual products and its value chain, boost the legitimacy of the complex supplier networks. With the belief of having immutable information across the supply chain, stakeholders empower to favor deliberately products, which information lies on the blockchain instead of other ones, which do not offer their required level of trust.

Furthermore, Hackius & Petersen (2017) see blockchain as the ideal base technology where IoT can operate on to enhance SC processes. As estimations from Gartner (2015), show a massive increase in connected devices year by year, it gets clear that today's internet architecture cannot handle such amounts of data. Although blockchain, because the removal of points of failure through decentralization, is considered being a solution to connect and manage IoT on a reliable basis, still its scalability remains questionable in meeting IoT's requirements accurately. Westerkamp et al. (2019) add that information distribution in decentralized networks is limited by its weakest link in terms of storage, bandwidth and processing capabilities. In the context of blockchain blocksize and completion time is adjusted to satisfy a node majority participating in the network. The consensus of this majority does not correspond necessarily with the opinions of supply chain participants. Saberi et al. (2019) argue that BC still in its early development stages and considers it as immature and unready technology in terms of scalability when it comes to handling larger numbers of transactions. Especially the handling of big data in real-time requires more substantial scalable base technology, same as improvements in storage management and cloud infrastructure.

Another limitation comes from Tijan et al. (2019), who attest that within blockchain technology, there is no single underlying standard, which is understood and accepted for a majority of the users. It leads to the creation of many difficult standalone concepts, where programming intervention, even in the purest form of change, happens regularly. Additionally, Kshetri (2018) points out that blockchain does not have the attribute of being a global technology, reachable for every supply chain actor in the world. It is because BC requires a high degree of computerization, which results in the issue that not all countries are ready to participate mainly because of their characteristic of being a developing country.

Figure 4 shows survey results where the most pressing barriers for blockchain adoption in the logistics industry are. The limitations clearly show typical aspects of insufficiencies within new technology adaptions, more than technological deficiencies. Kshetri (2018) speaks about a complex environment in which global supply chains operate and thus emphasizes, to some extent, regulatory uncertainty as a significant challenge and limitation to overcome. Various parties have to comply with regulations, various laws and institutions, which include, for example, commercial codes, laws regarding ownership and multiple jurisdictions for shipping routes. The issue here is that human beings, who vindicate against these old established laws, manage customs and institutions and implementing blockchain-based solutions can, therefore, get a very complicated task. On

the barrier where different parties have to join forces, Treiblmaier (2018) exhibits a possible change of competencies for supply chain companies that make use of BC. The importance of resources for a sustainable advantage across various industries alters because factors as company size or managerial experience are not that important any more. This should help companies to open up, but firms still struggle to reduce control structures and centralized databases in order to share information and work together towards a higher level of information or process enhancements.

Korpela et al. (2017) show the lack of technological maturity with the example of automated data transfer between organizations. While in traditional trade finance contexts, it is possible to show data transfers of payments, the document collection for letters of credit transactions or trade documents, such as bills of lading, various certificates or shipping documents, gets significantly more complicated. The formats of seller and buyer documents are often incompatible, same as the information within these documents, which required further manual entries and computer-paper solutions. That means in order to achieve improvements, on the one hand, the way the supply chain works with these documents needs to be adjusted and streamlined, same as technology needs to find a way to model various requirements on the chain.

As one of the most critical issues, Perboli et al. (2018) identify a lack of acceptance in the industry, which eventually results in the absence of all relevant actors of the SC. It goes hand in hand with indolence in the process of technology adoption. For this reason, for implementation, it is vital to start with an analysis of all needs, objectives and exclusion criteria of the different actors involved. The business model created after this fine-grained analysis should be capable of emphasizing both customer satisfaction and economic returns. The basis, therefore, is a solid understanding of what BC can offer to enhance SC processes.

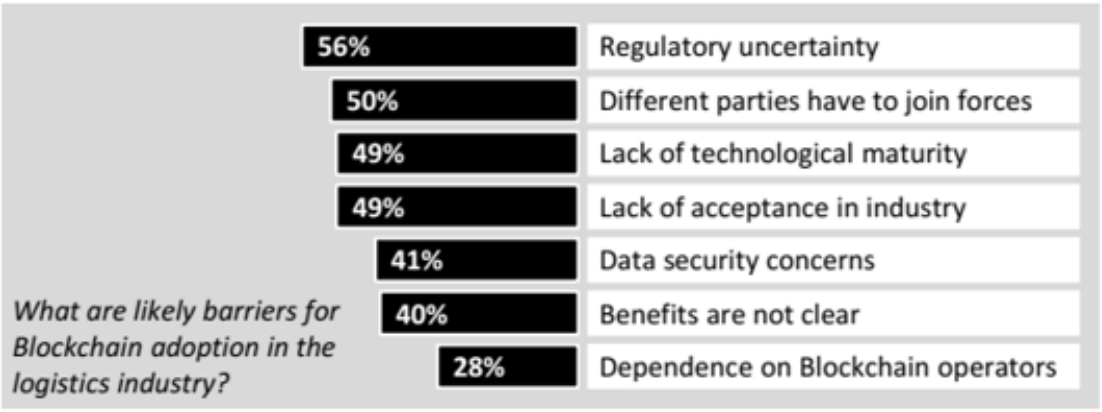

FIGURE 4 – BARRIERS TO BLOCKCHAIN ADOPTION
(HAKIUS & PETERSEN, 2019, P. 14)

2.2.3 Role of governments and politics

The role of governments and regulations in the implementation phase of new technology is an interesting one and undoubtedly, there needs to be put attention to that field. Table 2 shows some connections between blockchain implementation and its regulatory junction.

Feature	Overlap	Insufficiency
General	• Decentralization contradicts with governmental checks and balances • Proactiveness by governments occasionally existing (Blockchain Act in Liechtenstein) • Motivation to act in the interest of society brings innovators and regulators together • External pressure from regulators would enhance the drive of innovation in SC organizations • Tokenization of assets and information opens new perspectives • Innovative features of blockchain may make old regulatory approaches obsolete	• Regulatory enforcement low in many areas of SC • Regulators still ill-equipped in blockchain knowledge which leads to overregulation • No intrinsic motivation for regulators, because still, no economic benefit elaborated • Questions on ownership, copyrights widely unanswered
Trust	• Levels of Governmental interference vary and need efficiency • The proposition of social value from blockchain usage in the SC by governments crucial for collaboration • Creation of consortia & regulatory sandboxes to bring parties together and test innovation respectively • Agreed permission infrastructure lowers conflicts	• Distrust in SC towards regulators prevalent • Best practices for correct regulatory approaches still widely missing
Data Security	• The validity of data transactions important for regulators during audits and checks • Regulators participate in the ecosystem as participants for auditing purposes	• Data usage and access with blockchain lacks an appropriate regulatory framework • Data governance and standardization misses as a precondition towards next maturity step
Smart contracts	• Self-execution of contracts enlarges end-to-end process enhancement	

	• Predefinition of rules for smart contracts to be done proactively by regulators	• Smart contracts still not binding from legal and over-regulated from a regulator perspective • Utilization within routine situation easier than others where regulatory individuality is of demand
Immutability	• Reliance on data provides certainty • Due diligence and disclosure obligations in the logistics require data and digital identity protection	• Data deletion contradicts with immutability
Privacy	• Zero-Knowledge proofs support regulatory expectations • Exception clauses of GDPR for blockchain applications in discussion	• Privacy contradicts with GDPR as it is in place

TABLE 2: REGULATORY OVERLAP BC VS. SC

Source: Adapted from Tseng et al., 2018; Ganne, 2018; Herian, 2018; Tijan et al., 2019; Mangla et al., 2018; Cermeno, 2016; Mirchandani, 2019; Fitzgerald, 2018; Cole et al., 2019; Grech & Camilleri, 2017; Behnke & Janssen, 2020; Baumann & Supe, 2018; Blemus, 2017; Dobrauz et al., 2018; Kshetri, 2018; Mattila, 2016; Filippi & Hassan, 2016; Macedo, 2018; Warren et al., 2019; Neuburger, 2018

Governments have a vast number of responsibilities towards its citizens in order to establish a stable society. Tseng et al. (2018) point out that distrust is the most important reason; the public needs the state as a supervisor. In more detail, that means, that dependent on the range of activities in different supply chains, different levels of governmental interference is expected. In health or financial trade supply chains, the surveillance may be higher than in others. Nevertheless, this kind of monitoring requires many resources and could still be inefficient. For this reason, blockchain technology can be just one way to provide the capability to raise the efficiency of regulatory enforcement. Ganne (2018) argues that the deployment of blockchain requires an appropriate regulatory framework that recognizes the validity of data transactions, clarifies the law and regulates the way of data access and usage. The legal status of blockchain transactions is treated as possibly critical because regulators still need to build frameworks to classify them properly legally. Furthermore, Herian (2018) discusses to a legal framework which requires the government to stand back and let actors have the choice as to how to accomplish their peer to peer information sharing, but at the same time taking active steps where needed, to ensure people have all the basic resources to act not only in the own but in the interest of the society as a whole. However, regulation has been widely denied by blockchain stakeholders, due to the spread opinions, that regulators are ill-equipped when it comes to proper dealing with the technological basis and benefits.

According to Tijan et al. (2019), the novelty of blockchain technology means restraints of the leading players in the supply chain, the same as regulators to adopt and accept it. The resulting lack of regulation creates a high level of insecurity because, for example, smart contracts might be adopted in the SC, but not binding from legal and overregulated from a political perspective. Mangla et al. (2018) puts governmental and industry policies in the category of external barriers affecting proper blockchain usage in companies. As governments classify as entities, which are not directly economically benefiting from supply chain activities, their intrinsic motivation towards sustainable regulation of blockchain implementation keeps within limits. While external pressure and support would drive supply chain organizations to integrate new ideas of enhancements, the absence of these leaves hurdles for precise technical mechanisms or technological sustainability in general. Moreover, Cermeno (2016) argues that blockchains' immutability features collide with the personal data protection of the European Union policymakers. As per these regulations, every citizen has the right to have their personal information deleted at any time from another party's paper or electronic records and databases.

Mirchandani (2019) adds that blockchain either obtains an exemption clause in a sense that personal data storage is simply allowed on permissioned blockchains according to the GDPR ruling, or the definition of deletion under the GDPR is revised. If a data erase allows moving onto a new block or even creating a forked blockchain may comply. The same applies to a possible access right restriction with blockchain if it can be classified as data erase as per European Union regulation. As of yet, there is no clear guidance on these issues in general, which opens room for interpretation and discussion and results in uncertainty and risk for supply chain stakeholders. Besides the GDPR ruling, Fitzgerald (2018) describes several due diligence and disclosure obligations for importers and exporters in the logistics context of the SC. Topics such as data protection, digital identity and payments may require additional legislation and are therefore of major importance for blockchain implementation.

Furthermore, Cole et al. (2019) propose a set of control mechanisms regulators can have at blockchain-backed supply chains. An example is the installment of a running auditing possibility for governments in a sense that the network initiators put in place regulatory authorities as participants of the chain with specific control access roles. Regulators here could check data and information flows nearly in real-time, instead of waiting for specific audit dates, which can be some time after the data transfer events. Grech & Camilleri (2017) point out what governments expect of new technologies such as BC. It is the importance of a valid proposition of social value, which arises out of blockchain utilization in the SC. Policymakers assess the current and future impact of technology, the same as the relative importance different stakeholders may attribute to a blockchain value proposition. Various conflicting interests of stakeholders can be an opportunity for some actors, but also a risk for other ones simultaneously. The correct and fair classification of these is essential for governments' motivation and interest in considering blockchain in their future reflections. On the other hand, this means that information sharing between

blockchain innovating actors and regulators recognizes as crucial for a fruitful collaboration.

Additionally, Behnke & Janssen (2020) state that regulatory frameworks between countries and regions diverge still widely and suggest the development of consortia within supply chain sectors, supported by institutions from the government in order to be able to define and enhance standardization. The overdue next step of maturity for BC technology towards long-term implementations includes interface standardization and data governance as an important precondition. Similar thoughts come from Baumann & Supe (2018), who see it as essential that participants in these consortia share knowledge and foster synergy effects. It intensifies the development of innovation and brings the ecosystem a unique characteristic through harmonization of processes with cost-saving results. Blemus (2017) mentions regulatory sandboxes, where applicant stakeholders who are ready to test innovative blockchain-related services, can hand in ideas and best practice information to authorities in order to achieve coherent action between innovators and regulators. Although, policymakers have been trying to adopt the most efficient regulation method for blockchain technology through either several soft law regulations or few hard law legislations its possible holistic impact on the global economy required to rethink possible requirements constantly.

As an example of government pioneerism serves the country of Liechtenstein, which provides, according to Dobrauz et al. (2018), proactively a Blockchain-Act to build - very openly and technology-friendly - a clear framework of blockchain usage in the country. For supply chain processes, it is especially interesting how the tokenization process, e.g., the digitalization of data elements, are treated from a legal and regulatory perspective. Hence, rights of ownership, exhibition rights and copyrights can add into the framework of a new digital economy, which is blockchain-based and can be pictured in transportation chains, selling transactions, contracts and proofs of ownership, respectively. Kshetri (2018) argues on the example of regulatory changes in pharma supply chains, about the willingness of swiss authorities to accept Ethereum based smart contracting. Hence, changes in supply chain data, such as pharma product temperature, is compared against various regulatory requirements to approve final supply chain shipments if all required conditions meet properly. Additionally, Mattila (2016) marks that blockchain may well make some of the old regulatory approaches obsolete because with the introduction of its unprecedented technological qualities, entirely new regulatory approaches could make use of it. The more technical the shift in regulatory capabilities is, the more clarity stakeholders have on the question of what kind of regulatory competence is required by the government in future decentralized systems.

Another viewpoint is brought up by Filippi & Hassan (2016), who speak about regulation through code, meaning dictated rules put into a self-fulfilling framework according to predefined rules in order to implement different sets of requests and restrictions. Through this step, possible widespread adoption of technical regulation maintains, but with the

distinction that it is more likely to work within routine situations, rather than edge-case where demand on more regulatory individuality is evident. Still, this is a tradeoff between gaining transparency inefficiency, the same as eventually a reduction of freedom and autonomy of individuals, which implementing actors have to consider when breaking new grounds here. Further, on, Macedo (2018) adds an example of guiding principles, applicable for non-finance organizations such as supply chains, in order to produce a proper regulatory framework. The start is a basic understanding of who and what can be a matter of regulation followed by a clear articulation of the goals regulatory policies have. Of importance is that there is no overregulation and that cooperation between participants sets the basis for the level of visibility maintained. Moreover, all information should be treated equally with the precise aim to ensure that the regulatory requirement is reasonable and expedient. For international trade, however, on top would include trade facilitation, taxation and supply-chain security.

Neuburger (2018) mentions the possibility of the existence of significant conflicts among regulators and SC actors on the question of interpreting the dimensioning of blockchain-based solutions. Therefore, parties should agree sufficiently early on the permission architecture to appropriately limit an individual’s ability to make use of network data. Warren et al. (2019) identify a lack of impartiality from regulators' perspective and at least this criticism comes from supply chain actors, who are arguing on regulators' attitudes towards blockchain technology. The questions if regulators strive against possible lack of knowledge, which ultimately leads to the unfortunate ruling, has to be answered. Additionally, it is debatable if there is a grey zone between no regulation and poor regulation or not.

3 METHODOLOGY

3.1 Introduction

After reviewing the state-of-the-art literature on the topic of DLT in the supply chain as a next step, the method needs to follow the formulated research questions. Based on these, I tried to distinguish among several research methods, including thoughts on their advantages and disadvantages in respect of the novelty of blockchain as a topic, same as the fact that methods are frequently overlapping each other during research. Yin (2014) adds that it depends on several conditions if the differentiation of methods is successful and reasonable. First, the type of posed research question determines a categorization on which method may be a good fit to put the base of research on. The second condition consists of the extent of control an investigator has over actual behavioral events. The third relevant situation focuses on the existence of either historical or contemporary events. I have applied Yins' approach after formulating the research questions and the key here was that I was successful in being wholly unbiased and without any preferences on the decision that could be the right choice of method for the empirical part of the thesis. In the end, I have followed what Gerring (2007) mentions with the terminology of insight. It defines as the unknown quantity, which helps to elude away from the deliberate choice of a scientific method. I was looking for insight and found out things, which eventually led to a classification into an existing research methodology. Merriam (1988) adds who, during an explanation of qualitative research, argues that there are instances, particularly in social sciences, where researchers are more interested in interpretation, discovery and insight than in a rigor testing of hypotheses.

3.2 Choice of method

The methodology used in this thesis is the case study research method, which has its basis on a framework explained by Yin (2014), who provides a leading piece of scientific literature, which meets a need in no laboratory social science methodology. What deems salient here is that according to Yazan (2015), the lack of a comprehensive guide to the utilization of case study method shows up in a sense that Yin presents the design and methods of case studies and pushes it as a legitimate methodology to conduct inquiries into a theoretical recommendation. Yin (2014) classifies the case study as one of the most challenging methods within social science, also because of the use of multiple sources of evidence. The full variety of evidence, such as interviews, observations and documents, helped a lot to find a broad approach to the topic. As case studies are not a data collection technique, the collection of data can happen in various ways and its extensiveness of the real-life context made it necessary to include more variables of interest, than data points only, namely complex social and behavioral phenomena, maturation of industries and individual life cycles. Based on the research questions, which seek to explain some present circumstances, the relevance of a case study as a research

instrument was clear without any alternative and most suitable. The question of what would be the distinctive advantage of doing a case study compared to other empirical methods was evident during the considerations of the research strategy. The complexity of explaining some presumed causal links in real-life situations, such as technology implementations, led to the decision to acknowledge the superiority of case studies over other methods, for example, surveys or experiments.

Moreover, according to Schramm (1971), the central tendency among all types of case studies is that it tries to examine either a decision or even a set of decisions. In more detail, questions on decision making, how decisions were implemented and with that result characterizes case studies notably. This holistic approach to tackle the topic empirically was compelling in the sense that blockchain implementation is mainly innovative both on the technological but also on the social-cultural aspect and simply needs that kind of diverse handling. As the literature review resulted in a robust information basis in order to develop theory, it is, according to Yin (2014), also more a blueprint for the case study, which helps to realize empirical research and generalize the case study results accordingly.

Given the conceptual framework of Yin (2014), the case study as an instrument serves the best when a) the research questions in their substance and form are posed with “how”, “why” in an explanatory manner; b) contemporary events are examined and c) little or no control over these events by the investigator. Although according to Yin (2014) case studies go beyond being types of qualitative research, using a mix of qualitative and quantitative evidence, I was keener to research a qualitative basis, which goes hand in hand with Creswell (2007), who recognizes the case study among the array of qualitative research options. That is because much of the implications and cross-linking information illustrated with certain topics can happen in a descriptive mode in order to enlighten several sets of outcomes. Yin (2014) distinguished between single and multiple case designs. Although, because of the novelty of the blockchain topic in the supply chain, a single case could represent a significant contribution to knowledge an theory building because it may represent a typical project among many others in the ecosystem. The lessons learned and valid information out of the case are assumed to be enough information about the experiences of an average BC project. Still, this is a risky approach, as a solid argument in justifying the choice of the case is needed. As evidence from multiple case studies is often considered more compelling and amble in terms of the development of theoretical frameworks, I followed a multiple case study with two cases investigated. The advantage in terms of the two cases is either predicting similar results or contrasting results but for anticipatable reasons. The analysis, though, is more comfortable to conduct because of pattern identification.

Another differentiation, which goes beyond hierarchical stereotypes Yin (2014), gives when classifying case studies in exploratory cases, descriptive cases and explanatory cases. Because case studies, as every other research method, can be classified in more

than only one of these categories, I would define my thesis as being descriptive, because patterns, relations and connections are delineated, same as explanatory give the nature of the cases' research questions. The proofs and arguments resulting from the case study findings serve to confirm or deny and extend existing theory. Yin terms this as analytics generalization where out of state-of-the-art theory statements or propositions are generated, which then get tested, validated or denied by the case study.

Additionally, in alignment with the study approach, Welch et al. (2011) define explanatory cases as studies, which use deductive logic to test propositions, appraise and compare rival explanations and revise existing theories and establish causal relationships. Therefore, verification of theory is rather targeted than a discovery of complete new theoretical standpoints. In terms of potential disadvantages case studies can have, Zainal (2007) addresses, based on Yin (2014), on the one hand, a possible lack of precision and reliability, on the other hand, a low basis of scientific generalization, because the number of subjects conducted is minimal. Here the goal was to make sure not to allow equivocal evidence and some biases to affect the findings and conclusions. Moreover, the potential of theory testing, rather than theory-building, stands as a basis for this thesis. Therefore the case study findings are getting compared to existing theory in the scientific literature, same as between each other's as each of the two cases tackles a different field of blockchain implementation.

3.3 Case study

In general, according to Yazan (2015), case study methodology has long been an area in social sciences, which is characterized by wavering, often opposing approaches provided by methodologists. Its evolution gets prevented because of a lack of full consensus on design and implementation. Nevertheless, Welch et al. (2011) point out that it is one of the most frequently used qualitative methods, gaining popularity across various disciplines. A reason could be what is mentioned by Noor (2008), who emphasizes the advantage of case studies, where they can be useful in capturing surfacing and inherent characteristics of life and happenings within organizations, same as lows and highs of organizational activity, especially in fast-changing environments. Additionally, Welch presents also opposing standpoints from Yins', namely quotations from Eisenhardt (1989), who has Yin's positivistic view of science in common but differs in the assentation in which case studies are narrowed in a very early stage of theorizing process, meaning that case studies are the preferred means of research when it comes to the building of theory.

Moreover, Yazan (2015) argues about the grounded theory concept followed by Eisenhardt at some point, but especially Stake (1995), in which through methodical gathering and analysis of data, construction of theory happens. That is quite different from the approach Yin favors, namely, perform data collection, which shows how one particular existing theory does apply or not apply given the gathered case study data.

3.4 Study research design

The decision on how to conduct the research design follows the framework of Yin (2014), identifies, and establishes the logic of the case study. Its task is to link the collected data and the drawn conclusions of this data with the initial questions of the study. Furthermore, Frankfort-Nachmias & Nachmias (1992) add that a holistic research design guides the investigator in the process of accumulating, evaluating and interpreting observations. It serves as a model of proof allowing the investigator to draw interferences about casual relations among data that is under investigation. Moreover, Yin (2014) emphasizes based on Kidder & Judd (1986) that the case study research design is supposed to represent a set of statements, which is logical and can measure the quality with logical tests. These logical tests are common to all social science methods, but for cast studies, mainly they should be applied throughout the whole conduct of the case study, instead of utilizing them only at the beginning. First, the test of external validity occurs when the research design conducted and the corresponding case study tactic for this thesis is the use of replication logic in the multiple case study. That means the theory gets tested by replicating the findings in a second neighborhood where the theory has specified that the same results should occur. The test of construct validity appears during data collection and should be met through both establishing a chain of evidence and the use of multiple sources of evidence. Additionally, during data collection, the test of reliability effectively if a case study protocol is used and a case study database is built. Finally, in the phase of data analysis, internal validity is ensured through pattern matching, explanation building and thematizing of rival explanations.

3.4.1 Study Questions

The case study's questions are based on the initial research questions of this thesis and include an in-depth view on the presence of some circumstance or, in other words, how and why happenings appear. A broader formulation of a question to start with would be: How blockchain implementation in the supply chain happens in practice. Based on this question, the case study will aim to answer the following three case study research questions:

1. How can blockchain solve existing business issues within the supply chain of companies?
2. What limitations does blockchain technology have if utilized in the supply chain?
3. Why do legal regulations play a role during blockchain implementation?

3.4.2 Study Propositions

Below several propositions of the case study are listed, which also include potential theory building answers derived from the literature review. They serve as a guide through the collection and analysis of the case study data. Generally, Yin (2014) strongly advises

emphasizing the coding of propositions, as the research questions alone are not sufficient to pilot the case study properly. The study propositions are also the basis for theoretical generalization and give a hint on where to look for relevant empirical evidence.

An apparent lack within today's SC systems in terms of traceability of goods reveals Assad (2018) and Zhao et al. (2019), who, in particular, show insufficiencies and criticize the shortage of truthful and authentic information. Many scholars illustrate those same issues as core competencies of blockchain features. In terms of traceability, Aung & Chang (2014) point out the unique identification of units and transfer information linked adequately by blockchain. Similarly, Tribis et al. (2018) speak about end-to-end visibility based on permission levels. Moreover, Westerkamp et al. (2019) emphasize the tokenization of information, which makes it easier available, while Sodhi (2019) highlights the blockchain potential to make SC more responsive to trends and more stable in order to connect supply chain stakeholders. Fisher et al. (2018) praise the possibility of identification of defective or grey market components along with the SC. Hence, Chang et al. (2019) mention the visibility of full tracking activities and refer to the transparent and cross-fitting information coming from the blockchain ledger, resulting in optimizations of time schedules, due to the detail level of the data provided.

However, scholars also criticize the feasibility of the blockchain applications rather than on the technological realization. Aung & Chang (2014) state that compatibility problems through inconsistencies in captured datasets challenge the correctness of tracing good flows. Casino et al. (2019) point out that blockchain faces constraints in the ability to project traceability solutions accurately because of performance issues caused by latency in the verification and confirmation process. Back et al. (2014), who introduce sidechains for information transfer enhancement, mention some remedial action here. Hence, it is proposed that:

P1. The use of blockchain technology can trace a flow of goods with a high level of detail

As one of the critical characteristics scholars, mention blockchains attribute of decentralization, which ensures the possibility that data and information can be saved locally from every network participant. Ray (2018) calls it a new paradigm of how information is accumulated and communicated, while Anderson (2019) states that redistribution and democratization of possibilities to participate and cooperate is set in motion. The consummation of information gets facilitated through an automated data transfer protocol, which according to Korpela et al. (2017), is a good idea but lacks comprehensiveness due to incompatibilities in data formats used by supply chain stakeholders. Based on Abeyratne & Monfared (2016), the flow of information is as trustful as data validity gets confirmed through democratic majority and controlled user access enables fairness. Sanjeev (2019) emphasizes the high level of granularity of data, especially during audits. Furthermore, Baker (2015) points out that with blockchain usage, supply chain participants are known, tracked and appropriately certified in order to count as trustworthy owners of

information. Moreover, Laaper et al. (2017), therefore, argue on the fact that all parties within a supply chain have access to the same information, pick up the irreversible character of blockchain data. Mattila (2016) assumes that stakeholders, which have the belief of holding immutable records of supply chain data, will deliberately favor blockchain-based applications, because of massive improvements in data accessibility.

A debatable aspect of information allocation across the blockchain provides Treiblmaier (2018), who sees the technological configuration as sufficient, but no safety net against a false choice of recipients of the information. Similar opinions come from Malik et al. (2019), who denies blockchain the ability to ensure full authenticity of observations within the SC and therefore show its limits if participants generate false data displays on the chain. Although Tholen et al. (2019) praise an improvement of data sensitivity through technological add-ons of the blockchain, such as zero-knowledge proofs, the risk of exposing confidential data restricts equal information levels for participants (Lyons & Courcelas, 2019).
Hence, it is proposed that:

P2. Blockchain technically ensures a fair distribution of available information amongst participants of the supply chain

Furthermore, the question of whether blockchain is well-fitting for supply chain processes requires nuanced answers. The self-execution ability of smart contracting, mentioned by Kamble et al. (2018) or Ganeriwalla et al. (2018), enables higher levels of trust because of agreed contract components, for example, materials, payments, data transfers or delivery information. Tribis et al. (2018) point out end-to-end visibility for all SC participants with appropriate permission levels on the chain, same as an enhancement of customer needs as stakeholders, in terms of enhancement of product knowledge and loyalty through transparency. Moreover, Hackius & Petersen (2017) emphasize benefits in product shelf life and waste reduction for non-usable food products and digitalization through paperless interaction, which reduces risks of data insecurity through physical loss or manipulation of documents. Through transparent tracking processes, according to Chang et al. (2019), frictions can be mitigated not only in the flow of goods but also on flows of capital and information. As potentially cost-saving, an eradication of the bullwhip effect, e.g., swings in stock, is mentioned by Blossey et al. (2019) and is achieved through real-time information of stock movements. When it comes to money loss through grey market activity, Fisher et al. (2019) point out that blockchain brings the ability to identify such business practices immediately. Mattila (2016) argues on the possibility to legitimate complex supplier networks and therefore reach higher bandwidths through globalization, same as Sodhi (2019) argues that DLT enables higher responsiveness to global trends in the supply chain.

The issue of the need for high computerization, which prevents usage of blockchain in mainly developing countries, gets picked up by Kshetri (2018) as the main issue for missing participation of all actors around the globe. The expectation of a fast and nearly real-time system gets doubted by scholars like Saberi et al. (2019), Tribis et al. (2018), Hackius & Petersen (2017), as scalability and processing of big data volumes remains a big issue in today's blockchain deployment. Behnke & Janssen (2020) argue that the development of trustworthy consortia within SC sectors, which foster standardization and synergy effects towards blockchain maturity are often very challenging to achieve, also because of fraud incidents which are mentioned by scholars like Abeyratne & Monfared (2016); Tholen et al. (2019). Lastly, Laaper et al. (2017) question the convincement of the public on the safeness of storage and transmission, putting the acceptance of DLT as new technology to low levels. Hence, it is proposed that:

P3. Blockchain, at its current stage of technological development, is not a perfect fit to meet the needs of stakeholders in the supply chain.

On the possibility that blockchain substitutes running systems in the supply chain scholars have differentiated opinions. Treiblmaier (2018) brings up the opportunity to reduce control structures of centralized databases. Furthermore, Malik et al. (2019); Kshetri (2018) points out that from a technical standpoint, blockchain can assure objectivity with a low level of biased data and is adaptable with technology matureness. Tribis et al. (2018), who emphasize the regulators' opportunity to monitor data movements adequately, point out the regulatory perspective. Another advantage compared to legacy systems mention Aung & Chang (2014) with blockchains' characteristics to uniquely identify data towards a security level enhancement. This data integrity, according to Abeyratne & Monfared, is characterized by low cost and system harmonization. Kshetri (2018) adds that the establishment of an errorless permissioned system is easy to implement through the nature of blockchain features.

While Apte & Petrovsky (2016) mark that the need for substantial PoW consensus is not always preferred, because participants are not used to it in previous centralized databases, Westerkamp et al. (2019) questions blockchains deployment and maintenance costs especially if the data amounts are high because of trust and transparency standards. Sarkis et al. (2011) miss an automatized blockchain functionality of proper data checks, which could lower information asymmetries before pulling data into the ledger. Furthermore, Tijan et al. (2019) criticize the fact that blockchain does not have a single underlying standard, which is understood and accepted by a majority, which then leads to a configuration of lots of difficult standalone concepts and programming intervention. Likewise, according to Kshetri (2018), regulatory uncertainty in implementation questions puts blockchain a step behind running legacy systems in the area of SC. Hence, it is proposed that:

P4. Blockchain technology is not ready to fully replace legacy systems in the supply chain.

In general, scholars like Tseng et al. (2018); Herian (2018); Mirchandani (2019) point out that decentralization, which is one of the core competences of blockchain technology, clashes with governmental checks and balances and that governments positioning in this case varies and needs efficiency. Mangla et al. (2018) recommend more external pressure from regulators, which would result in an enhancement of innovation in blockchain-based supply chain organizations. That is partially shown by Dobrauz et al. (2018), who argue that proactiveness by governments occasionally existing and gives the example of Liechtenstein's' Blockchain Act, which among others, regulates tokenization of assets and information towards the opening of new innovative perspectives within the SC. Furthermore, Grech & Camilleri (2017) state the governments' expectations towards blockchain in being a valid proposition of social value when utilized in the supply chain.

Conversely, Herian (2018) discusses that due to blockchain stakeholders opinions', regulators are ill-equipped in terms of proper dealing with the technology. Therefore regulatory proposals are not appropriate recommendations. Hence, Mangla et al. (2018) deny regulators the intrinsic motivation to put in place appropriate legislation because economic benefits from BC are still not recognized suitably. Although Blemus (2017) mentions regulatory sandboxes for testing innovation, he criticizes the lack of best practices exchange to achieve coherent action between regulators and blockchain innovators. Behnke & Janssen (2020) see standardization and data governance as missing but, on the other hand, an important precondition for technological maturity of blockchain in logistics. Finally, Mirchandani (2019) compares the GDPR and other current governmental rulings around the world with the blockchain approach, and spots contradiction in the areas of privacy and immutability of data. Hence it is proposed that:

P5. Governments do not provide sufficient legislation regarding the implementation of blockchain technology.

3.4.3 Unit of Analysis

After the development of the studies' research questions, followed by propositions for theory verification, the third component, according to Yin (2014), is related to the fundamental problem of defining what the case is about. As already mentioned, the case is a multiple case study, and its increase of external validity comes from the data collection and analysis of two cases, which selection bases on the theoretical assumption that either conflicting results in theoretical or similar results in a literal replication could appear. The vital step in these replication procedures is the development of a theoretical framework. Both cases are not about any abstractions, such as arguments or hypotheses, but the real-life phenomenon, eg. Projects of blockchain implementation in the supply chain.

Although both cases operate in different areas of the supply chain, emphasizing its improvement in different segments, both have in common that blockchain as technology amends supply chain processes to enhance stakeholder satisfaction.

The first case is the “Blockchain Initiative Logistik” that was initiated by the consultancy company EY, to bring leading Austrian logistics companies together. This new form of collaboration can classify as a consortium, where the money is raised and collected. The aim is to reach process enhancement with the help of blockchain technology. In particular, the improvement was the digitalization of supply chain documents. The outcomes of the initiative should, furthermore, serve as fruitful insights for future cooperation and best practices. The exchange of information benefits to the commonweal of logistics in Austria and pushes barriers for future innovative blockchain ideas in the supply chain. The second case is the “Rotharium” project that was founded by the blockchain startup Crypto Future GmbH. Their goal was to build a gate to the blockchain and enable the integration of apps into the blockchain ecosystem. Their first use case was supply chain-related, meaning a tracing application based on blockchain, followed by a tokenized medium of exchange for more straightforward payment execution in supply chain ecosystems.

3.4.4 Case Study Protocol

The necessity of conducting a case study protocol is clearly emphasized by Yin (2014), who illustrates it as essential and reliability increasing, especially if a multiple case study is the selected empirical method. Hence, the protocol means more than a questionnaire or instrument, as I contain procedures and general rules to be followed.

Section	Content Case Study: Blockchaininitiative Logistik	Content Case Study: Rotharium
Overview	• A consortium of Blockchain Consulting company, leading Austrian logistics companies and IT firms • General mission is the digitalization of supply chain documents • Background information before investigating: press releases and internet research on user forums, blogs and similar	• Startup company builds tracing application for food supply chain • General mission is the facilitation of goods traceability for customers and supply chain actors • Background information before investigating: press releases and internet research on user forums, blogs and similar
Data collection & field procedures	• The everyday situation on the field distorted by restriction of COVID19 • Interviews and data collection scheduled for Q2 2020 • Data collection plan see section appendix 3	• The everyday situation on the field distorted by restriction of COVID19 • Interviews and data collection scheduled for Q2 2020 • Data collection plan see section appendix 4

	• Recorded guided online interviews instead of personal communication including notes • Preparation before interviews with internet-based project and product research • Collection of internal memos • Collection of pp-presentations • Collection of letter of intent	• Recorded guided online interviews instead of personal communication including notes • Preparation before interviews with internet-based project and product research • Data collection plan see section appendix 4 • Collection of whitepaper information • Collection of product videos • Collection of meeting minutes • Review of the product (app) in real-life context at a grocery store
Case study questions	• See section 3.4.1	• See section 3.4.1
Guidance	• Interviews conducted in german • No transcription of interview data • Analytic and structured summary of recordings and documents in English	• Interviews conducted in german • No transcription of interview data • Analytic and structured summary of recordings and documents in English

TABLE 3: CASE STUDY PROTOCOL

3.4.5 Data Collection and Interpretation

The process of data collection, especially having the case study as an empirical method, is a very tedious one. The goal for this thesis is, following Yin (2014), to collect enough data so that there is confirmatory evidence for the main topics covered, which means that at least two sources of evidence are included. Moreover, there is an attempt to include investigations on rival propositions. As the basis, I have chosen guided interviews with included people in both projects, conducted in german. The implication and theoretical assumption are that they represent expert knowledge and can give fruitful opinions to outline proper and meaningful case study results. Of significant importance is the effort to find a good breakdown of interviewees, who have different views and angles on the topic and, therefore, could provide differentiated answers. A positive side effect was that interviewees suggested other persons for interviewing, as well as other sources for evidence to incorporate. Overall for one case, three interviews, for the other case, four interviews were done. The respective interview guideline can be found in Appendix 2. Besides the interviews, various other documents get utilized. Examples are presentations, whitepapers, internal memos, videos, meeting minutes and a self-testing of an application in a real-life environment. Although the plan was to include direct observations, higher power in the form of the COVID19 virus made this virtually impossible. The approach to corroborate interview data with other sources collected enhanced the significance of the case results. Additionally, I have followed the recommendation of Yin (2014)

in terms of interpretation of interview recordings. As Yin does not recommend transcribing and excerpting the interview, because he misses benefits compared to the effort input, I have done structured summaries in English.

As a precondition for the proper interpretation of case study findings counts the establishment of a chain of evidence. Based on Yin (2014), I, therefore, tried to work backward with a statement of a hypothetical conclusion for the topic of blockchain usage in the supply chain. Afterward, there is the identification of specific evidence and data that would support such a conclusion. Then some protocol questions were elaborated, which then led to the starting point of case study questions. That helped to understand the chain of evidence in terms of how the components are linked together. On the topic of data interpretation, I have followed Yin (2014) on general analytic strategies again. The first one is a comparison of interpreted case data with theoretical propositions, which led to the examination of the case study, which is the essential technique used in the thesis. The other one is to postulate rival explanations and examine them in contrast to the initial propositions. Given the fact that the case was done explanatory, the technique of explanation building gets used. Here in order to analyze the data, explanations about the case are formulated and again compared to initial statements.

4 CASE STUDY: BLOCKCHAININITIATIVE LOGISTIK

The consultancy company EY initiated the founding of the Blockchain Initiative Logistik (BIL) and its first use case is the digitalization of freight documents and its illustration on a blockchain. This solution should help to automatize processes and save costs. The starting participants are leading Austrian logistics companies such as DB Schenker or Walter Group, together with the associations GS1, Bundesvereinigung Logistik (BVL) or the IT company EDITEL. The project was an awarding winner of the futurezone award in 2019 in the category Blockchain. The following subchapters will summarize the four recordings and translate them from German into English. Moreover, the case documentation consolidates in a sense that core statements of the case study tenor get clear.

4.1 Interview Matthias Leibetseder (WALTER Group)

Leibetseder, who is Innovation Manager at the Austrian company Walter Group, which in terms of revenue, is the second-largest logistics firm in Austria, points out that the company engages with blockchain from a research aspect. That means blockchain is seen as a technology considerable when it comes to an estimation of how it could enhance supply chain processes. The path of cooperative work of logistics companies with blockchain in this project was found through extensive communication on several questions. The participants of the initiative asked themselves where potential use cases would arise and played through several scenarios where information overlap between parties, who share goods or data, happens. The premise was that no share of own confidential documentation happens.

Even if the technology may look disruptive for several topics, it is essential to examine if and to what extent it makes sense to use it. In general, Leibetseder sees blockchain as a complementary system, therefore more as an addition to established systems than utter disruption. Especially the use case with the Ethereum based digitalization freight documents shows, in his opinion, that blockchain brings the proof of entitlement because the main goal here is to illustrate freight related documents as digital service on a decentralized ledger. With this approach, the main problem within today's logistics gets addressed, namely that there is no system harmonization in the supply chain. As every company and sub providers, eg. GPS providers have their system solutions in various fields of application.

Hence, the collaboration project with their competitor DB Schenker within the initiative has the main goal to set an industry standard, which results in a reduction of complexity of various interfaces connecting system programs. That helps supply chain companies, although being in a rivalry relationship, a step towards bettering their processes, facilitate the on and off-boarding of the particular platforms. In a second phase, the initiative will focus on increasing the participant's number to image a larger number of logistics processes on the blockchain. It then should show relevance for the market overall, as the

European Union has commissioned a technical evaluation of the deployment of digital waybills on the blockchain. As a challenge for the project, Leibetseder emphasizes that both Walter Group and DB Schenker have a very diverse system landscape and different standard processes in place. The implementation of one tool, which serves as a layer on the surface, is described as hard to assemble. Very positive feedback there is on the collaboration and information swap between participants of the initiative. The openness to share process steps without obvious withhold of information helped the project to grow towards participants' satisfaction.

As core strengths of the blockchain within the area of supply chain Leibetseder see the decentralization and immutability of data. He emphasizes the suitability of entries in the ledger that means the possibility to gain exact knowledge which the user has done entries and when this input happened. Especially the tokenization of information within the process of digitalization of the waybill, which enables backtracking of at least the devices, which are used during a goods flow, is very helpful. That is because nowadays, in a paper process, it is not possible to force all participants of the chain to register and sign the waybills in a proper way, which results in information gaps. Therefore, blockchain is a way of enhancing transparency and data security. Although he is not a technician, coming more from the business side into the project, the formation of a means of security is praised and also the accomplishment to restrict mutual visibility of information. That is important because it is difficult to find a superordinate partner who is trusted by all logistics parties. He argues that competition plays a crucial role and that logistic companies do not want that data to circulate between themselves because the customer’s base is the same, and the fight for customer retention is hard enough.

Still, as one of the most significant weaknesses of the supply chain, especially in the area of land logistics, according to Leibetseder, is the level of technology used in daily work, which is far behind of being state-of-the-art. That is shown by lots of paper-based processes, with, on the one hand, uncontrolled growth of this form of data, on the other hand, no regulatory frameworks behind it. The standard waybill, which related to the handling of road transportation, can be classified more as a recommendation than a legally binding document. Moreover, he sees it questionable if truck drivers, who have an average age of almost sixty years, can be part of a new digital era and are keen and knowledge equipped enough to use apps in their daily business activities.

The bright, unique selling proposition (USP) of the working product which emerges out of the initiative for Leibetseder is that, on the one hand, clear cost savings in terms of processes can be achieved, on the other hand, an acceleration of internal processes. As the today's process of settlement of waybills into payment is manual and time lagging, because the paper needs to be transported, scanned and accounted accordingly, the new digital solution with the blockchain-based electronic waybill ensured more transparency and smoother execution of payment as all information on the chain is available near

real-time. If executed with fully automatized over smart contracts, a potential cost saving of several full-time equivalents (FTE) is possible.

Besides the digitalization of waybills, blockchain can help in other areas of the supply chain too. Leibetseder mentions other documentation that gets collected during transportation of goods, for example, information on insurance-related damage cases, exchange of pictures of goods or the whole communication between customers, truck drivers and carrier companies. These types of data, same as custom related documentation, could be necessary information included in a decentralized platform. There is also another blockchain-based project running at WALTER Group, namely a loyalty points system for truck drivers. That motivates the participants of this program to manage several steps in the application. For example, photographing the waybill and settle the information on the blockchain.

Potential for improvement during the project Leibetseder sees in the act of finding mutual consent for the definition of standard processes. The more stakeholders involved, the more difficult and slow progress can happen. He suggests that one or two logistics companies internally find potential demand for a specific solution, and this solution then serves as a blueprint for further onboarded stakeholders on the project. The level of digitalization in the supply chain, even with big players in the industry, is described as quite sobering. Therefore, the understanding that even a relatively smaller project of document digitalization in a goods loading process has a lot of fine-grained steps and potential information to be processed accordingly is crucial to success. The prototype of the product was amended quite roughly, including several interactions in product development. It was because developers on the blockchain side did not have enough logistics background knowledge in order to gain enough initial understanding of the subject matter.

Leibetseder does not see any apparent negative aspects of blockchain integration in the supply chain from a functionality perspective. Still, he emphasizes again difficulties of the implementation of highly sophisticated technology as blockchain is in a not fully technologically developed supply chain ecosystem. That is because Excel still represents the basis of daily work and the foundation of many companies' enterprise resource planning (ERP) systems. In order to make it possible to work with blockchain nodes, the model needs to simplify many process steps and work on the enhancement of acceptance with supply chain participants. Moreover, a consideration of the costs of a running blockchain system compared to benefits is a topic to occupy with properly. A transparent calculation is possible because blockchain service providers can easily show in much detail cost-benefit ratios on use cases. As the Walter group runs the node, which controls the billing process of the blockchain-based e-CMR by themselves, steering of its level of usage and costs is easily possible.

In terms of collaboration, Leibetseder points out, that with governmental institutions, such as various project-related ministries, there were attempts to find adequate contact persons for a further interchange of information in the fields of e-CMR and technological innovation. It was described as arduous, especially if political administration changes come up, as Austria experienced during summer 2019. The result is a replacement of people and regulators in charge represents a hurdle towards coherent cooperation with rule-makers. Although it is essential to step in as early as possible and gain a foothold with mutual interaction, it is not clear if valid statements on governmental perception, especially with the EU can be expected. The ratification of legal binding rules takes up to thirty months when it comes to the digitalization of freight papers. That is, at least currently, untouched by the fact if implementations happen with centralized or decentralized solutions. The participants of the initiative rely on local juristic decisions whether a digital waybill is legal and accepted, instead of having clear superordinate directives.

Hence, Leibetseder criticizes that it is challenging to find investing partners and people financially involved if regulation is not formulated correctly and does not ensures legal security. Furthermore, in order to be satisfied with the regulatory collaboration, he would expect transparent role allocation in the governmental institutions, same as open communication of the entire agenda topic, which is on the desks of governmental decision-makers. Especially in times of crisis as COVID19, a clear need for digitalization, because of asocial and distancing behavior in traditional communication, should encourage regulators to formulate proper rulings. There is no fitting hedge against potential risks within digitalization with blockchain at the moment, the only way to be on the safer side is to digitalize, but at the same time also keep the paper in a deposition for audit purposes in the future.

4.2 Interview Michael Schramm (EY)

Schramm is the initiator of the project leads the blockchain competence center for the management consulting company EY. Their goal is to support companies in terms of digital transformation. Here blockchain plays a big role and has relevance, not that much in internal improvements, but especially in an enhancement in transaction and communication with other stakeholders in their ecosystem. Schramm points out that blockchain can either be seen as an addition to existing systems but also be a complete disruption, dependent on the case of application. The additive character shows when used as a technological tool for the improvement of partial aspects of a problem. The premise here is that its utilization brings benefits over existing IT remedies. Examples are its features to protocol events or to create tokens, which act as containers in data transfers. The creation of disruption happens when utterly new business models come up. An example from the logistics field is the insurance of container vessels. Insurance companies can cover not only blanket amounts insured but include various means of data into the insurance base calculations to tailor the premiums accordingly. These data can be information about location, weather and other details copied into the ledger in a secure, undeniable

and not debatable way. This opens up creativity when conducting price models, which can change in real-time when taking account of proper risk allocation during shipments.

As of major importance for technology development Schramm sees the public blockchain and prefers it to be private or consortium chain solutions, which are, in his view, only short-dated workarounds. The existence of distributed applications, which are running by themselves backed up by blockchain, ensure new ways of how the economy works, without the need for third-party involvement towards a systematic performance without intermediaries. The more companies enlist to these kinds of solutions, the faster and easier the adoption of new business models can happen.

The initiative Schramm initiated has the goal to spot how different companies can work together. That includes logistic companies and also firms, for example GS1, which develop and maintain global standards for business communication and act as multiplicators for standardization and distribution. The cost allocation for the project happens on a joint basis and the product and the property belong to all participating parties. The digitalization of the waybill serves as a valid document of several governmental stakeholders, as regulators or customs. That is important because these institutions are seeking for proper levels of security and replicability. The establishment of a market standard is one-step towards widespread recognition amongst stakeholders. As challenging, he sees less in the implementation of the technology itself, because he defines this an easy to achieve, more on the organizational part. As within such a project, there is not a single customer where a single problem gets tackled, but lots of diverse similar problem formulations and solution approaches, the crucial part is to find a correct setup to satisfy all involved parties. Other challenges are on the legal side of the project. That is because; there are several statutory principles on various levels of legislation. Institutions like the United Nations, European Union and lastly, local countries handle and ratify the digitalization of waybills in different, sometimes contrary ways.

Schramm brings up traceability as an important topic within the supply chain and emphasizes it as one of the core strengths blockchain as a technology has. The question when several steps in the chain where done and who exactly performed actions is an important one for supply chain actors. That is because transparency is needed either in terms of costs, risk allocation, adherence to schedules and similar. Furthermore, compliance reasons in order to meet regulatory observance could be one of the reasons. The obligation to produce undeniable proof amongst several parties brings blockchain into the position of being a fair fact-based arbitrator between participants of the chain, who naturally act driven by their diverse interests. Moreover, the process of archiving and findability of documentation is especially relevant when it comes to audits by governmental regulators and easily facilitated by having blockchain solutions. As a central point, Schramm refers to the additional level of trust, brought by blockchain into the digitalization process. The process of digitalization, which often happens with other non-block-

chain based centralized systems, lacks an adequate level of reliance, especially if participants do not know each other. At the same time, he identifies digitalization projects as a catalyst for enhancements in established supply chain processes, which are manual and characterized through human mistakes, media breaks, different system landscapes or incompatibilities. Blockchain eliminates most of these kinds of steps towards a significant reduction of process costs, which marks the clear USP of the initiatives' product. The project of the digital waybill also offers the possibility to reduce conflicts in terms of trustfulness of documents, the validity of signatures and similar disputes amongst supply chain participants. Several conflictual examples are manual changes of handwritten figures and signatures on documents and the question when exactly these changes happened on these pieces of paper. Therefore, validity achieved through automated management of damage and losses, furthermore the electronic proof of delivery in real-time, and especially crucial for companies who need to prove this kind of information for compliance reasons because of stock exchange listings. Other beneficiary participants are customs or finance departments of countries, who are interested in the correct transfer of taxes. Although an eventual appeal of some documentation happens rarely, in case of controversy, the solid proof of correct documentation helps to save lots of money in a possible legal battle.

The next steps within the e-CMR project are the integration of other logistics partners and then on a long-term perspective, also other external stakeholders, such as regulators and end customers. That means it shall be possible to allow these groups to check data and information movements on the chain independently. As a crucial task here, he emphasizes to bring the proof in a comprehensible way and to show with proper visualization that blockchain entries are correct, especially to participants who are skeptical on its benefits and validity. As a future vision, but still not established nowadays, Schramm speaks about the blockchain being the basis of one solely system. Now blockchain is used as an additional mechanism to enable an interchange of information of various heterogeneous systems towards a frequent basis of trust. As a formula for success, he adds that whenever blockchain is added like a puzzle piece to existing or desired business applications, instead of being put into the center of the considerations, projects can focus on the business problem itself and have higher chances to be thriving ones.

The product prototype of the blockchain-based e-CMR is running on a hybrid version of an Ethereum blockchain. Schramm formulates the ambition to use a public blockchain but points out that scalability, costs and especially level of privacy are not sufficient enough with the progress of technology Ethereum has today. With upcoming updates, which would include zero-knowledge proofs and lower costs, a move to a fully public blockchain is a possibility. That would reduce the level of complexity and boost the possibility to address further participants, who then could easier attend the future possible market standard.

Schramm adds some negative aspects and a possible deal-breaker for blockchain implementation in the supply chain in a sense that blockchains' ability to show flows transparently drowns at the same time the possibility to hide unwanted information. He admits, based on the experiences within the initiative's project, that not every participant is keen to live with the level of transparency blockchain offers and describes it as a balancing act to find the proper middle way, paired with a tailored approach of authorization levels for participants. In terms of data security, there is a need to distinguish between private and public blockchains. The lower the number of nodes, the higher the chance of fraudulent activity. Therefore, he characterizes private blockchains not as tamper-proof enough and sees especially big public blockchains as a premise for data security.

According to Schramm, the initiatives' project required short and long-term contact with governmental institutions. Widely detached from the topic of blockchain, a clarification with regulators was needed on questions if paperless documentation is permitted or not. The long-term level of collaboration includes blockchain in the future and goes in the direction of incorporating regulators in order to give them an integrative view of the blockchain. As examples, he brings the possibility to equip financial authorities with authorizations to check if tax payments on transportation activities transfer correctly. Other examples are checks on toll systems and weather trucks conform to rules or not. Moreover, companies as Brau Union, which rely on detailed information, wherein the supply flow goods locates, could be using blockchain in a customized way to maintain their tax reportings and due dates automatically. That is how to fit precisely the demands of governmental institutions and create a valuable interface towards authorities.

Furthermore, Schramm compares Austria to other European countries, like Estonia, Georgia or Switzerland, which are far in advance in terms of blockchain understanding, knowledge and proactiveness. Although there are minor initiatives and punctual ideas in Austrian institutions about blockchain implementation and research, the topic is still present and far off widespread usage. In terms of privacy regulations, according to Schramm, the GDPR contradicts with blockchains' privacy features. He marks it as very important to ensure that blockchain is used correctly in terms of design and architecture. Hence, it is important not to save any personal data on the ledger, because retrospective deletions are not possible without being obvious. Additionally, he mentions smart contracts, which from a legal standpoint, are not binding, although the wording may suggest that. However, if automatic running functionalities are implemented, they could be interpreted as such contracts under the premise that an accountable legal vehicle is defined, which is legally liable and responsible for a particular action. Therefore, he sees the implementation of smart contracting as still not distinct enough to be adopted legally accepted by the mainstream.

4.3 Interview Gerald Gregori (BVL)

Gregori, who acts as co-founder and external logistics consultant within the initiative, represents, at the same time, the interests of the national association of logistics in Austria. From his point of view, blockchain has an overrated role in the supply chain, because of the hype created about possible groundbreaking features of the technology. He is thoroughly skeptical and defines blockchain as a vehicle to promote digitalization in the SC. If blockchain utilized within its full potentials, including smart contracts, then it could have huge impacts on the area of logistics. Now Gregori spots a fundamental misunderstanding because people see blockchain as a substitute for electronic data interchange (EDI) and cloud services. He denies that kind of view as blockchain implies the use of both technologies and brings several attributes, such as security, dislocation and traceability, as additional features layer into legacy technologies.

On top of that, he states that many solutions, which have attributed to the blockchain, could also be solved by other existing technologies. Furthermore, he does not define blockchain as disruptive in the area of the supply chain because blockchain needs existing requirements for business processes and standardized information with electronic messages to make it usable. Hence, this can be one of the reasons for being not a coincidence that blockchain forces through very slowly in the logistics and SCM, because standardization is more important than additional features. He defines blockchain as a technology with features and not as a standard, which shows how to implement processes practically. As long as there is no common language and codification valid for all supply chain participants, blockchain cannot help, because its data input lacks proper standardization.

The idea of the initiative, according to Gregori, was to find out what blockchain solutions can offer concretely for the supply chain. For him, the electronic waybill is a meaningful utilization of blockchain technology because after he critically reviewed the protocol of e-CMR from 2008, he recognized that all the requirements for a digital waybill require features, which represent blockchains' core competencies such as data certainty, traceability and visibility of changes. Especially holistic data management in the supply chain gets established with the help of blockchain technology. Gregori mentions the supply chain operations reference model (SCOR), which includes payment and goods, also flows the information flow. This information flow can be massively enhanced with the stated blockchain features, so long as the business models elaborate properly, the right partners are included and blockchain is used expediently. A bulk solution where blockchain provides the technological basis is the conjunction of smart contracting with vendor-managed inventory (VMI). Where VMI is the solution for the goods flow, blockchain enhances information sharing and payments through tokens and therefore makes full digitalization possible.

Gregori adds that that, especially paper documentation, but also information flows overall in the SC lack consistency and data quality. That is because manual or semi-manual documentation goes along with possible mistakes in entering data. Here he adds that the use of blockchain forces actors to switch to standardized digital solutions such as electronic delivery notes, waybills, confirmations and similar. He sees transparency as positive but mentions that this kind of transparency is steered in a way that separate participants should exactly see into these kinds of data, which are of relevance for them. Here the supply chain sector is exceptionally restrictive when it comes to unwanted data share amongst participants, such as competitors. If there would be too much transparency supply, chain actors usually very rapidly close the door for such technology. Besides digital documentation, Gregori sees blockchain as a factor of improvement in the area of product piracy prevention, namely whenever it is vital to verify the correctness and validity of units. Still, the significance of a labeled tag, which includes information based on the blockchain, is only valid when it is ensured that there was no manipulation in tagging particular units.

On the topic of regulation, Gregori adds that a clear framework of digitalization within supply chain documentation misses locally, and the execution of binding rules is not established in a way that regulators understand the issue adequately. Moreover, the split of responsibilities if not always clear when it comes to innovative business models. That is not precisely the case for blockchain implementation, but in general for new kinds of innovation.

4.4 Interview Andrea Plöchl-Krejci (EY)

Plöchl-Krejci is leading the Logistics Technology Transformation department at EY and handles the project as the supply chain expert from the consulting side at EY. She characterizes blockchain as an exciting technology for the supply chain, primarily because due to the variety of involved parties, who usually do not know each other. This fact makes a possible usage of blockchain evident and exciting to explore. Blockchain, for her, is a complement to an existing system landscape but has, at some point, disruptive character because in future manual steps within processes will become obsolete. A complete replacement of current ERP systems through blockchain is not realistic. In her opinion, it is crucial to impart information to companies on blockchain being an existing alternative solution, namely in cases where it adds up and brings real enhancements and ads that this is not the case for many topics in the supply chain. The initiatives' primary goal with the waybill digitalization project is to better the degree of automatization in a process which is labeled as being very manual, painstaking for participants on the chain, prone to error and open for manipulations.

Furthermore, the initiatives' project showed that supply chain actors, who entered this new field of technology, were confronted with lots of open questions, with no existing use case or best practice approaches. This field of unknown provides several possibilities for

paths to go but is, in general, tackled very collaborative in smaller working groups. Plöchl-Krejci sees it as a novelty that competitors in the supply chain openly discuss their processes for the sake of progress. Although information exchange is not always possible to a considerable extent, because of cartel law, there is no refused permission of blockchain because of antitrust law. Moreover, blockchain can act supportive, as the supply chain will face many changes in the future, mainly because of climate regulations, which will require higher levels of cooperation amongst supply chain actors in order to make more efficient use of capacities. Additionally, Plöchl-Krejci adds that in the brainstorming process for the initiatives' use case, other possible blockchain-based supply chain use-cases were in discussion. These are track and trace applications, solutions for the transport of sensitive goods with IoT sensors, incentivization of truck drivers, food tracing or load carrier management. These use-cases bring improvements not only to internal supply chain stakeholders but also to external ones, for example, customers. It ensures a more effective end-to-end supply chain. The benefits are trust-building with a basis of transparency and data security.

Plöchl-Krejci emphasizes several benefits blockchain can bring to the supply chain. These are the possibilities to reduce manipulation and enhance data security, especially in environments where several business participants do not trust each other sufficiently or even do not know each other. That is common practice in the supply chain, because of possible long chains of people, the features of blockchain can tackle the limitations of the supply chain accordingly. Additionally, more limitations, such as data inconsistencies or manual gaps in automatized processes, foster data errors. With blockchain in place, the correct flow of supply chain data, paired with information coming from sensors via IoT, also helps within customs-related topics, for example, to estimate relevant benchmarks figures and span a proper safety net for risk reduction. Another example comes from the field of insurance companies, who react very briefly when it comes to changes within real-time data and therefore, adaptations in the products deem necessary. This trusted partnership between insurance companies and end customers gets even stronger because customers can be sure that based on the given data, the adaptation of their policies happens in their full interest based on external happenings.

In general, Plöchl-Krejci sees room for improvement when implementing innovative business models. On the technological side, she points out that there is no consistent standard that is widely used. On the practical side, it is difficult to drive such projects forward if there are no clear legal and regulatory terms that need to be followed. As one of the lessons learned out of the initiative, she sees the approach of creating a product, which may not be instantly perfect, but gives the basis to work on it towards market readiness. That is contradictory to the approach of tedious discussions through theoretical frameworks on how blockchain could be useful. The question of how supply chain companies determine whether blockchain could be useful or not, Plöchl-Krejci answers with a referral to the Gardner Hype Cycle and is relieved that common opinions of blockchain being able to displace every other technology are not valid anymore. The critical step here is

to find an appropriate business case first where blockchain can play out its strengths. Frequently decision-makers in companies want to learn more about new kinds of technology and out of that interest, further implementation steps arise. Hence, she does not see blockchain features creating unfortunate effects on the supply chain processes. The features that blockchain offers customize according to predefined permissions.

On the regulatory topic, Plöchl-Krejci states that in the first step, issues with regulators have not much to do with any technological aspects, meaning that regulators are not primarily interested in how digitalization is achievable, but more if and what level of digitalization is legally allowed and officially accepted. Therefore, independently if blockchain or any other technology gets used as a driver for innovative business models, it is not a regulator's responsibility to expose himself in particular with technological details. In a second step, this could change, namely, if rule makers decide that particular issues require particular features and if blockchain illustrates as the framework, which fits the best, then more detailed guidelines, would emerge. The waybill digitalization project required collaboration with the Austrian governmental departments of climate & innovation and ministry of finance. Here there are working groups on the enhancement of proactive participation within the data transfers on the chain. Here authorities can benefit because of automatized data integrity, which shows through viewable changes in the data structure and eradicates the possibility of manual entries. Plöchl-Krejci questions if authorities nowadays are ready and equipped enough in terms of political will. The next step towards the incorporation of blockchain-based solutions into their processes and acceptance of these from a juristic standpoint is still outstanding.

4.5 Documentation

4.5.1 Internal Memo

An internal memo showed results out of a Kick Off-Meeting, which took place end of 2018. The participants of the event, which was called Blockchain Consortium for Transport & Logistics, attended because the fundamental idea is to lower the entry barrier for new technology and establish together with market players results, which would be noticeably more challenging to accomplish all alone. Several Austrian logistics companies, EY as an organization, a research team of the university of economics, IT companies and corporations across various industries who are interested in enhancing their supply chain got invited to brainstorm on possibilities and fetch a small piece of funds and know-how in order to profit from a bigger collective project which gets maybe also governmental funded. The paper promises coordinated cooperation amongst participants of the supply chain, which creates synergy effects and possible blockchain use cases are of great utility as soon as collaboration and automatization amongst partner is established. Whoever decides to participate at the consortium contributes partially to the costs and can expect co-creation and complete rights of use on a pilot product, its source code and documentation. The participants can send functional or technical experts in

terms of content and for technological expertise transfer. The outcome can bring a value of ten times the investment volume.

The suitability in terms of synergy and cooperation gets examined and after brainstorming, the following five use cases identify as relevant to work on further in smaller groups

- Automatized contracting up to invoicing/payment
- Digitalization of freight documents
- Management of load carriers
- A decentralized marketplace transport platform
- Track & Trace

After every team presented, there was voting, which decided on the digitalization project to be the use case of choice.

4.5.2 PowerPoint Presentation

The content of a PowerPoint presentation from EY outlines in detail how the initiatives' project schedules and how the information flow in the e-CMR product exactly looks. Moreover, further steps towards widespread blockchain usage in the supply chain are targeted. First, a recognition of a significant market happened, as carriage of goods will slow growth steadily for the next decades and almost all trans-border movements included paper-based documentation. The paper-based documentation is of high relevance for customs, invoicing, taxes and other authorities, but their handling is often not professional enough as mistakes happen, which result is less data quality and integrity. Furthermore, a CMR costs approximately four euros per piece, including shipping and activation, hence the accomplishment of enormous cost savings through digitalization is possible. The platform includes core participants, such as shippers, loading agents and haulers who simultaneously act as holsters of the platform. They interact with end-to-end participants, such as receivers, drivers, customers or authorities, through an application directly. Furthermore, service contractors, such as insurance companies, banks or logistic service providers, can make use of the platform for the collection of tailored information. Lastly, IT companies provide the software development and enhancement on functional features of the application.

A blockchain-based e-CMR contains various attributes and features. There is a unique CMR number, which marks an identification for the sender and receiver. Furthermore, there is textual information on every step of the goods transport, including timestamp, changelog and a possibility to add specific comments or report damages. Moreover, there is information about the steps of the chain. Examples are place and date of the takeover, place of delivery, attachments, instructions and participants. The document, in the end, is digitally signed and then marked as completed. The technical architecture is Ethereum based and requires every participant to run a blockchain node in a private blockchain environment, which secures metadata of the transactions in order to keep

data integrity. The validators are participants in the private environment of the blockchain and the data storage gets separated between each participant for the sake of data privacy. Furthermore, there is a notary service included wherever a private blockchain node is running. A public blockchain validates the data within this notary service for proper compliance with external market participants. Here there are neutral validators among the public blockchain, which is a trust-building factor.

After the finish of phase one, which included the pilot product and first testing, in 2020, scalability and product maturity is on the bucket list and the participants' number should be expanded. Phase three in 2021 should then herald commercial operations.

4.5.3 Letter of intent

The letter of intent of the project overall includes the formulation of several goals such as reduction of process costs, facilitation and enhancement of data access, exact protocols of entry changes, electronic proof-of-delivery and accessible archiving functions. It should be reached with DLT in which transparency, security and protection against forgery is in focus. Furthermore, there is the aim to establish a decentralized commercial platform, which is prosecuted by pioneering logistic companies and made available for other manufacturing companies, forwarders or carriers or insurance companies for the handling of damage claims.

Equivalent to that, one of the involved logistics companies includes in its letter of intent the importance of spreading digitalization amongst as many market participants as possible. Relevant here is that there is compatibility with EU regulations hand in hand with process complexity reduction and trust foundation. To facilitate the formulation of possible use cases, the approach to tackle as a consortium with knowledge transfer should bring better project results. Goals for a more extended period are cost reduction per transaction, tamper-proof, reduction of erroneous shipments, continuous access to documents for all participants and reduction of human capital resources. Other benefits apart from the product-related ones are an enlargement of IT Knowledge through cooperation, technological edge compared to the competition and positive employer branding in the eyes of talents through the approach of innovative business models.

5 CASE STUDY: ROTHARIUM

The start of Rotharium was initiated by the blockchain startup Crypto Future GmbH at the beginning of 2017. After some finance, related use cases beginning of 2019, a food tracing use case gets created. The app is about to deliver a proof of origin for products based on blockchain technology. With the help of QR-Code, product information is instantly available for end-to-end customers. Several online market stores, for example, Markta, use Rotharium as a technical solution to depict the origin of organic food. Several scholars, such as Wisniewski & Buschulte (2019), warn on severe costs because of food fraud on a global scale.

The following subchapter summarizes three recordings of Crypto Future members and premium partners and translates into English. Besides that, the case documentation includes an analysis of the Rotharium whitepaper, a product video review, meeting minutes and product testing in a Viennese grocery.

5.1 Interview Tomislav Matic (Crypto Future)

Matic acted as a blockchain pioneer and started in the field of crypto mining. Gradually he founded his blockchain startup in a sense that it provides blockchain-based IT solutions and today acts as Chief Executive Officer of Crypto Future. He characterizes blockchain as an addition to many other systems. As companies in times past already invested and deployed many other information systems, which in the example of a supply chain display and process data, funds, goods and communication flows this progress, will not be abandoned that easy. That is because blockchain, according to Matic, at this point, is not dimensioned and designed to substitute legacy systems in their broad impacts on businesses. He sees blockchain more in an evolutionary phase, which makes it necessary to input for the next couple of times its features and benefits into working and established system landscape. Furthermore, he implies that policies, such as the one on data privacy, also create barriers for full systematic blockchain implementation. Precisely because of the recognition that blockchain is a complement to tried and trusted systems, it is vital to highlight the benefits blockchain brings compared to the limitations of existing systems. He brings here features such as transparency or data immutability and argues on the approach to put in place these beneficial features on a specific use case as a combination of established system structure with blockchain characteristics. A reinvention of the wheel by putting in place blockchain where legacy systems are sufficient Matic describes as unrewarding and needless.

As one of the first companies in Austria, which engaged with the topic of blockchain, the organization Cryptofuture wanted to develop new business cases, which were based on DLT and therefore create recognition value for the brand of Rotharium. The brand is similar to Microsoft, defined as a base platform and umbrella term, which includes many different applications in various fields of usage. One of the first applications was the food-

tracking app Rotharium Food, which was made available for Apple and Google Play users. Compared to many other blockchain projects in the supply chain, he emphasizes the Rotharium project as one of only a few, which has a working use case in a live environment. Matic mentions several challenges on the path of being a first mover in the field of technology innovation. As there are not many empirical values and experience overall in implementing blockchain solutions, people question one's approaches and uncertainty about regulation is pervasive. Here it is important to make sure that the implementation phase is well structured in a project environment. On the technical part, he emphasizes the dependence on network updates in the public blockchains of Ethereum or IOTA, amongst others. At the same time, the mainstream reaction on positive or negative happenings in the blockchain ecosystem influenced the interests and motivation of companies heavily to implement blockchain solutions. Matic sees this phenomenon as one within the early adoption phase of technology and not relevant in times of future technological maturity.

In order to enhance the trust of innovative technology for new entrants, he points out that it is crucial to simplify the utilization for the end customer as much as possible. The argument is that the complicated subject of blockchain should be explained in easy words, with an emphasis on its benefits instead of overcomplicating the matter. In the second mainstream step, no one will be interested in technological gimmicks and how data exactly is exchanged on protocol layers, but more on the premise if the product works with proper security or trust levels or not. Therefore, the Rotharium food-tracing app constructs in the sense that it is user friendly and enables a facilitated input of product data for producers of the supply chain. If a customer is interested in the flow of information of a particular good, he can retrieve the information out of the application in seconds. The huge benefit here is transparency, which leads to customer retention.

Matic mentions two benefits, which influence supply chain processes by blockchain implementation. These are transparency and irreversibility of data. Wherever in a supply chain, these features are essential, blockchain should apply, because a win-win situation results, as soon as a substantial need within a particular process come upon groundbreaking features of a technology. Furthermore, he adds that the more critical and sensitive information of a shipped good is, the more important it is to create a trustful environment among participants. Especially the interaction between parties is shown in a comprehensive, trusted manner and causes stakeholders to feel safe and secure when it comes to swapping of data in a supply chain. As there is no single administrator of the database, but more participants running nodes confirming the truth of transactions and inhibiting manipulations, users of the food tracing app can be sure that the information, where a particular good comes from, can be seen as unquestionably valid. Matic brings the example of local products, which are promoted in stores as such, but merchants may be dishonest. In this case, producers would tag their products and in the next step, consumers could verify this without being dependent on a third party, e.g., merchants' infor-

mation. As full transparency is not always favorable for every actor within the SC, because location advantages or purchasing benefits possibly reveal, the direction here would go more on a private blockchain. Here the disadvantage is that trust levels are lowered accordingly to the smaller number of participants, e.g., nodes, which could be difficult when actors do not know each other. If attendees of a network have contradicting interests, it is essential to clarify these first before starting a business relationship based on a blockchain technology-based system landscape. Moreover, as Matic states, the topic of data privacy was one to take care of during the implementation of the Rotharium food-tracing app. The protection of private and sensible data was achieved by simply not inputting any individual-related data into the blockchain and instead of that saving them on a centralized legacy system where deletion is possible at any point in time. Furthermore, Matic says that a fully integrated tracking application, where there are seamless and unbroken data flows, is something, which misses in today's' supply chain, at least as an end-to-end process. These data can include several different data sets, for example, geographical or timing information, under which weather conditions shipments happened and if regulatory on the cooling chain was correctly satisfied. Hence, integration of the service, which provides information on the goods flow with the service of payment, is something Rotharium combines. The result is a coin, which represents a means of payment for the supply chain information service and the underlying good, both incorporated in ident-structured applications

A possible hindering limitation of blockchain in the supply chain Matic mentions by criticizing the velocity of transactions in a blockchain ecosystem. The amount of transactions per second is limited compared to legacy systems and will stay like that for a couple of times in the future. That is because the exchange of various data from different industries, such as payments, transportation information and copyrights, needs to be processed within a particular public blockchain, which merely from a technological aspect still has not progressed far enough yet. Besides that, at peaks of utilization, the network simply requires more time to confirm and process data. That brings uncertainty for users, as they do not know if the network is overloaded and operates at full capacity with delays or not. It is also not a task user should have, as they should rely on a system independent of network workloads. As the app runs on the public blockchain, Rotharium depends heavily on progress in network development in terms of scalability. As this happens on a global scale, the level of dependence is very high. Hence, the achievement to scale the network accordingly will be crucial and a specific condition for the technology to prevail. As a solution here, side chains are mentioned, where transactions could handle with fewer confirmations in a smaller based network environment. Still, according to Matic, there is the preference to update the main networks properly; nevertheless, he sees on the example of Ethereum, not enough progress, given the fact than hundreds of people are working to enhance the ecosystem since 2014. The reason is the high technological complexity of the system.

As a lesson learned out of the implementation of Rotharium Food Matic marks that the project was a bit ahead of times for many external people involved. He emphasizes the importance to undeceive interested parties on the topic by explaining the correlations of blockchain and supply chain in simplified words. That and the fact that benefits are showed to stakeholders helped that understanding and acceptance nowadays are rising. The potential demand of customers to have the possibility to trace a food item determines by thoughts where blockchain benefits in detail can enlarge trust levels. Additionally, producers and end customers were questioned on their real desires in this particular field. The important step here is to set clear boundaries where blockchain should not be used because of existing satisfying solutions for customers. In general, Matic does not see any negative impact blockchain has on supply chain processes, as features such as transparency or privacy can be lowered for the substantial needs of stakeholders, although the features potential therefore is cut accordingly.

The collaboration with authorities Matic characterizes as unproblematic. There was a point of contact on hand for any questions. For both parties, the project was one on new grounds and therefore, learnings, especially for the authorities, were existent. It was not the case that regulators gave many directives, but more the fact that their blockchain project set a direction and in arrangement with authorities pursued the project. Moreover, he sees regulation only on the crowdfunding part of money collection rather than on technological standpoints and the question if a particular approach of using BC in supply chain processes is permitted or not. The topics discussed were on the legal and data privacy aspect, where it was important to act in consultation with rule-makers. An approach, which follows the direction of authorities is also important because this helps to set clear boundaries of where the project stands from a regulatory perspective. Matic sees blockchain projects ideally as proactive suppliers of information for authorities. That means that the aim to raise awareness and familiarize governmental institution for the topic of blockchains helps its overall acceptance for mainstream usage. Some drawbacks were the linkage of blockchain with fraudulent activities on the market of blockchain-based cryptocurrencies. The media coverage of such happenings inevitably created at least negative beliefs of rule-makers. The need to do much persuading is the logical consequence. Overall he marks it as necessary that possible issues, especially on a long term basis of a project, are as early as possible discussed with authorities in order to save valuable time within the project execution. An internally defined strategy with a clear-cut course on how to communicate with authorities is also crucial in order to gain trust among them.

5.2 Interview Zsolt Scheffer (Crypto Future)

Scheffer worked as a blockchain analyst at Crypto Future and was heavily involved in the project of Rotharium Food. He characterizes blockchain as an addition to existing systems. In the timeframe of the next ten to twenty years, it still can either disrupt whole businesses or disappear altogether, depending on the running costs of transactions and

scalability of the network. Most public blockchain developing consortiums promise huge steps forward towards a cost reduction paired with transaction speed refinements. According to Scheffer, the pioneer project of Rotharium in the area of the supply chain had the aim to show people that blockchain-based solutions work for everyone who wants to make use of it. On top of that, the worthy cause was that every participant on the chain has a value-added because of the publicly viewable information. In the project, this superior societal objective, paired with mainstream circulation, stands over profit orientation. The USP of the product Scheffer sees in a completely new definition of trust between producers, retailers and end-customers. The level of trustworthiness is much more pronounced compared to today's solutions, where not every participant amounts to the same level of knowledgeable information.

An emphasis Scheffer puts on the core strengths of blockchain application in the supply chain. Hence, it is the possibility to exchange information between agreed parties without any third party involvement. As this information in the ledger is immutable and irreversible, it qualifies as being trustworthy. In the example of the tracing app, the consumer, who does not know about producers' practices and other happening along the supply chain, trusts that the information and data are valid and correct. Any fraudulent changes on the smart contracts or other settings in the chain are possible, but at the same time, viewable and verifiable, which lower general motivation to manipulate entries. At the same time, according to Scheffer, features with are core competencies of blockchain technology can also imply drawbacks when implementing in a particular field. For the Rotharium app, the feature of data privacy opposed against the GDPR ruling of the European Union. The issue of permitting the deletion of data is only a problem in public blockchains. On the other hand, private blockchains work more as small databases where data is stored decentralized, but other features resemble centralized legacy databases. In Scheffer's opinion, the private solution of a blockchain does not make much sense as ore values of blockchain cannot be used to a full extend.

A challenging fact during the implementation of the supply chain solution for Scheffer was that, in theory, many people are interested. However, when it comes to execution, including funds and labor input, many efforts at persuasion and presentation of possible advantages and merits is needed. A limitation of today's supply chain in terms of track and tracing Scheffer sees in the variety of systems and programs participants are operating. In case that blockchain as a coherent base layer of data exchange gets used, multiple companies, actors or organizations can easily use this ledger as a connection point and harmonize their datasets, processes and approaches accordingly. The possibility to use their systems and interface them to a decentralized ledger for data storage and processing lowers general dependence on centralistic key players. Further development of the application depends on the global progress of the network output, for example, reduction of transaction costs and improvements on the velocity of transactions. In case that these upgrades happen, project implementations and running costs of the ledger could be reduced and price reductions of transactions could get passed to users

and end-consumers. Furthermore, Scheffer states that an enhancement towards the establishment of a marketplace structure is a real next step alternative. That means a complete paradigm shift as the supply chain then happens purely based on supply and demand between end-users. As soon as it gets crucial that data is transferred as soon as possible towards real-time execution, another limitation gets visible, namely that an estimate of whether the transaction takes seconds or hours cannot be estimated accurately enough.

From the perspective of regulation, Scheffer only mentions money laundering and data privacy aspects. He does not know any regulations explicitly relevant to supply chain processes.

5.3 Interview Martin Juric (AURA Delikatessen)

Juric founded a delicacy store nearby Vienna several years ago. He acts as a premium partner of Rotharium Food, where he contributes to the spread of Rotharium in Austria by using the product from both production and retail perspective. For quite some time from his perspective, blockchain was fraught with negativity, because of negative press on currency business models. Today he recognizes it as a chance to realize essential changes in the supply chain of goods. While governments and banks, in his opinion, try to decelerate the progress of blockchain adoption, companies and enthusiasts try to foster innovation in the sense that more fairness is achievable. Furthermore, Juric sees it as important to try out innovative business models, especially if there are substantial demand and interest on the customer side, which he acknowledges. His store is the first retailer in Austria to work officially with a blockchain solution, which integrates track & trace with payments.

The most interesting perspective of the Rotharium Food solution Juric sees from the producers' aspect. As a delicacy store, the USP of their products is based on the origin and producing method. As only small producers are contributing to AURA's product line, Rotharium was a well-fitting solution for the needs of their customers. The customers get attracted by the fact that a true and comprehensible story around the product can be told, mainly because, according to Juric's experiences, many questions about various product-related potential buyers at his retail store posed facts. As usually there is not enough space to print out full information of the product viewable for customers, the blockchain solution with a scan of the QR-Code, which includes all necessary information written on the blockchain, offers a welcome opportunity to feed various stakeholders with full information on for example the products origin, packing time and travel routes.

An example of why track and tracing of especially perishable goods can mean a substantial competitive benefit, Juric brings with the illustration of fish. Well-known and established groceries with their supply chain processes would not dare to use the track and trace for fish, because it takes over a week from a cast for fish until the product is at the grocery store. This common practice is unknown by most of the customers and would, if

being known, lead to a refusal of the product. With a real-time track and trace functionality based on blockchain, a huge competitive edge is created for producers who apply more efficient and sustainable supply chains. Moreover, this automatically changes routines for the better and betters existing processes towards enhancement of the general supply chain standards amongst all providers of goods. That, of course, tends to move power away from big producers with huge industrialized supply chains towards local supply based on organic source, at least for the customer group, who is keen to pay premiums for qualitative and healthy food standards.

Moreover, Juric emphasizes the possibility to equip end consumers with valuable information, which is not doubtful because of blockchains features of data irreversibility and transparency. According to him, particularly the stakeholder group, which spends the money on the product, has the right to be adequately informed. That especially is a growing trend in the last several years because consumers are more and more aware of their purchases instead of directly buying the product, as it was the case before. The identification with the product rises with its level of information and on top of that makes it more attractive compared to other not traceable goods. From a consumer perspective, Juric claims that there is not too much transparency as people precisely filter the amount of information they need in particular. From producers and retailers' perspective, the aim to be transparent correlates with the fact that customers react loyal to products with transparent supply chains. The reasons why big food supply chains in their groceries do not make use of blockchain solutions for Juric are, besides their poor quality standards, also the negative media releases of blockchain-related to fraudulent actions in the business models of currencies. In order to solve this issue, a decoupling of blockchain from cryptocurrencies is necessary. In another step, realistic and knowledge building press coverage about blockchain as a technology with emphasis on its beneficial features would be helpful for widespread adoption and understanding.

5.4 Documentation

5.4.1 Whitepaper

The whitepaper of Rotharium is, of course, very technical and gives a not legally binding overview of certain aspects of the Rotharium applications, the token and its intended use. It furthermore contains forward-looking statements, which are subject to risks, uncertainties and other factors. The platform model of the Rotharium platform has two primary layers. The first layer is the Ethereum blockchain, which uses data from private and cloud databases. The second layer is Rotharium services, which then builds the basis for several applications running on it. The applications, such as Rotharium Food, which connects to the Rotharium platform, will enable ordinary users to create smart contracts on the blockchain, without being required to have sophisticated IT knowledge. There is an emphasis on the consideration of the advantages blockchain brings to the customer that means decentralization, data integrity and smart contracting. The Rotharium Food

App is one of the business applications running on the decentralized business to the customer blockchain platform. For maximum security, the app runs on its own developed encrypted transfer protocol. The data management is split, as personal data should not be visible for everyone and therefore are stored in common, not blockchain-based database solutions. The means of payment for services in the Rotharium Food application is an own token. In a Frequently Asked Questions section linked within the whitepaper describes Rotharium Food as a platform that allows everyone to find different agricultural products and manufacturers in their immediate area. The aim is to give producers the possibility to create a known public profile and define their products in detail. Examples for findable goods are fruits, vegetables, dairy products, eggs, fish, meat, cereals and beverages. A tagged Rotharium Food sticker with a QR code includes all the information saved on the blockchain.

5.4.2 Product Video and visual presentations

For new users of the application, whether they are on the producers or consumer side, there are several Rotharium Food App Explainer Videos. On the one hand, producers create a profile and choose the specific products they want to advertise. That is the first possibility to promote products without massive spending for commercials or similar promotions. Additionally, more information about the origin of the products, harvesting details, available amounts, expiration dates and similar, including pictures, can be added. In order to stand out from the crown, a certification by Rotharium responsible people is possible too. It enlarges the trust level accordingly also because the origin of the goods is shown by an additional blockchain proof, viewable explicitly for interested customers. The slogan ‘Know your farmer, know your food’ directs the interest directly towards customers, who want to be sure about the origin of their consumed goods.

Furthermore, there was also an introduction of Rotharium Food at the Austrian Federal Railways Headquarters. The app there was described as a possibility that a higher level of transparency gets enabled in the supply chain of goods. The producers point out products and mark their core competencies in a sense that, for example, organic food is offered, without pesticides, made in Austria. The customer even does no need any app. Instead of that with a QR-Code scanning camera on the smartphone, a recognition of the code is possible. After successful recognition, the customer can look directly into the blockchain and can find an entry with a clear text, which describes precisely the information, which comes from the producer, in detail a timestamp on then the harvesting was done, what was exactly the product, the conditions of the product and many more. The question of how digitalization comes to farmers and producers of the supply chain gets answered with referral to smartphones. As everyone can easily take the smartphone while working on the fields or stables a recognition via the app is possible in minutes or even seconds. After the packing of products, the labels are printed and tagged before being sent out to the respective groceries or points of sale. The focus here lies on a boost of local and organic products. Given the COVID19 crisis, this from today’s standpoint

can get even more important, as the globalization movement suffers massive cuts and changes these days.

5.4.3 Meeting Minutes

A review of internal documentation in the form of meeting minutes revealed the thoughts and idea creation of the tracing app. There were several concerns about how food production happens nowadays, primarily because of the quality and sustainability of goods. As food has become increasingly global, consumers walk into the store and expect their food to be safe for consummation. However, there is no real background knowledge on specific points, namely where the product has been and what intermediaries may have done with it. The fact that many processes during the chain were unknown to the end customers brought the idea of giving consumers easy access to this information. The power of consumers to scrutinize the supply chain process gets very real with decentralized solutions. The effect on human health will be immediate as soon as companies in the supply chain would be forced through consumer expectations to reveal their production and further manufacturing process and therefore enhance quality steadily. The emphasis on partnerships with retailers gets also highlighted as this brings an enlargement of potential customer scope. The principle of excluding intermediaries realizes through the digital conduct of product data.

5.4.4 Product Testing

The research investigation in one of its steps also brought a product testing of the app at two points of sale in Austria. The first one is the shop ‘AURA Delikatessen’ in Lower Austria. This premium partner of Rotharium enables tracing for every product within the product line. After reviewing the products, which were all tagged with Rotharium, branded QR-Code labels, the decision felt on a cherry jam, schnapps and an aubergine-paprika sauce. For all three products, the application, after successful scanning of the labeled code, showed a unique product code and facts such as date and time of production, terms and location of production, use by date, information on awards, website and contact data. A short description of the specifications of a particular product helps the customer to understand more about it. An official digital Rotharium seal includes the direct link to Etherscan, where the blockchain entry is reviewed in full detail with all its history. Moreover, the product overview gives hints to more products of the same producer and lets customers know where on the interactive map, more Rotharium based products are on sale. The second point of sale was at a pick-up place of the online marketplace markta.at. Similar to the approach at AURA Delikatessen, the packed products’ labels were scanned and reviewed accordingly. From the producers' perspective, a presentation to end customers is possible over a public profile, which links to the product scan procedure. Here beneficial information about standard practices within the supply chain process can be made public.

6 CASE RESULTS AND DISCUSSION

6.1 Case Study Report Blockchain Initiative

6.1.1 Study Questions Analysis

How can blockchain solve existing business issues within the supply chain of companies?

In general, the BIL initiative showed that blockchain helps to find a path of cooperation, through communication and a play of several scenarios, which can solve business issues in the SC by a share of information between parties. All of the interviewees see blockchain as complementary to existing system solutions, as some kind of enhancement of communication and information transactions with other stakeholders in the system. In this role, blockchain can improve the flow of goods, information and funds through its core features of transparency and data immutability and data security. In order to make it possible that blockchain can pointedly solve issues in the supply chain, the possible use case should be appropriate in the sense that the core features apply purposefully.

As the level of technology used in daily work is very low for most supply chain actors, Leibetseder argues that blockchain helps to bring more system harmonization in the supply chain and forces actors to set an industrial standard and reduce the complexity of processes. That is one of the reasons why companies such as GS1 are interested in blockchain technology as multiplicators for standardized processes in the supply chain. Furthermore, Plöchl-Krejci sees it very positive that supply chain actors, because of possible enhancements through blockchain usage, openly discuss their processes, possible issues and solutions to enable progress within their processes. Moreover, Schramm and Gregori add that blockchain brings more of automatization and digitalization into the supply chain. Holistic data management, linkage of inventory management with contracting and assurance of goods validity shows this.

Further documents showed that process costs reduce, data access facilitates and electronic proof of delivery with protocols on entry changes establishes. It helps to reduce erroneous shipments, reduces costs per transaction, lowers manual processes and enables document access for all respective participants in real-time. Leibetseder adds that through tokenization of information, paper processes get replaced and therefore, information gaps closed adequately. The handling of paper often brings uncontrolled growth of data, time lags and is done with errors resulting in less data quality and integrity, but with higher overall cost. Therefore, improvements, which are brought by the use of blockchain, are welcome, especially as digitalization through blockchain brings a suitability of entries in the ledger and internal processes are accelerated. More documentation of the project showed that the use of blockchain in the e-CMR project provides a unique identification number, together with textual information on every step of the goods transport.

That, of course, includes attachments, timestamps, changelogs and specific comment functions and stands for a gapless flow of information, which is digitally signed too. Plöchl-Krejci states that due to the variety of involved parties in the SC, who usually do not know each other additional trust through blockchain is value-adding. Moreover, the degree of automatization in the supply chain classifies as very low, which results in errors and manipulations.

Here blockchain acts supportive by requiring higher levels of cooperation amongst participants towards efficient use of capacities. Schramm brings up the issue of unequally distributed information within the supply chain. The actors naturally act driven by their diverse interests and blockchain ensures, through its competence to deliver undeniable proof, that a fair fact-based arbitration between chain participants happens. That is according to Gregori, because of the extremely restrictive sector of SC and despite full transparency through blockchain, accomplished as Plöchl-Krejci mentions with restrictions of mutual visibility of information by selective transparency standards according to predefined permission levels. Furthermore, Gregori adds that supply chain issues within product piracy, e.g., missing validity of units, can be improved by blockchain. The correctness and verification get ensured if the label tagged on a particular product is attached correctly. Schramm points out that supply chain processes characterize through unsolid data processes, different system landscapes and incompatibilities of data material. Therefore high process costs, trust conflicts with documents and missing or handwritten signatures make the supply chain insufficient. Here blockchain, basically through its features of fast consensus through network confirmation, eradicates such disadvantages and acts as an additional mechanism for interchanging various data from heterogeneous systems in order to achieve a trustful environment. Plöchl-Krejci states that a proper end-to-end mechanism in the supply chain is missing. It means that end customers but also many stakeholders in between the start and end processes of the chain do not have enough background information about the supplied product. The track and trace mechanism based on the blockchain provides a transparent view where changes in data structures are identified quickly and questioned accordingly.

What limitations does blockchain technology have if utilized in the supply chain?

The implemented solution for the e-CMR has not demonstrated limitations of blockchain technology, as the project is ready to use in a live environment. However, the brainstorming for the idea and thoughts on blockchain utilization overall brought limitations on either technological or organizational manner. For more complex issues than the digitalization of a waybill, Leibetseder argues that in order to make it possible to work with blockchain nodes, process steps need to are simplified and participants of the chain need to improve the level of their acceptance towards new technology. A question mark he sees whether older participants, who are operational actors of the chain, such as drivers or packers, are keen to use decentralized apps in their daily business routines. Schramm has similar opinions and describes the implementation of the technology itself as less challenging.

However, given the complexity of the supply chain with a lot of diverse problem formulations and exceptions, it makes it difficult to find a blockchain-based setup where all involved parties are satisfied and equally addressed. Moreover, as a crucial task for blockchain adoption in the supply chain, proper visualization of blockchain entries is needed. Nowadays, blockchain is seen very technical and therefore, many actors lack understanding. Additionally, Schramm formulates several limitations blockchain has explicitly utilized in the supply chain. First, because of scalability issues of today's public blockchains, a private or hybrid solution is required in order to handle the amounts of transactions. That, of course, reduces the data security, trust and transparency level by far, includes possible fraudulent action and shrinks the possibility to roll out blockchain solutions in the supply chain as a mainstream technology. Second, supply chain actors are unconvinced if it is possible to reduce transparency properly as the visibility of data for everyone in the chain is not wanted. Technological developments in this field are present but still not mature enough. Gregori states that in order to make use of blockchain in the supply chain in a proper way, standardized information and existing requirements for business processes are essential. Blockchain implementation presupposes clear defined processes, reduction of exceptions and common language and codification. That is still not achieved for most of the supply chain and is one of the reasons that the spread of BC in the supply chain happens very slow. Similar statements come from Plöchl-Krejci, who points out that there is no consistent standard, which is of full use in the supply chain. Therefore on the functional side, it is challenging to drive blockchain projects forwards, especially if there are no clear legal and regulatory terms to be followed. More limiting standpoints come from Plöchl-Krejci, who argues that blockchains benefits of information exchange cannot be used in the supply chain to a considerable extent because of cartel law and refused permissions resulting out of it.

What is evident here is that technological progress, same as the adaption to it, still lacks readiness. The potential is existing, but it is still not possible to retrieve it at its maximum. At this stage, being a pioneer and early adaptor with the right eye for the right business case can be of immense advantage at future levels of maturity.

Why do legal regulations play a role during blockchain implementation?

The study showed, based on statements of all interviewees, that regulators look at digitalization widely detached from the topic of blockchain. In the opinion of Leibetseder, blockchain implementers in the supply chain rely on a juristic decision whether a digitalized document is legally acceptable or not, more than the question of how digitalization is achievable. Hence, Plöchl-Krejci adds that regulators are not primarily interested in how digitalization happens, but more if and what level of digitalization is legally allowed and accepted. Schramm points out that all the information sitting on the blockchain in either the e-CMR or other supply chain-related use cases is valuable for authorities. As governmental institutions, such as customs or finance authorities are generally seeking for proper levels of security and traceability, this means that the utilization of BC is the

right choice to be auditable. Authorities generally have no preference or interest on whether a particular technology or database is in use, as long as the process is understandable and legally correct. Moreover, given the fact that different institutions, such as the European Union, the United Nations or local countries handle the interpretation of what is permitted or forbidden contrary, makes it difficult for a global applied technology to function coherently. Both Schramm and Plöchl-Krejci add that the possibility creates a valuable interface with authorities, to give regulators as an independent group an integrative view and the opportunity to check data and information movements on the chain, makes blockchain interesting for authorities even without blockchain-related directives. That especially can get important when, as Leibetseder argues, changes in the political administration come up. If people in rulemaking positions change, this can get a hurdle towards coherent cooperation. The usage of blockchain can absorb these risks partially by enabling the proactivity of regulators in a transparent environment. Still, a lack of regulation and clear role allocation within authorities' organization means more difficulty in finding proper partners and investors who want to be involved financially in a promising future project. Gregori adds that clear regulatory framework miss and the execution of binding rules is not in place, because regulators do not understand the issues adequately in order to react correctly. The issue shows as a compound one by the fact that splits of responsibilities are unclear when authorities engage with innovative business models.

Furthermore, Schramm gives an example where blockchain does not fit with existing legal regulation. The privacy feature of blockchain, where no deletion is possible, contradicts with the GDPR of the European Union. Therefore, this has enormous impacts on the design and architecture of the blockchain solution. Moreover, legal regulations play a vital role when it comes to the recognition of smart contracts as legally binding agreements. Today smart contracts lack legal approval and, therefore, despite the potential, cannot be used for self-automated contracting. Plöchl-Krejci adds that if authorities decide that blockchain is a widely accepted means of choice for a particular issue, more detailed guidelines and directives will follow naturally.

6.1.2 Study Propositions Analysis

This section provides a validity check on the studies' propositions. The first proposition that the use of blockchain technology can trace a flow of goods with a high level of detail cannot explicitly be answered by the BIL case, because the use case was about the digitalization of documentation on the blockchain. Still, given the fact that tracing information of goods requires lots of computing and data processing, today's blockchain development does not allow a proper process on the public blockchain due to scalability issues. On a private blockchain, of course, the performance of the tracing feature is better to the disadvantage of other features such as data security and transparency.

The second proposition where blockchain ensures a fair distribution of available information amongst participants of the supply chain can by reference to the initiative's project

be answered with yes. All involved participants can copy and analyze the immutable record of the blockchain. From a technical perspective, tailoring of transparency is possible according to permission levels.

The third proposition, which states that BC, at its current stage of technological development, is not a perfect fit to meet the needs of stakeholders in the SC is correct. Blockchain has lots of potentials, but due to its low maturity from a development perspective, it does not fit perfectly yet. Examples are scalability issues, an overload of network capacity on public blockchains and contradictions with privacy law.

The fourth proposition that blockchain technology is not ready to fully replace legacy systems in the supply chain is true. The BIL project showed that blockchain provides unique features more than being a standalone concept. It works as a complementary system in the running landscape of legacy systems. Its goal should be to enhance the power to tackle issues that are still unsolved with current concepts.

The fifth proposition that governments do not provide sufficient legislation regarding the implementation of blockchain technology can be answered with yes. Participants of the BIL initiative state that regulators are not responsible for exposing themselves with technological details on blockchain mechanics. The legislation more tends to cover the topic of digitalization, where blockchain can be part of the solution. Unfortunately, here governments also miss having clear directives and announcements.

6.1.3 Conclusion

In order to conclude the outcomes of the BIL case analysis, firstly, answers on the study questions are found and then a check on the validity of the theory-based propositions followed. The BIL case study showed that blockchain implementation is more part of a digitalization approach within the supply chain than a groundbreaking and disruptive game-changer. Its features help to close information gaps and build a trustworthy environment but still lack to create sufficient acceptance amongst supply chain actors. The topic of regulations is mainly covered by the notion of digitalization, rather than explicitly aiming at blockchain-related circumstances. With the growing maturity of technology, blockchain has the strength to be an integral part of supply chain enhancement and will also get into the focus of more detailed regulation principles. The case results mainly cover the theory-based statements, which means that theoretical standpoints are valid for practical implications. Although the project covered only one out of many possible use cases, the digitalization of the waybill is a first small step towards the acceptance of decentralized solutions, which act as a catalyst for digital innovation. In order to be ready for innovative business models, the supply chain has to open up for changes in its core processes, from manual working steps toward automatization.

6.2 Case Study Report Rotharium

6.2.1 Study Questions Analysis

How can blockchain solve existing business issues within the supply chain of companies?

The Rotharium case study showed that blockchain, if put with its features into working and established system landscape, brings benefits to supply chain actors. Although the development of the technology is in its evolutionary phase, it brings in the particular use case of track and trace through an application, features such as transparency and data immutability into the rigid world of the supply chain. The way blockchain solves supply chain limitations, which get apparent in the field of gapless tracking and tracing of goods, should be in combination with established system structures. Matic emphasizes that the idea of putting in place blockchain where existing legacy systems in the supply chain are sufficient is redundant. Furthermore, blockchain solves only issues if utilized in a possible simplified way. The customers' utilization of the technically complicated blockchain should be in emphasis on its benefits rather than overcomplicating the matter. Moreover, Scheffer adds that a limitation of today's' supply chain in terms of track and tracing shows in the variety of systems and programs participants are operating. In case blockchain as a coherent base layer of data exchange is used, participants can easily use the ledger as a point of connection and harmonize their processes and data structure. As a next step, he states that marketplace structures are a possibility for enhancement, which would mean a paradigm shift in the supply chain because companies who provide products or services would more and more get substituted through private providers of the same.

As the information on the flow of goods within the supply chain is limited, long-term customer retention happens if the level of transparency enlarges. That is the case for the Rotharium Food App, as, according to Matic, it puts together a substantial need of the end customer with a groundbreaking feature of blockchain technology in a user-friendly way. It provides for both sides of the chain facilitated ways of data input, app usage and information exchange with reliable and irreversible data. Scheffer points out that an entirely new definition of trust between producers, retailers and end-customers is reached by making sure that the data is irreversible and immutable without any third party involvement. At the same time, the fact that data is viewable and verifiable lowers general motivation to manipulate entries. Furthermore, Matic looks at supply chains today and the validity of data represents a limitation in today's' supply chain, as examples of dishonest merchants and not transparent further processing of third party actors show. According to Matic, the more important and sensitive information of a shipped good is, the more important it is to create a trustful environment amongst supply chain participants. With no single administrator of the database, but independent participants, who run nodes to confirm the truth of transactions and inhibit manipulations, a new era of the supply chain

can originate, mainly because consumers could verify information without being dependent on a third-party stakeholder inside the supply chain process. Juric points out that particularly the stakeholder group, which spends the money for the product, has the right to be appropriately informed and adds that a product's USP more and more is based on the origin and producing method. As of today's supply chain lack enough and especially gapless information on this, customers get attracted by the fact that a true and comprehensible story around the product can be told. Trustful information, therefore, gets a substantial demand for customers and is served to them with unchangeable information on a decentralized ledger.

Another limitation of supply chain processes shows in the fact that data flows are broken and not seamless in an end-to-end process. The fully integrated tracking application of Rotharium includes data flows of different data sets, such as geographical data or timing information, without any data gaps. Moreover, blockchain also provides the possibility to embed payments into supply chain processes and therefore acts as a fully integrated service. The respective coin represents means of payment, same as a token with information on the underlying good, which lowers costs and dependence of particular supply chain processes on third party involvement. In case that blockchain features have to be lowered in order to be a tailored fit for the individual needs of supply chain participants, this is possible but cuts its potentials of decentralization accordingly.

The Rotharium services solution for the supply chain builds the basis for several applications that enable customers to make use of smart contracting with unquestionable integrity of data without the risks centralized application in terms of security have. Split from the decentralized database is the area of personal data, which should not be visible for everyone and stores in a centralized database solution. This workaround is valid until blockchains development does reach certain levels. It still allows having full amounts of data at disposal, which is not always common in supply chain practices. The possibility to offer blockchain certifications through a variety of information, such as product origin, timestamps, historical movements, harvesting details, expiration dates, pictures and current condition positions, blockchain-based supply chain solutions as means of choice compared to existing supply chain information systems. Moreover, participants can by themselves look directly on the blockchain to review and verify entries and make sure that a transaction happens. This proactiveness can mean a paradigm shift in how information in the supply chain exchanges in the future. The convenience to use the app on the smartphone, though, brings technology right into the pockets of producers and consumers, compared to a former computer or even paper-based approach.

Additionally, Matic points out that the lack of information on how food production happens nowadays is a present limitation in the supply chain. The ignorance of quality and sustainability of goods prevents consumers from knowing if their food is safe, healthy and unaffected. Blockchain provides consumers' with the power to scrutinize the supply chain process with immediate effects on human health. Hence, supply chain actors with the

adoption of technology will be forced to reveal their production and manufacturing processes with the result of steady quality enhancement. Juric argues that customers react loyal to products with a transparent supply chain and that the information on the blockchain, which is accessible via QR-Code, feeds customers with all relevant information, especially product origin packing time and travel routes. The fact that this information cannot be altered or manipulated gets according to him more and more important with mainstream adoption and global loss of trust levels. Furthermore, real-time track and trace mechanisms bring huge competitive benefits, especially for perishable goods. Enhancements in general supply chain standards conquer the limitation of an unsustainable supply chain because qualitative food standards are the basis for customers to pay premiums on the price. If established actors in the supply chain do not better their processes, the power tends to move away from substantial industrialized supply chains towards local suppliers.

What limitations does blockchain technology have if utilized in the supply chain?

The case study of Rotharium showed challenging issues on the path of being a first mover in the field of technology innovation. The limitations illustrate in a sense that blockchain at today's development level is not dimensioned and designed to substitute legacy systems in their broad impacts on businesses. The dependence on network updates in the public blockchains, together with mainstream reactions on happenings in the blockchain ecosystems, heavily influenced the implementation progress of the Rotharium products. That means that blockchain is still not mature enough to be resistant against negative and non-reflected views from people outside the stakeholder spectrum. Moreover, the fact that people in the supply chain usually do not know each other a lower level of transparency in terms of a private blockchain is favorable. The disadvantage then is that trust levels are low because of the smaller number of participating nodes. For Scheffer, this is not the preferred solution as it lowers blockchains' core competencies and equals private blockchains as small databases where, on the one hand, storage of data is decentral, but other features look like legacy systems. Matic argues that, especially if network participants have contradicting interests, as it may be the case for situations in the supply chain, a prior clarification of these before setup of blockchain technology is advisable. Blockchain, therefore only works, if consensus on interests is established and participants work towards an enhancement for everyone involved.

There are limitations blockchain shows on the topic of data privacy. The implementation of Rotharium Food took care of data privacy and followed an approach of establishing a workaround, by merely not inputting any individual-related data into the blockchain. That is because, from a development perspective, a deletion, according to GDPR, is not possible using public blockchains, which means that a potential feature also means a possible drawback for implementation. The implication is that today's data policies create barriers for full systematic blockchain implementation. Moreover, Matic argues that more limitations are created because of the speed of transactions. The reasons are that the

exchange of data from different industries besides the supply chain in one public ecosystem causes data congestions in the network and from the technological aspect, the progress is improvable compared to legacy systems. As users need to rely on system capacities and overloads bring uncertainty and delays, the long-term solution here should bring enhancements in network scalability. Here the global network development, which is usually preferred compared to private or hybrid solutions, sets the standard if progress happens fast or not and simultaneously builds the basis of whether technology can prevail or fail. Scheffer adds that blockchain can either disrupt whole businesses or disappear entirely, depending on the running costs and scalability of the network. A limitation of blockchain here is that nowadays, an estimation of whether transactions take seconds, minutes or hours is not accurate enough. It can get harmful, especially if the transaction speed needs to happen in real-time. For Juric, a limitation is shown by the fact that the topic of blockchain in the supply chain is connected with the business case of currencies. With a decoupling of these two different business cases, a realistic, and knowledge building press coverage about blockchain as a technology with emphasis on its beneficial features, more applications will be adopted in the future.

Why do legal regulations play a role during blockchain implementation?

During the planning and implementation phase of Rotharium Food, Matic argues that it was not the case that regulators gave a lot of recommendations or legal binding policies. Quite the reverse was the case because this innovative topic of blockchain tracing was new for implementers and regulators and therefore, learnings on both sides were existent. Although the collaboration with authorities was there and a point of contact at the authorities' side reacted on requests, regulation, as it is usual for blockchain implementation on finance, currencies or fundraising, is not in place for supply chain solutions. The question if an approach of using blockchain in supply chain processes is permitted or not, is not posed by regulators. What can be necessary is the legal aspect of privacy, where under rule-makers, clear boundaries get set, which personnel information is allowed to remain visible on the chain and which is not. Scheffer mentions that from the perspective of regulation, only money laundering and data privacy aspects as relevant. Any other regulations explicitly relevant to SC processes are unknown to him.

Ideally, blockchain projects act as suppliers of information proactively and make sure that authorities get familiar and their awareness towards the topic of blockchain rises accordingly. As a first step, this happens through the simple explanation of the correlation between supply chain and blockchain and an emphasis on benefits, features and core competencies of blockchain in connection with the particular supply chain topic. A communication strategy towards rule-makers, which is determined to be open and keen to debate on, saves, on the one hand, some valuable time within the project execution and builds on top of that trustworthiness within an interaction.

6.2.2 Study Propositions Analysis

The propositions which were created by theory building get analyzed in the below sub-chapter. The first proposition, which claims that the use of blockchain technology can trace a flow of goods with a high level of detail, can be affirmed. The Rotharium Food app provides various information levels within a track and trace mechanism. The level of detail can be adequately determined, as entries are immediately written on the block-chain ledger and remain untouched for further checks.

Furthermore, the proposition that blockchain technically ensures a fair distribution of available information amongst participants of the supply chain is answered positively. The case has shown that especially end-customers, who usually are the least informed stakeholder in a supply chain process, enjoy inequitable allocated information. The fact that the information is openly accessible makes it fairly distributed, as whoever is inter-ested can check on entries in the blockchain.

The proposition that blockchain at its current stage of technological development is not a perfect fit to meet the needs of stakeholders can be answered with yes based on the case outcomes. Although the tracing of products works well in terms of facilitation of the application or network speed, further deployment steps are more difficult to realize, as network capacities are not sufficient and features as zero-knowledge proofs, which would enhance data privacy according to GDPR are still not in place. It conducts that the po-tential is existing, but the technology has to come to maturity and keep promising ideas and conditions.

The fourth proposition that blockchain technology is not ready to fully replace legacy systems in the supply chain is true based on the architecture of the Rotharium applica-tion. For a full replacement of legacy systems, the issues with data privacy should get solved first. Moreover, it is not dimensioned and designed to substitute legacy systems in their broad impacts on businesses.

The fifth proposition that governments do not provide sufficient legislation regarding the implementation of blockchain technology can be answered positively. It is more learning for both sides on how to approach technological innovation. The question if an approach of using blockchain in supply chain processes is permitted or not is nothing posed by regulators. Instead of that, they expect a robust, auditable and secure base of datasets to be in the position to check if compliance on legal norms is in place.

6.2.3 Conclusion

The conclusion of this chapter results in a comparison of studies' questions and propo-sitions. The case has shown that from the customers' perspective, blockchain means a win situation, as the level of information, especially for this stakeholder group, is highly enlarged. Nevertheless, producers or retailers also can benefit from being transparent,

as the positioning as a trustful supply chain actor can bring customer loyalty and higher margins through price premiums. A paradigm shift can happen when customers start to see transparency as being without alternatives. It profoundly will affect the process landscape of established industrialized supply chains towards more attention to health and sustainability aspects.

Still, all the potential remains unused as technological development is still not sufficient to make use of the potentials. Scalability and transaction costs improvements are crucial for further use cases in the supply chain. The case results mainly cover the theory-based statements, which means that theoretical standpoints are as valid for practical implications.

6.3 Comparison of Cases

6.3.1 Similarities

Very similar results are identified when a comparison on the checks on the validity of theoretical assumptions for both cases gets made. Both cases attest blockchain a fair distribution of available information amongst participants of the supply chain. Furthermore, both cases reveal that blockchain at its current stage of technological development and maturity is not sufficient to be a means of choice for broader shifts in supply chain-related action. Both projects fight with issues of proper data privacy handling with blockchain. The next proposition in common the cases share in the statement that blockchain is not ready to replace legacy systems. Instead of that, its features are praised as an improvement of certain parts of processes along the chain.

The issues caused by the data privacy law BIL and Rotharium solve by saving this type of data on centralized solutions. That means both projects work with workarounds, which lower the level of decentralization. Another similarity is that both blockchain-based digitalization cases want to lower the use of paper in supply chain processes and enlarge the level of digital device usage in the operational supply chain. The outcomes of both cases exhibit that the use of blockchain fosters a system harmonization and sets standards, which will not be possible without a mutual base layer, which works as a decentralized database.

6.3.2 Differences

The two cases looked at blockchain implementation from two different angles. On the one hand, BIL worked on improvements in internal processes, such as digitalization towards paperless documentation and cost savings, which result out of it. On the other hand, Rotharium tried to include all stakeholders in a holistic track, trace database, and therefore create an equal amount of information. BIL addresses to large actors in the supply chain who fight with issues on low harmonized processes, while Rotharium works on the goods' quality aspect, which customers may recognize in a valuable way.

Both cases profit from blockchain features differently. While for the digitalization use case scalability and speed of transaction is secondary, the track and trace use-case requires high velocity and transaction volume levels. It goes for transparency, where BIL allowed a tailored approach for lowering transparency levels, while Rotharium stands for full equal transparency for every participant of the chain. It goes hand in hand with the approach of a hybrid form of a private blockchain at the e-CMR case and a public blockchain for Rotharium Food application. Moreover, participants of the digitalized waybill project are not keen to check entries for validity that often, as they feel the trust because the systems guarantee it. Hence, participants of Rothariums' track and trace solution are more eager to look up entries on the ledger, because there they find the needed information.

7 CONCLUSION

7.1 Summary

In general, the propositions, which were derived from the theoretical part of the thesis, were validated against the case outcomes from previous chapters. The cases showed conformity with the existing theory on blockchain usage in the supply chain. The ability to answer the research questions was factual. The following subchapters are not merely a restatement of the research outcomes, but more a synthesis of the critical points contributed to theory and practice. The aim is to elaborate on the significance of the findings.

7.2 Theoretical contribution

The contribution to theory contains the following brief answers to the research questions of this thesis.

1. Which business issues can Blockchain solve within the supply chain of companies?

As soon as the limitations of the supply chain come up against unique features of blockchain technology, a potential solution for business issues is possible. Several scholars point out that SC structures need to change towards digital transformation in order to be competitive. The study showed that blockchain acts as a catalyst for digitalization and paves the way for solutions, which solve business issues existing because of too little automatization and manual intervention in processes.

Furthermore, gaps in information, fragmentation of data, insufficient visibility and delays and defaults because of poor scaling are nowadays topics, which occupy supply chain actors. Statements in both case studies confirm this, where especially limitations in data quality through paper-based documentation, missing system harmonization and standardized processes, data inconsistencies and unequal distribution of information are emphasized.

In order to solve the issues mentioned above, the blockchain acts as the bringer of trust through integrated features such as transparency, data immutability and data security. Especially the trust-building process is crucial, as participants within the supply chain often do not know each other. This issue blockchain solves by the fact that participants proactively can check on the validity of data. The usage of blockchain eases the establishment of a full end-to-end process as it functions as a base layer of information. Lastly, the use of blockchain in the supply chain brings incremental paradigm shifts, mainly how actors work and what kinds of emphasis will be required to meet changing stakeholder expectations.

2. *Which limitations does blockchain technology have in the supply chain?*

The limitations of blockchain in the supply chain mainly arise because of missing maturity of the technology. Several issues, such as poor scalability and speed of transactions, make it difficult to use the technology on a larger dimension, especially as the amount of data in complex supply chains is high. Additionally, human involvement allows erroneous data input, resulting in a limitation, which cannot be eradicated by any form of computerization.

Furthermore, both cases showed the fact that data privacy issues cannot be solved within a blockchain solution today, which limits it for usage in the supply chain. Moreover, supply chain actors may want to tailor blockchain features towards lower transparency or more centralized approaches with private blockchains, which is possible but limits the technology far off its possible potentials. Lastly, the confidence in blockchain solutions is expandable, as public opinions on fraudulent activities are a matter of discussion amongst supply chain participants. Here the limitation does not sit on the technological side, but more on a general adaption to technology in a digitally slow-moving supply chain environment.

3. *In which ways are legal regulations considered within possible blockchain implementation?*

For implementations of blockchain, technology in supply chain use cases, there is no specific regulation. Several regulations tackle areas of data privacy, legal recognition of smart contracts, tokenization, payments or the equation of digital documents compared to paperwork. Still, blockchain provides authorities' to have a proactive look into the data on the ledger, including possibilities to audit data properly. That opens the possibility to formulate future legal and administrative frameworks towards an information system, which is sufficient to meet the needs of governmental institutions. As questionable remains, the fact that blockchains core competence of decentralization contradicts governmental supremeness and therefore, an interesting conflict is possible.

Both literature and cases showed that in terms of understanding technology, regulators are ill-equipped. Therefore, in particular, pointed regulation and directives are challenging to articulate. That could be another reason why regulation is not at all or very poorly formulated.

7.3 Implications for relevant stakeholders

For readers who want to implement blockchain solutions in the field of the supply chain or are affected by any of the limitations of today's supply chain, the following implications can be of concern.

General:

- Blockchain is not an All-in-One solution for every issue in the SC, but features of blockchain should meet limitations of the supply chain.
- Larger roll-outs of blockchain projects in the supply chain require proper estimations if the network can handle the data flows and whether transactions must happen in real-time or not.
- The handling of private data issues happens, preferably on centralized databases.
- Regulation is more about legal issues on digitalization than on blockchain in particular.

Producers:

- Possibility to highlight competitive advantage with a focus on goods flow transparency.
- Adoption of Blockchain in the supply chain urges for higher quality standards of goods.
- The more trustworthy the product is, the easier it is to claim price premiums.

Logisticians/Carriers:

- Smart Contracts prevent human errors and save human capital, although legal obligations outstanding.
- Blockchain-based digitalization of data processing, by running own nodes results in cost savings and risk mitigation.
- Blockchain enables the establishment of new business models, such as transport platforms.

Customers:

- Blockchain enlarges customers' amount of information and gives possibilities to scrutinize supply chain procedures.
- Customers enjoy in future integrated tracking and payment solutions.
- Marketplace structure enables to trade without third party involvement, for example, supply and demand for solar energy or electricity.

7.4 Limitations

The midpoint of this thesis built the two case studies based on the framework by Yin (2014). Here may be some possible limitations, as the results of the cases are not representative of some population. Therefore, the cases' findings and outcomes cannot be generalized to all blockchain implementations in the supply chain. The interviews, which were the basis of the case study evidence, could have brought disadvantages such as subconscious bias, inaccurate articulation and poor recall.

Furthermore, the findings of this study have to be seen in light of some limitations of time. The COVID19 pandemic restrictions led to a lower number of interviews than initially planned. Still, the number of interviews was enough to be able to make clear statements and implications. Additionally, one of the most significant advantages of a case study approach, described by Ary et al. (1972) as the possibility to understand subjects and participants in the totality of the environment, where the immediate actions, emotions and thoughts can be probed, was diminished, because of no investigation on the field as possible.

7.5 Future research

The thesis analysis shows that practical cases can thoroughly explain the theory of blockchain implementation. The reason could be that existing literature on the topic is very new, as the topic itself. Many authors deal with blockchain implementation in various fields of use. Therefore ideas, statements and correlations worthy of empirical checking come up for discussion. However, more research is a need in order to recognize the impact factors why blockchain is a possibility to enhance supply chain processes from the view of more differentiates participants of the SC.

Furthermore, the study demonstrates that after blockchain is mature enough to prove the promised potential, further research should investigate the questions of whether the potential is fully used, given better technological circumstances. Moreover, additional study is interesting, as soon as blockchain as technology emerges from its first use case of currencies, as nowadays this blurs the view on the opportunities of the technology, same as mainstream opinions.

Additionally, some quantitative research is an asset when it comes to a full-pictured approach. It would be a matter of interest how many supply chain stakeholders would participate using blockchain solutions, how the use of mobile applications would affect this number and similar.

Lastly, the topic of blockchain regulatory was not that fruitful in a context with the supply chain. Future research could either concentrate on this field in the particular use case of finance and currencies, where it carries weight or confine oneself on investigating on it on a lower scale.

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APPENDICES

Appendix 1: Interview guiding principle (German)

Original Language of the interview conducted: german

1. Welche Bedeutung hat Blockchain Technologie für Ihr Unternehmen? Sehen Sie Blockchain als Ergänzung zu bestehenden Systemen oder als völlige Disruption?
2. Was möchte Cryptofuture als Unternehmen im Blockchainbereich bzw. Rotharium als Produkt erreichen? Was ist dabei ihre konkrete Rolle?
3. Was sind die Herausforderungen dabei und wie werden diese gemeistert?
4. Was funktioniert dabei gut?
5. Was sind die großen Stärken der Blockchain für potentielle Anwendungen in der Supply Chain?
6. Warum eignet sich die Blockchain zur Verbesserung der Supply Chain? Welche Schwächen der Supply Chain werden durch Blockchainanwendung korrigiert?
7. Welche Verbesserungen bringt Rotharium als Produkt potentiellen Anwendern in der Supply Chain? Was ist konkret der USP von Rotharium?
8. Sind die Vorteile welche das Rotharium Geschäftsmodell bringt auch auf ähnliche in der Supply Chain befindliche Problemstellungen anzuwenden?
9. Wo hat Rotharium als Produkt noch Verbesserungspotential?
10. Welche Relevanz haben Ethereum Updates auf die Funktionalität von Rotharium?
11. Welche Lessons-Learned haben Sie wenn Sie heute auf das Projekt blicken?
12. Welche Maßnahmen werden gesetzt um den Bedarf potentieller Kunden nach Blockchain Technologie in der Supply Chain zu eruieren?
13. Gibt es aus Ihrer Sicht Elemente der Blockchain Technologie, welche sich negativ auf Supply Chain Prozesse auswirken?
14. In welcher Form gibt es Zusammenarbeit mit Behörden? Gab es Probleme bei dieser?
15. Fühlen Sie sich bezüglich Regulatorien ausreichend informiert? Falls nicht, erläutern Sie bitte den Verbesserungsbedarf.
16. Welche Risiken bei Implementierungen von Blockchain Technologie bestehen aufgrund des bestehender gesetzlicher Regelungen?
17. Wie sichert sich das Unternehmen gegen solche Risiken ab?

Appendix 2: Interview guiding principle (English)

Translation of Appendix 1 in English:

1. Which relevance has blockchain technology for your company? Do you see blockchain as an addition to existing systems or as complete disruption?
2. What does Cryptofuture as a company want to achieve, what respectively Rotharium wants to accomplish as a product? What is thereby your role?
3. What are the challenges in the project and how are these mastered?
4. What works well here?
5. What are the biggest strengths of blockchain technology for potential utilization in the supply chain?
6. Why does blockchain qualify to improve the supply chain? Which weaknesses of the supply chain were reduced through blockchain usage?
7. Which improvements bring Rotharium Food as a product to potential users in the supply chain? What is its concrete USP?
8. Are the benefits of the Rotharium Use Case applicable for similarly business models and problem formulations?
9. Where Rotharium, as a product, has the potential for improvement?
10. What relevance Ethereum updates have on the functionality of the business application?
11. Which Lessons-Learned do you have when looking back at the implementation and Go-Live of the product?
12. Which measures were set to determine a need from a potential customer for blockchain technology in the supply chain?
13. Are there from your point of view elements of blockchain technology, which are negative effects on supply chain processes?
14. In what way is there a collaboration with authorities? Is collaboration problematic?
15. Do you feel sufficiently informed about regulatory guidelines? If not, please outline possible improvements.
16. Which risks while blockchain implementation persists because of existing legal requirements?
17. How does the company mitigate these risks?

Appendix 3: Case Data collection schedule 'Blockchaininitiative Logistik.'

Type of Data	Name, Role	Date, Time, Length
Interview 1 at WALTER Group (Logistics)	Matthias Leibetseder, Innovation Manager of the logistics company Walter Group	08.04.2020 via Skype, Start: 3 p.m., Length: 45 minutes
Interview 2 at EY (Consultancy)	Michael Schramm, Leader of EY Blockchain Competence Center (project initiator)	16.04.2020 via Skype, Start: 11 a.m., Length: 50 minutes
Interview 3 at Bundesvereinigung Logistik Österreich (external)	Gerald Gregori, Vice president of BVL and external logistics consultant	24.04.2020 via Skype, Start: 2 p.m., Length: 20 minutes
Interview 4 at EY (Consultancy)	Andrea Plöchl-Krejci, Head of Logistics Transformation	29.04.2020 via Skype, Start: 11 a.m., Length: 35 minutes
Document	PowerPoint Presentation	
Document	Internal Memo	
Document	Letter of intent	

Appendix 4: Case Data collection schedule 'Rotharium'

Type of Data	**Name, Role**	**Date, Time, Length**
Interview 1 at Crypto Future GmbH (IT Consultancy)	Tomislav Matic, CEO and Founder of Cryptofuture GmbH	09.04.2020 via Skype, Start: 11 a.m., Length: 45 minutes
Interview 2 at Crypto Future GmbH (IT Consultancy)	Zsolt Scheffer, Blockchain Analyst at Cryptofuture GmbH	13.05.2020 via Skype, Start: 1 p.m., Lengh: 25 minutes
Interview 3 at AURA Delikatessen (Retail)	Martin Juric, Owner of AURA Delikatessen	14.05.2020 in Person, Start: 2 p.m., Lengh: 20 minutes
Observation	Product Testing	
Document	Whitepaper	
Document	Meeting Minutes	
Document	Product Video	